TAXONOMIC STUDIES ON THE GENUS SALVIA L. (LABIATAE) IN CENTRAL ANATOLIA, TURKEY

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Approval of the thesis;

TAXONOMIC STUDIES ON THE GENUS SALVIA L. (LABIATAE) IN CENTRAL ANATOLIA, TURKEY

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Signature :
This research study is a revision of the genus *Salvia* (Labiatae) in Central Anatolia. The author has carried out extensive research studies conducted in a 3 year period starting from June 2005 by collecting specimens from all the localities in Central Anatolia, Turkey. Specimens collected from Turkey by the other researchers and kept either in Turkey or abroad were also examined.

The samples were studied using their root, stem and leaf morphology including essential characteristics of flowers. Using this information dendograms were obtained and taxa cut off lines were drawn. The cross sectional preparations of stem and leaf were observed for taxonomical evaluation. *Salvia* taxa leaf surface, flower organs and seed surface were studied for understanding the diagnostic value of their micro morphological characteristics. Anatomical sections of the specimens were analyzed under light microscope and the data was used for further taxa separations.

The *Salvia* species were further investigated for their pollen characteristics such as surface view and dimensions. Numeric taxonomic methods were used for constructing a natural infrageneric grouping in the genus as far as the species allows. Using software and computer grouping each sample was ranked and placed into specific taxa.
First the samples were identified by using the species key given in Turkish Flora. According to the Turkish Flora there were two ways to identify samples. One way based on the stamen features and the other based on the leaves and flowers. For nomenclatural reasons the specimens were cross checked with the existing type specimens known from Turkey and kept in some international herbaria.

This thesis is formed by two sections. The first section is comprised of introduction, materials and methods and basic findings. Basic finding are the result of morphological, anatomical, palynological and ecological investigations. In the second section of the thesis, a revision of *Salvia* in Central Anatolia, Turkey is given. This includes results of numeric studies and infrageneric grouping.

Soil types and habitat characteristics were also studied. Soil samples were taken from the various locations and analyzed for their content. The populations were revisited to determine the sustainability and vulnerability of each taxon. IUCN threat categories were determined based on habitat information and species limitations. The phenological data and relevant field observations were all recorded.

In Central Anatolia 43 *Salvia* species were found. Among the specimens collected from the area one taxon was re-discovered after 116 years.

Key Words: Labiatae, *Salvia*, Revision, Turkey.
ÖZ

İÇ ANADOLU BÖLGESİ’NDE BULUNAN SALVIA L. TÜRLERİNİN
TAKSONOMİK ÇALIŞMALARI

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Tez Yöneticisi: Prof. Dr. Musa Doğan

Haziran 2010, 203 sayfa


Çalışılan türlerin polen özellikleri ve yüzey mikromorfolojileri ayrıntılı olarak çalışılmıştır. Belirlenmiş türler kullanılarak cinsîçi doğal sınıflandırmanın yapılabilmesi için numerik taksonomik metodlar kullanılmıştır. Her bir örnek bilgisayar ve yazılım kullanılarak özel bir takson olarak atanmıştır.


Toprak tipleri ve habitat özellikleride incelenmiştir. Toprak örnekleri çeşitli lokalitelerden alınmış ve bunların içeriği analiz edilmiştir. Popülasyonlar her bir taksonun sürdürülebilirlik ve duyarlığını belirlemek için tekrar ziyaret edilmiştir. Habitat bilgilerine ve tür limitlerine dayalı olarak IUCN tehlike kategorileri belirlenmiştir. Fenolojik veriler ve bilimsel arazi gözlemlerinin tümü kaydedilmiştir.


Anahtar Kelimeler: Labiatae, Salvia, Revizyon, Türkiye.
To my wife Dawn and my three sons: Daniel, Michael and Andrew.
ACKNOWLEDGMENTS

I would like to thank my supervisor Prof. Dr. Musa Doğan for his guidance and professionalism. I appreciate the time he invested in this study and thesis. I especially enjoyed our field research trips.

I also would like to thank my thesis jury and my thesis committee for their suggestions and constructive criticism.

I appreciate my co-workers for keeping this “yaramaz yabancı” out of trouble. Ferhat Celep, Ahmet Kahraman, Evren Cabi and Ozlem Mavi.

I also respectfully acknowledge The Scientific and Technical Research Council of Turkey (TUBITAK – TBAG – 104 T 450) for their financial assistance and also the Curators of the following Herbaria: AEF, ANK, B, BM, E, G, GAZI, HUB, ISTE, ISTF, K, KNYA and W for their assistance in the study of their specimens.

Because Prof. Dr. Gönül Tankut inspired me to continue my education at METU a new subspecies is named in her honour.

Most of all my wife deserves credit for taking care of our sons during my summer research trips.
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ABBRIVIATIONS

ANK : Ankara Üniversitesi Fen Fakültesi Herbaryumu  
c. : Approximately  
CR : Critically endangered  
Da. : Dağı-mountain  
E : Edinburgh Herbaryumu (Edinburgh, Scotland)  
EGE : Ege Üniversitesi Fen Fakültesi Herbaryumu  
EN : Endangered  
Fig. : Figure  
G : Genève Herbaryumu  
GAZI : Gazi Üniversitesi Fen Fakültesi Herbaryumu  
Holo. : Holotype  
HUB : Hacettepe Üniversitesi Fen Fakültesi Herbaryumu  
Ic. : Ikona (Figure)  
ISTE : İstanbul Üniversitesi Eczacılık Fakültesi Herbaryumu  
ISTF : İstanbul Üniversitesi Fen Fakültesi Herbaryumu  
IUCN : International Union for Conservation of Nature  
KNYA : Selçuk Üniversitesi Fen Fakültesi Herbaryumu  
LC : Least Concern  
NT : Near Threatened  
Subsp. : Subspecies  
Syn. : Synonym  
UPGMA: Un-weighted Pair Group Method with Arithmetic mean  
VAN : Yüzüncüylü Üniversitesi Fen Fakültesi Herbaryumu  
var. : Variety  
VU : Vulnerable
CHAPTER 1

INTRODUCTION

1.1 Historical background

CIVILIZATION rose to two great heights in Southwest Asia, namely in the Bronze Age and in the later Classical period. In the latter medicine advanced considerably and culminated in the work of Hippocrates. Knowledge of medicine in the Greek Bronze age depended on the study of Homer until this century, when work in the fields of archaeology and philology provided more facts. This work has shown that this early Greek medicine had much in common with that of its contemporary Near Eastern civilizations. During this period medicine was taken to a much higher level than that practiced in Egypt. Discovery of tablets from this period indicate a long list of plants. The plants were named in palace records and were described by dry volume and weight. The following plant names have been identified on the tablets: celery, coriander, cumin, cyperus grass, fennel, figs, garden grass, ginger grass, iris root, linseed, mint, pennyroyal, rose, safflower, sage and sesame. The mention of sage in this list emphasizes the importance of it as far as 1500 B.C. (Warren, 1970).

The genus Salvia (sage) has been an important medicinal plant since earliest times. This is an herb that has the reputation as one which wards off evil. It was thought to be efficacious against the biting of serpents and the dispelling of evil spirits [Ceres, 1984]. It was employed in ancient Egypt to increase the fertility of women [Schauenberg and
Theophrastus records two taxa of *Salvia*, one a spineless wild under shrub whose name he gives as Joakos (sphakos), the other resembling it, but cultivated, called (elelisphakos) [Theophrastus]. Pliny says that elelisphakos called *Salvia* by the Romans, is a mint-like, hoary and aromatic plant. It was cultivated more than sphakos of Theophrastus, and was used as a diuretic, for promoting menstruation, as a local anesthetic (numbing the surface of the skin where it is applied), and when taken in drink with wormwood, a treatment for dysentery [Pliny]. Monastery gardens in the time of the Carolingian empire of the early Middle Ages were cultivating the plant. Walahfrid Strabao, in his Hortulus, describes it as having a sweet scent and being of proved value in many human ailments. He goes back to the Greek root for the name he gives it, Lelifagus [Strabao]. There can be little doubt that, from the time of Theophrastus and Pliny on, the *salvia* cultivated under these different names is *Salvia officinalis* (Dweck, 2000).

More recent scientists site *Salvia* species as being used in medicines all around the world, possessing antibacterial, antioxidant, antidiabetic and antitumor properties (Senol et al., 2010; Ulubelen, 2003). In addition, many *Salvia* species are used as herbal tea and food flavoring, as well as in cosmetics, perfumery and the pharmaceutical industry (Demirci et al., 2003). They are also grown in parks and gardens as ornamental plants (Nakipoğlu, 1993).

Anatolia is a major center for the genus in Asia. Some species are native to the Mediterranean region while also cultivated all over the world. Dried leaves and flowers are used as a culinary spice for flavoring and seasoning and tea. In Western countries, essential oils from some species are used for the treatment of various diseases. The name *Salvia* came from the Latin word meaning “to save” or “to heal.” A few centuries ago, it was nearly always at the top of the list of household remedies for the relief of itching, the lowering of fevers, and the relief of nervous headaches. Extracts and essential oil have been used to treat digestive disorders and to control excessive sweating (Duke, 1985). Additionally some extract are reported to be strong antioxidant (Chang et al.,
The chemical components of *Salvia* species are very complex. Flavonoids from *Salvia* are useful for taxonomy (Nakipoğlu, 2002).

Turkey is an exporter of *Salvia* (*Salvia fruticosa*) leaves. *Salvia* is collected from the wild in western Turkey, dried and exported. There is also a sizeable internal market for *Salvia* leaves, since they are used as herbal tea in western and southern provinces of Turkey. *Salvia* leaf exports of Turkey (kg/US$/unit value in dollars) are as follows:

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<td>508.646</td>
<td>563.863</td>
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<td>400.220</td>
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<td>1,096.145</td>
<td>1,118.746</td>
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<td>2.160</td>
<td>1.980</td>
<td>2.370</td>
<td>2.090</td>
<td>2.050</td>
<td>2.170</td>
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In Turkey, *Salvia* oil is produced from *S. fruticosa* (wild) in Manisa and Alanya by steam distillation using commercial stills. The oil also known as elma yagi (apple oil) is obtained using cottage-type stills in South-Aegean parts of Turkey. In some districts, the plant is locally known as “elma” (apple) due to the resemblance of galls growing on its leaves and stems to small apples. *Salvia* oil is locally used medicinally as herbal oil. Annual production is an estimated 500 kg (Baser, 1994).

### 1.2 Literature review

Lamiaceae or Labiatae, also known as the mint family, is a family of plants comprising about 210 genera and some 3,500 species. The plants are frequently aromatic in all parts and include many widely used culinary herbs, such as basil, mint, rosemary, *Salvia*, savory, marjoram, oregano, thyme, lavender, and perilla. Some are shrubs, but rarely trees or vines. The original family name is Labiatae, so given because the flowers typically have petals fused into an upper lip and a lower lip. Although this is still considered an acceptable alternate name, most botanists now use the name "Lamiaceae" in referring to this family.
Briquet’s (1895-1897) classification of Labiatae, currently the most widely used system for the family, was heavily influenced by and has largely displaced Bentham’s (1876) classification, with which it differs mainly in ranking and interrelationship of suprageneric groups rather than the content of those groups (Table 1.2). Briquet’s most significant alteration of Bentham’s system was the merging of four tribes Lamieae, Nepeteae, Salvieae and Mentheae in one subfamily Lamioideae which should not have been made. Briquet’s transfer of Rosmarinus from Bentham’s Salvieae to his own Ajugoideae was a mistake; Rosmarinus has hexacolpate pollen and was thus better placed in Salvieae. Bentham’s classification is highly congruent with Erdtman’s subfamilial system. By and large, Bentham’s tribe Ajugeae, Prostantheroideae, Prasieae, and Lamieae correspond to Erdtman’s Subfam. Lamioideae, while Bentham’s other four tribes correspond to subfam. Nepetoideae. The most recent and the best classification (Erdtman, 1945) includes subfamily Nepetoideae which comprises the taxa of Salvia (Cantino, 1986).

**Table 1.2.** Comparison of classification of Bentham (1876), Briquet (1895-1897), and Erdtman (1945).

<table>
<thead>
<tr>
<th>Bentham</th>
<th>Briquet</th>
<th>Erdtman</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tribe Ajugeae</td>
<td>Subfam. Ajugoideae (including Rosmarinus)</td>
<td>Subfam. Lamioideae</td>
</tr>
<tr>
<td>Tribe prostantheroideae</td>
<td>Subfam. prostantheroideae</td>
<td></td>
</tr>
<tr>
<td>Tribe prasieae</td>
<td>Subfam. Prasioideae</td>
<td></td>
</tr>
<tr>
<td>Tribe Lamieae</td>
<td>Subfam. Lamioideae</td>
<td>Subfam. Nepetoideae</td>
</tr>
<tr>
<td>Tribe Nepeteae</td>
<td>Subfam. Ocimoideae (including Subfam. Lavanduloideae and Subfam. Catopherioideae)</td>
<td></td>
</tr>
<tr>
<td>Tribe Salvieae (including Rosmarinus)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Tribe Mentheae</td>
<td>Subfam. Ocimoideae (including Subfam. Lavanduloideae and Subfam. Catopherioideae)</td>
<td></td>
</tr>
</tbody>
</table>

Salvia L. belongs to the subfamily Nepetoideae within the Labiatae, a monophyletic group well supported by both molecular and morphological data (Claben-Bockhoff et al. 2004). Salvia is a fascinating plant genus. One of the widest-spread members of the Labiatae family. The genus Salvia represents an enormous and cosmopolitan assemblage
of nearly 1000 species displaying a remarkable range of variation. *Salvia* 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.) Bentham’s (1848) study of Salvia separated the genus into 12 sections and remains the most widely accepted treatment of Salvia (Walker, 2004).

According to the most recent edition of the Turkish Flora there are 86 *Salvia* species in Turkey (Hedge 1982a) and later the number of species was raised to 89 (Davis et al., 1988; Guner, 2000; Vural & Adiguzel, 1996; Dönmez, 2001). About 50% of the species residents of Central Anatolia and of these 26 are endemic to this area. The distribution in neighboring countries or “Flora areas” is as follows: 75 species in the former USSR (Pobedimova, 1954), 70 in the *Flora Iranica* (Hedge, 1982b), 36 in Europe (Hedge, 1972).

It is assumed that *Salvia* originated in the Old World, from an ancient Mediterranean ancestral species. Member species might have migrated during the Miocene and Pliocene via tropical mountains to South America and South Africa. Fossils from Mexico and Alaska date from the Lower and Upper Miocene and thus indicate an age of at least 25 million years (Claben-Bockhoff et. al., 2004). There are seven important distribution areas for the genus in the world (Map 1.1). Anatolia is a major centre for *Salvia* in Asia.
Taxonomy of *Salvia* at the present time has many inconsistencies. It is becoming increasingly difficult to recognize above species groups from each other (according to the most recent edition of the flora of Turkey, Hedge, 1982a). Because of the interest in the medicinal activity of this genus to date the majority of the research is directed toward this area (Ulubelen A., 2003). Therefore, what gives importance to *Salvia* has distracted many from directing research into the most important aspect of any plant and that is its proper taxonomy. Additionally there are inconsistencies in literature about the total number of species and their rate of endemism. At the present time there are no sectional divisions prepared for *Salvia* in Turkey.

Therefore, we prepare a more detailed taxonomic study based both on morphology and micro-morphology. The aim of this project is to produce a complete revision of the genus *Salvia* in Central Anatolia, Turkey.

Boissier (1875), in his *Flora Orientalis*, recognized 107 species of *Salvia*; some of which were either described or recorded from Turkey. He placed these species under seven sections, which had been all recognized previously by Bentham (1833). These sections are as follows: *Eusphace, Hymenosphace, Drymosphace, Aethiopis, Plethiosphace, Horminum* and *Hemisphace*. Section *Eusphace* was later designated as

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**Map 1.1. Salvia distribution worldwide.**
the type section of the genus *Salvia* (Hedge, 1972; Reales et al., 2004). Section *Drymosphace* Benth is absent in the Central Anatolia.

The first revision of *Salvia* L. in Turkey was made by Hedge (1982a) in *Flora of Turkey and the East Aegean Islands* vol. 7. Additional to the same were supplements 10 (Davis et al., 1988) and 11 (Guner et al., 2000) in which 88 species in total were recognized. Since the publication of the flora and the supplements, 5 more new taxa, *S. hedgeana* (Dönmez, 2001) and *S. anatolica* (Hamzaoğlu & Duran, 2005), *S. marashica* (İlçim et al., 2009), *S. ekimiana* (Celep & Doğan, 2009) and *S. sericeotomentosa* (Celep et al., 2009), and 3 new records, namely *S. macrosiphon* Boiss. (Kahraman et al., 2009) and *S. aristata* Aucher ex Benth. (Behçet & Avlamaz, 2009) and *Salvia viscosa* Jacq. (Celep et al., 2009) have been recorded. The total at present is 95 species.

### 1.3 The study area

There are three major phytogeographical regions in Turkey: Euro-Siberian, Mediterranean and Irano-Turanian. Central Anatolia, part of the Irano-Turanian phytogeographical region is the most isolated section of Turkey. It contains over 50% of the endemic taxa of *Salvia* in Turkey. This region stretches inland from the Aegean; it occupies the area between the two zones of folded mountains: the Sultan and the Sundukan mountains on the west-northwest and the Taurus Mountains on the south. It extends east to the point where the two mountain ranges converge. The Central Anatolian region occupies 19% of the total area of Turkey with its 151,000 square kilometers of land; it's the second largest region of Turkey after Eastern Anatolia.

The plateau-like, arid highlands of Anatolia are considered the heartland of the country. The region varies in altitude from 300 to 3,900 meters west to east, predominately about 900 meters in elevation. The two largest vegetational areas are the peripheral areas of deciduous scrubs which represents the originally forested areas and the treeless basin occupied by Tuz Gölü (Salt Lake). This unique region of the Central Anatolian basin is
composed of salt steppe, saline lakes and halophytic vegetation as well as marshes, rivers and freshwater bodies (Davis, 1965).

This study was conducted in Central Anatolia, Turkey where the most abundant gypsum areas are present. Gypsum areas occupy 0.5% of Turkey. The largest fraction of gypsum is present within the Sivas province. The rate of endemism in the Sivas area is high due to the presence of gypsum habitats. The chief advantage of gypsum for \textit{Salvia} is perhaps reduced moisture stress during the early summer drought. This is due either to reduced competition for water because of low densities or to intrinsic properties of the gypsum soil (Akpulat, 2005). Habitat and soil development are also dependent on temperature and precipitation, both of which require long-term study (Doğan, 2003). Such studies have been done by many authors (Akman and Ketenoğlu, 1976; Cetik, 1985; Ketenoğlu et al., 1983, 1996, 2000). The northern part of the Central Anatolia area is well studied by Doğan(2003) and he finds the northern part as receiving lower amount of precipitation than the southern area, but since the area has colder climate it has lower annual actual evaporation. The most critical period suggested by Doğan (2003) for the studied area was during the month of May and September. During this period evaporation exceeds precipitation resulting in critical water deficiencies.

For ecological studies, soil samples were taken from suitable habitats of \textit{Salvia}. All soil samples were analyzed at the Soil, Fertilizer and Water Resources Central Research Institute, Ankara. Soil texture, organic matter, total salt, pH, CaCO$_3$, P and K analysis were made using standard techniques (Bayraklı, 1987) and the results have been evaluated according to Kaçar (1972).
1.4 Objectives and Scope of the study

The objectives of this study were to:

a) To collect all of *Salvia* taxa growing in Central Anatolia so as to prepare a taxonomic revision of it.

b) To classify the *Salvia* species by means of using numeric taxonomic methods.

c) To study ecological preferences of the taxa.

d) To determine the conservation status of *Salvia* taxa on the basis of IUCN threat categories.

e) To understand morphological, palynological, phytogeographical and anatomical diagnostic characteristic of the taxa.

f) To determine significance of the micro-morphological properties of pollens.

g) To prepare a revision of *Salvia* found in Central Anatolia.
CHAPTER 2

MATERIALS AND METHODS

2.1 Sampling Methodology

The Central Anatolia area was divided into grids according to Davis’s grid system. The Flora location information was entered into excel file and each grid was identified for its existing species richness. In general, limestone and igneous slopes and or quercus and calcareous rocky areas are preferred by taxa of *Salvia*. Therefore, it was decided to concentrate sampling to these areas and repeat sampling at different times of year. Flowering times of the flora was also incorporated into the sampling plan. Sampling time was began in March and ended in August. During the field trips samples were carefully labeled and numbered. The location information and field identifications were recorded in the field notebook. This included GPS information for each sampling site. Digital photographs were taken to be used later in identifying the specimens. The samples were pressed, dried, brought to the lab, and kept in a safe area (Davis & Heywood, 1973). They were identified using the species key given in the Flora (Hedge, 1982a). According to the Flora there were two ways to identify samples. One was based on stamen features and the other was based mostly on leaves and flowers. They were cross-checked with the *Salvia* accounts of various relevant floras, such as Flora Orientalis (Boissier, 1879), Flora Iranica (Hedge, 1982b), Flora of the USSR (Pobedimova, 1954) and Flora Europaea (Hedge, 1972). The samples were also compared with the samples in existing herbaria; Ankara (ANK), Gazi (GAZI) and
Istanbul (ISTE). International collections deposited at the University of California at Riverside, CA, United States and Edinburgh (E) were also consulted.

2.2 Morphological and Anatomical Methods

The samples were studied using their stem and leaf morphology including essential characteristics of their flowers and reproductive organs. The cross sectional preparations of stem and leaf were observed for taxonomical evaluation (Metcalfe & Chalk, 1950). The *Salvia* taxa leaf surfaces, flower organs and seed surfaces were studied for their micro morphological characteristics. Using statistical analysis, histograms were prepared and the position of each taxa was determined (Doğan, 1982). Cross sectional specimens were also studied under electron microscope. The *Salvia* species were further investigated for their pollen characteristics such as surface and diameter. Finally numeric taxonomic methods were used for constructing a natural infrageneric grouping in the genus. This includes character selection followed by measurements. Using software and computer grouping each sample was ranked and placed into specific groups (Sneath & Sokal, 1973).

Anatomical studies were carried out on the specimens kept in 70% alcohol. The paraffin method was used for the cross sections of the leaves and stems. The specimens were embedded in paraffin and then sectioned (10-15 um thickness) with a Leica RM2125RT rotary microtome. All sections were stained with safranin-fast green and mounted with entellan. Measurements and photos were taken using a Leica DM1000 binocular light microscope with a Leica DFC280 camera.

Nutlets were first examined using a Leica S8AP0 stereomicroscope to ensure that they were of normal size and maturity. In order to determine the average seed sizes, mature nutlets were measured. For SEM, the mature nutlets were placed on stubs directly and covered with gold. After that, they were observed and photographed with a JEOL JSM-6400 scanning electron microscope (Dogan 1988).
2.3 Palynological Methods

Pollen materials were obtained from plant specimens collected in the field during the flowering time in the years 2005, 2006, 2007, 2008. Pollen grains for examination by LM were prepared according to the Wodehouse (1935) method. Pollen grains were dissected from herbarium specimens and placed on a clean microscope slide. Two to three drops of 96% ethanol were added to melt the resin and oil. Glycerin-jelly with basic fuchsine was placed on pollen grains and allowed to melt. The pollen grains and jelly were mixed by a clean pin to get scattered pollen grains. The pollen grains were photographed from a permanent slide with an Olympus BX51 camera. All measurements were determined on thirty pollen grains. The terminology of the exine sculpturing and structure follows mainly that of Henderson et al. (1968), Faegri–Iversen (1984) and Punt et al. (2007).

Pollen slides for morphologic examination by light microscopy were prepared (Wodehouse, 1935) and the measurements were made with a Leica DM1000 microscope. The measurements corresponding to the polar length (P) and equatorial length (E) of pollen grains were taken, and P/E ratios were calculated. Colpus length, exine thickness and intine thickness were measured. For studying pollen ornamentation, dry pollen grains were first mounted on double-sided carbon tape affixed to aluminum stubs. Grains were coated with gold using a Bio-Rad Polaron Division coating system and observations were made using a Jeol JSM-6490LV Scanning Electron Microscope (SEM) at the Turkish Petroleum Corporation (TPAO). SEM images were used to describe surface texture of the pollen, the calyx, inflorescence indumentum and nutlet. The descriptive terminology of Faegri and Iverson (1975) was followed.

For SEM studies, pollen grains were transferred directly to a stub with double-sided tape and micrographs were obtained using Jeol-6060 SEM (at Gazi University) and Jeol JSM-6400 SEM (at Middle East Technical University), at an accelerating voltage of 20 KV. The measurements on the base of SEM photomicrographs were recorded.
2.4 Methods used for Numeric Taxonomy

There were at least five steps in phonetic classification that results in numeric taxonomy (Stuessy, 1990). The first step was the selection of operational taxonomic units (OTU), followed by the selection of characters. Measurements and/or description of character states were made on the herbarium specimens. The data obtained from the herbarium materials were averaged and tabulated. The data matrix resulting from the morphometric study, composed by 41 rows (species) and 53 columns (characters) (Table 4.2), was constructed prior to multivariate analyses. Multiple correspondence analyses were used to obtain a single phenogram, applying UPGMA (the unweighted pair-group method using arithmetic averages) algorithm and the Gower General Similarity Coefficient. A similarity matrix was created first, using the Gower General Similarity Coefficient which can handle binary, multistate, and quantitative data equally well (Sneath and Sokal, 1973). These similarity values were then clustered by UPGMA and the results are shown in the phenogram. UPGMA is the most frequently used clustering method (Rosemburg, 1984) and also appears to produce the best results (Radford, 1986). For these analyses, the MVSP (a multivariate statistics package for PC and compatibles) program package for clustering analysis was applied.
CHAPTER 3

BASIC FINDINGS

3.1 Morphological information

Leaf, calyx and corolla observation and measurement results were recorded (Table 4.2) and used in numeric taxonomy evaluation. Leaves are opposite in all taxa of *Salvia* and vary in shape and size from one part of a plant to another. Because of this variation the most mature and most common forms are used as a general description tool. Due to wide variation in leaf shape, there has been a great deal of taxonomic confusion over the years. The variation in leaf depends on geographical area. Plants growing on the south and western part of Turkey usually have smaller leaves while plants growing on the north and eastern side of Turkey have much bigger leaves. Leaf variations are many, from narrowly oblong leaves of *S. Russelli* and *S. hypargeia* to almost rounded leaves of *S. Candidissima* and *S. cyanescens*. Many taxa of *Salvia* have pinnate leaves. Pinnate leaf taxa are generally endemic to Turkey. Some examples are *S. hedgeana*, *S. wiedemannii*, *S. freyniana*, *S. tchihatcheffii*, *S. heldreichiana* and *S. caespitosa*. Leaf margins are also an important taxonomic characteristic, varying from smooth leaves of *cryptantha* to sharply toothed leaves of *S. virgata*. *S. halophila* has the fleshiest leaf of all *Salvia* taxa. *S. ceratophylla* and *S. longipedicellata* poses the largest leaves.
The calyx shape varies considerably from species to species within *Salvia*: tubular, campanulate and infundibular or a combination of these shapes. In Central Anatolia most calyces are campanulate like: *S. hedgeana, S. freyniana, S. euphratica, S. suffruticosa* and *S. cadmica*. Calyces are either membranous or none. There are only six taxa of *Salvia* with membranous calyx in Central Anatolia. They include: *S. cadmica, S. blepharochlaena, S. euphratica, S. anatolica, S. multicaulis* and *S. cryptantha*.

The calyx is made of two lips (bi-lobate) in *Salvia*. Usually the upper lip is three toothed (tri-dentate) and the lower lip two toothed (bi-dentate). Seldom the upper lips of the calyx are truncate, *S. viridis* and *S. hypargeia*. The upper lip is usually higher than the lower lip. Calyx upper lips of *S. cryptantha* and *S. cadmica* are flat. Calyx variations in *Salvia* are not just due to lips. Other varying points are indumentum and the length of the aristae. Aristae are mostly acuminate (*S. bracteata, S. verbenaca* and *S. viridis*), sometimes acute (*S. tomentosa, S. aytachii* and *S. divaricata*) and rarely spinosa (*S. yosgadensis*). There are four taxa of *Salvia* with no aristae (*S. cryptantha, S. multicaulis, S. cadmica* and *S. blepharochlaena*). Additionally there are color variations from green, blue, and purple. Comparison of the calyx to the size of the bract is also significant in taxonomic differentiation.

Like the calyx, the corolla also is bi-lobates and comes in many shapes and colors. The corolla in *Salvia* is composed of five fused petals, two upper lip and three lower lip. The corolla shape and features are very difficult to see in the dried herbarium specimens. Therefore we noted the size and shape of corolla in fresh materials in the field. In some cases the fresh corollas were photographed to record the exact color of the flowers. The corolla shape is mostly described by the upper lip whether it is straight (most taxa of *Salvia*), or falcate like: *S. eriophora, S. aethiopis* and *S. modesta*. The tube of corolla is characterised by being squamulate or non-squamulate and the presence or absence of short hairs within the tube as being annulate or non-annulate. Corolla of *Salvia* taxa in Central Anatolia are mostly lilac violet to blue, however pink to white, yellow to yellowish white and cream colored are also noticed. Finally the size of the corolla is a major distinguishing factor in classification. Section *Hymenosphace* all have large corollas.
3.1.1 Indumentum types

*Salvia* has a variety of indumentum from a density and texture viewpoint (El-Gazzar, 1970). The hair on the surface contributes to the gray color of the *Salvia*. Generally *Salvia* indumentum is divided into two types, glandular (Figure 3.1d,e,f) and eglandular (Figure 3.1a,b,c). Glandular trichomes which can be seen with the naked eye are sticky and yellowish orange in color. The indumentum head is normally multicellular (2-10 celled), however a survey of 127 genera of the Labiatae Cantino (1990) found *Salvia* to have mostly four cells. Other authors have reported up to 12 celled indumentum heads (Kahraman et al., 2010). Species maybe glabrous, sparingly hirsute to densely pilose, or tomentos. In some cases there are varieties of hair types within a species. The eglandular hairs on the stem are often in antrose (Figure 3.1a) or retrose (Figure 3.1b) formation. The dendroid hairs look like stars and cover the surface of some *Salvia* like *S. cryptantha*. The pilose hairs sometimes are formed from many cells or multicellular (Figure 3.1c,d,e) and sometimes from a single cell or unicellular (Figure 3.1f).

![Figure 3.1. Indumentum types.](image-url)
The long villous (Figures 3.1g and 3.2a) hair covers the entire leaf or calyx surface of some *Salvia* species however within the same species pilose glandular hairs (Figure 3.2b) can be found.

![SEM of Indumentum types: Villous (a), and glandular pilose (b).](image)

3.1.2 Inflorescence

The inflorescence varies considerably among *Salvia* species. There are two main types recognized based on branching. However at least three forms of branching were noticed. In Central Anatolia there are 17 racemose (unbranched). Examples of racemose are *S. cadmica*, *S. tchihatcheffii*, *S. cryptantha*, and *S. vermifolia*.

The paniculate (branched) taxa of *Salvia* are mostly candelbriform like *S. aethiopis*, *S. ekimiana* and *S. syriaca*. While the *S. divaricata*, *S. recognita* and *S. nemorosa* are paniculate-cymose.

- Racemose (unbranched); with the flowers arranged densely: *S. tchihatcheffii* (Figure 3.3a)
- Paniculate (branched); forming cymose or candelbriform: *S. recognita* (Figure 3.3b)
Figure 3.3. The racemose inflorescence of *S. tchihatcheffii* (a) and the paniculate inflorescence of *S. recognita* (b).

### 3.1.3 Fruit and seed

Nutlet morphology is used in taxa description (Hedge, 1970; Oran, 1996; Kahraman and Doğan, 2009). While the surface sculpturing in *Salvia* species varies as recorded by Oran (1996), there are some common features among them. The fruit of schizocarp divides into four nutlets. The nutlets are ellipsoidal and rounded to somewhat acute at the apex. The seeds are ellipsoidal and flattened longitudinally. At maturity, the seeds contain little or no endosperm. The embryo is straight.

SEM and light microscope were employed to observe the seed surface and other morphological characteristics. The nutlet shape, size and surface sculpturing are the most significant diagnostic characteristics. These observations and measurements are recorded in the infrageneric description of each *Salvia*. The largest seeds belong to the sect. *Hymenosphace* and sect. *Salvia*. The smallest seeds are in sect. *Hemisphace* and sect. *Plethiosphace*. Seed shapes vary from oblong, ovate, spherical, trigonous, suborbicular and ovoid. Observation under 1000x amplification revealed that most *Salvia* seeds are glabrous, however some seeds show, the presence of small hairs. The surface varies from smooth to roughly waved. Below there are SEM photographs of the seeds from the six sections present in the Central Anatolian region: (Figure 3.4 - 3.9).
Figure 3.4. Nutlet shape and surface sculpturing of *S. euphratica* var. *leiocalycina* (Sect. *Hymenosphae*). Nutlets suboblate to rounded trigonous, 4.3-5.4 x 3.5-4.5 mm.

Figure 3.5. Nutlet shape and surface sculpturing of *S. freyniana* (Sect. *Salvia*) Nutlets rounded- trigonous and suboblate, 3.1 – 4 x 2.5 - 3 mm, surface slightly tuberculate.

Figure 3.6. Nutlet shape and surface sculpturing of *S. aethiopis* (Sect. *Aethiopis*) Nutlets rounded trigonous, ovate 3 x 2 mm.
Figure 3.7. Nutlet shape and surface sculpturing of *S. viridis* (Sect. *Horminum*) Nutlets oblong-elliptic, 3 x 1.5 mm.

Figure 3.8. Nutlet shape and surface sculpturing of *S. verticillata* (Sect. *Hemisphace*) Nutlets c. 2.2 x 1.3 mm.

Figure 3.9. Nutlet shape and surface sculpturing of *S. nemorosa* (Sect. *Plethiosphace*) Nutlets rounded trigonous, ± ovoid, c. 2 x 1.5 mm.
3.1.4 Stamens types

The stamen morphology has figured prominently in infrageneric taxonomy of *Salvia* for a long time (Bentham, 1848; Zalewska, 1928). There are two stamens in *Salvia* and are oriented along the dorsal side of the upper lip of the corolla. The stamens are always epipetalous. The relative length of staminal filaments and corolla tube vary from species to species; thus the filaments may be longer than the tube with the anthers clearly exerted or shorter with the anthers completely hidden within the tube.

There are 3 major types of stamens according to Flora of Turkey (Davis, 1965). Others have reported four (El-Gazzar et all, 1968) and as much as five (Walker, 2004) stamen types in *Salvia*. The three types are indicated in the Figure 3.10. While type A stamens have both their upper and lower theca, the lower theca is sterile. Both type B and C only have the upper theca and the lower theca is absent in type C and reduced in type B. The designations a and b in each stamen type indicates the variations within each type. Of the six sections of *Salvia* found in Central Anatolia, two are type A (Sect. *Salvia*, and Sect. *Hymenosphace*); three are type B (Sect. *Aethiopis*, Sect. *Plethiosphace*, and Sect. *Horminum*); and one is type C (Sect. *Hemisphace*).

![Figure 3.10. Salvia species stamen types (Hedge, 1982A) f filament, c connective, db dolabriform sterile tissue.](image-url)
3.1.5 Palynology

The basic shapes of the pollen grains are oblate, spheroidal to prolate (P/E: 0.85-1.09). The outline in polar view is more or less circular while that in equatorial view is circular-ovoid. Pollen grains of the *Salvia* taxa are often hexacolpate: with six equidistant furrows in the exine, radially symmetrical and isopolar. In polar view, two mezocolpia are larger than the other four. Hexacolpate pollen grains have been reported previously in *Salvia* (Trudel & Morton, 1992; Afzal-Rafii, 1983; Henderson et al., 1968)). Colpi are distributed symmetrically and their ends are acute. Colp length (Clg) ranges from 23.95 to 47.33 µm and its membranes are finely or coarsely granular. Mezocolpial area or colpus width (Clt) varies between 3.39 and 8.51 µm (Table 3.1).
Table 3.1. Pollen analysis data. Summary of pollen morphological data for the taxa examined (mean value ± standard deviation in μm). * indicates endemic to Turkey.

<table>
<thead>
<tr>
<th>Taxa</th>
<th>Polar axis (P)</th>
<th>Equatorial axis (E)</th>
<th>Colpus Length Clg</th>
<th>Colpus width (CHt)</th>
<th>Exine thickness</th>
<th>Intine thickness</th>
<th>Apocolpium (t)</th>
</tr>
</thead>
<tbody>
<tr>
<td>S. divaricata *</td>
<td>50.87 ± 7.08</td>
<td>46.76 ± 5.30</td>
<td>44.55 ± 6.84</td>
<td>3.43 ± 0.93</td>
<td>1.12 ± 0.12</td>
<td>0.50 ± 0.03</td>
<td>8.67 ± 0.48</td>
</tr>
<tr>
<td>S. tomentosa</td>
<td>38.62 ± 3.29</td>
<td>44.73 ± 3.61</td>
<td>32.63 ± 3.80</td>
<td>4.72 ± 0.43</td>
<td>1.16 ± 0.14</td>
<td>0.72 ± 0.10</td>
<td></td>
</tr>
<tr>
<td>S. recognita *</td>
<td>46.85 ± 4.14</td>
<td>50.72 ± 6.09</td>
<td>41.48 ± 8.14</td>
<td>5.37 ± 0.61</td>
<td>1.23 ± 0.20</td>
<td>0.65 ± 0.12</td>
<td></td>
</tr>
<tr>
<td>S. bracteata</td>
<td>41.73 ± 1.72</td>
<td>47.77 ± 5.89</td>
<td>34.92 ± 2.20</td>
<td>5.81 ± 2.26</td>
<td>1.42 ± 0.19</td>
<td>0.65 ± 0.12</td>
<td>8.78 ± 0.82</td>
</tr>
<tr>
<td>S. wiedemannii *</td>
<td>43.81 ± 5.84</td>
<td>42.21 ± 3.76</td>
<td>37.29 ± 5.92</td>
<td>4.37 ± 0.72</td>
<td>1.19 ± 0.26</td>
<td>0.63 ± 0.13</td>
<td></td>
</tr>
<tr>
<td>S. freyniana *</td>
<td>42.10 ± 8.87</td>
<td>39.17 ± 6.61</td>
<td>37.38 ± 7.59</td>
<td>4.28 ± 0.85</td>
<td>1.02 ± 0.09</td>
<td>0.62 ± 0.09</td>
<td></td>
</tr>
<tr>
<td>S. tchihatcheffii *</td>
<td>41.56 ± 4.14</td>
<td>40.55 ± 6.89</td>
<td>36.57 ± 5.18</td>
<td>3.39 ± 0.76</td>
<td>1.21 ± 0.20</td>
<td>0.73 ± 0.17</td>
<td></td>
</tr>
<tr>
<td>S. heldreichiana *</td>
<td>49.61 ± 1.83</td>
<td>52.39 ± 4.74</td>
<td>41.16 ± 1.74</td>
<td>4.08 ± 0.52</td>
<td>0.81 ± 0.08</td>
<td>0.68 ± 0.08</td>
<td></td>
</tr>
<tr>
<td>S. caespitosa *</td>
<td>43.95 ± 3.92</td>
<td>49.85 ± 5.40</td>
<td>38.59 ± 3.35</td>
<td>5.27 ± 0.82</td>
<td>1.33 ± 0.15</td>
<td>0.83 ± 0.15</td>
<td></td>
</tr>
<tr>
<td>S. suffraticosa</td>
<td>45.76 ± 4.78</td>
<td>44.01 ± 4.21</td>
<td>38.79 ± 5.21</td>
<td>4.56 ± 1.11</td>
<td>1.22 ± 0.19</td>
<td>0.79 ± 0.17</td>
<td>6.55 ± 1.91</td>
</tr>
<tr>
<td>S. cadmica *</td>
<td>49.36 ± 3.99</td>
<td>51.44 ± 3.82</td>
<td>44.14 ± 3.92</td>
<td>8.20 ± 0.64</td>
<td>1.34 ± 0.12</td>
<td>0.62 ± 0.01</td>
<td></td>
</tr>
<tr>
<td>S. blepharochlaena *</td>
<td>55.71 ± 7.35</td>
<td>58.37 ± 3.88</td>
<td>47.33 ± 6.78</td>
<td>5.98 ± 2.32</td>
<td>1.37 ± 0.13</td>
<td>0.73 ± 0.10</td>
<td>9.84 ± 2.70</td>
</tr>
<tr>
<td>S. euphratica var. euphratica *</td>
<td>54.25 ± 8.68</td>
<td>49.59 ± 6.60</td>
<td>45.17 ± 8.99</td>
<td>3.70 ± 1.13</td>
<td>1.47 ± 0.22</td>
<td>0.68 ± 0.17</td>
<td>8.23 ± 1.98</td>
</tr>
<tr>
<td>S. euphratica var. veiocalycina *</td>
<td>42.73 ± 3.44</td>
<td>39.55 ± 6.84</td>
<td>34.95 ± 2.20</td>
<td>3.84 ± 1.82</td>
<td>1.61 ± 0.19</td>
<td>0.63 ± 0.10</td>
<td>6.32 ± 0.92</td>
</tr>
<tr>
<td>S. multicaulis</td>
<td>41.34 ± 7.81</td>
<td>39.53 ± 5.41</td>
<td>36.00 ± 6.90</td>
<td>4.58 ± 1.15</td>
<td>1.10 ± 0.15</td>
<td>0.68 ± 0.13</td>
<td></td>
</tr>
<tr>
<td>S. cryptantha *</td>
<td>38.27 ± 3.38</td>
<td>45.09 ± 3.49</td>
<td>32.09 ± 4.22</td>
<td>8.06 ± 0.86</td>
<td>1.43 ± 0.16</td>
<td>0.68 ± 0.12</td>
<td></td>
</tr>
<tr>
<td>S. syriaca</td>
<td>39.23 ± 6.48</td>
<td>44.88 ± 8.48</td>
<td>32.85 ± 5.63</td>
<td>7.06 ± 0.52</td>
<td>1.61 ± 0.20</td>
<td>0.51 ± 0.06</td>
<td></td>
</tr>
<tr>
<td>S. viridis</td>
<td>39.34 ± 3.00</td>
<td>38.34 ± 5.73</td>
<td>33.82 ± 5.22</td>
<td>5.13 ± 0.85</td>
<td>1.14 ± 0.13</td>
<td>0.58 ± 0.07</td>
<td></td>
</tr>
<tr>
<td>S. hypargeia *</td>
<td>51.50 ± 4.05</td>
<td>52.42 ± 4.47</td>
<td>43.64 ± 3.91</td>
<td>3.57 ± 0.96</td>
<td>1.16 ± 0.15</td>
<td>0.54 ± 0.06</td>
<td>11.58 ± 0.72</td>
</tr>
<tr>
<td>S. eriophora *</td>
<td>44.53 ± 5.17</td>
<td>48.78 ± 5.92</td>
<td>39.24 ± 5.33</td>
<td>4.87 ± 0.39</td>
<td>1.09 ± 0.09</td>
<td>0.46 ± 0.06</td>
<td>6.85 ± 0.82</td>
</tr>
<tr>
<td>S. sclarea</td>
<td>32.64 ± 1.22</td>
<td>34.58 ± 1.87</td>
<td>26.8 ± 1.84</td>
<td>5.37 ± 0.56</td>
<td>1.12 ± 0.17</td>
<td>0.67 ± 0.13</td>
<td></td>
</tr>
<tr>
<td>S. aethiopis</td>
<td>39.29 ± 1.42</td>
<td>44.10 ± 2.31</td>
<td>33.71 ± 1.00</td>
<td>7.21 ± 0.63</td>
<td>1.27 ± 0.15</td>
<td>0.65 ± 0.08</td>
<td></td>
</tr>
<tr>
<td>S. ceratophylla</td>
<td>40.33 ± 3.17</td>
<td>45.77 ± 4.38</td>
<td>34.65 ± 3.35</td>
<td>4.00 ± 0.58</td>
<td>1.25 ± 0.14</td>
<td>0.76 ± 0.08</td>
<td></td>
</tr>
</tbody>
</table>
Table 3.1 (Continue): Pollen analysis data. Summary of pollen morphological data for the taxa examined (mean value ± standard deviation in μm). * indicates endemic to Turkey.

<table>
<thead>
<tr>
<th>Taxon</th>
<th>Mean Value ± Standard Deviation</th>
<th>45.3 ± 1.27</th>
<th>0.73 ± 0.12</th>
<th>8.28 ± 1.06</th>
</tr>
</thead>
<tbody>
<tr>
<td>S. longipedicellata*</td>
<td>40.27 ± 4.26</td>
<td>32.61 ± 4.84</td>
<td>1.38 ± 0.10</td>
<td>0.73 ± 0.12</td>
</tr>
<tr>
<td>S. microstegia</td>
<td>46.96 ± 1.34</td>
<td>37.05 ± 1.76</td>
<td>0.69 ± 0.07</td>
<td>0.63 ± 0.13</td>
</tr>
<tr>
<td>S. frigida</td>
<td>37.86 ± 4.10</td>
<td>5.06 ± 0.50</td>
<td>1.15 ± 0.13</td>
<td>0.70 ± 0.11</td>
</tr>
<tr>
<td>S. yosgadensis*</td>
<td>35.61 ± 1.71</td>
<td>29.60 ± 1.38</td>
<td>1.29 ± 0.07</td>
<td>0.70 ± 0.07</td>
</tr>
<tr>
<td>S. modesta *</td>
<td>43.47 ± 2.24</td>
<td>36.43 ± 2.76</td>
<td>1.24 ± 0.33</td>
<td>1.06 ± 0.18</td>
</tr>
<tr>
<td>S. candidissima ssp. candidissima</td>
<td>46.73 ± 1.49</td>
<td>41.55 ± 1.52</td>
<td>7.57 ± 0.74</td>
<td>1.45 ± 0.24</td>
</tr>
<tr>
<td>S. candidissima ssp. Occidentalis*</td>
<td>54.56 ± 3.9</td>
<td>43.58 ± 4.36</td>
<td>4.91 ± 0.75</td>
<td>1.04 ± 0.12</td>
</tr>
<tr>
<td>S. cyaneasens *</td>
<td>49.45 ± 2.36</td>
<td>42.18 ± 1.85</td>
<td>8.51 ± 0.54</td>
<td>1.80 ± 0.10</td>
</tr>
<tr>
<td>S. vermifolia *</td>
<td>33.57 ± 4.80</td>
<td>29.01 ± 4.31</td>
<td>4.47 ± 0.65</td>
<td>1.21 ± 0.19</td>
</tr>
<tr>
<td>S. virginata</td>
<td>36.20 ± 1.51</td>
<td>29.75 ± 1.08</td>
<td>3.71 ± 0.33</td>
<td>1.28 ± 0.31</td>
</tr>
<tr>
<td>S. halophila *</td>
<td>35.09 ± 3.04</td>
<td>29.68 ± 1.98</td>
<td>3.68 ± 0.38</td>
<td>1.11 ± 0.20</td>
</tr>
<tr>
<td>S. nemorosa</td>
<td>35.44 ± 2.93</td>
<td>29.34 ± 2.94</td>
<td>4.81 ± 0.75</td>
<td>1.37 ± 0.14</td>
</tr>
<tr>
<td>S. dichroantha *</td>
<td>41.30 ± 2.89</td>
<td>34.33 ± 3.31</td>
<td>4.33 ± 0.50</td>
<td>1.36 ± 0.14</td>
</tr>
<tr>
<td>S. verbenaca</td>
<td>53.17 ± 4.7</td>
<td>46.94 ± 5.51</td>
<td>4.7 ± 0.41</td>
<td>0.81 ± 0.15</td>
</tr>
<tr>
<td>S. verticillata ssp. amasiaca</td>
<td>32.13 ± 0.98</td>
<td>26.32 ± 1.46</td>
<td>6.48 ± 1.06</td>
<td>1.22 ± 0.24</td>
</tr>
<tr>
<td>S. russellii</td>
<td>28.42 ± 0.87</td>
<td>23.95 ± 0.99</td>
<td>3.67 ± 0.80</td>
<td>1.03 ± 0.11</td>
</tr>
<tr>
<td>S. aytachii *</td>
<td>37.68 ± 4.89</td>
<td>33.55 ± 5.14</td>
<td>5.50 ± 1.01</td>
<td>1.50 ± 0.13</td>
</tr>
<tr>
<td>S. hedgeana *</td>
<td>46.24 ± 3.81</td>
<td>38.97 ± 3.57</td>
<td>5.54 ± 1.30</td>
<td>1.62 ± 0.21</td>
</tr>
<tr>
<td>S. anatolica *</td>
<td>50.86 ± 4.35</td>
<td>43.28 ± 4.47</td>
<td>8.01 ± 1.05</td>
<td>1.63 ± 0.27</td>
</tr>
</tbody>
</table>
Table 3.2. Summary of morphometric data on SEM micrographs of the taxa examined.

<table>
<thead>
<tr>
<th>Taxa</th>
<th>Primary reticule number in 5 µm(^2)</th>
<th>Primary lumina diameter (µm)</th>
<th>The thickness of primary lumina (µm)</th>
<th>Secondary lumina diameter (µm)</th>
<th>The thickness of secondary lumina (µm)</th>
<th>Average lumina number in reticule</th>
</tr>
</thead>
<tbody>
<tr>
<td>S. hedgeana(x10000)</td>
<td>7.5</td>
<td>2.25</td>
<td>0.45</td>
<td>0.69</td>
<td>0.3</td>
<td>3-10</td>
</tr>
<tr>
<td>S. verticillata subsp. verticillata (x10000)</td>
<td>15</td>
<td>1.45</td>
<td>0.23</td>
<td>0.45</td>
<td>0.15</td>
<td>3-12</td>
</tr>
<tr>
<td>S. caespitosa(x10000)</td>
<td>7</td>
<td>2.48</td>
<td>0.46</td>
<td>0.8</td>
<td>0.25</td>
<td>2-14</td>
</tr>
<tr>
<td>S. caespitosa(x10000)</td>
<td>8</td>
<td>2.63</td>
<td>0.36</td>
<td>0.81</td>
<td>0.22</td>
<td>4-12</td>
</tr>
<tr>
<td>S. hypargeia(x10000)</td>
<td>8.5</td>
<td>3.11</td>
<td>0.36</td>
<td>0.5</td>
<td>0.23</td>
<td>3-26</td>
</tr>
<tr>
<td>S. suffraticosa (x10000)</td>
<td>13</td>
<td>1.55</td>
<td>0.35</td>
<td>0.41</td>
<td>0.22</td>
<td>3-8</td>
</tr>
<tr>
<td>S. euphratica var. euphratica(x10000)</td>
<td>12</td>
<td>1.42</td>
<td>0.54</td>
<td>0.41</td>
<td>0.23</td>
<td>-------</td>
</tr>
<tr>
<td>S. caespitosa (x10000)</td>
<td>7.5</td>
<td>2.63</td>
<td>0.36</td>
<td>0.66</td>
<td>0.24</td>
<td>3-13</td>
</tr>
<tr>
<td>S. nemorosa(x10000)</td>
<td>7.5</td>
<td>2.28</td>
<td>0.38</td>
<td>0.58</td>
<td>0.19</td>
<td>3-10</td>
</tr>
<tr>
<td>S. longipedicellata (x10000)</td>
<td>8</td>
<td>2.14</td>
<td>0.37</td>
<td>0.43</td>
<td>0.15</td>
<td>1-19</td>
</tr>
<tr>
<td>S. divaricata (x7500)</td>
<td>9</td>
<td>2.75</td>
<td>0.28</td>
<td>---</td>
<td>0.16</td>
<td>-------</td>
</tr>
<tr>
<td>S. dichroantha(x8500)</td>
<td>9</td>
<td>1.82</td>
<td>0.27</td>
<td>0.69</td>
<td>0.17</td>
<td>2-8</td>
</tr>
<tr>
<td>S. microstegia (x10000)</td>
<td>7</td>
<td>2.3</td>
<td>0.44</td>
<td>0.53</td>
<td>0.14</td>
<td>1-7</td>
</tr>
<tr>
<td>S. heldreichiana(x10000)</td>
<td>11.5</td>
<td>2.02</td>
<td>0.32</td>
<td>0.41</td>
<td>0.24</td>
<td>2-19</td>
</tr>
<tr>
<td>S. candidissima subsp. occidentalis (x7500)</td>
<td>5</td>
<td>3.92</td>
<td>0.37</td>
<td>---</td>
<td>---</td>
<td>5-32</td>
</tr>
<tr>
<td>S. wiedemannii(x10000)</td>
<td>8</td>
<td>2.24</td>
<td>0.36</td>
<td>0.56</td>
<td>0.28</td>
<td>2-14</td>
</tr>
<tr>
<td>S. aytaochii(x7500)</td>
<td>7.5</td>
<td>4.42</td>
<td>0.46</td>
<td>0.76</td>
<td>0.18</td>
<td>-</td>
</tr>
<tr>
<td>S. cyanescens(x10000)</td>
<td>7</td>
<td>3.16</td>
<td>0.26</td>
<td>1.06</td>
<td>0.28</td>
<td>7-24</td>
</tr>
<tr>
<td>S. recognita(x7000)</td>
<td>9</td>
<td>2.08</td>
<td>0.45</td>
<td>0.5</td>
<td>0.16</td>
<td>-</td>
</tr>
<tr>
<td>S. candidissima subsp. candidissima (x10000)</td>
<td>10.5</td>
<td>2.87</td>
<td>0.5</td>
<td>---</td>
<td>0.3</td>
<td>6-24</td>
</tr>
</tbody>
</table>
Table 3.2. (Continue): Summary of morphometric data on SEM micrographs of the taxa examined.

<table>
<thead>
<tr>
<th>Taxa</th>
<th>Morphometric Data</th>
<th>SEM Magnification</th>
</tr>
</thead>
<tbody>
<tr>
<td>S. verticillata subsp. amasiaca (x10000)</td>
<td>20.5</td>
<td>1.49</td>
</tr>
<tr>
<td>S. anatolica (x10000)</td>
<td>9.5</td>
<td>2.61</td>
</tr>
<tr>
<td>S. cryptantha (x9000)</td>
<td>17</td>
<td>1.38</td>
</tr>
<tr>
<td>S. cryptantha (x10000)</td>
<td>16</td>
<td>1.35</td>
</tr>
<tr>
<td>S. frigida (x8500)</td>
<td>8</td>
<td>2.99</td>
</tr>
<tr>
<td>S. yosgadensis (x10000)</td>
<td>12.5</td>
<td>1.55</td>
</tr>
<tr>
<td>S. cryptantha (x10000)</td>
<td>10.5</td>
<td>2.3</td>
</tr>
<tr>
<td>S. ceratophylla (x10000)</td>
<td>12.5</td>
<td>1.19</td>
</tr>
<tr>
<td>S. virgata (x10000)</td>
<td>13</td>
<td>1.88</td>
</tr>
<tr>
<td>S. halophila (x10000)</td>
<td>9</td>
<td>2.5</td>
</tr>
<tr>
<td>S. cadmica (x10000)</td>
<td>6</td>
<td>2.8</td>
</tr>
<tr>
<td>S. viridis (x10000)</td>
<td>20.5</td>
<td></td>
</tr>
<tr>
<td>S. virgata (x10000)</td>
<td>11</td>
<td>1.18</td>
</tr>
<tr>
<td>S. eriophora (x10000)</td>
<td>16.5</td>
<td>1.18</td>
</tr>
<tr>
<td>S. frigida (x10000)</td>
<td>13</td>
<td>1.44</td>
</tr>
<tr>
<td>S. frigida (x10000)</td>
<td>12</td>
<td>1.61</td>
</tr>
<tr>
<td>S. dichroantha (x8500)</td>
<td>12.5</td>
<td>1.82</td>
</tr>
<tr>
<td>S. tchihatcheffii (x7500)</td>
<td>8.5</td>
<td>2.31</td>
</tr>
<tr>
<td>S. bracteata (x7500)</td>
<td>14</td>
<td>1.6</td>
</tr>
<tr>
<td>S. caespitosa (x10000)</td>
<td>3</td>
<td>3.21</td>
</tr>
<tr>
<td>S. euphratica var. leiocalycina (x10000)</td>
<td>3</td>
<td>2.66</td>
</tr>
<tr>
<td>S. caespitosa (x10000)</td>
<td>7</td>
<td>2.03</td>
</tr>
<tr>
<td>S. blepharochlaena (x10000)</td>
<td>6.5</td>
<td>2.36</td>
</tr>
<tr>
<td>S. russellii (x10000)</td>
<td>20</td>
<td>0.83</td>
</tr>
</tbody>
</table>
Table 3.1 shows measurements obtained from the pollen grains in the taxa examined. The largest pollen grains were found in *S. euphratica* var. *euphratica* and *S. candidissima* ssp. *Occidentalis* and the smallest were the *S. russellii*, *S. sclarea*, *S. verticillata* subsp. *amasiaca*, *S. virgata* and *S. vermifolia*.

Pollen morphology of Lamiaceae has been studied by many authors (Erdtman, 1945; Harley et al., 1992; Abu-Asab and Cantino, 1993, 1994; Moon et al., 2008, b; Celenk et al., 2008; Salmaki et al., 2008). The studies reveal that the pollen morphology has proved useful in classification of the family. However, there are only a few investigations focused on pollen morphology of *Salvia* using LM and TEM (Henderson et al., 1968), and SEM (Hamzaoğlu et al., 2005; Jafari and Nikian, 2008).

We classified Turkish *Salvia* into two main groups: reticulate as in, *S. bracteata*, *S. divaricata*, *S. aytachii*, *S. tomentosa*, *S. tchihatcheffii*, *S. anatolica*, and *S. recognita* (Figure 3.11) and bireticulate as in, *S. candidissima* subsp. *candidissima*, *S. eriophora*, *S. cyanescens*, *S. candidissima* subsp. *occidentalis*, *S. ceratophylla*, *S. longipedicellata*, *S. verticillata* subsp. *amasiaca*, *S. suffruticosa*, *S. nemorosa*, *S. wiedemannii*, *S. microstegia*, *S. frigida*, *S. russellii*, *S. multicaulis*, *S. cryptantha*, *S. Viridis*, *S. vermifolia*, *S. sclarea*, *S. euphratica* var. *euphratica*, *S. frigida*, *S. caespitosa*, *S. aethiopis*, *S. dichroantha*, *S. hedgeana*, *S. halophila*, *S. yosgadensis*, *S. blepharochlaena*, *S. euphratica* var. *leiocalycina*, *S. virgata*, *S. heldreichiana*, *S. hypargeia*, and *S. cadmica* (Figure 3.12).
3.2 Anatomical information

In addition to vegetative morphological features, vegetative anatomical characters are useful taxonomic tools. Looking inside the stems and leaves serve to refine the relationship among taxa (Stuessy, 1990).

In general the stem transverse section of *Salvia* is quadrangular with the exception of *S. tchihatcheffii* (Aktaş et al. 2009) and *S. divaricata* which are round. *Salvia* stem has a single layer of epidermis, covered with a cuticle. The collenchymatous tissue is present under the epidermis at the corners and consists of oval or rounded cells. Metcalfe and Chalk (1972) also reported a four-cornered stem of *Salvia* containing collenchymatous tissue. The collenchymatous tissue between the corners consists of rounded cells. The cortex constitutes oval parenchymatous cells with intercellular spaces. Vascular bundles
are often separated by parenchymatous cells and those at the corners are larger. The phloem is usually surrounded by 5-10 sclerenchymatous cells or more. Cambium is present between the phloem and xylem elements. The xylem covers a larger region than the phloem. The pith is large and comprises hexagonal or orbicular parenchymatic cells.

The Central Anatolia taxa of *Salvia* studied thus far can be divided into two groups according to their stem epidermis: those with one layered epidermis like, *S. blepharochlaena* (Özkan, 2007), *S. hypargeia* (Kandemir, 2003), *S. sclarea, S. virgata, S. vermicifolia* (Figure 3.13a) (Bagherpour, 2010) and *S. viridis* as described by Özdemir et al (2009), and those with two layered epidermis; *S. divaricata, S. suffruticosa* and *S. aytachii* (Figure 3.13b).

![Figure 3.13. Stem cross section of *S. vermifolia* (a), and *S. aytachii* (b).](image)

c cortex, ca cambium, ch chlorenchyma, e epidermis, ph phloem, pi pith, s sclerenchymatic cells, x xylem. Bars = 100 um.

The xylem tissue is also used in classification. The Central Anatolia species like; *S. divaricata, S. blepharochlaena* as described by Özkan (2007) poses stems with the xylem cell layers very close together and in the *S. hypargeia* (Kandemir, 2003), *S. sclarea* (Özdemir, 1999), *S. virgata, S. verbena*, and *S. nemorosa* the xylem cell layers are very much apart and separate from each other.
The leaf transverse section of *Salvia* is generally composed of a one-layered (rarely two) epidermis, covered with a cuticle. Both upper and lower epidermal cells consist of uniseriate, oval or rectangular cells. The upper and lower walls of the epidermis cells are thicker than the lateral walls. The stoma cells of varying size and density are present on both sides of the leaf. The midrib region forming a projecting part contains large bundles which are the type of collateral. Their upper side is flat to slightly convex and their lower side is convex.

Leaf anatomical characteristics such as the number of vascular bundles present on the midrib are used for classification. For example in Central Anatolia we find some taxa of *Salvia* with one large vascular bundle in the midrib of the leaves (with one or two small ones on the sides) like *S. blepharochlaena, S. euphratica, S. eriophora, S. sclarea, S. virgata*, and *S. divaricata* (Figure 3. 14a). In contrast some have two sets of vascular bundles like in *S. halophila* as described by Kaya (2008) or 3 smaller ones like: *S. viridis* and *S. verticillata* (Figure 3. 14b).

**Figure 3.14.** Leaf cross section of *S. divaricata* (a) and *S. verticillata* (b). vb vascular bundle, ad adaxial epidermis, ab abaxial epidermis, c cortex, m mesophyll, ph phloem, x xylem. Bars = 50 um.

Leaf upper epidermis is another factor used in classification. In Central Anatolia there are many taxa of *Salvia* with the adaxial epidermis (ad) larger than the abaxial (ab) as in
S. divaricata, S. blepharochlaena (Özkan, 2007), S. euphratica, S. aethiops, S. longipedicellata, S. virgata, S. dichroantha, S. viridis (Özdemir et al, 2009), S. halophila (Kaya, 2008). S. hypargeia (Kandemir, 2003), and Salvia tchihatcheffii (Aktaş et al. 2009). There are taxa of Salvia with the adaxial and abaxial epidermis the same size with a very thin layer of cuticle such as S. verticillata as described by Koyuncu (2009).

3.3 Ecological and Phytogeographical information

3.3.1 Sampling

Distributions of Salvia species were somewhat uneven throughout the Central Anatolia. However, most Salvia species prefer limestone and igneous slopes and or quercus and calcareous rocky areas. We found three major hot spots in Central Anatolia. As indicated in the map one major area is near Ankara Beypazari. The second distribution hot spot is the Kayseri-Pinarbashi area. The third hot spot is in the greater Sivas area (Map 3.1).

Map 3.1. The distribution of Salvia in Central Anatolia.
The gypseous characteristic of these three hot spots along with climatic isolation produces the conditions preferred by Salvia. As mentioned in the materials and methods Akpulat (2005) suggested that the reduced moisture around gypsum was advantageous to Salvia growth and resulted in survival of highly specialized species. Davis in The Cliff Vegetation of Eastern Mediterranean (1951) states that peculiarity of these gypseous, calcareous areas with their lower moisture content is a good foundation for endemism.

Ecological data differ from comparative data used in taxonomy. In this section instead of looking at the plant features we analyze the environmental factors such as soil, elevation and habitat. One of the most important ecological data is soil. Salvia is especially impacted by soil type as documented by various authors (Davis, 1951 & Akpulat, 2005).

In general the bedrock preferred by Salvia is calcareous composite.

According to the soil analysis collected from suitable habitats for taxa of Salvia (Table 3.4), they generally prefer clayish soil which are slightly alkali (Ave. pH 7.83) with low organic content (Ave. 1.99%). The preferred N and CaCO₃ content of the soil was 0.13% and 20.71% respectively. The average amounts of P and K present were 4.82 and 151.52 ppm respectively. Salt concentration in Central Anatolia varies from 0.01 to 0.07%. The higher concentration of salt around Salt Lake (Tuz Gölü) produces a habitat in which only a limited number of plants (S. halophila) can adapt and survive.

In total 43 species were collected from Central Anatolia (Table 3.3), of these 26 were endemic. Therefore the rate of endemism is about 60%.
Table 3.3. Collected *Salvia* species indicating Flora code, Habitat and flowering time (*indicates endemism).

<table>
<thead>
<tr>
<th>Flora code</th>
<th>Species</th>
<th>Habitat</th>
<th>Flowering Time</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td><em>S. divaricata</em></td>
<td>Mountain slopes, 1500-1800m</td>
<td>6-7</td>
</tr>
<tr>
<td>4</td>
<td><em>S. tomentosa</em></td>
<td>Associated with pinups on limestone and igneous 90-2000m.</td>
<td>4-8(9)</td>
</tr>
<tr>
<td>9</td>
<td><em>S. recognita</em></td>
<td>Limestone slopes with quercus scrubs 900-2200m.</td>
<td>5-8</td>
</tr>
<tr>
<td>12</td>
<td><em>S. bracteata</em></td>
<td>Limestone slopes with quercus scrubs 50-2000m.</td>
<td>5-7</td>
</tr>
<tr>
<td>19</td>
<td><em>S. wiedemanni</em></td>
<td>Limestone slopes 500-1400m</td>
<td>5-7</td>
</tr>
<tr>
<td>21</td>
<td><em>S. freyniana</em></td>
<td>Limestone slopes 900-1000m</td>
<td>6-7</td>
</tr>
<tr>
<td>24</td>
<td><em>S. tchihatcheffii</em></td>
<td>Limestone slopes with pinus brutia woodland 400-1200m.</td>
<td>5-6</td>
</tr>
<tr>
<td>25</td>
<td><em>S. heldreichiana</em></td>
<td>Limestone slopes, 900-2000m</td>
<td>6-8</td>
</tr>
<tr>
<td>26</td>
<td><em>S. caespitosa</em></td>
<td>Limestone and igneous slopes rocky areas 1400-2400m.</td>
<td>(5)6-7</td>
</tr>
<tr>
<td>29</td>
<td><em>S. suffruticosa</em></td>
<td>Banks of steps 300-2000m.</td>
<td>4-6</td>
</tr>
<tr>
<td>32</td>
<td><em>S. cadmica</em></td>
<td>Limestone slopes with quercus scrubs 900-1810m.</td>
<td>5-7</td>
</tr>
<tr>
<td>34</td>
<td><em>S. blepharochlaena</em></td>
<td>Limestone and igneous serpentine slopes 1000-1620m.</td>
<td>6-7</td>
</tr>
<tr>
<td>37</td>
<td><em>S. euphratica</em></td>
<td>Rocky limestone slopes 850-1800m.</td>
<td>4-5</td>
</tr>
<tr>
<td>40</td>
<td><em>S. multicaulis</em></td>
<td>Limestone and igneous slopes, shale and sandy slopes, amongst cedrus 550-2600m.</td>
<td>4-7</td>
</tr>
<tr>
<td>41</td>
<td><em>S. cryptantha</em></td>
<td>Limestone and igneous slopes, dry steps, follow fields, roadsides 700-2500m.</td>
<td>5-7</td>
</tr>
<tr>
<td>42</td>
<td><em>S. syriaca</em></td>
<td>Steps, marly banks, fallow and cultivated fields 450-1850m.</td>
<td>4-7</td>
</tr>
<tr>
<td>43</td>
<td><em>S. viridis</em></td>
<td>Grassland, fallow fields 700-1150m.</td>
<td>3-7</td>
</tr>
<tr>
<td>44</td>
<td><em>S. hypergea</em></td>
<td>Limestone and igneous slopes, fallow fields 800-2000m.</td>
<td>6-7</td>
</tr>
<tr>
<td>48</td>
<td><em>S. eriophora</em></td>
<td>Volcanic rocky and stony slopes, alpine steppe and limestone slopes, 1525-1900 m.</td>
<td>6-7</td>
</tr>
<tr>
<td>50</td>
<td><em>S. sclarea</em></td>
<td>Limestone and igneous slopes and rocky areas, fields, roadsides 1-2000m.</td>
<td>5-8</td>
</tr>
<tr>
<td>52</td>
<td><em>S. aethiopis</em></td>
<td>Limestone and igneous slopes, fallow fields, roadsides 1-2100m.</td>
<td>5-8</td>
</tr>
<tr>
<td>53</td>
<td><em>S. ceratophylla</em></td>
<td>Limestone and igneous slopes and gypsum slopes, corn and fallow fields 300-2150m.</td>
<td>4-6</td>
</tr>
<tr>
<td>55</td>
<td><em>S. longipedicellata</em></td>
<td>Disturbed steps, meadows and fallow fields 1620-2040m.</td>
<td>7-8</td>
</tr>
</tbody>
</table>
While there are some highly specialized Salvia species such as *S. caespitosa* that grow on high elevations (above 1400 m), there are many species that are found none discriminating. There seems to be a very determinate line drawn for the habitat of some species in Central Anatolia. For example *S. recognita* follows an almost assigned line from Kayseri to Ankara going through Elma Mountain and the area of Kalecik and Eldowan Mountain down to the Cobuk dam of northwestern Ankara.
Table 3.4. Soil analysis data. C=Clay, L = Loam, CL= Clay Loam, SiCL= Silt-Clay Loam.

<table>
<thead>
<tr>
<th>species name</th>
<th>Moisture %</th>
<th>Texture</th>
<th>EC (dS/m)</th>
<th>Total Salt %</th>
<th>Soil pH</th>
<th>CaCO₃ %</th>
<th>Soil content for plant nutrition (ppm)</th>
<th>Organics %</th>
<th>Total Nitrogen%</th>
<th>Organic Carbon%</th>
<th>Soil structure</th>
</tr>
</thead>
<tbody>
<tr>
<td>S. aethiopis</td>
<td>65</td>
<td>CL</td>
<td>1.255</td>
<td>0.052</td>
<td>7.71</td>
<td>28.01</td>
<td>1.32</td>
<td>74.18</td>
<td>1.66</td>
<td>0.08</td>
<td>0.96</td>
</tr>
<tr>
<td>S. anatolica</td>
<td>50</td>
<td>CL</td>
<td>0.019</td>
<td>7.76</td>
<td>35.29</td>
<td>5.97</td>
<td>150.49</td>
<td>1.07</td>
<td>0.53</td>
<td>0.03</td>
<td>0.31</td>
</tr>
<tr>
<td>S. ayachthii</td>
<td>48</td>
<td>L</td>
<td>1.692</td>
<td>0.052</td>
<td>7.80</td>
<td>39.00</td>
<td>4.35</td>
<td>149.86</td>
<td>0.53</td>
<td>0.03</td>
<td>0.31</td>
</tr>
<tr>
<td>S. blepharochlaena</td>
<td>76</td>
<td>C</td>
<td>1.168</td>
<td>0.057</td>
<td>7.75</td>
<td>25.53</td>
<td>7.75</td>
<td>174.67</td>
<td>2.00</td>
<td>0.10</td>
<td>1.16</td>
</tr>
<tr>
<td>S. bracteata</td>
<td>66</td>
<td>CL</td>
<td>1.235</td>
<td>0.052</td>
<td>7.84</td>
<td>42.54</td>
<td>2.56</td>
<td>119.56</td>
<td>2.62</td>
<td>0.13</td>
<td>1.52</td>
</tr>
<tr>
<td>S. caespitosa</td>
<td>38-68</td>
<td>L-CL</td>
<td>0.63-1.1</td>
<td>0.015-0.048</td>
<td>7.58</td>
<td>1.43-3.19</td>
<td>1.24-3.19</td>
<td>30.11-130.55</td>
<td>0.62-2.21</td>
<td>0.36-2.45</td>
<td>21.5-87.2 5.4-47.2</td>
</tr>
<tr>
<td>S. candidissima subsp. candidissima</td>
<td>70-38</td>
<td>L-CL</td>
<td>0.63</td>
<td>0.015-0.023</td>
<td>7.98-8.2</td>
<td>3.19-26.64</td>
<td>1.24-1.62</td>
<td>30.11-209.11</td>
<td>0.22-0.62</td>
<td>0.03 0.36</td>
<td>87.2 5.4 7.4</td>
</tr>
<tr>
<td>S. candidissima subsp. occidentalis</td>
<td>77</td>
<td>C</td>
<td>0.03</td>
<td>7.84</td>
<td>7.77</td>
<td>79.44</td>
<td>828.35</td>
<td>73.8</td>
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<td></td>
<td></td>
</tr>
<tr>
<td>S. ceratophylla</td>
<td>67</td>
<td>CL</td>
<td>1.116</td>
<td>0.048</td>
<td>7.72</td>
<td>41.83</td>
<td>0.93</td>
<td>112.48</td>
<td>0.44</td>
<td>0.02</td>
<td>0.26</td>
</tr>
<tr>
<td>S. cryptantha</td>
<td>38-76</td>
<td>C-CL</td>
<td>0.63-1.235</td>
<td>0.015-0.057</td>
<td>7.58-8.08</td>
<td>1.43-4.25</td>
<td>0.93-7.97</td>
<td>30.11-210.53</td>
<td>0.44-4.22</td>
<td>0.02-0.40</td>
<td>0.26-2.45 12.0-87.2 5.4-7.4</td>
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<tr>
<td>S. cyanea</td>
<td>49</td>
<td>L</td>
<td>0.021</td>
<td>7.79</td>
<td>24.16</td>
<td>2.13</td>
<td>227.33</td>
<td>0.82</td>
<td></td>
<td></td>
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</tr>
<tr>
<td>S. dichroa</td>
<td>66</td>
<td>CL</td>
<td>1.235</td>
<td>0.052</td>
<td>7.84</td>
<td>42.54</td>
<td>2.56</td>
<td>119.56</td>
<td>2.62</td>
<td>0.13</td>
<td>1.52</td>
</tr>
<tr>
<td>S. divaricata</td>
<td>49</td>
<td>L</td>
<td>0.013</td>
<td>8.18</td>
<td>7.77</td>
<td>0.94</td>
<td>74.68</td>
<td>0.28</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>S. ekimina</td>
<td>64</td>
<td>CL</td>
<td>0.977</td>
<td>0.040</td>
<td>6.81</td>
<td>-</td>
<td>6.81</td>
<td>162.04</td>
<td>5.15</td>
<td>0.26</td>
<td>2.99</td>
</tr>
<tr>
<td>S. euphratica</td>
<td>67</td>
<td>CL</td>
<td>1.116</td>
<td>0.048</td>
<td>7.72</td>
<td>41.83</td>
<td>0.93</td>
<td>112.48</td>
<td>0.44</td>
<td>0.02</td>
<td>0.26</td>
</tr>
<tr>
<td>S. frigida</td>
<td>68</td>
<td>CL</td>
<td>1.103</td>
<td>0.048</td>
<td>7.58</td>
<td>1.43</td>
<td>7.58</td>
<td>130.55</td>
<td>4.22</td>
<td>0.21</td>
<td>2.45</td>
</tr>
<tr>
<td>S. freyniana</td>
<td>55</td>
<td>CL</td>
<td>1.092</td>
<td>0.038</td>
<td>7.86</td>
<td>21.27</td>
<td>7.86</td>
<td>166.20</td>
<td>1.50</td>
<td>0.08</td>
<td>0.87</td>
</tr>
<tr>
<td>S. halophila</td>
<td>72</td>
<td>C</td>
<td>1.299</td>
<td>0.060</td>
<td>8.57</td>
<td>56.72</td>
<td>5.12</td>
<td>174.67</td>
<td>3.28</td>
<td>0.16</td>
<td>1.90</td>
</tr>
<tr>
<td>S. hedgeana</td>
<td>70</td>
<td>CL</td>
<td>0.023</td>
<td>8.20</td>
<td>26.64</td>
<td>1.62</td>
<td>209.11</td>
<td>0.22</td>
<td></td>
<td></td>
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</tr>
<tr>
<td>S. heldreichiana</td>
<td>63</td>
<td>CL</td>
<td>0.019</td>
<td>7.690</td>
<td>1.48</td>
<td>4.87</td>
<td>339.36</td>
<td>6.38</td>
<td></td>
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</tr>
</tbody>
</table>
### Table 3.4. (Continue): Soil analysis data. C=Clay, L = Loam, CL= Clay Loam, SiCL= Silt-Clay Loam.

<table>
<thead>
<tr>
<th>Species</th>
<th>Code</th>
<th>C-L</th>
<th>38-63</th>
<th>0.015-0.048</th>
<th>3.19-7.12</th>
<th>30.11-170.41</th>
<th>0.03-0.05</th>
<th>0.36-14.0</th>
<th>25.7-27.1</th>
<th>5.4-27.1</th>
</tr>
</thead>
<tbody>
<tr>
<td><em>S. hypergea</em></td>
<td>38-79</td>
<td>C-L</td>
<td>0.63-0.1315</td>
<td>0.015-0.066</td>
<td>7.84-7.98</td>
<td>30.11-170.41</td>
<td>0.03-0.28</td>
<td>0.36-14.0</td>
<td>25.7-27.1</td>
<td>5.4-27.1</td>
</tr>
<tr>
<td><em>S. longipedicellata</em></td>
<td>66</td>
<td>CL</td>
<td>1.235</td>
<td>0.052</td>
<td>7.84</td>
<td>42.54</td>
<td>119.56</td>
<td>2.62</td>
<td>0.13</td>
<td>1.52</td>
</tr>
<tr>
<td><em>S. microstegia</em></td>
<td>39-68</td>
<td>L-CL</td>
<td>1.103</td>
<td>0.013-0.048</td>
<td>7.58-8.18</td>
<td>1.43-7.77</td>
<td>130.55</td>
<td>0.28-4.22</td>
<td>21</td>
<td>21.5</td>
</tr>
<tr>
<td><em>S. modesta</em></td>
<td>39</td>
<td>L</td>
<td>0.020</td>
<td>0.17</td>
<td>0.94</td>
<td>306.83</td>
<td>1.54</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><em>S. multicaulis</em></td>
<td>39-68</td>
<td>L-CL</td>
<td>1.103</td>
<td>0.020-0.048</td>
<td>7.45-7.62</td>
<td>1.43-7.58</td>
<td>130.55</td>
<td>0.15-4.22</td>
<td>21</td>
<td>21.5</td>
</tr>
<tr>
<td><em>S. nemorosa</em></td>
<td>52</td>
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<td>0.016</td>
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<td>0.94</td>
<td>9.36</td>
<td>113.55</td>
<td>2.07</td>
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</tr>
<tr>
<td><em>S. recognita</em></td>
<td>78</td>
<td>C</td>
<td>1.315</td>
<td>0.066</td>
<td>7.84</td>
<td>21.98</td>
<td>170.41</td>
<td>5.50</td>
<td>0.28</td>
<td>3.19</td>
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<tr>
<td><em>S. russellii</em></td>
<td>57</td>
<td>CL</td>
<td>0.032</td>
<td>7.74</td>
<td>17.17</td>
<td>4.47</td>
<td>285.95</td>
<td>2.10</td>
<td></td>
<td></td>
</tr>
<tr>
<td><em>S. sclearea</em></td>
<td>49</td>
<td>L</td>
<td>0.013</td>
<td>8.18</td>
<td>7.77</td>
<td>0.94</td>
<td>74.68</td>
<td>0.28</td>
<td></td>
<td></td>
</tr>
<tr>
<td><em>S. suffraticosa</em></td>
<td>67</td>
<td>CL</td>
<td>1.116</td>
<td>0.048</td>
<td>7.72</td>
<td>41.83</td>
<td>112.48</td>
<td>0.44</td>
<td>0.02</td>
<td>0.26</td>
</tr>
<tr>
<td><em>S. syriaca</em></td>
<td>66-70</td>
<td>CL</td>
<td>1.116-1.235</td>
<td>0.023-0.048</td>
<td>7.72-8.20</td>
<td>26.64-42.54</td>
<td>112.48-209.11</td>
<td>0.44</td>
<td>0.02-0.13</td>
<td>0.26</td>
</tr>
<tr>
<td><em>S. tankutiana</em></td>
<td>40</td>
<td>L</td>
<td>0.841</td>
<td>0.022</td>
<td>7.97</td>
<td>12.76</td>
<td>52.61</td>
<td>1.53</td>
<td>0.08</td>
<td>0.89</td>
</tr>
<tr>
<td><em>S. tomentosa</em></td>
<td>63</td>
<td>CL</td>
<td>1.724</td>
<td>0.070</td>
<td>7.54</td>
<td>48.21</td>
<td>71.31</td>
<td>0.66</td>
<td>0.03</td>
<td>0.04</td>
</tr>
<tr>
<td><em>S. vermicifolia</em></td>
<td>38</td>
<td>L</td>
<td>0.63</td>
<td>0.015</td>
<td>7.98</td>
<td>3.19</td>
<td>1.24</td>
<td>30.11</td>
<td>0.62</td>
<td>0.03</td>
</tr>
<tr>
<td><em>S. verticillata amasiaca</em></td>
<td>38-78</td>
<td>L-C</td>
<td>0.63-1.315</td>
<td>0.015-0.066</td>
<td>7.84-7.98</td>
<td>3.19-42.54</td>
<td>1.24-2.92</td>
<td>30.11-170.41</td>
<td>0.62</td>
<td>0.03-0.28</td>
</tr>
<tr>
<td><em>S. virgata</em></td>
<td>38-78</td>
<td>L-C</td>
<td>0.63-1.315</td>
<td>0.015-0.066</td>
<td>7.84-7.98</td>
<td>3.19-21.98</td>
<td>1.24-2.92</td>
<td>30.11-170.41</td>
<td>0.62</td>
<td>0.03-0.28</td>
</tr>
<tr>
<td><em>S. viridiss</em></td>
<td>38</td>
<td>L</td>
<td>1.115</td>
<td>0.027</td>
<td>8.04</td>
<td>6.74</td>
<td>2.64</td>
<td>63.00</td>
<td>0.31</td>
<td>0.02</td>
</tr>
<tr>
<td><em>S. wiedemannii</em></td>
<td>48-72</td>
<td>L-C</td>
<td>1.012-1.692</td>
<td>0.047-0.052</td>
<td>7.80-8.08</td>
<td>32.62-39.00</td>
<td>149.86-210.53</td>
<td>0.53-1</td>
<td>0.31-0.58</td>
<td>0.31</td>
</tr>
<tr>
<td><em>S. yozgadensis</em></td>
<td>44-55</td>
<td>L-CL</td>
<td>0.626-1.092</td>
<td>0.018-0.038</td>
<td>7.63-7.86</td>
<td>1.71-7.86</td>
<td>178.98</td>
<td>0.16-1.50</td>
<td>0.08</td>
<td>0.87</td>
</tr>
</tbody>
</table>
After analyzing the data in the above table the resulting clusters (Figure 3.15) indicate the closeness of these species to each other in regard to soil type. In Central Anatolia some species are found generally all over. This list includes *S. cryptantha*, *S. aethiopis* and *S. syriaca*. The endemic species such as *S. cryptantha* and *S. wiedemanni* share the same soil type with *S. aethiopis* and *S. syriaca* (none endemics); however they limit themselves to Central Anatolia borders. This fact shows the effect of climate on restrictions of endemics to Central Anatolia.

**Figure 3.15.** Cluster analysis indicates the closeness of *Salvia* species to each other in regards to soil type.
3.3.2 Distribution range by altitude

The bulk of ecological data is often characterized by elevation. Taxa of *Salvia* in Central Anatolia are limited to elevations of about 400-3200 meters. The lowest point is near Eskisehir; a valley within Sundukan Mountains. The highest point is Mt. Ercies in Kayseri. The majority of *Salvia* taxa can be found at 1000 meters. It is worth noting that all the tree hot spots in Central Anatolia are between 900-1100 meters.

![Altitude distribution chart for *Salvia* species of Central Anatolia.](image)

**Figure 3.16.** Altitude distribution chart for *Salvia* species of Central Anatolia.
There are very few *Salvia* found above the 2000 m level and only one above 3000 m in Central Anatolia. By observing Figure 3.16 we can deduce that many species live indiscriminate to elevation while others have a very limited preference of elevation.

### 3.3.3 Phenology

Flowering time varies greatly among taxa of *Salvia* in Central Anatolia (Figure 3.17). The taxa of *Salvia* can be seen in full bloom during the rainy season of March. *S. viridis* which prefers lower elevation and moister grassland climate is the first *Salvia* to be seen around this area. *S. halophila* ends the flowering season in October. In some areas *S. virgata* can still be seen with flower. But the majority of *Salvia* taxa are in flower during the month of June. The flowering times can however shift slightly due to climatic changes as noticed by the author during the drought peak of 2007.
3.3.4 Phytogeography and Endemism

According to Davis (1965) most endemism occurs in the Central Anatolia and the Mediterranean regions of Turkey. Since Central Anatolia does not border any countries the endemics are conserved in this region. As noticed by other authors (Ekim et al, 2000), endemics were concentrated in the calcareous areas around Sivas-Gurun and Cankiri and the arid soil around Salt lake.
Anatolian endemics are numerous in the Sivas and the Beypazari areas. The rate of endemism in this area is about 60%. Of the 26 endemic species in Central Anatolia about 14 are residents of the Sivas area. Seven of the remaining 11 are found in the vicinity of Beypazari. Both of these locations are high in gypsum. Overall Central Anatolia provides a unique habitat for these endemics. Some species carry themselves all the way to the borders of Eastern Anatolia without crossing over. *Salvia cryptantha* is a good example. There are some very rare endemics in the region that are known only from one location. This list includes *Salvia vermifolia*, *Salvia freyniana* and *Salvia halophila*. These species are under threat. Davis (1971) produced the first document about the endemism in Turkey. A list of endemics and rare plants of Turkey was published by Ekim (Ekim et. al, 1989). Due to the importance of these rare plants, the threat categories of each species were determined and reported in the description of each species.
Table 3.5. The species distributed in the study area and their IUCN categories and criteria. \(^x\): the species endemic, \(^*\): taxa known only within the study area in Turkey. Ir.-Tur. Irano-Turanian element, DD Data Deficient, CR Critically Endangered, EN Endangered, VU Vulnerable, NT Near Threatened, and LC Least Concern.

<table>
<thead>
<tr>
<th>Species</th>
<th>Phytogeographic regions</th>
<th>Turkish Red</th>
<th>Regional</th>
<th>National threat</th>
<th>International</th>
<th>IUCN Red List Criteria</th>
</tr>
</thead>
<tbody>
<tr>
<td><em>S. freyniana</em>(^x)</td>
<td>Ir.-Tur.</td>
<td>DD</td>
<td>CR</td>
<td>CR</td>
<td>CR</td>
<td>B1ab(i,ii,iv); C2a(ii)</td>
</tr>
<tr>
<td><em>S. anatolica</em>(^x)</td>
<td>Ir.-Tur.</td>
<td>CR</td>
<td>CR</td>
<td>CR</td>
<td>CR</td>
<td>B1ab(i,ii,iv); C2a(ii)</td>
</tr>
<tr>
<td><em>S. hedgeana</em>(^x)</td>
<td>Ir.-Tur.</td>
<td>CR</td>
<td>EN</td>
<td>EN</td>
<td>EN</td>
<td>B2ab(i,ii,iv)</td>
</tr>
<tr>
<td><em>S. ekimiana</em>(^x)</td>
<td>Ir.-Tur.</td>
<td>-</td>
<td>EN</td>
<td>EN</td>
<td>EN</td>
<td>B2ab(i,ii,iv)</td>
</tr>
<tr>
<td><em>S. eriophora</em>(^x)</td>
<td>Ir.-Tur.</td>
<td>VU</td>
<td>EN</td>
<td>EN</td>
<td>EN</td>
<td>B2ab(i,ii,iv)</td>
</tr>
<tr>
<td><em>S. halophila</em>(^x)</td>
<td>Ir.-Tur.</td>
<td>VU</td>
<td>EN</td>
<td>EN</td>
<td>EN</td>
<td>B2ab(i,ii,iv)</td>
</tr>
<tr>
<td><em>S. reeseana</em>(^x)</td>
<td>Ir.-Tur.</td>
<td>VU</td>
<td>EN</td>
<td>EN</td>
<td>EN</td>
<td>B2ab(i,ii,iv)</td>
</tr>
<tr>
<td><em>S. vermifolia</em>(^x)</td>
<td>Ir.-Tur.</td>
<td>VU</td>
<td>VU</td>
<td>VU</td>
<td>VU</td>
<td>B2ab(i,ii,iv)</td>
</tr>
<tr>
<td><em>S. aytaclii</em>(^x)</td>
<td>Ir.-Tur.</td>
<td>VU</td>
<td>VU</td>
<td>VU</td>
<td>VU</td>
<td>B2ab(i,ii,iv)</td>
</tr>
<tr>
<td><em>S. modesta</em>(^x)</td>
<td>Ir.-Tur.</td>
<td>NT</td>
<td>VU</td>
<td>VU</td>
<td>VU</td>
<td>B2ab(i,ii,iv)</td>
</tr>
<tr>
<td><em>S. longipedicellata</em>(^x)</td>
<td>Ir.-Tur.</td>
<td>NT</td>
<td>NT</td>
<td>VU</td>
<td>VU</td>
<td>B2ab(i,ii,iv)</td>
</tr>
<tr>
<td><em>S. blepharochlaena</em>(^x)</td>
<td>Ir.-Tur.</td>
<td>NT</td>
<td>NT</td>
<td>VU</td>
<td>VU</td>
<td>B2ab(i,ii,iv)</td>
</tr>
<tr>
<td><em>S. ichihatchefii</em>(^x)</td>
<td>Ir.-Tur.</td>
<td>NT</td>
<td>VU</td>
<td>VU</td>
<td>VU</td>
<td>B2ab(i,ii,iv)</td>
</tr>
<tr>
<td><em>S. recognita</em>(^x)</td>
<td>Ir.-Tur.</td>
<td>LC</td>
<td>VU</td>
<td>VU</td>
<td>VU</td>
<td>B2ab(i,ii,iv)</td>
</tr>
<tr>
<td><em>S. yosudensis</em>(^x)</td>
<td>Ir.-Tur.</td>
<td>LC</td>
<td>VU</td>
<td>VU</td>
<td>VU</td>
<td>B2ab(i,ii,iv)</td>
</tr>
<tr>
<td><em>S. wiedemannii</em>(^x)</td>
<td>Ir.-Tur.</td>
<td>LC</td>
<td>VU</td>
<td>VU</td>
<td>VU</td>
<td>B2ab(i,ii,iv)</td>
</tr>
<tr>
<td><em>S. heldreichiana</em>(^x)</td>
<td>Ir.-Tur.</td>
<td>LC</td>
<td>NT</td>
<td>NT</td>
<td>NT</td>
<td>B2ab(i,ii,iv)</td>
</tr>
<tr>
<td><em>S. euphratica var. euphratica</em>(^x)</td>
<td>Ir.-Tur.</td>
<td>NT</td>
<td>NT</td>
<td>NT</td>
<td>NT</td>
<td>B2ab(i,ii,iv)</td>
</tr>
<tr>
<td><em>S. euphratica var. leiocalycina</em>(^x)</td>
<td>Ir.-Tur.</td>
<td>NT</td>
<td>NT</td>
<td>NT</td>
<td>NT</td>
<td>B2ab(i,ii,iv)</td>
</tr>
<tr>
<td><em>S. cadmica</em>(^x)</td>
<td>Ir.-Tur.</td>
<td>LC</td>
<td>NT</td>
<td>NT</td>
<td>NT</td>
<td>B2ab(i,ii,iv)</td>
</tr>
<tr>
<td><em>S. cyanescens</em>(^x)</td>
<td>Ir.-Tur.</td>
<td>LC</td>
<td>NT</td>
<td>NT</td>
<td>NT</td>
<td>B2ab(i,ii,iv)</td>
</tr>
<tr>
<td><em>S. divaricata</em>(^x)</td>
<td>Ir.-Tur.</td>
<td>LC</td>
<td>NT</td>
<td>NT</td>
<td>NT</td>
<td>B2ab(i,ii,iv)</td>
</tr>
</tbody>
</table>
Table 3.5. (Continue): The species distributed in the study area and their IUCN categories and criteria. \(^x\): the species endemic, \(*\): taxa known only within the study area in Turkey. Ir.-Tur.: Irano-Turanian element, Medit: Mediterranean element, Unk. or Multi.: Unknown or Multiregional. DD Data Deficient, CR Critically Endangered, EN Endangered, VU Vulnerable, NT Near Threatened, and LC Least Concern.

<table>
<thead>
<tr>
<th>Species</th>
<th>Phytogeographic regions</th>
<th>Turkish Red</th>
<th>Regional</th>
<th>National threat</th>
<th>International</th>
<th>IUCN Red List Criteria</th>
</tr>
</thead>
<tbody>
<tr>
<td><em>S. caespitosa</em> (^x)</td>
<td>Ir.-Tur.</td>
<td>LC</td>
<td>NT</td>
<td>NT</td>
<td>NT</td>
<td>B2ab(i,ii,iv)</td>
</tr>
<tr>
<td><em>S. hypargeia</em> (^x)</td>
<td>Ir.-Tur.</td>
<td>LC</td>
<td>NT</td>
<td>NT</td>
<td>NT</td>
<td>B2ab(i,ii,iv)</td>
</tr>
<tr>
<td><em>S. dichroantha</em> (^x)</td>
<td>Ir.-Tur.</td>
<td>LC</td>
<td>NT</td>
<td>NT</td>
<td>NT</td>
<td>B2ab(i,ii,iv)</td>
</tr>
<tr>
<td><em>S. cryptantha</em> (^x)</td>
<td>Ir.-Tur.</td>
<td>LC</td>
<td>NT</td>
<td>NT</td>
<td>NT</td>
<td>B2ab(i,ii,iv)</td>
</tr>
<tr>
<td><em>S. aethiopis</em></td>
<td>Unk. or Multi.</td>
<td>-</td>
<td>LC</td>
<td>LC</td>
<td>LC</td>
<td>Widely distributed</td>
</tr>
<tr>
<td><em>S. bracteata</em></td>
<td>Ir.-Tur.</td>
<td>-</td>
<td>LC</td>
<td>LC</td>
<td>LC</td>
<td>Widely distributed</td>
</tr>
<tr>
<td><em>S. candidissima subsp. candidissima</em></td>
<td>Ir.-Tur.</td>
<td>-</td>
<td>LC</td>
<td>LC</td>
<td>LC</td>
<td>Widely distributed</td>
</tr>
<tr>
<td><em>S. candidissima subsp. occidentalis</em></td>
<td>Ir.-Tur.</td>
<td>-</td>
<td>LC</td>
<td>LC</td>
<td>LC</td>
<td>Widely distributed</td>
</tr>
<tr>
<td><em>S. ceratophylla</em></td>
<td>Ir.-Tur.</td>
<td>-</td>
<td>LC</td>
<td>LC</td>
<td>LC</td>
<td>Widely distributed</td>
</tr>
<tr>
<td><em>S. frigid</em></td>
<td>Ir.-Tur.</td>
<td>-</td>
<td>LC</td>
<td>LC</td>
<td>LC</td>
<td>Widely distributed</td>
</tr>
<tr>
<td><em>S. microstegia</em></td>
<td>Ir.-Tur.</td>
<td>-</td>
<td>LC</td>
<td>LC</td>
<td>LC</td>
<td>Widely distributed</td>
</tr>
<tr>
<td><em>S. multicaulis</em></td>
<td>Ir.-Tur.</td>
<td>-</td>
<td>LC</td>
<td>LC</td>
<td>LC</td>
<td>Widely distributed</td>
</tr>
<tr>
<td><em>S. russelli</em></td>
<td>Ir.-Tur.</td>
<td>-</td>
<td>VU</td>
<td>LC</td>
<td>LC</td>
<td>Widely distributed</td>
</tr>
<tr>
<td><em>S. scabra</em></td>
<td>Unk. or Multi.</td>
<td>-</td>
<td>LC</td>
<td>LC</td>
<td>LC</td>
<td>Widely distributed</td>
</tr>
<tr>
<td><em>S. suffruticosica</em></td>
<td>Ir.-Tur.</td>
<td>-</td>
<td>LC</td>
<td>LC</td>
<td>LC</td>
<td>Widely distributed</td>
</tr>
<tr>
<td><em>S. syriaca</em></td>
<td>Ir.-Tur.</td>
<td>-</td>
<td>LC</td>
<td>LC</td>
<td>LC</td>
<td>Widely distributed</td>
</tr>
<tr>
<td><em>S. tomentosa</em></td>
<td>Medit.</td>
<td>-</td>
<td>LC</td>
<td>LC</td>
<td>LC</td>
<td>Widely distributed</td>
</tr>
<tr>
<td><em>S. verticillata ssp. amasiaca</em></td>
<td>Ir.-Tur.</td>
<td>-</td>
<td>LC</td>
<td>LC</td>
<td>LC</td>
<td>Widely distributed</td>
</tr>
<tr>
<td><em>S. virgata</em></td>
<td>Ir.-Tur.</td>
<td>-</td>
<td>LC</td>
<td>LC</td>
<td>LC</td>
<td>Widely distributed</td>
</tr>
<tr>
<td><em>S. viridis</em></td>
<td>Medit.</td>
<td>-</td>
<td>LC</td>
<td>LC</td>
<td>LC</td>
<td>Widely distributed</td>
</tr>
<tr>
<td><em>S. nemorosa</em></td>
<td>Medit.</td>
<td>-</td>
<td>LC</td>
<td>LC</td>
<td>LC</td>
<td>Widely distributed</td>
</tr>
<tr>
<td><em>S. verbenaca</em></td>
<td>Medit.</td>
<td>-</td>
<td>LC</td>
<td>LC</td>
<td>LC</td>
<td>Widely distributed</td>
</tr>
</tbody>
</table>
Of the three major phytogeographical regions in Turkey, all of the Central Anatolia rests in the Irano-Turanian phytogeographical region. As discussed in the materials and methods, it is well isolated by various mountains. About 60% of the *Salvia* taxa in Central Anatolia are endemic. Among the specimens collected from the area one taxon was re-discovered after 116 years (Bagherpour, 2009).

In final assessment, of the 43 *Salvia* species in Central Anatolia only 4 are from the Mediterranean origin, 2 are multi regional or from unknown origins and the remainder are Irano-turanian based (% 85.7). Endemic Central Anatolian taxa of *Salvia* consist of two CR (Critically Endangered), 7 EN (Endangered), 8 VU (Vulnerable), and 9 NT (Near Threatened).
CHAPTER 4

REVISION OF THE GENUS SALVIA L. (LABIATAE) IN CENTRAL ANATOLIA, TURKEY

4.1 Infrageneric Grouping

Boissier (1879), in his *Flora Orientalis*, recognized 107 species of *Salvia*; some of which were either described or recorded from Turkey. For the first time, he placed these species under seven sections, which had been all recognized previously by Bentham (1833) and Dumort. These sections are as follows: *Eusphace*, *Hymenosphace*, *Drymosphace*, *Aethiopis*, *Plethiosphace*, *Horminum* and *Hemisphace*. Section *Eusphace* Benth. Later designated as the type section of the genus *Salvia* (Hedge, 1972, Reales et al., 2004). However the section *Drymosphace* is not found in Central Anatolia.

In Flora of Turkey Vol.7, concerning the genus *Salvia*, no infrageneric grouping was made. Therefore, as an initial part of the revisional study conducted on this genus since 2005 an infrageneric grouping is done. Towards achieving this goal, multivariate analysis was carried out in order to elucidate the sectional delimitation as well as understand taxonomic relationships in the genus.

Following is a list of characters chosen and their possible status value:
Table 4.1. Morphological characters screened for the numerical taxonomic analysis.

<table>
<thead>
<tr>
<th>No</th>
<th>Character</th>
<th>Scoring</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>HABITAT OF SPECIES</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Limestone soil</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>Calcareous rocks</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>Serpentine rocks</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>FORMATION TYPES</td>
<td></td>
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<tr>
<td></td>
<td>Perennial</td>
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</tr>
<tr>
<td></td>
<td>Annual</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>Plant erect</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>Plant caespitose</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>Plant mat-forming</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>Plant ascending</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>Plant procumbent</td>
<td>4</td>
</tr>
<tr>
<td></td>
<td>Shrubby</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>Suffruticose</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>Herbaceous</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>STEM CHARACTERISTICS</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Stem with capitate glandular hair</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>Stem without capitate glandular hair</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>Stem branched above</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>Stem branched below</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>Stem unbranched</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>Stem indumentum with mostly antrose hairs</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>Stem indumentum with mostly retrorse hairs</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>Stem with spreading hairs</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>Others</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>Stem glabrous, glaucous</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>Stem pilose</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>Stem villous</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>Stem scabridulous</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>Stem arachnoid</td>
<td>4</td>
</tr>
<tr>
<td></td>
<td>Stem pubescent</td>
<td>5</td>
</tr>
<tr>
<td></td>
<td>Stem tomentosa</td>
<td>6</td>
</tr>
<tr>
<td></td>
<td>BRACT CHARACTERISTICS</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Bracts or floral leaves equal or shorter than calyx</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>Bracts or floral leaves longer than calyx</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>Bracts linear</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>Bracts lanceolate</td>
<td>1</td>
</tr>
</tbody>
</table>
**Table 4.1. (Continue):** Morphological characters screened for the numerical taxonomic analysis.

<table>
<thead>
<tr>
<th>Character Description</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bracts elliptic</td>
<td>2</td>
</tr>
<tr>
<td>Bracts oblong</td>
<td>3</td>
</tr>
<tr>
<td>Bracts ovate</td>
<td>4</td>
</tr>
<tr>
<td>Bracts rhombic</td>
<td>5</td>
</tr>
<tr>
<td>Bracts absent</td>
<td>6</td>
</tr>
<tr>
<td>Bracts length (average) (mm)</td>
<td></td>
</tr>
<tr>
<td>Bracts width (average) (mm)</td>
<td></td>
</tr>
<tr>
<td>Bracts pink to mauve</td>
<td></td>
</tr>
<tr>
<td>Bracts green</td>
<td>1</td>
</tr>
<tr>
<td>Bracts absent</td>
<td>2</td>
</tr>
<tr>
<td>Bracts membranous</td>
<td>0</td>
</tr>
<tr>
<td>Bracts not membranous</td>
<td>1</td>
</tr>
<tr>
<td>Bracts absent</td>
<td>2</td>
</tr>
<tr>
<td>Inflorescence paniculate</td>
<td>0</td>
</tr>
<tr>
<td>Inflorescence not paniculate</td>
<td>1</td>
</tr>
<tr>
<td>Verticillasters distant</td>
<td>0</td>
</tr>
<tr>
<td>Verticillasters close</td>
<td>1</td>
</tr>
<tr>
<td>Verticillaster 1-2 flowered</td>
<td>0</td>
</tr>
<tr>
<td>Verticillaster 2-8 flowered</td>
<td>1</td>
</tr>
<tr>
<td>Verticillaster 8-40 flowered</td>
<td>2</td>
</tr>
<tr>
<td>Pedicel length (mm)</td>
<td></td>
</tr>
<tr>
<td>Calyx campanulate</td>
<td>0</td>
</tr>
<tr>
<td>Calyx infundibular</td>
<td>1</td>
</tr>
<tr>
<td>Calyx tubular</td>
<td>2</td>
</tr>
<tr>
<td>Calyx tubular-campanulate</td>
<td>3</td>
</tr>
<tr>
<td>Calyx obtangular</td>
<td>4</td>
</tr>
<tr>
<td>Calyx membranous in fruit</td>
<td>0</td>
</tr>
<tr>
<td>Calyx not membranous in fruit</td>
<td>1</td>
</tr>
<tr>
<td>Calyx not or scarcely accrescent (in fruit)</td>
<td>0</td>
</tr>
<tr>
<td>Calyx strongly accrescent (in fruit)</td>
<td>1</td>
</tr>
<tr>
<td>Calyx upper lip tri-dentate</td>
<td>0</td>
</tr>
<tr>
<td>Calyx upper lip flat</td>
<td>1</td>
</tr>
<tr>
<td>Calyx actinomorphic</td>
<td>2</td>
</tr>
<tr>
<td>Calyx upper lip one dentate</td>
<td>3</td>
</tr>
<tr>
<td>Calyx upper lip truncate</td>
<td>4</td>
</tr>
</tbody>
</table>
Table 4.1. (Continue): Morphological characters screened for the numerical taxonomic analysis.

<p>| | | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>23. Calyx length (average)</td>
<td>(mm)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>a. Fruiting Calyx length (average)</td>
<td>(mm)</td>
</tr>
<tr>
<td>24. Calyx green</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Calyx green and purplish</td>
<td>1</td>
</tr>
<tr>
<td>25. Calyx with capitate hair</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Calyx without capitate hair</td>
<td>1</td>
</tr>
<tr>
<td>26. Calyx teeth spinulose</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Calyx teeth acute</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>Calyx teeth acuminate</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>Calyx teeth obtuse</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>Calyx teeth absent</td>
<td>4</td>
</tr>
<tr>
<td>27. Corolla more than 20 mm</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Corolla less than 20 mm</td>
<td>1</td>
</tr>
<tr>
<td>28. Corolla lilac</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Corolla blue</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>Corolla red</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>Corolla yellow</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>Corolla white</td>
<td>4</td>
</tr>
<tr>
<td></td>
<td>Corolla mauve-pink</td>
<td>5</td>
</tr>
<tr>
<td>29. Upper lip of corolla same color</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Upper lip of corolla different color</td>
<td>1</td>
</tr>
<tr>
<td>30. Lower lip of corolla spotted</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Lower lip of corolla unspotted</td>
<td>1</td>
</tr>
<tr>
<td>31. Upper lip of corolla narrowed at base</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Upper lip of corolla not narrowed at base</td>
<td>1</td>
</tr>
<tr>
<td>32. Corolla squamulate</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Corolla non-squamulate</td>
<td>1</td>
</tr>
<tr>
<td>33. Corolla tube gradually wider towards throat</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Corolla tube ventricose</td>
<td>1</td>
</tr>
<tr>
<td>34. Corolla upper lip strait</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Corolla upper lip falcate</td>
<td>1</td>
</tr>
<tr>
<td>35. Corolla tube annulate</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Corolla tube non-annulate</td>
<td>1</td>
</tr>
<tr>
<td>36. Petioles ciliate with long white eglandular hairs</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Petioles without ciliate hairs</td>
<td>1</td>
</tr>
<tr>
<td>37. Stamen type A</td>
<td>0</td>
<td></td>
</tr>
</tbody>
</table>
Table 4.1. (Continue): Morphological characters screened for the numerical taxonomic analysis.

<table>
<thead>
<tr>
<th>Character Description</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Stamen type C</td>
<td>2</td>
</tr>
<tr>
<td>38. Stamens included upper lip of corolla</td>
<td>0</td>
</tr>
<tr>
<td>Stamen clearly exceeding upper lip of corolla</td>
<td>1</td>
</tr>
<tr>
<td>LEAF CHARACTERISTICS</td>
<td></td>
</tr>
<tr>
<td>39. Leaves pinnatisect</td>
<td>0</td>
</tr>
<tr>
<td>Leaves lyrate</td>
<td>1</td>
</tr>
<tr>
<td>Leaves undivided</td>
<td>2</td>
</tr>
<tr>
<td>40. Terminal leaflet broad</td>
<td>0</td>
</tr>
<tr>
<td>Terminal leaflet linear-oblong</td>
<td>1</td>
</tr>
<tr>
<td>Simple, terminal leaflet absent</td>
<td>2</td>
</tr>
<tr>
<td>41. Leaves linear</td>
<td>0</td>
</tr>
<tr>
<td>Leaves lanceolate</td>
<td>1</td>
</tr>
<tr>
<td>Leaves elliptic</td>
<td>2</td>
</tr>
<tr>
<td>Leaves oblong</td>
<td>3</td>
</tr>
<tr>
<td>Leaves ovate</td>
<td>4</td>
</tr>
<tr>
<td>Leaves orbicular</td>
<td>5</td>
</tr>
<tr>
<td>Leaves obovate</td>
<td>6</td>
</tr>
<tr>
<td>42. Leaves petiolate</td>
<td>0</td>
</tr>
<tr>
<td>Leaves sessile</td>
<td>1</td>
</tr>
<tr>
<td>43. Leaf length (average)</td>
<td></td>
</tr>
<tr>
<td>44. Leaf width (average)</td>
<td></td>
</tr>
<tr>
<td>45. Leaf indumentum of unbranched hairs, or absent</td>
<td>0</td>
</tr>
<tr>
<td>Leaf indumentum of dendroid to dendroid-stellate</td>
<td>1</td>
</tr>
<tr>
<td>Leaf indumentum absent</td>
<td>2</td>
</tr>
<tr>
<td>46. Leaf indumentum with gland or glandular hair</td>
<td>0</td>
</tr>
<tr>
<td>Leaf indumentum without gland or glandular hair</td>
<td>1</td>
</tr>
<tr>
<td>47. Leaves not fleshy</td>
<td>0</td>
</tr>
<tr>
<td>Leaves fleshy</td>
<td>1</td>
</tr>
<tr>
<td>NUTLET AND POLLEN CHARACTERISTICS</td>
<td></td>
</tr>
<tr>
<td>48. Nutlets suborbicular</td>
<td>0</td>
</tr>
<tr>
<td>Nutlets ovoid</td>
<td>1</td>
</tr>
<tr>
<td>Nutlets trigonous</td>
<td>2</td>
</tr>
<tr>
<td>49. Nutlet length</td>
<td></td>
</tr>
<tr>
<td>50. Nutlet width</td>
<td></td>
</tr>
<tr>
<td>51. Pollen polar length</td>
<td></td>
</tr>
<tr>
<td>52. Pollen equatorial length</td>
<td></td>
</tr>
</tbody>
</table>
The morphometric analysis was carried out by measuring 53 morphological characters, selected according to two criteria: (a) their common use for taxonomic identification in this section; (b) the variability among different taxa. The compiled data from each OTU analysis was inserted into the MVSP program for cluster analysis. Using gover’s general similarity index (Gover, 1971) which is applicable to both continuous and discontinuous data, and the unweighted pair-group method using arithmetic averages the following cluster emerged. As a result of the analysis, we obtained the dendograms shown in Figure 4.1, in which we can distinguish six major clusters. In these clusters, we find all those sections that were determined by Bentham. Of the seven sections determined by Bentham, Section *Drymosphace* Benth. is not found within Central Anatolia. The cut-off line across the phenogram at 0.76-0.80 similarity level distinguishes the species.
| OTUs     | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 | 21 | 22 | 23 | 24 | 25 | 26 | 27 | 28 | 29 | 30 | 31 | 32 | 33 | 34 | 35 | 36 | 37 | 38 | 39 | 40 | 41 | 42 | 43 | 44 | 45 | 46 | 47 | 48 | 49 | 50 | 51 | 52 | 53 | 54 | 55 | 56 | 57 | 58 | 59 | 60 | 61 | 62 | 63 | 64 | 65 | 66 | 67 | 68 | 69 | 70 | 71 | 72 | 73 | 74 | 75 | 76 | 77 | 78 | 79 | 80 | 81 | 82 | 83 | 84 | 85 | 86 | 87 | 88 | 89 | 90 | 91 | 92 | 93 | 94 | 95 | 96 | 97 | 98 | 99 | 100 |
We found remarkable variation in the characters among two sections Section *Hymenosphace*, *Salvia* and the other four sections found in Central Anatolia. While these two sections are very similar their separation from other four sections is very distinct. The Section *Hymenosphace* and *Salvia* are similar in the upper lip of corolla, more or less straight and tube hairy-ringded inside.

Sect. *Aethiopis* is the largest section of the Central Anatolian *Salvia* taxa and is similar with Section *Plethiosphace*. These two sections are similarly perennial, rarely annual herbs. Calyx campanulate; upper lip concave. Upper lip of corolla straight or falcate; tube not hairy-ringded. Also similar to Section *Hemisphace*. The section Horminum with one species separates itself from all others by being annual.

A description of all species and subspecies studied are recorded, including distribution according to the collected specimens. We found some species like *S. sclarea* and *S. vermifolia* placed close to *S. viridis* while they belong to section *Aethiopis*. *S. nemorosa* and *S. dichroantha* which both belong to section *Plethiosphace* were found outside this group. The distribution of the characters and their values among the six clusters shows how these characters behave and how helpful they are for a taxonomic differentiation of the groups studied.
Figure 4.1. The cluster analysis dendogram showing the six sections of Salvia: Salvia (1), Hymenosphace (2), Aethiopis (3), Plethiosphace (4), Hemisphace (5) and Horminum (6) as determined by Bentham.
Finally the analysis of matrices representing similarities and dissimilarities among taxonomic units and their ordering into taxa based on their affinity has been greatly simplified by the use of computers. The following table represents the actual similarity among species as we see them in the field. The cluster analysis resulted in separation of highly correlated species. As observed the closest species *S. frigida* and *S. modesta* are similar species at 0.963. *Salvia* bracteata and reeseana are practically same with only a hair difference. Additionally the table indicates many other species with high affinity to each other on the remaining nodes in the cluster:
Table 4.3. Cluster analysis results.

<table>
<thead>
<tr>
<th>Node</th>
<th>Group 1</th>
<th>Group 2</th>
<th>Simil.</th>
<th>in group</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td><em>S. frigida</em></td>
<td><em>S. modesta</em></td>
<td>0.963</td>
<td>2</td>
</tr>
<tr>
<td>2</td>
<td><em>S. bracteata</em></td>
<td><em>S. reeseana</em></td>
<td>0.953</td>
<td>2</td>
</tr>
<tr>
<td>3</td>
<td><em>S. verticillata</em></td>
<td><em>S. russellii</em></td>
<td>0.940</td>
<td>2</td>
</tr>
<tr>
<td>4</td>
<td>Node 1</td>
<td><em>S. yosgadensis</em></td>
<td>0.933</td>
<td>3</td>
</tr>
<tr>
<td>5</td>
<td><em>S. freyniana</em></td>
<td><em>S. caespitosa</em></td>
<td>0.915</td>
<td>2</td>
</tr>
<tr>
<td>6</td>
<td><em>S. longipedicellata</em></td>
<td><em>S. candidissima</em></td>
<td>0.911</td>
<td>2</td>
</tr>
<tr>
<td>7</td>
<td>Node 6</td>
<td><em>S. microstegia</em></td>
<td>0.900</td>
<td>3</td>
</tr>
<tr>
<td>8</td>
<td><em>S. cadmica</em></td>
<td><em>S. blepharochlaena</em></td>
<td>0.899</td>
<td>2</td>
</tr>
<tr>
<td>9</td>
<td><em>S. eriophora</em></td>
<td><em>S. aethiopis</em></td>
<td>0.890</td>
<td>2</td>
</tr>
<tr>
<td>10</td>
<td>Node 7</td>
<td>Node 4</td>
<td>0.890</td>
<td>6</td>
</tr>
<tr>
<td>11</td>
<td><em>S. wiedemannii</em></td>
<td><em>S. tchihatcheffii</em></td>
<td>0.867</td>
<td>2</td>
</tr>
<tr>
<td>12</td>
<td><em>S. virgata</em></td>
<td><em>S. halophila</em></td>
<td>0.859</td>
<td>2</td>
</tr>
<tr>
<td>13</td>
<td>Node 10</td>
<td><em>S. cyanescens</em></td>
<td>0.858</td>
<td>7</td>
</tr>
<tr>
<td>14</td>
<td>Node 8</td>
<td><em>S. euphratica</em></td>
<td>0.857</td>
<td>3</td>
</tr>
<tr>
<td>15</td>
<td><em>S. syriaca</em></td>
<td>Node 9</td>
<td>0.851</td>
<td>3</td>
</tr>
<tr>
<td>16</td>
<td><em>S. multicaulis</em></td>
<td><em>S. cryptantha</em></td>
<td>0.847</td>
<td>2</td>
</tr>
<tr>
<td>17</td>
<td>Node 12</td>
<td><em>S. verbenaca</em></td>
<td>0.837</td>
<td>3</td>
</tr>
<tr>
<td>18</td>
<td>Node 15</td>
<td>Node 13</td>
<td>0.836</td>
<td>10</td>
</tr>
<tr>
<td>19</td>
<td><em>S. hedgeana</em></td>
<td>Node 5</td>
<td>0.835</td>
<td>3</td>
</tr>
<tr>
<td>20</td>
<td><em>S. tomentosa</em></td>
<td><em>S. recognita</em></td>
<td>0.822</td>
<td>2</td>
</tr>
<tr>
<td>21</td>
<td>Node 16</td>
<td><em>S. aytachii</em></td>
<td>0.821</td>
<td>3</td>
</tr>
<tr>
<td>22</td>
<td><em>S. hypargeia</em></td>
<td><em>S. dichroantha</em></td>
<td>0.814</td>
<td>2</td>
</tr>
<tr>
<td>23</td>
<td>Node 11</td>
<td><em>S. suffruticosa</em></td>
<td>0.814</td>
<td>3</td>
</tr>
<tr>
<td>24</td>
<td>Node 19</td>
<td>Node 23</td>
<td>0.805</td>
<td>6</td>
</tr>
<tr>
<td>25</td>
<td>Node 17</td>
<td>Node 3</td>
<td>0.803</td>
<td>5</td>
</tr>
<tr>
<td>26</td>
<td>Node 18</td>
<td>Node 22</td>
<td>0.792</td>
<td>12</td>
</tr>
<tr>
<td>27</td>
<td><em>S. viridis</em></td>
<td><em>S. vermifolia</em></td>
<td>0.786</td>
<td>2</td>
</tr>
<tr>
<td>28</td>
<td>Node 14</td>
<td>Node 21</td>
<td>0.784</td>
<td>6</td>
</tr>
<tr>
<td>29</td>
<td>Node 25</td>
<td><em>S. nemorosa</em></td>
<td>0.779</td>
<td>6</td>
</tr>
<tr>
<td>30</td>
<td><em>S. divaricata</em></td>
<td>Node 20</td>
<td>0.778</td>
<td>3</td>
</tr>
<tr>
<td>31</td>
<td>Node 24</td>
<td><em>S. heldreichiana</em></td>
<td>0.777</td>
<td>7</td>
</tr>
<tr>
<td>32</td>
<td>Node 26</td>
<td><em>S. ceratophylla</em></td>
<td>0.768</td>
<td>13</td>
</tr>
<tr>
<td>33</td>
<td>Node 32</td>
<td>Node 29</td>
<td>0.761</td>
<td>19</td>
</tr>
<tr>
<td>34</td>
<td>Node 30</td>
<td>Node 31</td>
<td>0.755</td>
<td>10</td>
</tr>
<tr>
<td>35</td>
<td>Node 33</td>
<td>Node 27</td>
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<td>21</td>
</tr>
<tr>
<td>36</td>
<td>Node 35</td>
<td><em>S. sclarea</em></td>
<td>0.732</td>
<td>22</td>
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<tr>
<td>37</td>
<td>Node 34</td>
<td>Node 2</td>
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<td>12</td>
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<tr>
<td>38</td>
<td>Node 37</td>
<td>Node 28</td>
<td>0.717</td>
<td>18</td>
</tr>
<tr>
<td>39</td>
<td>Node 38</td>
<td><em>S. anatolica</em></td>
<td>0.684</td>
<td>19</td>
</tr>
<tr>
<td>40</td>
<td>Node 39</td>
<td>Node 36</td>
<td>0.655</td>
<td>41</td>
</tr>
</tbody>
</table>
4.1.1 General features of the Genus, *Salvia*

*Salvia* is one of the largest member of the Labiatae family. Herbaceous or shrubs, often aromatic form numerous glands: stems square, leaves opposite, usually simple, flowers irregular (zygomorphic), in distant lateral clusters (verticillasters) which often form whorls around the stem numbering from (1) 2-10(50): calyx with 5 teeth, and 2-lipped corolla, the lower lip 3-lobed and the upper lip 2. Stamens 2 and fruit consisting of 4 nutlets hidden at the base of the persistent calyx. While one *Salvia* is annual, majority of *Salvia* taxa are perannual and the remainder biannual.

4.1.2 Sectional key

1. Annuals
   1. Biennials or Perennials
      2. Corolla tube annulate (hairy-ringed inside)
         3. Connective longer than filament and not articulated with it, arms unequal, the sterile arm shorter, subulate
         4. Calyx membranous and strongly accrescent in fruit
      2. Corolla tube not annulate (not hairy-ringed inside)
      3. Connective as long as filament or shorter; arms subequal, the anterior ending in a more or less sterile cell
         4. Calyx not membranous and not strongly accrescent in fruit

4.1.3 Species key

1. Annual; purple sterile bracts present on the stem apex.
   1. Biennials or Perennials; no colored sterile bracts present on the stem apex.
   2. Fruiting Calyx membranous; infundibular shape, strongly accrescent with rounded lobes.
      3. Leaves pinnatisect; long eglandular ciliate indumentum present on the petioles.
         4. Pinnate leaves terminal segment linear-oblong, pinnate leaf with 3-5 lateral segments.
   14. *blepharochlaena*
      4. Pinnate leaves terminal segment broadly oblong, pinnate leaf (simple) with 1-2 lateral segments.
      3. Leaves simple (seldom 1-2 lateral lobes present); long ciliate indumentum absent on the petioles.
      5. Mat-forming; lower part of stem woody, fruiting calyx up to 35 mm long.
   15. *euphratica*
   5. Herbaceous plants with woody rootstock; fruiting calyx up to 28 mm long.
      6. Corolla 27-33 mm; stem glandular pilose or eglandular villous.
   13. *cadmica*
6. Corolla 15-22 mm; stem eglandular branched or dendroid hairs.
7. Calyx generally green colored; stem branched with dendroid hairs.

17. cryptantha

7. Calyx generally purple; stem glabrous, glandular or dendroid hairs.
8. Corolla 10-18 mm; pedicel 1-5 mm.

16. multicaulis

8. Corolla 23-25 mm; pedicel 6-7 mm.

18. aytachii

2. Fruiting Calyx non-membranous, thick textured, tubular to infundibular, with acute lobes.
9. Stamen connective equal or shorter than filaments; upper theca larger than the poorly developed lower theca, lower theca bears at least some fertile pollen. (Stamen type A); corolla with upper lip straight and corolla tube annulate.
10. Leaves simple or lyrate or pinnatified
11. Leaves mostly basal; flowering stem up to 35 cm long, stem bellow with glandular hairs.

1. divaricata

11. Leaves distributed over stem; flowering stem 100-120 cm long; eglandular bellow.

2. tomentosa

10. Leaves pinnatisect or trisect
12. Leaves terminal segment broadly oblong to ovate; petioles usually without prominently ciliate hairs.

13. Bracts or floral leaves clearly longer than calyces.
14. Stems indumentum entirely eglandular.
14. Stems with or without long spreading eglandular hairs (seldom glandular).

12. reeseana

11. bracteata

13. Bracts or floral leaves equal or shorter than calyces.
15. Stems below glabrous.
15. Stems glandular-villous below and above.
12. Leaves terminal segment ± linear-oblong or shortly obovate-cuneate; petioles often prominently ciliate with long white eglandular hairs.
16. Corolla yellow or yellowish-white.
16. Corolla pink or white, violet to blue colored.

19. suffruticosa

17. Dwarf mat-forming sub shrubs.
18. Leaves trifoliolate or trisect
18. Leaves pinnatisect with 2-4 pair lateral segment.
17. Taller growing ascending or erect sub shrubs.
19. Inflorescence clearly condensed ± ovoid or oblong spike.
20. Stems eglandular above and below; corolla 10-15 mm
20. Stems capitate glandular above; corolla (20) 25-30 mm
19. Inflorescence of distant or approximating verticillasters.
21. Indumentum scabridulous.
21. Indumentum softly pilose.

19. anatolica

3. recognita

21. Indumentum scabridulous.
21. Indumentum softly pilose.

9. Stamen connective clearly longer, lower theca reduced to a usually dolabriform plate of tissue, corolla with upper lip falcate and corolla tube usually not annulate (Stamen type B).
22. Upper lip of corolla straight (not falcate), corolla tube annulate; verticillasters 8-40 flowered; lower theca subulate (Stamen type C)
22. Leaves linear-oblong; calyx teeth not mucronate.
22. Leaves oblong to ovate; calyx teeth mucronate.
22. Upper lip of corolla slightly falcate, corolla tube not annulate; verticillasters 2-8 flowered; lower theca is reduced and generally dolabriform (Stamen type B).

23. Corolla more than 20 mm.
24. Corolla tube not squamulate, ventricose or not.
24. Corolla tube squamulate, ventricose.
25. Upper lip of corolla lilac.

32. hypargeia

35. sclarea

31. cyanescens
25. Upper lip of corolla white.  
27. Leaves linear, linear-lanceolate or linear-oblong  
27. Leaves oblong, ovate to orbicular.  
28. Calyx short papillose or glandular pilose hairs; inflorescence ± slender  
25. candidissima  
28. Calyx with long spreading capitate glandular hairs; inflorescence ± sturdy  
26. microstegia  

23. Corolla less than 20 mm.  
29. Flowers lilac or violet or pinkish  
30. Corolla tube squamulate.  
31. Inflorescence axis, bracts and calyces ± dark violet blue; calyx teeth subulate; stems eglandular  
32. Stems above and below eglandular-pilose  
32. Stems above glandular-pilose to villous  
33. Corolla 16-20 mm; Leaves pilose to lanate beneath; calyx teeth short spinulose.  
33. Corolla shorter than 16 mm; leaves arachnoid to sublanate beneath; calyx teeth long spinulose.  
34. Corolla 12-16 mm, generally white; bracts 8-12 x 7-11 mm  
34. Corolla 8-11 mm, generally purple; bracts 6-18 x 6-8 mm  
27. frigida  
28. modesta  

30. Corolla tube not squamulate.  
35. Bracts strongly colored violet to blue or purple.  
36. Inflorescence axis, bracts and calyces ± dark violet blue; calyx teeth subulate; stems eglandular  
39. nemorosa  
35. Bracts green or lightly tinged purple.  
36. Inflorescence axis, bracts and calyces ± dark violet blue; calyx teeth subulate; stems eglandular  
21. eriophora  
38. Leaves ovate-oblong to broadly ovate; corolla 8-11 mm  
38. halophila  
39. Leaves ± fleshy, margins subentire (saline habitats).  
40. Leaves not fleshy, margins subentire to erose to pinnatifid (non-saline habitats).  
41. Calyx 5-7 mm; stems usually less than 30 cm.  
41. Calyx 6-10 mm; stems 30-100 cm.  
37. virgata  

29. Flowers white, yellow or cream  
42. Leaves pinnatifid with spreading linear segments; biennial; corolla generally sulphor yellow, with upper lip rarely lilac.  
33. ceratophylla  
42. Leaves not pinnatifid; perennial, rarely biennial.  
43. Inflorescence candelibriform; stems eglandular lanate; perennial or biennial.  
44. Leaves ovate-elliptic- oblong , 10-31 x 5-9 cm, leaf margins erose; Upper lip of corolla 7-9 mm  
32. aethiopis  
44. Leaves oblong (seldom ovate-oblong), 2.5-7.5 x 1-2.5 cm, crenulate serrulate, upper lip of corolla 3.5-4.2 mm  
23. ekimiana  
43. Inflorescence not candelibriform; stems pilose or villous; perennials.  
24. longipedicellata  
45. Pedicels 7-12 mm  
56. Pedicels shorter than 5 mm.  
46. Leaves ovate, cordate, serrulate; corolla c. 10 mm  
20. syriaca  
46. Leaves oblong to broadly ovate or orbicular, cordate, cuneate, margins crenulate to erose; corolla 8-20 mm  
47. Upper lip of calyx bisulcate in flower, clearly so in fruit and recurved.  
37. virgata  
47. Upper lip of calyx not bisulcate and not recurved in fruit.
48. Leaves ± densely lanate.
49. Corolla 17-20 mm; upper lip strongly falcate
26. microstegia

49. Corolla 7-11 mm, upper somewhat falcate.
23. ekimiana

48. Leaves not lanate.
50. Stem eglandular above and below; calyxes’ eglandular.

50. Stem glandular above; calyces glandular.
51. Inflorescence rescence with vilose hair
51. Inflorescence without vilose hair
52. Corolla 8-11 mm, purple; bracts 6-18 x 6-7.5 mm
52. Corolla 12-16 mm, white or lilac; bracts 8-12 x 7-11 mm.

29. tobeyi

28. modesta

27. frigida

4.2 Species descriptions

4.2.1 Section Salvia Hedge (Sect. Euphace Benth.):

Shrubs or perennial herbs. Calyx generally not accrescent or only slightly so. Upper lip of corolla more or less straight; tube hairy-ringed inside. Connective as long as filament or shorter; arms subequal, the anterior ending in a more or less sterile cell. Species for Sect. Salvia Hedge:


Perennial herb with woody rootstock. **Stems** 30-60 cm, erect, branched above, green to purplish, shortly eglandular (sometimes eglandular retrorse pilose) with some sessile glands below, glabrous above. **Leaves** mostly basal, simple, rarely with a pair of small lateral lobes, narrowly oblong, (2- ) 3-8 (-9) x 0.8-2.5 cm, upper surface sparsely eglandular pilose and beneath densely tomentose with sessile glands, rugose, crenulate. **Petiole** 1-5 (-7) cm, ciliate. **Inflorescence** an elongate, widely branched panicle. **Verticillasters** 2-4(-6)-flowered, clearly distant. **Bracts and bracteoles** absent. **Pedicels** 10-35 mm, glabrous, rigid, erecto-patent. **Calyx** tubular-campanulate, 12-18 mm, slightly longer in fruit, fruiting calyx thick-textured, often purplish, densely glandular pilose and sometimes a few eglandular villous hairs; upper lip obseletely tridentate, acuminate. **Corolla** pink or lilac, 25-35 mm; tube straight below, widening above, 15-25
mm, incompletely annulate; upper lip ± straight. **Stamens** A. **Styles** 27-37 mm. **Nutlets** c. 4-5 x 3-3.5 mm, black. Chromosome count: 2n=14.

The **pollen** of *S. divaricata* is isopolar and prolate with *P* = 50.87 ± 7.08 µm and *E* = 46.76 ± 5.30 µm. The aperture is hexacolpate and the colpi = 44.55 ± 6.84 x 3.43 ± 0.93 µm. The exine is 1.12 ± 0.12 µm thick and the intine is 0.50 ± 0.03 µm. Its ornamentation is reticulate.

*Fl: 6-7, limestone slopes and mountain slopes, 1030-1870 m.*

**Type Specimen:** [Turkey B7] in Cappadocia Orientalis [ad Euphratem], Aucher [1528]


**Endemic. Ir.-Tur. element.** Threat category: **NT**

*S. divaricata* is distantly related to *S. aucheri* on account of the habit and the stem indumentum, but very distinct in terms of the narrowly oblong mostly basal leaves, the wide-branching glabrous panicles and the very long pedicels.
Figure 4.2. General appearance of *S. divaricata* Montbret & Aucher ex Bentham.

Map 4.1. *S. divaricata* distribution map.

Perennial Clump-forming suffruticose herb. **Stems** to 1 m, stiffly erect, quadrangular, often branched above, eglandular-tomentose with sessile glands (rarely with capitate glandular hairs above). **Leaves** simple, narrowly oblong to ovate, 0.8-11 x 0.5-6 cm, rounded to cordate at base (rarely with small basal lobules), entire to crenulate; **petiole** 0.8-6.0 cm. **Inflorescence** branched. **Verticillasters** 4-10 flowered, distant or condensed above. **Bracts** broadly ovate, 3-20 x 2-11 mm, deciduous; **bracteoles** present. **Pedicels** 2-10 mm. **Calyx** ± tubular, 7-16 mm, accrescent to 11-18 mm in fruit, usually violet, pilose to villous, with or without capitate glandular hairs; upper lip shortly tridentate. **Corolla** lilac to purple, or white, c. 21-30 mm; tube straight, 18-22 mm, incompletely annulate; upper lip straight. **Stamens** A. **Nutlets** rounded trigonous, ± spherical, 3.5 x 3.2 mm. Chromosome count: 2n = 14, 15, and 16.

The **pollen** of *S. tomentosa* is isopolar and oblate with \( P = 38.62 \pm 3.29 \mu m \) and \( E = 44.73 \pm 3.61 \mu m \). The aperture is hexacolpate and the colpi = \( 32.63 \pm 3.80 \times 4.72 \pm 0.43 \mu m \). The exine is \( 1.16 \pm 0.14 \mu m \) thick and the intine is \( 0.72 \pm 0.10 \mu m \). Its ornamentation is reticulate.

*Fl. 4-8(-9). Often associated with Pinus brutia and P. nigra, Quercus pubescens, in macchie, on limestone or igneous slopes, 90-2000 m.*

Described from cultivated material, Miller (holo. BM!).

**Mainly Outer Anatolia, Islands.** A2 (E) Istanbul: Rumeli Kavak, Azn. 1740! A2 (A) Bursa: Çekirge, A. & T. Bay top (ISTE 2451)! A3 Zonguldak: Zonguldak to Çaycuma, 450 m, D. 37636. A4 Ankara: Eldivan Mountain near fire department, 40 29 738 N 33 30 371 E, 1081 m, 17 vii 2008, SBagherpour 502! A5 Sinop: Sinop to Gerze, 90 m, Hub.-Mor. 15292! A6 Ordu: Fatsa to Aybasti, 400 m, Tobey 1327! A7 Gümüşane: Gümüşane to Trabzon, Zigana Pass, 1200 m, Lamond 2602! B1 Izmir: kamal Paşa Mountain, 38 25 061 N 27 24 015 E, 490 m, 2 vi 2008, SBagherpour 455! B2 Kütahya: Gediz to Uşak, 620 m, Demiriz 1817! B2 Uşak: pass the Kula 2 Km, 38 39 868 N 29 07 582 E, 592 m, 31 v 2008, SBagherpour 455! B3 Eskişehir: Sündiken Da., Ekim 633! B5 Kayseri: Sakar Çifliği road above the village, about 5-6 km into the forest, 38 27 014 N 35 24 296 E, 1595 m, 22 vii 2006, SBagherpour 375! B6 Maraş: d, Goksun, Hobek Da., 1600 m, D. 20227! C1
Izmir: Samsun Da. above Giizecamli, Fitz & Spitz. 664! C2 Antalya: Kuhu Da. S. of Elmali, Çiğlikara, Fitz & Spitz. 221! C3 Isparta: Ağlassun to Isparta, 1600 m, Khan et al. 341! C4 Konya: Ermenek to Kahraman, 1040 m, Hub.-Mor. 8384! C5 Adana: d. Feke, Suphandere to Belankoy, 1000 m, D. 19563! C6 Hatay: d. Antakya, Harbiye to Şenkoy, 500 m, D. 27209! Is: Samos, mt. Kerki, 500 m, Runem. & Snog. 19267!


Threat category: **LC**

![Figure 4.3. General appearance of S. tomentosa Miller.](image-url)

Perennial herb. **Stems** 40-90 (up to 160) cm, erect, quadrangular, branched above, glandular-villos above and below with long spreading hairs, glabrous and glaucous in middle and sometimes capitates glandular. **Leaves** pinnate. (Rarely simple) with a large oblong-ovate terminal segment, 3-9(-13) x 1-5 cm and 1-2 pairs of small lateral segments, rugose, crenulate, glandular-pilose; **petiole** 1-13 cm. **Verticillasters** 4-6-flowered, clearly distant. **Bracts** 12-15 x 1-7 mm, deciduous. **Pedicels** 3-5 mm, ± erect. **Calyx** ovate tubular-campanulate, 8-15 mm, to 18 mm in fruit, glandular-villos, upper lip straight, very shortly tridentate, not mucronate. **Corolla** lilac-pink, 20-40 mm; tube straight, widening above, ± annulate c. 14 mm from base; upper lip straight. **Stamens** A. **Nutlets** ± spherical, c. 3.5 x 3 mm. Chromosome count: 2n = 14, 16.

The **pollen** of *S. recognita* is isopolar and oblate with P = 46.85 ± 4.14 µm and E = 50.22 ± 6.09 µm. The aperture is often hexacolpate (rarely octacolpate) and the colpi = 41.48 ± 4.18 x 5.37 ± 0.61 µm. The exine is 1.23 ± 0.20 µm thick and the intine is 0.65 ± 0.12 µm. Its ornamentation is reticulate.

*Fl.* 5-8. Limestone and, igneous slopes and screes in steppe, Quercus scrub, 900-2200 m.
Type: [Turkey B5 Kayseri] Ali-Da, prope Kaiseriam, 1849, Tchihatcheff, (holo. P?).

**Mainly C. Anatolia, rare in S. & E.** A4 Çankiri: Eldivan to Ankara road at the Eldivan dam next to Mavici Çeşmesi, 40 31 331 N 33 27 093 E, 1199 m, 01 vi 2006, SBagherpour 257! A4 Ankara: Kalecik to Akyurt. Pass the rail road on the right side on the bank of the river, 40 08 724 N 33 21 351 E, 1052 m, 7 vii 2005, SBagherpour 154! B5 Kayseri: Ali Mountain, 38 40 437 N 35 33 451 E, 1600 m, 10 vi 2008, SBagherpour 470! B5 Nevşehir: Urgiip, 1300 m, Stainton 8466! B5 Kayseri: Ercies Mountain 2-3 km after ski center on the left side of the road, 38 27 985 N 35 31 101 E, 1833 m, 22 vii 2006, SBagherpour 378! B5 Kayseri: About 6 km N. of Develi, Çamaklı köy, Hills above Çamaklı Çay, 38 27 985 N 35 31 552 E, 1740 m, 22 vii 2006, SBagherpour 380! B6 Adana: Saimbeyli, Maniss. 1007! B7 Tunceli: above Selepur, 1500 m, D. 31607. C4 Icel: 33 km E. of Mut, 1260 m, Hub.-Mor. 9602! C5 Niğde: Ala Da., 1980 m, Wood & Gibson 144! C5 Adana: Ala Da., N. of Pozanti, Bisby’29! To Maraş, c 10 km N. of Andirin, c. 950 m, Sorger 73-1-3-35!

**Endemic. Ir.-Tur. element.** Treat category: **VU**

Characterized by the stem indumentum and large corollas. In the same broad alliance as *S. pilifera*, *S. pinnata* and *S. tigrina*, but clearly differing from them in several features.
Figure 4.4. General appearance of *S. recognita* Fisch. & Mey.

Map 4.3. *S. recognita* distribution map.

Dwarf perennial suffrutiocose herb. **Stems** 5-10 (-15) cm, procumbent, ascending, branched at base, with sterile shoots, retrorsely pilose hairs with sessile glands on stem and inflorescence. **Leaves** trifoliate, lanceolate in outline, with one pair of lateral segments, lateral segments (4-) 6-9 (-11) x 1-2 mm, terminal leaf segment lanceolate, 20-30 (-40) x 3-5 mm, margin entire, slightly involute. **Petiole** 10-20 mm, winged, ciliate. **Inflorescence** racemose, (3-) 5-8 x 2-3 cm, slightly exceeding the leaf level with (3-) 4-5 (-6) verticillasters. **Verticillasters** 2-4 (-6)-flowered. Floral leaves similar to stem leaves. **Bracts** clearly shorter than calyces, lanceolate at base, 8-15 x 2-3 mm, lower bracts up to 40 mm; bracteoles present, lanceolate, (4-) 6-10 (-13) x 1-2 (-4) mm. **Pedicels** 5-9 mm. **Calyx** campanulate, 10-15 mm, up to 17 mm in fruit, (13-) 14 (-15) veined, retrorsely pilose, with sessile glands, violet mainly on upper half, bilabiate, lobes divided to nearly mid length, lower lobe with two teeth, broadly lanceolate, 6-8 mm, upper lobe with small three teeth, triangular 1-2 mm. **Corolla** 15-20 mm, blue, with white spot on lower lip, sparsely villous outside, densely long hairs on outside of upper lip; tube 8-14 mm, non-squamulate, with an annulus in throat; upper lip falcate. **Stamens** A, included upper lip of corolla, staminal connectives shorter than filaments; filaments c. 5 mm, upper thecae 3.5 mm, lower thecae 1-1.2 mm. **Style** 30-35 mm, exerted from corolla lips. **Nutlets** oblong to ovoid, 2.5-4 x 2-2.5 mm, dull green, entire to slightly papillate. Chromosome count: unknown.

The **pollen** of *S. hedgeana* is isopolar and oblate with $P = 46.24 \pm 3.81 \text{µm}$ and $E = 49.30 \pm 3.45 \text{µm}$. The aperture is hexacolpate and the colpi = $38.97 \pm 3.57 \times 5.54 \pm 1.30 \text{µm}$. The exine is $1.62 \pm 0.21 \text{µm}$ thick and the intine is $0.55 \pm 0.06 \text{µm}$. Its ornamentation is bireticulate.

*Fl:* June, limestone slopes and steppe, 1200-1600 m.

**Type Specimen:** [Turkey] B7 Sivas: Divriği, Dumluca dağ, Karasar pass, above Kayaburun village, 1600 m, steppe, 15.6.1995, AAD 4579, slide no: AD 1390, AD 1391 (holo HUB! iso E).
E. & C. Anatolia border. B7 Sivas: Divriği, Dumluca dağı, Karasar pass, above Kayaburun village, S. of Uzunkaya village, N. slopes of hills, 39 16 53 N 38 00 00 E, 1460 m, 6 vi 2006, AKahraman 1159! 4 km from junction of Divriği-Mursal road, 39 15 889 N 38 00 466 E, 1200 m, 2 vi 2008, AKahraman 1521A! above Mursal road, 39 15 572 N 38 00 622 E, 1343 m, 2 vi 2008, AKahraman 1521B!

**Endemic. Ir.-Tur. element.** Threat category: EN

![Figure 4.5. General appearance of S. hedgeana Dönmez.](image-url)

Perennial suffruticose herb with a woody rootstock. **Stems** many, ascending to erect, 15-35 cm, unbranched (rarely branched), grayish-green, dense eglandular antrorsely pilose-pubescent with some villous hairy. **Leaves** pinnatisect with 1-2 pairs of lateral segments, terminal segments linear-oblong, 1.5-5 x 0.3-1 cm, grayish-green, densely eglandular-pubescent to pilose with sessile glands, margins entire to crenulate toward apex, petiole 0.4-2.5 cm, slightly widened at base, dense antrorsely pubescent to pilose with long ciliate hairy. **Inflorescence** racemose, clearly exceeding leaves with 3-6 verticillasters, each **verticillaster** with 2-8 flowered ± distant. **Bracts** ovate to lanceolate, dense white capitate glandular pilose, 4-10 x 2-5 mm. **Bracteoles** present. **Pedicel** 2-5 mm. **Calyx** campanulate, c. 7 mm to c. 11 mm in fruit, eglandular and glandular villous. Corolla lilac-blue with white center, 10-18 mm, tube 10-13 mm straight, annulate upper lip straight. **Stamens** A, staminal connectives shorter than filaments, upper theca 1.9–2.7 mm, the lower theca 1–1.3 mm, filaments c. 2.7–3.2 mm. **Style** glabrous, 16–20 mm long, exerted from corolla lips and divided in two part at apex. **Nutlets** rounded-trigonious and suboblate, dark brown, c. 3.15 - 4 x 2.5 - 3 mm, surface slightly tuberculate. Chromosome count: Unknown.
The **pollen** of *S. freyniana* is isopolar and oblate-spheroideal to prolate-spheroideal with $P = 42.10 \pm 8.87 \, \mu\text{m}$ and $E = 39.17 \pm 6.61 \, \mu\text{m}$. The aperture is hexacolpate and the colpi are long $C = 37.38 \pm 7.59 \times 4.28 \pm 0.85 \, \mu\text{m}$. The exine is $1.02 \pm 0.09 \, \mu\text{m}$ thick and the intine is $0.62 \pm 0.09 \, \mu\text{m}$. Its ornamentation is bireticulate.

Fl. 6. *Dry sandy calcareous slopes 1082m.*

Type: [Turkey B5 Kayseri/Yozgat] inter Caesaream (Kayseri) et Yosgad (inter pagos Köprüköi et Keller), 900-1100 m, 23 vi 1890, Bornmüller 1730 (iso. BM! G! K! LD! W! Z!).

The first specimens belonging to *S. freyniana* Bornm. were collected by J.F.N. Bornmüller from Yozgat B5 near Köprüköi et Keller in 1890 and than described as a new species in 1892. Near yenipazari at the village of Kaşkışla on sandy hillsides above the village cemetery, 39 30 553 N 35 06 970 E, 1082 m, 04 vi 2006, SBagherpour 277.

Endemic. Ir.-Tur. element. A rather problematical species, known only from one location (CR). Apparently closest to *S. wiedemannii* but differing by softer indumentum, larger sometimes serrulate terminal leaflet and campanulate calyx.

**Endemic. Ir.-Tur. element.** Treat category: **CR**

![Figure 4.6. General appearance of *S. freyniana* Bornm.](image)
Map 4.5. *S. freyniana* distribution map.


Dwarf suffruticose perennial forming mats to c. 60 cm diam. **Stems** procumbent to ± erect, eglandular pubescent below, pubescent to villous above with some capitate glandular hairs. **Leaves** pinnatisect, obovate in outline, crenate, terminal segments ± lanceolate, 0.6-3 x 0.1-1 cm, with 2-4-pairs of lateral ± oblong segments; **petiole** 0.5-2 cm, often long-ciliate. Racemes condensed, scarcely exceeding leaf level. **Verticillasters** 2-6-flowered. **Bracts** ovate, acuminate, 11-15 x 5-12 mm; **bracteoles** present. Pedicels 3-6 mm. **Calyx** campanulate, often purplish, 10-16 mm, to 18 mm in fruit, indumentum variable, from eglandular pilose/villous with sessile glands to densely capitate-glandular. **Corolla** violet-blue to lilac-pinkish (rarely white), 18-30 mm; tube straight, 11-20 mm annulate. **Stamens** A. **Nutlets** rounded trigonous, ± spherical, 2.7 x 2.5 mm. Chromosome count: 2n = 14.

The **pollen** of *S. caespitosa* is isopolar and oblate with P = 43.95 ±3.92 μm and E = 49.85 ±5.40 μm. The aperture is hexacolpate and the colpi = 38.59 ±3.35 x 5.27 ±0.82 μm. The exine is 1.33 ±0.15 μm thick and the intine is 0.83 ±0.15 μm. Its ornamentation is bireticulate.

*Fl. (5- )6-7. Rocky limestone and igneous slopes, terraces, 1400-2700 m.*
Type: [Turkey B6 Sivas] in Monte Saru-tchitchek (Sarıçiçek) in Cappadocia Orientali, Montbret [2015] (iso. W!).


Close to *S. pachystachys*. A variable species in leaf shape, indumentum and flower color. In this and the following species, indumentum characters have been unduly emphasized in the past; in the same population there may occur glandular and eglandular forms or strongly villous/ pilose and sub glabrous forms.

**Endemic. Iran Turan Element.** Treat category NT
Figure 4.7. General appearance of *S. caespitosa* Montbret & Aucher ex Bentham.


Perennial suffruticose herb. **Stems** ± erect, 15-30 cm, usually branched above, eglandular-scabridulous with short or longer often antrose white hairs and some sessile glands. **Leaves** pinnatisect with two pairs of lateral segments, terminal segment linear-oblung to linear-ovate, 1-3(-4) x 0.1-0.6(-1) cm, eglandular with very short antrose hairs, depressed punctate, margins entire; petiole 0.2-1 cm, long-ciliate. **Verticillasters** 2-8(-10)-flowered, ± approximating. **Bracts** ovate, 2-10 x 1-5 mm; **bracteoles** present. **Pedicels** 2-5 mm. **Calyx** reddish-purple, tubular-campanulate to campanulate, 6-14 mm, to 10-15 mm in fruit, villous with many sessile glands. **Corolla** lilac-blue, 12-22 mm; tube c. 12 mm, annulate; upper lip straight. Stamens A. **Nutlets** rounded trigonous, oblong, c. 3 x 2 mm. Chromosome count: 2n = 14, 15, and 16.

The **pollen** of *S. wiedemannii* is isopolar and prolate-spheroidal with P = 43.81 ±5.84 µm and E = 42.21 ±3.76 µm. The aperture is hexacolpate and the colpi = 37.29 ±5.92 x 4.37 ±0.72 µm. The exine is 1.19 ±0.26 µm thick and the intine is 0.63 ±0.13 µm. Its ornamentation is bireticulate.

**Fl. 5-7. Limestone slopes, in Artemisia steppe with Pinus nigra, roadsides and fieldsides, 500-1400 m.**

Type: [Turkey A3 Ankara] prope Kadikioi, Wiedemann [340] (holo. G!).

C. (western) Anatolia.

A3 Ankara: Beypazari, Elma Beli, 40 10 289 N 31 51 520 E, 741 m, 04 vi 2005, SBagherpour 117! A3 Ankara: Fasil Dorugu Sariyar above Hassan polatkan dam. 40 02 542 N 31 26 735 E, 598 m, 31 05 2006, SBagherpour 237! A4 Ankara: 13 km E. of Beypazari, 700 m, Sorger 73-42-9! A4 Ankara to polatli, 20 km past ümitköy, 500 m to Başkent organize sanayi. 39 45 699 N 32 27 646 E, 822 m, 31 v 2006, SBagherpour 216! A4 Ankara: 21km past polatli, 39 34 541 N 31 55 304 E, 751 m, 10 v 2008, SBagherpour 413! B3 Eskişehir: 20 km past Alpu, toward Mehiliççik, hills above old Osmanli symmetry, 39 49 102 N 31 09 677 E, 849 m, 11 v 2008, SBagherpour 418! B3 Kütahya: 38 km from Kütahya to Eskişehir, 900 m, Hub.-Mor. 12718! Eskişehir: m Balcihisar, 950 m, D. 37182! B4 Ankara: m Tatlikuyu, Haymana to Sivrihisar, 800 m, Demiriz 2943! B4 Sivrihisar 10 km to
Beylikova, 39 37 053 N 31 09 018 E, 888 m, 31 v 2006, SBagherpour 231! B4 Konya: 28 km from Sarayonu to Cihanbeyli, 830 m, Hub.-Mor. 14207.

Closest to S. pisidica but margins of leaflets always entire.

**Endemic. Ir.-Tur. element.** Treat category: **VU**

![General appearance of S. wiedemannii Boiss.](image)

**Figure 4.8.** General appearance of *S. wiedemannii* Boiss.

![Distribution map](image)

**Map 4.7.** *S. wiedemannii* distribution map.

Perennial suffrutiocose herb. Sterile stems prostrate, leafy; fertile stems procumbent-ascending, unbranched, 10-20 cm, eglandular-pubescent with sessile glands, hairs ± retrorse. Leaves trisect or pinnatisect with 2 pairs of lateral segments, terminal segment linear oblong, 0.7-2.5 x 0.1-0.6 cm, glabrescent with sessile glands, entire or terminal segment apically toothed; petiole 0.3-0.8 cm, ciliate. Inflorescence a condensed ± dense 'spike'. Verticillasters 2-6(-8)-flowered. Bracts ovate-acuminate 6-16 x 4-7 mm; bracteoles present. Pedicels 3-4 mm. Calyx tubular-campanulate, 8-11 mm, to 9-12 mm in fruit;" puberulent-ciliate with sessile glands. Corolla not squamulate, light violet to white, 10-15 mm; tube 7-10 mm, annulate; upper lip ± straight. Stamens A. Nutlets rounded trigonous, ovoid, c. 3 x 2.3 mm. Chromosome count: 2n=18.

The pollen of *S. tchihatcheffii* is isopolar and oblate-spheroidal to prolate-spheroidal with \( P = 41.56 \pm 7.11 \, \mu m \) and \( E = 40.55 \pm 6.89 \, \mu m \). The aperture is hexacolpate and the colpi are long \( C = 36.57 \pm 5.18 \times 3.39 \pm 0.76 \, \mu m \). The exine is 1.21 ±0.20 \, \mu m thick and the intine is 0.73 ±0.17 \, \mu m. Its ornamentation is reticulate.

*Fl. 5-6. Limestone slopes, Pinus brutia woodland, vineyards, 400-1200 m.*

Type: [Turkey B4 Ankara] [in vallibus herbosis sylvaticis montis] Kure-dagh (Galatia), 950 m, Tchihatcheff (G!).

C. (western) Anatolia. A3 Eskişehir: Mayislar, 400 m, Ekim 201! A4 Çankiri: 7 km S. of Çankiri,670 m, Simon 69-403! A4 Ankara: Ankara ODTU. 39 51 586 N 32 47 481 E, 972 m, 24 v 2005, SBagherpour 102! A4 Ankara: Ankara to Kızılaahamam, 2 vi 1953, Çetik! B2 Kütahya: Kütahya to Bozüyük, 22 km S. of Inonu, 950 m, Hub.-Mor. l2720! B3 Eskişehir: Eskişehir to Kütahya, 880 m, Demiriz 1780! B3 Kütahya: 40 km from Kütahya to Eskişehir, 930 m, A. Bay top (ISTE 25368)! B4 Ankara: Polatlı to Haymana, 1100 m, Kasapligil 350!
Endemic. Ir.-Tur. element. Distinctive among the suffruticose pinnatisect leaved species on account of the spike-like inflorescence, puberulent-ciliate calyces and small corollas.

**Endemic. Ir.-Tur. element.** Treat category: **VU**

**Figure 4.9.** General appearance of *S. tchihatcheffii* (Fisch. & Mey.) Boiss.

**Map 4.8.** *S. tchihatcheffii* distribution map.

Perennial herb, somewhat suffruticose at base. **Stems** many, ascending, 30-60 cm, branched above, often yellowish-green, usually glabrous, occasionally pilose. **Leaves** pinnatisect, with 2-3 (-4) pairs of smaller lateral segments, ovate in outline, terminal segment lanceolate, 2.5-5.5 x 0.5-2 cm, pilose on veins with 2-3 (-4) pairs of smaller lateral segments, pilose on veins with some sessile glands, serrulate to serrate. **Petiole** 1-3 cm. **Inflorescence** paniculate. **Verticillasters** 2-8 (-10)-flowered, distant. **Bracts** shorter than calyces, ovate-acuminate, 8-17 x 4-8 mm; bracteoles present. **Pedicels** 3-8 mm. **Calyx** campanulate, 10-12 mm, to c. 15 mm in fruit and broadening, sub glabrous to pilose-villous with dark sub sessile glands; upper lip tridentate. **Corolla** sulphur yellow or with lilac coloration, 22-25 (-28) mm, simple hairs on outside of upper lip; tube c. 15 mm, annulate; upper lip ± straight. **Stamens** A, included upper lip of corolla, staminal connectives shorter than filaments. **Nutlets** rounded trigonous, ovoid, 4.5 x 3.5 mm. Chromosome count: Unknown.

The **pollen** of *S. suffruticosa* is isopolar and prolate-spheroidal with \( P = 45.76 \pm 4.78 \mu m \) and \( E = 44.01 \pm 4.21 \mu m \). The aperture is hexacolpate and the \( \text{colpi} = 38.79 \pm 5.21 x 4.56 \pm 1.11 \mu m \). The exine is 1.22 ± 0.19 \( \mu m \) thick and the intine is 0.79 ± 0.17 \( \mu m \). Its ornamentation is bireticulate.

*Fl. 4-7, banks in steppe, fallow fields, cornfields, vineyards, 300-2000 m.*

**Type Specimen:** [Turkey B6 Maraş] ad Akdog in Tauro Orientalis, [1834], Aucher [2131] (holo. G, iso. W! K!).

**Inner Anatolia (mainly eastern and southern parts).** A4 Çankırı: Kalecik to Çankırı, D. 21453. B4 Ankara: Middle Technical University, next to indoor swimming pool, 39 51 586 N 32 47 481 E. 972 m, 10 v 2005, SBagherpour 104!, Mamak, foots of Hüseyingazi hills, 1000 m, 19 v 1980, K. Alpinar 52401 (ISTE!).

In its most typical form, *S. suffruticosa* is characterized by the large yellow corollas, the almost glabrous stems and pinnatisect leaves. It is, however, variable in bract size, number of flowers to the verticillasters and the density and type of calyx indumentum. Color variants in which lilac is present may indicate hybridization with *S. bracteata* (see below).
Figure 4.10. General appearance of *S. suffruticosa* Montbret & Aucher ex Bentham.
Map 4.9. *S. suffruticosa* distribution map.


Perennial shrub **stems** much branched, 25-50 cm, to1.5 m. Young shoots ± erect, leafy, pilose and villous with some sessile glands below, short hairs ± retrorse, glandular-pilose to -villous above with capitate glandular hairs. **Leaves** trisect, terminal segment much larger than laterals, broadly elliptic to obovate, 1-2.6 (-3) x 0.5-1.8 cm, glabrous, pubescent and villous with numerous sessile glands to glabrescent, serrulate to crenulate; **petiole** 0.4-1.8 cm, long ciliate. **Inflorescence** ca. 5-10 cm long. **Verticillasters** 2-6-flowered, forming an ovoid or elongated oblong spike. Bracts ovate-acuminate, often tinged reddish-purple, c. 20-35 x 7-12 mm; **bracteoles** present. **Pedicels** 1-4 mm. **Calyx** ± tubular infundibular, 14-17 mm, **scarcely accrescent** to 16-20 mm in fruit, often purplish, glandular-ciliate, bilabiate, upper lip tridentate, ovate-lanceolate, acute to acuminate, median tooth shorter. **Corolla** blue-purple, (20-) 25-35 mm; tube straight and gradually wider towards throat c. 20 mm, not squamulate, annulate. **Stamens** A. Anther 3-4 mm, upper theca ca. 3 mm, lower theca ca. 1 mm, filaments ca.
5-6 mm. **Nutlets** rounded, oblong, c. 4 x 3 mm, brown. Chromosome count: \(2n = 14, 15, 16\).

The **pollen** of *S. heldreichiana* is isopolar and oblate with \(P = 49, 61 \pm 1, 83 \mu m\) and \(E = 52, 39 \pm 4, 74 \mu m\). The aperture is hexacolpate and the colpi = 41, 16 \pm 1, 74 x 4, 08 \pm 0, 52 \mu m. The exine is 0, 81 \pm 0, 08 \mu m thick and the intine is 0, 68 \pm 0, 08 \mu m. Its ornamentation is bireticulate.

*Fl. 6-8. Limestone slopes, with Pinus nigra and Quercus, screes, fieldsides, 900-2000 m.*

Syntypes: [Turkey C5 Icel] in monte Tauro prope Güllek Bogas, Kotschy 437 (G!); [Turkey B4 Konya] in collibus aridis Lycaoniae ad Karaman, Heldreich (G!).

**Mainly S. Anatolia.** B/C3 Isparta: Sarkikaraagac to Beyşehir, Sezik & Cubukcu 14! B3 Isparta: Sarkikaraagac, Kale Da., 1250 m, Simon 75-079. B4 Ankara: Elma dağ on the road to kırıkkale, 39 55 346 N 33 15 826 E, 1084 m, 05 vii 2005, SBagherpour 136! C3 Konya: 19 km from Sarkikaraağaç to Beyşehir, 1100 m, Hub.-Mor. 8380! Isparta: 17 km S.W. of Sarkikaraagac, 1350 m, Sorger 66-44-18! C4 Konya: Karaman to Mut, 11 km S. of Karaman, 1350 m, Hub.-Mor. 17190! Icel: 33 km W. from Silifke to Gülner, c. 900 m, Hub.-Mor. 9590! C5 Adana: d. Karaisali, Pozanti to Asmancık Y., 1230 m, Hub.-Mor. 15299! Niğde: 20 km from Ulukisja, 12 vi 1937, Reese! Konya: d. Eregli, Aydos Da., 1700 m, Erik 2445!

Distinctive among this group of trifoliate-pinnatisect species on account of the shrubby habit, large terminal leaflets, large usually colored bracts and spike-like inflorescences.

**Endemic. E. Medit. element.** Treat category NT
Figure 4.11. General appearance of *S. heldreichiana* Boiss. Ex Bentham.

Map 4.10. *S. heldreichiana* distribution map.
Perennial herb, somewhat suffruticose at base. **Stems** several, branching above, 20-50 cm, often purplish, ascending or erect, densely glandular pilose-villous, sometimes with long eglandular-villous hairs. **Leaves** pinnatisect, with an ovate to oblong terminal segment 1-7 x 0.7-3.5 cm and 1-2 pairs of smaller lateral segments, ± densely eglandular-glandular and sessile gland present pilose, serrulate; petiole 1-5 cm, sparsely ciliate. **Inflorescence** paniculate. **Verticillasters** 5-10-flowered, distant, ± enclosed by sub membranous floral leaves, c. 15-30 x 9-17 mm. **Bracts** many 0.9-3.2 x 0.5-2.0 cm, purplish; **bracteoles** present. **Pedicels** 1-5 mm. **Calyx** tubular-infundibular, 5-16 mm, scarcely expanding in fruit, glandular-villous. **Corolla** pink to purplish, 20-30 mm; tube 14-20 mm, irregularly annulate; upper lip straight. **Stamens** A. **Nutlets** ± spherical, C. 3.5 x 3 mm. Chromosome count: Unknown

The **pollen** of *S. bracteata* is isopolar and oblate with P = 41.73 ± 1.72 µm and E = 47.77 ± 5.89 µm. The aperture is hexacolpate and the colpi = 34.92 ± 2.20 x 5.81 ± 2.26 µm. The exine is 1.42 ± 0.19 µm thick and the intine is 0.65 ±0.12 µm. Its ornamentation is reticulate.

**Fl.** 5-7. *Igneous and calcareous slopes, with Quercus brantii, fallow fields, edge of vineyards, roadsides, waste places, 2000 m.*

Type: [Syria] Aleppo, Russell.

**Widespread, especially in Anatolia.** A1 (E) Tekirdag: Çorlu to Seymen, 50 m, Dudley (D. 34500)! A2(A) Bilecik: Beldos nr Bilecik, 500 m, Bornm. 1899:5426! A4 Ankara: Ayaş road around Ayaş beli, 40 01 371 N 32 20 482 E, 1052 m, 04 vi 2005, SBagherpour 107! A4 Cankiri: Eldivan exiting city limit 1km to Sarayköy, 40 31 756 N 33 29 205 E, 991 m, 01 vi 2006, SBagherpour 254! A5 Amasya: nr Merzi-fon, Maniss. 504! A6 Tokat: Tokat, Wiedemann! A7 Sivas: Suşehri to Refahiye, 1580 m, Hub.-Mor. 11861! A8 Erzurum: nr Ispir, Bourgeau 1862:217! B2 Kütahya: 8 km from Simav to Gediz, 900 m, Demiriz 2095! B3 Afyon: 6 km from Dinar to Denizli, Hub.-Mor. 5198! B3 Eskişehir: Sivirhisar 72 km to Eskişehir, 39 29 303 N 31 16 380 E, 1018 m, 31 v 2006, SBagherpour 229! B4 Ankara: Ankara, Freres E.C. 48! B5 Nevşehir: 8 km S.E. of
Palestine, Syrian Desert, N. Iraq, N.W. & W. Iran. **Ir.-Tur. Element.** Threat category: **LC**

Characterized by the large colored floral leaves, numerous bracts and pink to purple corollas. A relatively constant species in most of Anatolia, but variable in the S.E. (e.g. C7, C8) where it intergrades with *S. trichoclada*. *S. bracteata* forms fertile hybrids with the clearly distinct *S. suffruticosa* (e.g. B7 Elazig: Elazig to Pertek, 1300 m, D. 29191!). Sex forms are also not uncommon.
Figure 4.12. General appearance of *S. bracteata* Banks & Sol.
Map 4.11. *S. bracteata* distribution map.


Perennial herbs, somewhat suffrutioue at base. **Stems** several, 35-50 cm, often purplish, ascending or erect, the indumentum which consists entirely of short crisp egladular hairs ± uniform in length. **Leaves** pinnatisect, with an ovate-oblong terminal segment c. 3.5 x 1.5 cm and 1-2-pairs of smaller lateral segments 2.5 x 0.7cm, ± densely egladular-pilose with some sessile glands, serrulate; petiole 1-2 cm, sparsely ciliate. **Inflorescence** paniculate. **Verticillasters** 4-8-flowered, distant, ± enclosed by submembranous floral leaves, c. 15-30 x 9-17 mm. **Bracts** many, purplish; bracteoles present. **Pedicels** c. 2 mm. **Calyx** tubular-infundibular, c. 10 mm, scarcely expanding in fruit, glandular-villous. **Corolla** pink to purplish, c. 15 mm; upper lip straight. **Stamens** A. **Nutlets** unknown, c. 3.5 x 3 mm. Chromosome count: unknown.

Pollen description: unknown.

FL.6. *Igneous and calcareous slopes, fieldsides, 700-1400 m.*

Type: [Turkey A6 Tokat] 15 km N Tokat, gegen Artova, c. 1400 m, 14.vi.1939, H.Reese (holo. Hb. Hub.-Mor.) (G-00000038) photo!

Central Anatolia. A3 Ankara: Beypazari, Elma beli, 700 m, Yamane 957 (ANK)!

Endemic. Irano-Turanian element. Treat category: EN
This species is known only these two localities. Similar to *S. bracteata* in facies, vegetative and floral structure but differing by the indumentum which consists entirely of short crisp eglandular hairs ± uniform in length. During the last three years field work this specimen was not found.

**Figure 4.13.** General appearance of *S. reeseana* Hedge & Hub.-Mor. holotype (Huber-Morath Herbarium)
4.2.2 Section *Hymenosphace* Benth.:

Shrubs, chamaephytes or perennial herbs. Calyx strongly accrescent. Otherwise similar to Sect. *Salvia*.

Species for Sect. *Hymenosphace*:


Perennial herb with a woody rootstock. **Stems** few or many, ascending to erect, usually unbranched or rarely branched, (8) 20- 35 cm, densely (or not) glandular pilose and eglandular villous. **Leaves** mostly basal, ovate, ovate-oblong to elliptic, obovate, simple or with 1-2 pairs of small lateral segments, 10-50 x 5-35 mm, rugulose, crenulate, densely (or not) eglandular villose and glandular pilose with sessile glands; petiole 1.0 – 5 (6) cm. **Inflorescence** racemose, (7) 10-30 cm long, clearly exceeding leaves with 4 – 8 (9) verticillasters, each verticilasters with 2–10 (12) flowered; internodes 1.5 – 4 cm long. **Bracts** broadly ovate - acuminate, 1.0 – 2.1 x 1.4 – 2 cm, green, villose and glandular pilose hairy with sessile glands. **Pedicels** 2-4 mm. Calyx campanulate, 12 – 20
mm, up to 28 mm in fruit, mainly green (or rarely purplish green), eglandular-glandular villose and glandular pillose with sessile glands, broadening and membranous with increasingly divergent lips in fruit; upper lip subentire. Corolla entirely white (with yellow spotted lower lip), 27 – 33 mm, sparsely villose and glandular hairy outside, not squamulate; tube 17 – 25 mm, straight below, gradually widening above, annulate. 

**Stamens** type A; staminal connectives shorter than flaments; upper theca 2-3 mm; the lower theca 1.5 – 3 mm; connective 4 – 6 mm. Style tip white, glabrous, 25 – 32 mm, long exerted from corolla lips and divided in two part at apex. Nutles globose, 3-3.5 x 2-3.2 mm, brown and smooth to slightly tuberculate. Chromosome count: 2n=14, 16.

The pollen of *S. cadmica* is isopolar and oblate with $P = 49.36 \pm 3.99 \mu m$ and $E = 51.44 \pm 3.82 \mu m$. The aperture is hexacolpate and the colpi = 44.14 ±3.92 x 8.20 ±0.64 μm. The exine is 1.34 ±.12 μm thick and the intine is 0.62 ±0.01 μm. Its ornamentation is bireticulate.

Lectotype: [Turkey C2 Denizli] in Cadmo orientali (Honaz Da.) supra Colossam (Honaz), vi 1842, Boissier (holo. G! iso. W!).

**N.W., C. & S.W. Anatolia.** A3 Sakarya: Therakli (Taraklı), Wiedemann. A4 Ankara: Ayaş Da., 1500 m, Akman 6636! B2 Eskişehir: Beylikova 7-8 km to Miheliçik off the main road from Beylik 500m to Kayıköy, 1070 m, 31 v 2006, SBagherpour 233! Uşak: Murat Da., nr Gürlek, 1100 m, A. Baytop (ISTE 39430)! B3 Konya: Sultan Da., 1100m, Bornm. 1899:5427! Eskişehir: 13 km from Sivrihisar to Haymana, 1120 m, Demiriz 2973! Afyon: d. Dinar, Karakuyu, 1000 m, Hub.-Mor. 9595! Bilecik: Karakoy, 21 v 1950, Heilbronn & Attila! B4 Ankara: Elmadağ befor Odtü Kayak merkezi roadside, 39 49 255 N 32 57 707 E, 1468 m, 09 vi 2005, SBagherpour 125! B4 Ankara: Haymana 35km to Polatlı just few km past Haymana, 39 28 205 N 32 27 888 E, 1004 m, 14 v 2007, SBagherpour 391! C2 Mugla: Ujuklu (Oyuklu) Da., 14 vi 1881, Luschan (type of *S. conradi*, as *S. lycia* Stapf, nomen)! Denizli: HonazDa., 1300 m, Hub.-Mor. 5192! C3 Burdur: 16 km from Burdur to Antalya, 1300 m, Dudley (D. 35673)! Antalya: İrmasan Gedigi, N. of Akseki, 1810 m, Nydegger 10851. Isparta: E. bank of
Egridir G., 1060m, Hub.-Mor. 8377! C4 Kenya: Dere Koy, 10 km W. of Konya, 1300m, Hub.-Mor. 8376!

Endemic. Characterised by the dwarf habit, usually entire leaves, long spreading glandular indumentum and the yellow-green, large fruiting calyces. Close to *S. smyrnaea* which is very similar in habit but apparently differing in calyx structure.

**Endemic. Ir.-Tur. element.** Threat category **NT**

![Image](image1.jpg)

**Figure 4.14.** General appearance of *S. cadmica* Boiss.


Perennial herb, woody at base. **Stems** ascending-erect, 10-30 cm, densely glandular-villous, clothed at base with petiolar remains. **Leaves** mostly basal, pinnatisect, oblong in outline, glandular-villous, with 3-5 pairs of lateral segments; terminal segment oblong-elliptic, serrate to serrulate, sessile, 10-22 x 4-8 mm; **petiole** to 10-50 mm. **Verticillasters** (2-)4c6-flowered, ± distant. **Bracts** of median verticillasters broadly ovate, c. 1.2-4 x 0.8-2 cm, cordate. **Pedicels** 0-3 mm. **Calyx** broadly infundibular, 12-24 mm, green or purplish-suffused, to c. 26 mm in fruit, with divergent lips, densely glandular-villous; upper lip subentire or indistinctly 3-toothed. **Corolla** not squamulate, white with a pale yellow upper lip and violet veined labellum, 27-50 mm; tube to 30 mm, broad, annulate. **Stamens** A. **Nutlets** very rounded trigonous, broadly obovate, c. 4.5 x 3.5 mm. Chromosome count: 2n=14.

The **pollen** of *S. blepharochlaena* is isopolar and oblate with $P = 55.71 \pm 7.35 \mu m$ and $E = 58.37 \pm 3.88 \mu m$. The aperture is hexacolpate and the colpi = 47.33 $\pm$ 6.78 x 5.98 $\pm$ 2.32 $\mu m$. The exine is 1.37 $\pm$ 0.13 $\mu m$ thick and the intine is 0.73 $\pm$ 0.10 $\mu m$. Its ornamentation is bireticulate.

*Fl. 6-7. Limestone and serpentine slopes, 1000-1620 m.*

C. Anatolia. B4 Eskişehir: 5 km E. of Sofular, 1500 m, Sorger 64-20-l! B5 Nevşehir 8 km N.W. of Urgüp, 1000 m, Sorger 73-39-24! B5 Urgup: Karlik to Yesiloz, on the hills to the right. 38 33 195 N 34 59 481 E, 1304 m, 29 v 2008, SBagherpour 447! B6 Sivas: Gurun to Sivas, 58 km N. of Gurun, 1450 m, Hub.-Mor. 11858! B6 Kayseri: Sariz to Pinarbaşı, Sopan Da., 15 km S. of Pinarbaşı, 1620 m, Hub.-Mor. 1077! B6 Pinarbaşı: 2km south of A. Baycayri, 38 38 800 N 36 26 605 E, 1032 m, 08 vi 2006, SBagherpour 321! C4 Konya: 10 km S. of Karaman on road to Mut, 14 vi 1950, Reese!

A very handsome plant" with similarities to S. cadmica and S. pachystachys. From the former it differs by its constantly pinnatisect leaves and larger tri-coloured corollas; from the latter, it differs by the densely glandular-villous indumentum covering the whole plant and the very large fruiting calyces.

Endemic. Ir.-Tur. element. Treat category: VU
Figure 4.15. General appearance of *S. blepharochlaena* Hedge & Hub.-Mor.

Tuft-forming aromatic perennial suffruticose herb. **Stem** ascending erect, glandular pilose to villous hairs, rarely eglandular, 25-50 (-60) cm, branched below, with sterile shoots. **Leaves** simple, ovate-oblong to elliptic, (1.5-) 2-7.5 x (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, shorter than calyces, 10-25 (35) x 10-23 (30) 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) x (10)15-20 (23) mm in flowering, broadening and expanding to 17- 25 (40) x 17-25 (45) mm in fruit, fruiting calyces membranous. **Corolla** violet-blue to pinkish, 25-30 (40) mm, with simple hairs on outside of upper lip; tube 21-30 mm, slightly curved and widening towards throat ± annulate. **Stamens** A, staminal connectives shorter than filaments, filaments 4-6.8 mm, fertile anters hairless, 2.5-4.1 mm and sterile anters 1.2-2.1 mm; upper thecae 2.2-4 mm
and lower thecae 2-3.7 mm. Style (26-) 30-40(-44) mm, exserted from corolla lips Nutlets brownish to blackish, suboblate to rounded trigonous, 4.3-5.4 x 3.5-4.5 mm, hilum diameter 1-1.4 mm. Chromosome count: 2n=14.

The pollen of *S. euphratica* is isopolar and prolate with $P = 54.25 \pm 8.68 \mu m$ and $E = 49.59 \pm 6.60 \mu m$. The aperture is hexacolpate and the colpi $= 45.17 \pm 8.89 \times 3.70 \pm 1.13 \mu m$. The exine is $1.47 \pm 0.22 \mu m$ thick and the intine is $0.68 \pm 0.17 \mu m$. Its ornamentation is bireticulate.

*Fl*: 3-5. Rocky, marly banks and river fronts. 850-1800 m.

**Syntypes.** [Turkey] B7 Malatya: in Cappadocia orientale (Aucher no. 1516 holotypes G!)

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

B6 Malatya: Darende to Malatya, after 1-1.5 km from the exit of Darende, 1000 m, A.Kahraman 1098A! Sivas: Gürün to Gökpınar, after 9 km from Gürün, 1525 m, A.Kahraman 1226A! B7 Malatya: Beydağı Mountain, between Gündüzbey and Kozluk, 1400 m, A.Kahraman 1116! between Arapkir and Divriği, near Çiğnir village, 1268 m, 25 vii 2008, A.Kahraman 1585B! Sivas:Divriği to Kangal 10 km to Kangal, 1450 m, 13 vii 2005, SBagherpour 192! Erzincan: Kemaliye (Taş Yol), near Gümüşçeşme village, around Fırat river, 1120 m, FCelep 883B!


*Salvia euphratica* var. *leiocalycina* differs from the typical variety of the species by having glabrous inflorescence, bracts and calyx. As well as, its bracts are usually longer than calyx and stems sometimes glabrous. According to our field observations, its calyx length is larger than the typical variety in the same populations. The field notes of A. Kahraman 1226 B are “bracts shorter than calyx” from Sivas-Gürün.

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

B6 Malatya: From Malatya to Darende, before 64 km from Darende and 2 km from Develi village, 1325 m, A.Kahraman 1216! Sivas: Gürün to Gökpınar, after 9 km from Gürün, 1525 m, A.Kahraman 1226B! B7 Malatya: From Malatya to Yeşilyurt, after 1.5 km from the exit of Beydağları, 950 m, A.Kahraman 1114A! between Arapkir and Divriği, near Çiğnır village, 1268 m, 25 vii 2008, AKahraman 1585B! Sivas: between Karasarbeli pass to Kayaburun village, 1505 m, A.Kahraman 1155B! Erzincan: Kemaliye (Taş Yol), near Gümüşçeşme village, around Fırat river, 1120 m, F.Celep 883A!

**Endemic. İran-Turan.** Treat category NT

*Figure 4.16.* General appearance of *S. euphratica* Montberet & Aucher ex Bentham var. *euphratica.*
Figure 4.17. General appearance of *S. euphratica* Montberet & Aucher ex Bentham var. *leiocalycina* (Rech.) Hedge.

Map 44.15. *S. euphratica* var. *euphratica* (★), and var. *leiocalycina* (■) distribution map.

Perennial herb, mat-forming, with a woody rootstock. **Stems** erect, unbranched, 12-55 cm, usually glandular-pilose to -villous, especially above, rarely glabrous, rarely with dendroid hairs. **Leaves** simple, mostly with 1-2-pairs of small basal lobes, broadly ovate-elliptic to suborbicular, 2-4.5(-7) x 1-4.7 cm, rugose, crenulate, with a dense indumentum of ± adpressed dendroid to dendroid-stellate hairs; petiole 1.5-6.5 cm. **Verticillasters** 4-10(~20)-flowered, usually-distant. Bracts broadly ovate, c. 4 x 25 mm; **bracteoles** present. **Pedicels** 1-5 mm, erecto-patent. **Calyx** campanulate, c. 8-27 mm, to C. 32 mm in fruit and broadening, sparsely to densely glandular-pilose or -villous, purplish-violet, rarely yellow-green; upper lip indistinctly 3-lobed. **Corolla** purplish-violet, rarely white, c. 10-18 mm; tube ± straight, c. 12 mm, annulate, not squamulate; upper lip ± straight. **Stamens** A. **Nutlets** rounded trigonous, 3.5 x 3 mm, dark brown. Chromosome count: 2n = 16, 18, 32.

The **pollen** of *S. multicaulis* is isopolar and prolate-spheroidal with $P = 41.34 \pm 7.81 \mu m$ and $E = 39.53 \pm 5.41 \mu m$. The aperture is hexacolpate and the colpi = 36.00 ±6.90 x 4.58 ±1.15 \mu m. The exine is 1.10 ±0.15 \mu m thick and the intine is 0.68 ±0.13 \mu m. Its ornamentation is bireticulate.

Fl. 4-7. Rocky limestone and igneous slopes, shale and sandy slopes, scree, fallow fields, in Quercus scrub, Artemisia steppe, amongst Cedrus, 550-2600 m.

Type: ‘Hab. in Oriente. Ex. Herb. Desfontainii’ (holo. C-Vahl!).

**E. & adjacent C. & S. Anatolia.** A6 Sivas: Yıldızeli to Çamlılıbeli, At the peak, below radio tower, 39 49 217 N 36 19 432 E, 1323 m, 12 vii 2005, SBagherpour 180! A7 Gümüşane: Gümüşane, 1400 m, Stainton 8323! A8 Erzurum: 27 km from Erzurum to Tortum, 1950 m, D. 47529! A9 Kars: W. Of Kağızman (Grossheim 7: map 449). B5 Kaysri: d. Develi, Bakirdağ to Saimbeyli, 1640 m, Hub.-Mor. 10745! B6 Sivas: Gürün
to Sivas, 17 km N. Of Gürün, 1680 m, Hub.-Mor. 11876! B6 Sivas: Ulaş, Tecer mountains, 2 km East of Tecerköy between the road and the railroad, 39 24 056 N 37 06 678 E, 1422 m, SBagherpour 432! B7 Malatya: Malatya to Pütürge, Kube Da., 1730 m, Hub.-Mor. 8975! B8 Erzincan: Tercan to Aşkale, 1600 m, D. 29341! B9 Van: 7 km from Van to Erçek, 1850 m, D. 44260! C5 Adana: d. Feke, Bakır Da., 1900 m, D. 19410! C6 Adana: d. Osmaniye, Yarpuz, 1600 m, Hub.-Mor. 14208! C7 Malatya: 74 km S.W. of Malatya, 1550 m, Sorger 71-45-25! C7 Şanlıurfa: Viranşehir, 61 km to Şanlıurfa, inside the pistation trees, 37 13 516 N 39 23 325 E, 657 m, 16 v 2008, SBagherpour 426! C8 Mardin: 10 km from Gerçüş to Hasankeyf, 750 m, D. 43011! C9 Mardin: Cudi Da. Above Hessana, 1300 m, D. 42841! C10 Hakkari: Zap river nr turning to Yüksekova, Trelawny 1307!

Varying considerably in leaf and stem indumentum ; specimens with the most clearly dendrois-stellate hairs are apparently from the most arid environments. A characteristic and often common stepe species of E. Anatolia. The bracts, calyces and flowers are generally violet or purple but not infrequently green and white. For note on the nomenclature of *S. multicaulis* see Notes R.B.G. Edinb. 22:427 (1958)

W. Syria, Syrian Desert, N. Iraq, Iran, Siniai. **Ir.-Tur. Element.** Treat category LC
Figure 4.18. General appearance of *S. multicaulis* Vahl.

Perennial herb, similar in facies and general dimensions to *S. multicaulis* but usually a smaller plant; **Stems** erect, mostly unbranched, 10-30(42), cm, usually glandular-pilose to -villous, especially above, rarely glabrous, usually with dendroid hairs. **Leaves** simple, rarely with 1-2-pairs of small basal lobes, usually narrow, 1.2-6.7 x 0.5-2.5 cm, rugose, crenulate, with a dense indumentum of ± adpressed dendroid to dendroid-stellate hairs; **petiole** 1-6.5 cm. **Verticillasters** (2-12)~20 flowered, ± distant. **Bracts** of median verticillasters broadly ovate, c. 0.6-2 x 0.4-1.6 cm, cordate. **Calyx** campanulate yellowish-green (rarely tinged purple), with an indumentum of sessile glands with or without some eglandular villous hairs, upper lip generally longer than lower 9-20 mm, 25 mm in fruit; **corollas** white to pinkish (to ± purple), 12-21 mm Tube ± straight, c. 15 mm, annulate; not squamulate, **Stamens** A. **Nutlets** pale brown. Chromosome count: 2n = 16.

The **pollen** of *S. cryptantha* is isopolar and oblate with $P = 38.27 \pm 3.38 \mu m$ and $E = 45.09 \pm 3.49 \mu m$. The aperture is hexacolpate and the colpi = $32.09 \pm 4.22 \times 8.06 \pm 0.86 \mu m$. The exine is $1.43 \pm 0.16 \mu m$ thick and the intine is $0.68 \pm 0.12 \mu m$. Its ornamentation is bireticulate.
Fl. 5-7. Rocky limestone slopes, dry steppe, fallow fields, roadsides, 700-2500 m.


Inner (mainly C.) Anatolia. A4 Ankara: Kızılıcahamam to Celtikçi, Bozak-man & Fitz 902! ASCorum: Iskilip, Kozviran, 1050 m, Kilinc. 3723! A6 Sivas: Koyulhisar, S. of Ordu, 1000 m, Mathew & Tomlinson 4391! A6 Tokat: Artova hills above Artova Radar (Antena) Tepe 40 07 076 N 03 61 5432 E, 1410 m, 05 vi 2006, SBagherpour 290! B3 Afyon: c. 9.5 km S.W. of Isçehisar towards Afyon, 1070 m, Buttler 13196! B3 Ankara: Past Polatlı, 15 km to Sivrihisar, 39 30 535 N 31 36 734 E, 960 m, 31 v 2006, SBagherpour 224! B3 Ankara: Sivrihisar, 72 km to Eskişehir, 39 29 303 N 31 16 380 E, 1018 m, 31 v 2006, SBagherpour 227! B3 Ankara: Sivrihisar 10 km to Beylikdüzü, 39 37 053 N 30 41 920 E, 1060 m, 01 vi 2006, SBagherpour 246! B3 Eskişehir: Seyitgazi ilçesinin üstü. 39 26 331 N 30 41 920 E, 888 m, SBagherpour 232! B3 Eskişehir: 20km past Alpu toward Mehiliççik eski near Osmanlı mezarı, 39 49 102 N 31 09 677 E, 849 m, SBagherpour 417! B3 Eskişehir past Alpu 20km to Mehiliççik, 39 49 568 N 31 17 204 E, 918 m, SBagherpour 419! B4 Ankara: ODTU fields 39 10 122 N 34 16 059 E, 1504 m, 20 v 2008, SBagherpour 438! B4 Ankara: Beypazarı, 40 05 705 N 32 25 623 E, 1125 m, 04 vi 2005, SBagherpour 106! B4 Ankara: Beynam Orman roadside, 39 40 032 N 32 54403 E, 1487 m, SBagherpour 130! B4 Çankırı: 5km before Çankırı, 40 28 803 N 33 40 317 E, 642 m, SBagherpour 140! B4 Ankara: Ankara to Polatlı, 20 km past Ümitköy. 500m to Başkent Organize Sanaye, 39 45 699 N 32 27 646 E, 822 m, SBagherpour 219! B4 Ankara: Polatlı to Ayaş müslüm köy hills on the right side, 36 58 205 N 37 46 307 E, 490 m, SBagherpour 390! B4 Ankara: Haymana 35km to Polatlı just few km past Haymana, 39 28 205 N 32 27 888 E, 1004 m, SBagherpour 392! B4 Ankara: 8km to Şereflikoçhisar, 39 00 901 N 32 27 122 E, 917 m, SBagherpour 394! B4 Ankara to Kırşehir 5km after Keskin toward Kalkanlı mountain, 40 04 027 N 32 35 782 E, 1002 m, SBagherpour 464! B4 Kırşehir: Hills N.of Kırşehir 39 08 365 N 34 13 701 E, 1246 m, SBagherpour 435! B5 Yozgat: Saraykent to Akdağmadeni, 39 40 598 N 35 47 259 E, 1328 m, SBagherpour 173! B5 Nevşehir:
Nevşehir about 8km to Ürgüp, 38 36 555 N 34 49 573 E, 1318 m. SBagherpour 442. B5 Kayseri: Pınarbaşı to Kayseri above Melkper village Aygörmez mountain, 38 43 837 N 36 13 021 E, 1972 m. SBagherpour 479. B5 Yozgıt: Akçakale 15km to Akdağmadeni, 39 35 175 N 36 11 412 E, 1412 m. SBagherpour 489. B6 Sivas: Yıldızeli 5km to Sivas, 39 43 738 N 36 53 392 E, 1284 m, SBagherpour 283. B6 Sivas: S.of Sivas 5-7km SW. of Ulaş Hills near sheep pens. 3-4km off road, 39 25 754 N 37 00 433 E, 1539 m. SBagherpour 292. B7 Erzincan: nr Altbuschik, Erzincan, Sint. 1889:1061. B8 Erzincan: Tercan to Aşkale, 1600 m, D. 29344. C3 Konya: Beys,ehir to Konya, 1 100 m, Dudley (D. 35833). C4 Konya: Konya to Beyshehir, 8 km W. of Konya, 1140 m, Hub.-Mor. 8372. C5 Nigde: Pozanti to Nigde, 1300 m, Coode & Jones 1239!

A less variable species than its close relative *S. muhicaulis* and generally more western in its distribution. In areas where they overlap, e.g. Sivas and Nigde, they appear to retain their identity and no hybrids have been seen. *S. cryptantha* is also closely related to the Lebanese and Syrian species *S. pinardii* Boiss. which is glabrous above and has pale bluish flowers. Two anomalous gatherings from A3 Ankara, Beypazari (Akman 1005, 1102!) may be hybrids (*S. aytachii*). In inflorescence, calyx and corolla characters they are atypical for *S. cryptantha* and have some features of *S. tomentosa*; the indumentum is typically that of the former species.

**Endemic. Ir.-Tur. element.** Treat category NT
105

**Figure 4.19.** General appearance of *S. cryptantha* Montbret & Aucher ex Bentham.

**Map 44.17.** *S. cryptantha* distribution map.


Caespitose perennial herb with a woody rootstock. **Stems** ascending-erect, unbranched, 20-50 cm, glabrous above, sparsely simple and dendroid hairs below. **Leaves** mostly clustered at base of flowering shoots, grayish, simple, ovate-elliptic to suborbicular, rounded at base, 1-4.5 x 0.5-1.5 (-1.7) cm, rugose, crenulate, with dense
dendroid hairs; **petiole** 1-3 (-4.4) cm. with dense dendroid hairs and long ciliate on margins. **Verticillasters** 4-8 (-10) flowered, clearly distant. **Bracts** green, broadly ovate, 6-15 x 5-10 mm, sparsely simple and glandular hairy; bracteoles linear to oblong, membranous, 1-3 mm. **Pedicels** 2-7 mm, with spreading and retrorse hairs, rarely glabrous. **Calyx** purplish-violet to yellowish-green, campanulate, 6-20 mm, to 22 mm in fruit and broadening with a indumentum of sparse long simple eglandular and short glandular hairs, with sparse sessile glands; upper lip indistinctly 3-lobed or subentire. **Corolla** whitish-pink, 14-32 mm; tube straight, annulate, c. 16 m m; upper lip ± straight. **Stamens** A; staminal connectives shorter than filaments; upper theca larger than the lower theca, 3 mm; lower theca 1.2 mm; filament 5 mm; connective c. 7 mm. Style glabrous below, sparsely soft, minute hairs towards apex, 22 m. **Nutlets** dark brown, ovoid, smooth, 4 x 3 mm. Chromosome count: unknown.

The **pollen** of *S. aytachii* is isopolar and oblate with P = 37.68 ±4.89 µm and Name: E = 41.19 ±4.02 µm. The aperture is hexacolpate and the colpi = 33.55 ±5.14 x 5.50 ±1.01 µm. The exine is 1.50 ±0.13 µm thick and the intine is 0.56 ±0.08 µm. Its ornamentation is bireticulate.

**Fl.** 5-7. Steppe, marly places and gypsum soils. 650-870 m.

Duman (GAZi)! ibid. 750 m, 29.vI.1983. Guner 5069 et K. Sorkun (HUB)! ibid. 2.VI.1982. Akman, Ekim et Buyukburc; s.n. (ANK)! B3 Eskişehir: Polatlı-Sivrihisar 25. km, 870 m. 10.VII.1993. Duman 5007 (GAZI)! B3 Ankara 21km past Polatlı towards Sivrihisar (~42km to)about 200m N.side of road, 39 34 541 N 31 55 304 E, 751 m, 10 v 2008, SBagherpour 412.

**Endemic, Ir.-Tur. element.** Treat category **VU**

![Figure 4.20](image)

**Figure 4.20.** General appearance of *S. aytachii* Vural & Adıgüzel.
Perennial herb with a woody rootstock; **stems** few, erect, 25-40 cm long, unbranched, (with sterile shoots), greenish, glabrous below, with glandular and simple patent hairs above; capitates glands some branching. **Leaves** mostly basal pinnatisect, oblong-lanceolate in outline, with two pairs of lateral segments, or more rarely with only one pair on sterile shoots; terminal leaf segments ovate-elliptic lanceolate, 2.0-6.5 X 0.9-2 cm, greenish, glandular and sometimes with a few simple hairs, margin crenululated; lateral segments 4-22 x 2-7 mm; **petiole** 1-3 cm, winged, with dense glandular hairs and long ciliate margins; inflorescence 15-24 cm long, clearly exceeding leaves with 5-7 **verticillasters**, each verticillaster 4-6 flowered, internodes 2.5-4.0 cm, clearly distant; floral leaves dissimilar to stem leaves, ovate to lanceolate, widening at base, 16-30 x 10-14 mm, greenish, with dense glandular and patent simple hairs and long ciliate margins; **bracts** narrowly lanceolate to elliptic, 10-20 x8-16 mm, greenish, indumentums similar to floral leaves; bracteoles present; pedicels 3-7 mm long, erect, with dense patent and sparse glandular hairs; **calyx** tubular-infundibular form, shortly bi-labiate, membranous-reticulate, greenish, 14-16 mm, to c. 19mm in fruit, 15-veined, with dense glandular and patent simple hairs; upper lip with tree teeth, triangular ca. 1 mm long, lower lip with
two teeth, triangular-lanceolate c. 3 mm long; **corolla** entirely yellow, 35-40 mm long, glandular and with long simple hairs on outside of upper lip; tube 20-24 mm long, not squamulate, gradually widening above, with an annulus in throat; upper lip straight equaling lower lip; stamens included within corolla lips; **stamens** A, filaments 6-8 mm, stamina connectives shorter than filaments; upper theca ca. 4 mm, longer than lower theca, with long villous hairs; style 35-40 mm, equaling corolla; immature nutlets obovoid, 2-2.6 x 1.2-1.6 mm, blackish rugose. Chromosome count: unknown.

The **pollen** of *S. anatolica* is isopolar and oblate-spheroidal with P = 50.86 ±4.35 μm and E = 51.08 ±4.00 μm. The aperture is hexacolpate and the colpi = 43.28 ±4.47 x 8.01 ±1.05 μm. The exine is 1.63 ±0.27 μm thick and the intine is 0.72 ±0.15 μm. Its ornamentation is bireticulate.

*FL. 5-6. Calcareous stony slopes and in open Quercus scrub, 1500-1600m.*

Distribution of *S. anatolica* seems to be Endemic to the area between Divriği and Kamaliye, East Anatolia, and belongs in the Irano- Turanian element. B7 Sivas: Divriği to Kemaliye 22km from Divriği to Maltepe, 39°31’210”N 38°09’370”E, 1560 m, 06 vi 2006, SB304.! B7 Sivas: Divriği to Kemaliye Maltepe to Çitme near çakır tarla 39°31’210”N 38°09’370”E, 1730 m, 09 vii 2006, SB306.

**Endemic. Ir.-Tur. element.** Treat category **CR**
Figure 4.21. General appearance of *S. anatolica* Hamzaoğlu & Duran.

Map 44.19. *S. anatolica* distribution map.
4.2.3 **Section Aethiopis Benth.**:

Biennial or perennial herbs or chamaephytes. Calyx tubular or campanulate. Upper lip of corolla more or less falcate; tube not hairy-ringed. Connective longer than filaments; arms unequal, the sterile arm shorter and more or less flattened distally. Species for Sect. *Aethiopis*:


Perennial herb; rhizomatous. **Stems** c. 30(-60) cm, yellowish-green, erect, branched, antrose hairs, eglandular-pubescent below, denser above (and rarely glandular). **Leaves** simple, ovate, cordate, c.5-13 x 3.4-8 cm, rugose, serrulate, shortly eglandular or glandular-pubescent below; petiole c. 3-6 cm. **Verticillasters** 4-6-flowered, distant. **Bracts** ovate, c. 4-5 x 3-5 mm. **Pedicels** 2-4 mm, erecto-patent. **Calyx** tubular, 5-7 mm, densely eglandular or glandular-pubescent, many sessile glands, upper lip straight, tridentate; calyx scarcely expanding in fruit. **Corolla** white, c. 10 mm; tube straight, not annulate, glabrous within; upper lip ± straight to slightly falcate. **Stamens** B. **Nutlets** rounded-trigonous, c. 3 x 2 mm. 2n = 22, 24.

The **pollen** of *S. syriaca* is isopolar and oblate with $P = 39.23 \pm 6.48 \mu m$ and $E = 44.88 \pm 8.48 \mu m$. The aperture is hexacolpate and the colpi $= 32.85 \pm 5.63 \times 7.06 \pm 0.52 \mu m$. The exine is $1.61 \pm 0.20 \mu m$ thick and the intine is $051 \pm 0.06 \mu m$. Its ornamentation is bireticulate.

*Fl. 4-7. Steppe, marly banks, fallow and cultivated fields, 450-1850 m.*

Type not designated (Hb. Linn. 42/15!).

18722! B4 Ankara to Kırşehir 5 km to Keskin, 39 42 495 N 33 34 496 E, 1060 m, SBagherpour 244! B5 Aksaray: Aksaray 30km to Nevşehir roadside, 38 31 686 N 34 24 826 E, 1260 m, 29 v 2008, SBagherpour 440! B5 Kayseri: Pınarbaşi to Kayseri above Melkper village Aygörmez mountain, 38 43 837 N 36 13 021 E, 1972 m, SBagherpour 481! B6 Sivas: Sivas to Hafik,soykeçerim, near fields,roadside, 39 49 800 N 37 07 658 E, 1858 m, SBagherpour 183! B7 Malatya: Malatya to Sivas, Alava 6870! B8 Erzurum: Askale Şegav to Meymansur, 1500 m, Demiriz 81! B9 Van: Kurubaş,'6 km S.E. of Van, 1850 m, D. 44585! C2 Denizli: Tavas to Kale Tavas, 950 m, Hub.-Mor. 5204! C3 Antalya: Elmali to Korkuteli, 1120 m, Dudley (D. 35216)! C4 Konya: Konya to Cumra, 980 m, Helbaek 2526! C6 Gaziantep: 40 km W. of Gaziantep, Andres 11! C7 Urfa: Urfa to Viranşehir, 500 m, D. 42285! C7 Urfa: Viranşehir 61km to Şanlıurfa inside pistachio trees, 37 13 516 N 39 23 325 E, 667 m, 14 v 2008, SBagherpour 424! C8 Mardin: Kızıltepe, 600 m, D. 28658! C9 Mardin: Cizre to Hessana, 600 m, D. 42748!

A distinctive, oligomorphic species, recognised by the tidy habit, regularly ovate leaves and the small white corollas.

W. Syria, Soviet Armenia, N. Iraq, Syrian Desert, Iran, Ir.-Tur. element. Treat category LC
Figure 4.22. General appearance of *S. syriaca* L.

Map 4.20. *S. syriaca* distribution map.

Perennial herb. **Stems** 10-20 cm in flower, to 40 cm in fruit, several from a woody rootstock, erect, widely branched above, eglandular lanate-arachnoid. **Leaves** simple, mostly basal, linear-oblong, (2-5) 3-6 (-6.5) x 0.6-1.3 cm, narrowing into a (10-) 15-25 mm petiole, arachnoid, rugose, crenulate. **Inflorescence** 5-25 mm, paniculate with stiffly erecto-patent branches, arachnoid-lanate, violet-blue. **Verticillasters** 2-6-flowered, approximating (slightly distant in fruit). **Bracts** usually almost equal to calyces, broadly ovate, 9-12 x 6-8 mm, arachnoid-lanate. **Pedicels** 2-3 mm, erect. **Calyx** tubular-campanulate, 8-11 mm, to 12-13 mm in fruit, violet, arachnoid-lanate, teeth long-subulate, c. 2 mm. **Corolla** violet-blue, 8-13 mm; tube 4-8 mm, straight, glabrous within; upper lip ± straight, lower lip unspotted. **Stamens** B. **Nutlets** usually brown, c. 3 x 2 mm. Chromosome count: unknown.

The **pollen** of *S. eriophora* is isopolar and oblate-spherical with $P = 44.53 \pm 5.17 \mu m$ and $E = 48.78 \pm 5.92 \mu m$. The aperture is hexacolpate and the colpi $= 39.24 \pm 5.33 \times 4.87 \pm 0.39 \mu m$. The exine is $1.09 \pm 0.09 \mu m$ thick and the intine is $0.46 \pm 0.06 \mu m$. Its ornamentation is bireticulate. *Fl*: 6-7, volcanic rocky and stony slopes, alpine steppe and limestone slopes, 1525-1900 m.

**Type Specimen**: [Turkey C5 Adana/Niğde] ab Jool Baatch (Yol Bahçe) ad radices montis Allahdagh (Ala Da.) Ciliciae, 1525 m, [3 vi 1859], Kotschy 229 (G iso. BM! W!.K)

*S. Anatolia (Anti-Taurus); local. B6 Kayseri/Sivas*: Pınarbaşı to Gürün, 50 km to Gürün, near Sivas city border, 38 57 35 N 36 39 19 E, 1870 m, 18 v 2007, AKahraman 1363! near Güneşli village, 38 52 054 N 36 51 744 E, 1878 m, 17 v 2008, AKahraman 1495! c. 45 km to Gürün, 38 52 221 N 36 51 492 E, 1900 m, 23 vii 2008, AKahraman 1584B! between Pınarbaşı and Gürün, 1900 m, 18 vi 1954, D. 21971 (ANK!).

**Endemic. Ir.-Tur. element.** Threat category: EN

Distinctive on account of its small size, violet-blue paniculate inflorescence, small flowers and arachnoid linear-oblong leaves. Distantly related to *S. brachyantha.*
Figure 4.23. General appearance of *S. eriophora* Boiss.
Map 44.21. *S. eriophora* distribution map.

22. *S. aethiopis* L. (Figure 8) Species plantarum, page 27, no. 25 (1753). Ic: Jav. & Csap., Ic. Fl. Hung. 432, t. 2931 (1934); Fl. RPR 8: t. 42 f. 1 (1961).

Biennial or perennial, robust herb. **Stems** erect, sturdy, quadrangular, 25-180 cm, eglandular lanate, hairs denser below, with sessile glands, more or less leafless above. **Leaves** simple, mostly basal, ovate-elliptic to oblong, 10-35 x 5-9 cm, acuminate, lanate rugose, deeply and irregularly serrate to erose; petiole 4-9 cm. **Inflorescence** widely branched, candelabriform, many-flowered. **Verticillasters** 4-10-flowered, approximating above. **Bracts** broadly obovate, slightly shorter than calyx, green or violet-tinged, c. 12 x 15 mm, cuspidate, sparsely pilose. **Calyx** tubular-ovate, c. 12 mm, densely lanate, in fruit to c. 15 mm; upper lip tridentate, median tooth shorter. **Corolla** white, 10-15 mm, often with a pale yellow lip; tube abruptly ventricose, squamulate; upper lip weakly falcate with purple glandular hairs. **Stamens** B. **Nutlets** rounded trigonous, ovate, c. 3 x 2 mm. Chromosome count: 2n = 22, 24.

The **pollen** of *S. aethiopis* is isopolar and oblate-spherical with $P = 39.29 \pm 1.42 \mu m$ and $E = 44.10 \pm 2.31 \mu m$. The aperture is hexacolpate and the colpi =
33.71 ±1.00 x 7.21 ±0.63 μm. The exine is 1.27 ±0.15 μm thick and the intine is 0.65 ±0.08 μm. Its ornamentation is bireticular.

*Fl*:5-8. *Steppe, igneous and limestone slopes, sandy slopes, fallow fields, dry meadows, roadside banks, nr s.l.-2100 m.*

**Types:** Described from Illyria (coastal Jugoslavia), Greece & Africa (Hb. S-LINN. 42/48 photo!).

**Throughout most of Turkey except S.E. Anatolia.** A1 **Kırklareli:** Lüleburgaz to Pınarhisar, A.Baytop (ISTE 13308!) Kırklareli: 10 km from Babaeski to İstanbul, 16 vi 1972, A.Baytop & E.Tuzlaci! İstanbul otoban yolunun Kumburgaz to Çamlıca right side of rest area, 41 04 011 N 28 30 343 E, 64 m, 06 v 2008, SBagherpour 460! Tekirdağ: Malkara, Tekirdağ to Malkara, 1 km before Ballı junction, roadside, 186 m, 30 v 2006, E.Karabacak 4533 ! Çanakkale: Gelibolu, Bolayır, Çimpe Castle, dry meadows, 145 m, 30 v 2006, E.Karabacak 4547 !, Çanakkale: Eceabat, Kabatepe, seaside, sandy slopes, 2 m, 26 v 2000, E.Karabacak 186! Çanakkale: Eceabat, Gelibolu peninsula, Behramlı village environs, Şarlayandere, roadside and scrubs, 63 m, 21 v 2006, E.Karabacak 4466! A1 Çanakkale: Renkoei (Erenköy), vi 1856, Kirk Çanakkale: İntepe environs, roadside, 132 m, 31 v 2006, E.Karabacak 4549!, A2 **İstanbul:** Yeşilköy to Safraköy, 28 vi 1904, Aznavour A2 **Kocaeli:** Pendik to Tuzla, 31 v 1896, Aznavour A3 Bolu: Abant G., 15 vii 1940, B.Post Bolu: Abant, stony place, 1500 m, 19 vii 1995, A.Uçar 2391 !, Bolu: Yeniçağa, Hamzabey village environs, 990 m, 7 vii 2000, M.M.Sümer 1453!, A4 **Kastamonu:** Daday to Eflani, c. 1100m, P.H.Davis 38617 Çankırı: Çerkeş, Gerede to Çerkeş, 5 km before Çerkeş, roadside slopes, 1120 m, 09 vii 2006, E.Karabacak 4824!, Kastamonu: 43 km E of Araç, wooded bank between road and field near wood/field edge, 980 m, 28 vi 1987, R.M.A.Nesbitt 1149!, Kastamonu: Karaçomak Dam, E of Kürteli ridge, Hasankayasi stream, 1080 m, 14 vii 1982, H.Sakallioğlu 602! Çankırı: Atkaracalar, Dumanlı mount, between Ulupınar and Taşlıdere plateau, 1300-1500 m, 6 vii 1991, A.Duran 1147 ! Ankara: Kızılcahamam, Işık mount, 1400 m, 10 vii 1976, M.Koyuncu & S.Kurucu. A5 **Amasya:** nr Merzifon, roadside, 1 vi 1969, A.Baytop & T.Baytop (ISTE 15244!) Amasya: Merzifon, Saraycık village environs, roadside and pathside, 872 m, 10 vii 2006, E.Karabacak 4880! Çorum: Boğazkale,
Boğazköy, Yazılıkaya ruins, 1210 m, 8 viii 1984, Ö.Seçmen 36 (EGE 17892!) A6
Tokat: Tokat to Sivas, Kızlıniş pass, slopes and scrubs, 1200 m, 10 vii 2006, E.Karabacak 4897! A7 Giresun: Suşehri to Şebinkarahisar, 4 km before Şebinkarahisar, slopes, 1335 m, 11 vii 2006, E.Karabacak 4940! Gümüşane: Erzincan to Kelkit, 2100 m, P.H.Davis 31899 Gümüşhane: 6 km before Torul, 950 m, 21 vii 1972, T.Kesercioğlu & T.Gözler (EGE 19702!) A8 Artvin: N.E. of Artvin (Grossheim 7: map 439) Bayburt: Soğanlı Mountains, 1200 m, 1 vi 1975, Y.Akman 9821 (ANK!) Bayburt: Gümüşhane to Bayburt, Nişantaşı village, Osluk (Korgan) bridge environs, steppe and rocky slopes, 1616 m, 11 vii 2006, E.Karabacak 4971! Erzurum: Tortum, Taşbaşı village to Tortum, 1600-1200 m, 24 vii 1984, N.Demirkuş 2083 (HUB 23125!) Erzurum: Tortum to Erzurum, Güzelyayla pass (2090 m), alpine pastures, limestone soil, 2132 m, 13 vii 2006, E.Karabacak 5070! Erzurum: Tortum to Narman, Kireçli (Kutumar) pass, alpine pastures, 2400 m, 14 vii 2006, E.Karabacak 5088! A9 Kars: 8 km from Akçay to Cumaçay, 1650 m, P.H.Davis 46808 Bl Manisa: Soma, Karaçam, E.Şarer 1003 B2 Bilecik: Pazaryeri, 750 m, P.H.Davis 36480 Afyon: Dazkırı, İdris village, Serenlikuyu environs, water side, 1325 m, 21 vi 1984, Z.Aytaç 1439! Kütahya: 34 km from Kütahya to Afyon, on foot of Kulaksız mountain, steppe, 1150-1200 m, 5 vii 1994, E.Akççeük 893643! Kütahya: Dumlupınar, Çal village, Zafer hill, 1200 m, 22 vi 1996, Ö.Seçmen 4712 (EGE 19358) Denizli: between Çivril and Işıkli, roadside and fallow field, 800-850 m, 6 vi 1983, Y.Gemici 2019 (EGE 25514!) B3 Eskisehir: Sivrihisar, c. 1250 m, Dudley (P.H.Davis 36027) Afyon: 1 km S of Bayat, 1100 m, 18 vi 1980, Ö.Seçmen 2238 et al. (EGE 16983!) B4 Ankara: Çankaya, Dikmen, Çal Mountain, steppe, 900 m, 4 vi 1983, M.Vural 2263 et al. (GAZI!) Ankara to Kirşehir 5 km to Keskin, 39 42 495 N 33 34 496 E, 1060 m, 01 vi 2006, SBagherpour 243! Ankara: Beytepe, steppe, 1000 m, 31 v 1975, S.Erik 1210 (AIBU!, HUB!) Kırıkkale: Keskin, Böbrek mount, Konur village, steppe, 800 m, 23 vi 1992, Ü.Güler 1776 (GAZI!) Konya: Konya to Aksaray, 1000 m, Dudley (P.H.Davis 35900) B5 Yozgat: 8 km E. of Sorgun, 1200 m, Watson 5657 B6 Sivas: Cumhuriyet Üniversitesi Campus, steppe, 1200 m, 25 vi 1983, B.Yıldız 3712 (EGE 32607), ibid. roadside, 1275 m, 6 vii 2007, E.Karabacak 5515! Sivas: Yıldızlizi, Demirözü village, 8.vii.1992, Kartal (AEF)
Malatya: Hekimhan, 1300 m, Stainton & Henderson 5442 Kahramanmaraş: Çardak to Göksun, 25 km before Göksun, field side, 20 vi 1979, E.Tuzlacı & M.Saraçoğlu (ISTE 42366!) B7 Elazığ: Elazığ to Hazar G., 850m, P.H.Davis 29105 B8 Erzurum: Erzurum to Aşkale, 1700m, Lamond 2595 B9 Ağrı: nr Diyadin, 1820 m, Hewitt 267 B10 Ağrı: Doğubeyazıt, Gürbulak Customs Gate road, near Telçeken village, 1600 m, 24 vi 1972, T.Gözler & T.Kesercioğlu (EGE 19701!) C2 Denizli: Cankurtaran, 1200 m, E.Şarer 1007 Denizli: between Sarayköy and Babadağ, 5 km before Babadağ, 700 m, 3 vi 1980, E.Tuzlacı & T.Çelebioğlu (ISTE 44505!) Burdur: 14 km from Dirmil to Korkuteli, fallow fields, 1220 m, 23 vi 1980, N.Özhatay, E.Özhatay & E.Tuzlacı (ISTE 44966!) C3 Isparta: between Isparta and Eğridir, 15 km before Eğridir, roadside, 23 vi 1982, Coşkun 625 & E.Şarer (AEF) Antalya: 21 km from Korkuteli to Elmali, 1270 m, A.Huber-Morath 8375 C4 Konya: Küçük Köy, Konya to çumra, 980 m, Helbaek 2551

Distinctive on account of the sturdy stems, lanate indumentum and the candelabridiform inflorescence. A tumble-weed.

C. & S. Europe, Caucasia, Crimea, Iran. Introduced in N. America. Threat category: LC
Figure 4.24. General appearance of *S. aethiopis* L.

Map 44.22. *S. aethiopis* distribution map.
23. *S. ekimiana* F.Celep & Doğan *sp. nova*

Type: Turkey. Central Anatolia, B5 Yozgat: Above Akdağmadeni, Aktaş region, 39 35 157 N 35 50 014 E, 1793 m, open *Pinus sylvestris* forest and alpine steppe, 16 VI 2007 F.Celep 1214 (holotype ANK; isotypes E, K, GAZI).

Perennial herbs with a woody rootstock at base. Stems ascending to erect, 10-30 (-40) cm, branched or not, densely eglandular lanata. Leaves mostly basal, mainly oblong (ovate to oblong or oblanceolate) c. 2.5-7 x 1-2.5 cm, greyish-green, densely eglandular lanate, rugose, margins crenulate to serrate, petiole up to (10) 15-30 (-45) mm. Inflorescence widely branched, candelabriform, densely eglandular lanate. Verticillasters 4-12, each verticilasters with 4-10 flowered, internodes 0.5-2 cm. Bracts broadly ovate, 0.3-1.5 x 0.2-1.2 cm, densely lanate. Pedicels 2-3 mm. Calyx tubular to campanulate, 7-11 mm, up to 13 mm in fruit, scarsely expanding in fruit, densely eglandular lanate hairy, teeth shortly spinulose 0.7-0.8 mm. Corolla white with lilac hood, 7-11 mm, squamulate; tube 4-7 mm, upper lip c. 3.5-4.2 mm, scarsely falcate. Stamens 2, type B; staminal connectives clearly longer than filaments. Style glabrous, 8-12 mm, long exerted from corolla lips and divided in two part at apex. Nutles rounded-trigonal, 2.7-2.9 x 2.2-2.5 mm, greenish to brown and surface slightly tuberculate. Chromosome count: unknown.

Pollen grains are hexacolpate, oblate spheroidal to prolate-spheroidal and its ornamentation is suprareticulate. The polar axis (39.2 ± 5 μm) is bigger than the equatorial axis (34.4 ± 5 μm), P/E: 0.97-1.14 and the colpi are long 31.7 ± 5 μm. The exine is (0.95 ± 0.12 μm) slightly thicker than the intine (0.75 ± 0.20 μm).

Fl. 6. Associated with *Pinus*. 1700-2100 m.
**Type:** Turkey. Central Anatolia, B5 Yozgat: Above Akdağmadeni, Aktaş region, 39°35'15.7" N 35°50'01.4" E, 1793 m, open *Pinus sylvestris* forest and alpine steppe, 16 VI 2007 F.Celep 1214 (holotype ANK; isotypes E, K, GAZI).

**Endemic. Ir.-Tur. element.** Treat category **EN**

*Figure 4.25.* General appearance of *S. ekimiana* F.Celep & Doğan.

Perennial herb. **Stems** 60-90 cm, erect, solitary or 2-3, sturdy, quadrangular, eglandular lanate below, densely capitate glandular pilose hairs above. **Leaves** mostly basal, ovale-lanceolate to elliptic, 6.5-20 x 2.5-7.5 cm, lanate to pilose below, with a thinner indumentum above, irregularly lobulate serrate, truncate or attenuate. **Petiole** 3-12 cm, lanate hairs. **Inflorescence** paniculate, densely glandular pilose. **Verticillasters** 4-6-flowered, clearly distant. **Bracts** clearly shorter than calyces, broadly ovate-acuminate, 7-18 x 6-15 mm. **Pedicels** (5-) 6-10 mm. **Calyx** tubular-campanulate, 9-11 mm, to 11-14 mm in fruit, densely glandular pilose. **Corolla** white, 15-30 mm; tube ventricose, squamulate; upper lip falcate. **Stamens** B. apex. **Nutlets** ovoid, c. 3 x 2 mm. Chromosome count: 2n=20.

The **pollen** of *S. longipedicellata* is isopolar and oblate with $P = 40.27 \pm 4.26 \mu m$ and $E = 44.08 \pm 2.82 \mu m$. The aperture is hexacolpate and the colpi $= 32.61 \pm 4.84 \times 4.53 \pm 1.27 \mu m$. The exine is $1.38 \pm 0.10 \mu m$ thick and the intine is $0.73 \pm 0.12 \mu m$. Its ornamentation is bireticulate.

*Fl*: 7-8, fields, roadsides, slopes, disturbed steppe and meadows, 1484-2110 m.

**Type Specimen**: Turkey B8 Erzurum: between Ilica and Tercan, near the turning to Aşkale, 1850 m, 10 vii 1957, Davis & Hedge, D. 30875 (holo. E! iso. BM K).
Related to the S.W. Anatolian *S. chionantha* but with broader leaves, longer pedicels and smaller calyces and corollas.

**Endemic. Ir.-Tur. element.** Threat category: VU
Figure 4.26. General appearance of *S. longipedicellata* Hedge.

Map 44.24. *S. longipedicellata* distribution map.

Perennial herb. **Stems** 30-60(-90) cm, erect, branched above, pilose to lanate below with few sessile glands, densely pilose to glandular-papillose above. **Leaves** simple, oblong to broadly ovate, 2.5-10(-14) x 1-9 cm, pubescent to densely pannose, subentire to erose, cordate to rounded; **petiole** 3-11 cm. Inflorescence paniculate, often yellowish-green; **Verticillasters** 2-6-flowered, distant. **Bracts** ovate-acuminate, 4-10 x 3-6 mm. **Pedicels** 2-4 mm. **Calyx** tubular-campanulate, 12-15 mm, to 18 mm and widening in fruit, densely pilose to glandular-papillose; upper lip with 3 closely connivent mucronate teeth. **Corolla** white or white with yellow lip, 22-27 mm; tube c. 12 mm, ventricose, squamate; upper lip strongly falcate. **Stamens** B. **Nutlets** rounded trigonous, ovoid, c. 3 x 2.5 mm. Chromosome count: 2n = 22, 24.

Fl. 5-9.

1. Leaves ovate to broadly ovate, 5-10(-14) x 3-9 cm, often discolorous with a thin (to thick) indumentum, serrulate to erose, cordate; flowers white with a yellow lip **subsp. Candidissima**

The **pollen** of *S. Candidissima subsp. candidissima* is isopolar and spheroidal with \( P = 46.73 \pm 1.49 \) µm and \( E = 46.81 \pm 2.07 \) µm. The aperture is hexacolpate and the colpi = 41.55 ±1.52 x 7.57 ±0.74 µm. The exine is 1.45 ±0.24 µm thick and the intine is 0.72 ±0.08 µm. Its ornamentation is bireticulate.

**Rocky limestone and shale slopes, bushy places, amongst Pinus, Quercus, Abies and Cedrus, fallow fields, 700-2000 m.**

**Type specimen:** Type: 'Hab. in Armenia;ex Otsular. Vaillantii [Sclarea armena, foliis rotundioribus, candidiss., iso. P-Tourn. 1103, photo!].

A3 Eskişehir: Beylikova 7-8 km to Miheliçik off the main road to east riverside road into farmlands, 39 50 562 N 31 24 094 E, 1070 m, 31 v 2006, SBagherpour 234! A4 Çankırı: Eldivan toward tv tower station on the mountain, 40 31 260 N 33 29 600 E, 673 m, 05 vii 2005, SBagherpour 141! A5 Amasya: Suluova-Amasya road, 2 km past Boğazköy (Kanlidere) köy, in the rocks next to railroad, 425 m, 10 vii 2006, K.4881. A6 Tokat: Tokat-Sivas road, 1060 m, 10 vii 2006, K.488 A7 Giresun: Şebinkarahisar-
Kelkit, 5-6 km past Karaçayır köy, 1335 m, 11 vii 2006, K.4943. A7 Gümüşhane: Torul-Hamsiköy road (old road), rocky areas, 1281 m, 12 vii 2006, K.4997. A8 Erzurum: Yusufeli-Tortum, 15 km to Tortum, rocky areas, 1351 m, 13 vii 2006, K.5049. B3 Konya: Beyşehir to Ilgin, 5-6 km before Aşağıçiğil village, 1100-1300 m, 27.7.2005, FCelep 1008! B4 Ankara: Beynam orman road, 39 40 032 N 32 54 403 E, 1487 m, 04 vii 2005, SBagherpour 131! Ankara Hills above Kalecik 4km to Gülköy, 40 05 067 N 33 22 060 E,18 vii 2008, SBagherpour 508! B6 Sivas: Zara to Divriği Çulhali Village, 37 50 397 N 43 86 828 E, 1541 m, 13 vii 2005, SBagherpour 188 Sivas: Gürün, Gökpınar, 1520 m, 7 vi 2006, AKahraman 1227! Maraş: Göksun Elbistan, 27 km E. of Göksun, 1320m, Hub.-Mor. 11864 Adana-Kayseri: Sarız, Yeşilkent (Yalak), around Doğankonak village, 1562 m, 10.6.2006, 38 14 757 N 36 25 724 E, FCelep 1074! B7 Erzincan: Kemaliye, 39 14 35 N 38 29 36 E, 977 m, 6 vi 2006, AKahraman 1390! Malatya: Beydağları, 1300 m, 7 vi 2006, AKahraman 1213! B9 Van: Van-Gürpinar arası, 1798 m, AKahraman 1327! C3 Konya: 6-8km west of Konya near Altunkaya barajı, 37 53 221 N 32 15 267E, 1350 m, 26 vii 2005, SBagherpour 209! C5 Niğde: Ulukişla to Niğde, 1420 m, Tuzlaci (ISTE 37506)! C9 Şırnak: Şırnak-Hakkari , Taşdelen, 997 m, 6 vi 2008, AKahraman 1547!

N. Iraq. **Ir.-Tur. element.** Threat category: **LC**
2. Leaves oblong to ovate, 2.5-1 1.5 x 1-6 cm, concolorous with a thick indumentum, serrulate to subentire, rounded to subcordate; flowers white throughout subsp. Occidentalis.

The pollen of *S. candidissima* subsp. *Occidentalis* is isopolar and spheroidal with $P = 54,56\pm3,9$ µm and $E = 50,69\pm4,12$ µm. The aperture is often hexacolpate (rarely octacolpate) and the colpi $= 43,58\pm4,36 \times 4,91\pm0,75$ µm. The exine is 1,04±0,1 µm thick and the intine is 0,72±0,12 µm. Its ornamentation is bireticulate.

**Inner, mainly W. Anatolia.** B2 Kütahya: Domanis to Tavşanlı, 800 m, D. 36421! B3 Kütahya: Kütahya, 28 km from Kütahya to Eskişehir, 800 m, Dudley (D. 36075)! Afyon: Dazkırı to Dinar, 18 km before Dinar, 38 00 779 N 29 58 205 E, 991 m, 5 vii 2006, FCelep 1169! B5 Nevşehir: 5km to Karalik-Yeşilöz turn off, 38 37 435 N 34 57 575 N, 1304 m, 22 vii 2008, SBagherpour 532! C2 Muğla: 3 km N.E. of Muğla, 880 m, Nydegger 10189. C2 Antalya: Elmalı, Cedar Research Forest, 36 35 800 N 30 02 077 E, 1690 m, 7 vii 2007, FCelep 1326! C3 Isparta:Aksu, above Yaka village, 37 44 169 N 31 15 462 E, 1558 m, 7 vi 2008, FCelep 1444! C4 İçel: Gülner to Ermenek, around Bereket village, 36 21 625 N 33 13 862 E, 1300-1400 m, 25 vii 2005 FCelep 993! C5 Nigde: Ala Da., Çukurbağ village, Emli Boğazı, 37 45 355 N 35 06 460 E, 1835-2000 m, 24 vii 2005, FCelep 975!

Distribution of species: Greece, Albania. Ir.-Tur. element? A widespread and common species throughout most of Inner Anatolia. The two subspecies — one eastern, one western - recognised here are based largely on leaf shape and indumentum; their extremes are quite distinct but there are many intermediates. Within them there are also numerous rather distinctive local populations, but these do not merit formal status.

Perennial herb with a woody rootstock. **Stems** few or several, erect, 20-100 cm, densely pilose-villous glandular, often eglandular lanate below. **Leaves** mostly basal, variable in size and shape, ovate to oblong, (5-)7-17(-20) x 3-8(-14) cm, white or grey lanate, obtusely lobed or irregularly serrate, sub-cordate; petiole 3-16(-20) cm. **Inflorescence** usually a widely spreading panicle, often yellowish-green. **Verticillasters** 4-6-flowered, usually distant. **Bracts** variable, broadly ovate, 9-17 x 8-14 mm. **Pedicels** 2-5 mm. **Calyx** ± campanulate, 9-12 mm, to c. 11-14 mm in fruit, densely glandular with capitate glandular hairs and sessile glands; upper lip shortly tridentate, median tooth much shorter; lips ± equal. **Corolla** white, lip fading yellow, 17-30 mm, tube 5-8 mm, ventricose, squamulate; upper lip compressed, strongly falcate. **Stamens** B. **Nutlets** ovoid, c. 3 x 2.5 mm. Chromosome count: 2n = 16.

The **pollen** of *S. microstegia* is isopolar and oblate with P = 46,96±1,34 µm and E = 52,49±2,88 µm. The aperture is hexacolpate and the colpi = 37,05±1,76 x 4,56±0,8 µm. The exine is 0,69±0,07 µm thick and the intine is 0. 0,63±0,13 µm. Its ornamentation is bireticulate.
Fl: 6-8. Rocky limestone and igneous slopes, alpine pastures, screes, in Quercetum, Pinus woodland, fieldside, 970-3350 m (nr permanent snowbeds).

Types: [Turkey B5 Kayseri] in monte Alidagh prope Caesaream (Kayseri) Cappadociae sito, 1400m, [9 viii 1856], Balansa [1083] (iso G!).


Kahramanmaraş: Göksun, Dibek mount, forest clearings, 1750 m, 19 vi 1979, E.Tuzlacı & M.Saraçoğlu (ISTE 42331!) Kahramanmaraş: Göksu, Binboğa mount, 1800 m, 17 vii 1992, M.Koyuncu 9702 Z.Aytaç (AEF) Kahramanmaraş: Çardak, Berit dağ, above Arpa Çukuru yaylası, 2800 m, 26 vii 1952, P.H.Davis 20332, Dodds & R.Çetik (EGE 27345!)

B7 Erzincan: Keşiş Da. above Cimin, 2700 m, P.H.Davis 31743 Erzincan: Keşiş (Spikör) mount, 1 km before Kolçekmez mount pass, calcareous slopes, 2099 m, 7 vii

Related to *S. xanthocheila*, *S. atropatana* and *S. argentea* (q.v.); also close to the Caucasian *S. verbascifolia* M.Bieb. which apparently always differs by its much thinner indumentum on all parts. *S. microstegia* varies considerably in the density of the leaf indumentum; the most lanate specimens are usually from the higher altitudes. Although in most cases there is little likelihood of confusion with *S. argentea*, despite the narrow morphological differences, some specimens from S. Anatolia (e.g. C4, C5) are close to the latter.

Latakia, Lebanon. **Irano-Turanian element.** Threat category: **LC**
Figure 4.29. General appearance of *S. microstegia* Boiss. & Bal.

Map 44.26. *S. microstegia* distribution map.

Perennial herb with a thick woody rootstock. Stems solitary or several, erect, 10-30( -50) cm, below pilose to villous with sessile glands, densely glandular above with capitate glands. Leaves mostly basal, variable, ovate to narrowly oblong, 2-12 x 1.2-5 cm, crenulate to erose, rugulose, arachnoid to lanate with many sessile glands; petiole 1.5-8 cm. Inflorescence little branched to widely paniculate. Verticillasters 2-6-flowered, usually distant. Bracts ovate to orbicular, C. 6-13 x 4-11 mm. Pedicels 1-3 mm. Calyx campanulate to infundibular,5-10mm.c. up to 12 mm in fruit and widening, densely capitate glandular and sessile glands; teeth usually prominently spinulose; upper lip tridentate, median tooth much shorter, truncate or not. Corolla white to lilac, 7-10 mm; tube C. 8 mm, ventricose, squamulate; upper lip narrow, somewhat falcate, scarcely bifid. Stamens B. Nutlets ovoid, C. 3.5 x 2.5 mm. Chromosome count: 2n = 20, 21, 22.

The pollen of *S. frigida* is isopolar and oblate with \( P = 37.86 \pm 4.10 \, \mu m \) and \( E = 40.59 \pm 3.65 \, \mu m \). The aperture is hexacolpate and the colpi \( = 33.10 \pm 3.93 \times 5.06 \pm 0.50 \, \mu m \). The exine is 1.15 \( \pm 0.13 \, \mu m \) thick and the intine is 0.70 \( \pm 0.11 \, \mu m \). Its ornamentation is bireticulate.

*Fl. 5-7. Pinus nigra, Juniperus, Abies and Pyrus woodland, limestone slopes and crevices, meadows, 1000-2450 m.*

Type: [Turkey C2 Denizli] in regione alpina excelsiori montium Cariae, Cadmi orientalis (Honaz Da.) supra Colossam (Honaz) et occidentalis (Baba Da.) supra Gheyra (Goyre), vi 1842, Boissier (holo. G!). :

**Inner & S.W. Anatolia.** A4 Ankara: Çamkoru, N.W. of Kızılcahamam, 1350 m, Bozakman & Fitz 807! A4 Çankar: Eldivan dağı top, 40 27 416 N 33 26 .874 E, 1777 m, 05 vii 2005, SBagherpour143.! A6 Sivas: Yıldızeli to Tokat 5km N. Of Yıldızeli, 39 54 478 N 36 32 961 E, 1403 m. SBagherpour 284.! B2 Kütahya: Murat
Close to *S. modesta* and *S. yosgadensis*. With some affinities to *S. argentea* and *S. microstegia* but with much smaller corollas. A most variable species in all respects. Although there is a core of specimens which is fairly typical for the species, there are many individuals which because of characters of habit, indumentum, leaf shape, bract size and calyx shape are anomalous. Mostly they occur in the northern peripheral parts of the range (e.g. A4, B2, B3). Male sterile sex-forms are very common and these plants tend to be aberrant in other respects. No definite hybrids have been reported but D. 19915 (B6 Maraş; d. Goksun, Yalak, 1400 m) combines features of *S. frigida* (calyx and corolla) and *S. microstegia* (height and indumentum) and is not readily assignable to either.

N.W. Iran. **Ir.-Tur. element.** Threat category: LC
Figure 4.30. General appearance of *S. frigida* Boiss.

Map 44.27. *S. frigida* distribution map.

Perennial herb with a thick woody rootstock. **Stems** solitary or several, erect, 10-30(-50) cm, below pilose to villous with sessile glands, densely pilose to villous glandular above with capitate glands. **Leaves** mostly basal, variable, ovate to narrowly oblong, 2-12 x 0.8-5 cm, crenulate to subentire, arachnoid to ± lanate with many sessile glands; **petiole** 1.5-8 cm. **Inflorescence** little branched to widely paniculate. **Verticillasters** 2-8-flowered, usually distant. Bracts broadly ovate, c. 4-8x5-8 mm. Pedicels 2-3 mm. **Calyx** tubular to campanulate, 5-9 mm, to 10-12 mm in fruit and widening, purplish, densely multicellular pilose to villous glandular or eglandular pilose capitate-glandular; teeth usually prominently spinulose; upper lip tridentate, median tooth much shorter, truncate or not. **Corolla** lilac, 8-11 mm; tube c. 6-8 mm, ventricose, squamulate; upper lip narrow, somewhat falcate, scarcely bifid. **Stamens** B. Anther ca. 2 mm, upper theca ca. 3-4 mm, lower theca ca. 1 mm, filaments ca. 2-3 mm. Chromosome count: unknown.

The **pollen** of *S. modesta* is isopolar and oblate with $P = 43,47 \pm 2,24 \mu m$ and $E = 47,81 \pm 2,8 \mu m$. The aperture is hexacolpate and the colpi = 36,43±2,76 x 5,42±0,31 µm. The exine is 1,24±0,33 µm thick and the intine is 1,06±0,18 µm. Its ornamentation is bireticulate.

*Fl. 6. Rocky slopes, 1700-2000 m.*

Type: [Turkey B5 Kayseri] in Cappadociae regione subalpina rrontis Argaei (Erciyas Da.) in valle Kamechly Tchai (Çomakli çay), [1700 m, 16 vi 1856],Balansa [242] (holo. G!).

C. & S. Anatolia (Anti-Taurus). B5 Kayseri: Bakırdag to Saimbeyli, 2000 m, Hub.-Mor. 10763! Erciyas Da., 1800 m, M. Zohary & Plitm. 17600-7!

Little-known and possibly not specifically different from *S. frigida*. All the gatherings examined were male sterile sex-forms. Boissier's original description and discussion of this species covered both it and the clearly distinct E. Anatolian *S.*
brachyantha. A specimen from B4 Kirşehir (Bozcalidağ, 1500 m, Sorger 64-20-12!) may also belong here.

**Endemic. Ir.-Tur. element.** Treat category VU

**Figure 4.31.** General appearance of *S. modesta* Boiss.

**Map 44.28.** *S. modesta* distribution map.

Perennial herb, clump-forming. **Stems** erect, 15-60 cm, villous to lanate, usually eglandular below, densely glandular above with villous eglandular hairs. **Leaves** mostly basal, ovate to ovate-elliptic, 3-9 x 2.5-4.5 cm, ± lanate with numerous sessile glands, subentire to ± serrate; **petiole** 1.3-4.0 cm. **Inflorescence** ± narrowly paniculate. **Verticillasters** 4-6-flowered, ± crowded. **Bracts** broadly ovate, acuminate, c. 12-17 x 10-14 mm. Pedicels 2-4 mm. **Calyx** campanulate, 8-11 mm, to 11-14 mm in fruit, densely glandular and with eglandular villous hairs; upper lip shortly , tridentate. **Corolla** white with yellow lower lip, c. 11-16 mm; tube c. 8 mm, ± ventricose, not squamulate; upper lip somewhat falcate. **Stamens** **Nutlets** ovoid, c. 3 x 2.5 mm.

**Fl.** 6. **Subalpine meadows, grassy slopes, 1400-2100 m.**

Type: Turkey A4 Kastamonu: Guiardagh (Gavur Da., c. 7 km N.W. of Tosya), in pascuis subalpinis, 13 vi 1892, Sintenis 3913 (holo. LD! iso. B! W! Z!).

N. Anatolia (central part). A4 Kastamonu: Ilgaz Da., 35 km S. of Kastamono, 2100 m, Edmondson 520!Zonguldak: Kel Tepe, Tobey 1860! B4 Ankara: elma daga above yesildere, 40 01 537 N 33 16 944 E, 1400-1700 m, 20 v 2010, SBagherpour 539!

**Endemic.** With features of *S. xanthocheila* (inflorescence structure and bract size) and *S. frigida* (floral characters). Closer to the latter but differing by its broader lanate leaves, villous eglandular hairs, larger bracts and slightly larger calyces and corollas.
Figure 4.32. General appearance of *S. tobeyi* Hedge.

Perennial herb. Stems 13-40 cm, usually stiffly erect, quadrangular, densely eglandular-pilose above with some sessile glands (rarely with some capitate glandular hairs). Leaves mostly basal, ovate to oblong, 2.7-13 x 1-6 cm, rugulose, pubescent with many sessile glands, irregularly serrate to erose; petiole 1-5 cm. Inflorescence widely paniculate. Verticillasters 4-6-flowered, ± distant. Bracts ovate, 5-15 x 4-14 mm. Pedicels 2-3 mm. Calyx infundibular, 7-11 mm, c. up to 15 mm in fruit and widening, eglandular pubescent with many sessile glands, teeth clearly spinulose. Corolla white or tinged lilac, 7-14 mm; tube c. 7 mm, ventricose, squamulate; upper lip narrow, scarcely falcate, scarcely bifid. Stamens B. Nutlet, rounded-trigonouous c. 2.95 x 2.3. Chromosome count: $2n=20$

The *pollen* of *S. yosgadensis* is isopolar and oblate with $P = 35.61 \pm 1.71 \, \mu m$ and $E = 39.13 \pm 1.77 \, \mu m$. The aperture is hexacolpate and the colpi = 29.60 ±1.38 x 5.57 ±0.36 μm. The exine is 1.29 ±0.07 μm thick and the intine is 0.70 ±0.07 μm. Its ornamentation is bireticulate.

*Fl. 5-6. In Quercus scrub, disturbed steppe, fields, 800-1400 m.*
Type: [Turkey B5 Kayseri/Yozgat] inter Caesaream (Kayseri) et Yosgad (Yozgat), 1400 m, 23 vi 1890, BornmuUer 2175 (holo. B!).

C. (western) Anatolia. A4 Ankara:29km past Polatlı to Sivrihisar 39 33 845 N 31 48 664 E, 880 m, 30 v 2008, SBagherpour 449! B3 Eskişehir: 11 km E. of Eskişehir, 800 m, Sorger 64-11-22! B4 Aksaray,Taşlıpınar Dikmen köyü altı, 38 09 456 N 34 05 312 E, 1285 m, 02 vi 2006, SBagherpour 262.! B4 Aksaray Heluadere Köşebaşı road to Hasan Dağı, 38 10 259 N 34 10 742 E, 1635 m, 03 vi 2006, SBagherpour 265.! B4 Ankara: Ankara to Konyaş, 1100 m, Tuzlaci (ISTE 39873)! Konya: Sarayönü to Cihanbeyli, 870 m, Hub.-Mor. 14215! B5 Yozgat: Roadside to Yozgat Büyükyaptı Köyü. 39 56 67 N 33 54 914 E, 884 m, 04 vi 2006, SBagherpour 266.! B5 Yozgat: 50km s.of Yozgat toward Kayseri at Karkışla above symmetry, 39 30 537 N 39 06 974 E, 1087 m, 04 vi 2006, SBagherpour 279.! B5 Nevşehir 12km to Gölşehir on the historic location 38 44 155 N 34 40 299 E, 938 m, 29 v 2008, SBagherpour 441.! B5 Nevşehir: Nevşehir to Gülşehir, 950 m, Tuzlaci (ISTE 40172)! Yozgat: Yozgat, Curtis 104! C5 Konya: Ereğli to Ulukişla, 1200 m, It. Leyd. 1959:1018!

Endemic. Ir.-Tur. element. Close to S. frigida but with an essentially eglandular indumentum on all parts; mostly from lower altitudes and less natural habitats.

**Endemic. Ir.-Tur. element.** Treat category VU
Figure 4.333. General appearance of *S. yosgadensis* Freyn & Bornm.

Map 44.30. *S. yosgadensis* distribution map.

Perennial herb. **Stems** erect, quadrangular, 25-70 cm, branched above, pilose to lanate below, pilose with sessile glands to ± densely papillose glandular above. **Leaves** simple, oblong to broadly ovate to suborbicular, 2-10 x 1.5-6.5 cm, pannose, serrulate to subentire, kuneat to cordate; petiole 1-7 cm. **Inflorescence** paniculate with slender branches; verticillasters (1-)2-6-flowered, distant. **Bracts** broadly ovate-acuminate, 2-6 x 2-4.5 mm. **Pedicels** 1.5-3 mm. **Calyx** tubular-campanulate, usually purple tinted, usually upper lip blue-purple, 7-10 mm, to 9-12 mm in fruit, shortly pilose or papillose glandular; upper lip tridentate, median tooth longer or shorter than, laterals, scarcely mucronate. **Corolla** lilac to violet, 16-30 mm; tube 7-8 mm, ventricose, squamulate (rarely not); upper lip strongly falcate. **Stamens** B. **Nutlets** rounded trigonous, ovoid, 2.5 x 1.7 mm. Chromosome count: Unknown.

The pollen of *S. cyanescens* is isopolar and oblate with \( P = 49.45 \pm 2.36 \) µm and \( E = 55.67 \pm 3.39 \) µm. The aperture is hexacolpate and the colpi = 42.18 ±1.85 x 8.51 ±0.54 µm. The exine is 1.80 ±0.10 µm thick and the intine is 0.62 ±0.11 µm. Its ornamentation is bireticulate.

**Fl:** 6-10. Limestone, serpantine and igneous slopes, shale banks, *Pinus nigra* forest, gravel river beds, fallow fields, vineyards, 400-2300 m.

**Type:** [Turkey C5 Nigde] in collibus secus fluvium Kamechly Tchai (Kameçli Çay) ad basin fluvii Masmenue Dagh Cappadociae inter Tarsous et Caesaream, [14 vi 1856], Balansa [233] (holo. G! Iso G!).

Kastamonu: Tosya, Gavur mount, serpentine slopes, 1175 m, 14 vii 2007, E.Karabacak A6
Çorum: Bayat, Aşağılapa village, 1200 m, 16 vii 1977, M.Kılınç 6524!
Samsun: Ladik, Sultan mount, 28 vi 1953, H.Birand 2290! Sivas: Yıldız Da., Çırçır, 1400 m, Tobey 2335 Sivas: Şerefiye to Suşehri, Karabayır pass limestone slopes, (1925 m), 1348 m, 11 vii 2006, E.Karabacak 4937! A7 Gümüşane: Erzincan to Kelkit, dry shaley slopes and fallow fields, 1750 m, 1 viii 1957, P.H.Davis 31923 & I.C.Hedge! B3 Eskişehir: Ankara to Sivrihisar, c. 40 km from Polatlı, 1000 m, Dudley (P.H.Davis 36014) B4 Ankara to Aksaray before Şerefli Koçhisar hills, 39 00 927 N 33 27 092 E, 1192 m, 03 vi 2006, SBagherpour 263! Ankara: d. Bala, Ankara to Şerefli Koçhisar, 50 km S. of Ankara, 1020 m, A.Huber-Morath 15314 Ankara: Beştepe, steppe, 850 m, 3 vii 1992, M.Vural 6028! B5 Yozgat: Yozgat to Boğazkale, 2 km N. of Derbet, 1200 m, Buttler 12845 Nevşehir: Zelve, volcanic turf, 1050 m, 22 vi 1989, M.Vural 5396 et al.!
B6 Sivas: Zara to Suşehri, P.H.Davis 20451 B6 Sivas: 2 km S of Şerefiye, forest opening, 1600 m, 10 viii 1984, B.Yıldız 4791! B7 Sivas: Refahiye to Zara, Kızıl Da., 1710 m, Bothmer 1581! Sivas: Suşehri to Zara, above Suşehri, dry slopes, 2000 m, 26 vii 1957, P.H.Davis 32700 & I.C.Hedge! C4 Konya: N. of Sille, A.Huber-Morath 8020 Konya: 25 NW of Kocaş, 1200 m, 22 vi 1953, H.Birand! Konya: 2 km from Hadim to Korualan, 1680 m, 14 vii 1998, K.H.C. Başer 1417! Karaman: 5 km from Ermenek to Tekeçatı, 1650 m, 28 vi 1995, G.Kökdil et al.! C5 Nigde: Ala Da., Ulupinar Y. to Kara G., c. 2300 m, Spitzenberger 64.

Close to *S. candidissima* but with smaller lilac-tinted calyces and corollas, a more slender habit and smaller nutlets. Specimens from the type locality, Niğde, appear to be smaller plants with more condensed inflorescences and darker flowers; they grow at higher altitudes than those from northern Anatolia.

**Endemic. Irano-Turanian element.** Treat category: NT
**Figure 4.344.** General appearance of *S. cyanescens* Boiss. & Balansa

**Map 44.301.** *S. cyanescens* distribution map.

*Salvia candidissima* Vahl X *Salvia cyanescens* Boiss. & Balansa

A7 Gümüşhane: Kelkit-Köse, 1550 m., dry gravelly banks, perennial, flowers varying from small with pale lilac blue hood to larger and white. A hybrid swam between *S.*
cyanescens and S. candidissima, 2 Aug. 1957, P.H.Davis & I.C.Hedge (D.31970) (ANK!) A9 Erzurum: Oltu, Çamlıdere picnic area, 1443 m, slopes, 22 vi 2008, E.Karabacak 6162! (leaves similar to S. cyanescens but corollas white) B6 Sivas: Şarkışla to Kayadibi, 1400 m, dry gravel hills. Upper lip lavender-blue (pale), lower lip cream. 28 viii 1957, P.H.Davis 32728 I.C.Hedge (ANK!)

Hybridisation and introgression between the two species is probably frequent although only a few definite instances of hybrids are known.

Map 4.312. S. candidissima X cyanescens distribution map.


Perennial herb forming tufts to 60 cm diam. Stems erect, sturdy, 25-60 cm, usually unbranched, eglandular arachnoid to lanate below, glandular pilose above. Leaves simple, linear to linear-oblong or spathulate, mostly basal, greenish above, white lanate below, margins subentire, 4-8 x 0.5-1 cm, incl. indistinct petiole. Verticillasters 4-8-flowered, clearly distant. Bracts broadly ovate, c. 15 x 12 mm, lower surface lanate. Pedicels 2-3 mm, ± erect. Calyx tubular-ovate, c. 10 mm, to c. 12 mm in fruit, lanate and glandular; upper lip truncate. Corolla lavender to purplish-blue, c. 25 mm; tube straight, slightly ventricose above; upper lip falcate. Stamens B. Nutlets rounded trigonous, 3.5 x 2.5 mm, Chromosome count: 2n = 22.
The pollen of *S. hypargeia* is isopolar and oblate-spherical with $P = 51.50 \pm 4.05 \, \mu\text{m}$ and $E = 52.42 \pm 4.47 \, \mu\text{m}$. The aperture is hexacolpate and the colpi $= 43.64 \pm 3.91 \times 3.57 \pm 0.96 \, \mu\text{m}$. The exine is $1.16 \pm 0.15 \, \mu\text{m}$ thick and the intine is $0.54 \pm 0.06 \, \mu\text{m}$. Its ornamentation is bireticulate.

*Fl. 6-7. Limestone slopes and banks, with Pinus brutia, fallow fields, 800-2000 m.*

**Type:** [Turkey B4 Kırşehir] inter Karadjeli (İsahocali) et Gaman (Kaman), [900 m, 1849], Tchihatcheff (holo. P).

**Central Anatolia, extending South & East**


*S. hypargeia* is closely related to *S. montbretii*; calyx and bracts of *S. hypargeia* smaller than *S. montbretii*’s.

**Endemic. Irano-Turanian element.** Treat category: **NT**
Figure 4.355. General habitus of *S. hypargeia* Fisch. & Mey.

Map 4.323. *S. hypargeia* distribution map.
33. *S. ceratophylla* L. (Fig. 9) Species plantarum, page 27, no. 24 (1753). = *S. semilanata* Czernjak., Feddes Repert. 27: 278 (1930).

Biennial very sticky herbs, lemon-scented. **Stems** sturdy, 25-70 cm, glandular-villous, densely so above. **Leaves** mostly basal, pinnatifid, oblong in outline, with spreading linear segments, white-lanate when young, 10-29 x 3-10 cm, rachis winged; petiole subabsent. **Inflorescence** spreading paniculate, yellowish-green. **Verticillasters** 2-8-flowered, distant. **Bracts** ovate, cuspidate, c. 15 x 12 mm. **Pedicels** erecto-patent, 2-4 mm. **Calyx** ovate-campanulate, c. 12 mm, to c. 18 mm in fruit with diverging lips, glandular-villous; upper lip tridentate with cuspidate teeth. **Corolla** cream or sulphur, rarely with lilac upper lip, 15-20 mm; tube 4-5 mm, abruptly ventricose, squamulate; upper lip falcate. **Stamens** B. **Nutlets** spherical, black, c. 3.5 x 2.5-3 mm. Chromosome count: 2n = 44.

The **pollen** of *S. ceratophylla* is isopolar and oblate with P = 40.33 ±3.17 µm and E = 45.77 ±4.38 µm. The aperture is hexacolpate and the colpi = 34.65 ±3.35 x 4.00 ±0.58 µm. The exine is 1.25 ±0.14 µm thick and the intine is 0.76 ±0.08 µm. Its ornamentation is reticulate.

**Fl**: 4-6. *Limestone, igneous and gypsum slopes, corn and fallow fields, waste ground, steppe*, 300-2150 m.

**Type**: Described from 'Persia' (Hb. S-LINN 42/47 photo!).

1993, M.Vural 6273 et al. B5 Yozgat: Akdağmadeni, Findicak stream, 1750 m, 4 vi 1980, T.Ekim 5265! Kayseri: İncesu to Develi, 1050m, A.Huber-Morath 10742 B6 Malatya: E. of Darende, 1500m, Watson 5563 Kayseri: between Kayseri and Sivas, 20 vi 1934, Balls 1439! Kahramanmaraş: Çardak to Göksun, 5 km before Göksun, roadside, 1350 m, 20 vi 1979, E.Tuzlacı & M.Saraçoğlu 42369! B7 Sivas: Divrik, Dumlucadağ, 30 v 1968, T.Baytop 12925! Erzincan: 3 km from Erzincan to Spikör mount, calcareous slopes, 1567 m, 7 vii 2007, E.Karabacak 5543! Diyarbakir: Ergani to Maden, 900 m, P.H.Davis 28878 B8 Erzincan: Tercan to Aşkale, 1600 m, P.H.Davis 29343 B9 Van: 20 km from Timar to Van, 1800m, P.H.Davis 44219 C2 Burdur: Tefenni to Burdur, 1100 m, A.Huber-Morath 5209 Burdur: 12 km from Karamanlı to Burdur, slopes of Karataş lake hills, 1150 m, 6 vii 1993, L.Bekat 3101 18912! C3 Burdur: Burdur to Antalya, A.Huber-Morath 5210 Antalya: between Kızılcaadağ and Korkuteli, 2 km before Korkuteli, Quercus scrub, 1150 m, 23 vi 1980, N.Özhatay, E.Özhatay & E.Tuzlacı! C4 Mersin: Mut to Büyük Egri Da., 800 m, Coode & Jones 913 C5 Niğde: Niğde, 100 m, Siehe 1898:38 Niğde: Ulukışla-Darboğaz junction, Artemisia steppe, 13 vi 1991, Y.Gemici 6072! C6 Adıyaman: Malatya to Besni, 1000 m, Balls 2262! C7 Urfa: Urfa to Hilvan, 700 m, P.H.Davis 28241 C8 Siirt: 5 km S. of Siirt, 700 m, P.H.Davis 43214 C10 Hakkari: Zap river valley, Trelawny 1319.

Very distinct and unmistakable on account of the pinnatifid leaves, white-lanate when young, and yellow or cream corollas.

Palestine, Syrian Desert, Soviet Armenia, N. Iraq, Iran, Afghanistan. **Irano-Turanian element.** Threat category: LC
Figure 4.366. General appearance of *S. ceratophylla* L.

Perennial herb. **Stems** 25-40(60) cm, simple, erect, eglandular pubescent floccose, retrose, and deep purple below, densely glandular and yellowish-green above. **Leaves** simple, narrowly linear to linear-oblong, 20-47 x 6-10 mm, margins crenulate, revolute, floccose-tomentose below, narrowed into **petiole**; cauline leaves sessile, 2-3 paired. **Verticillasters** 2-3 flowered, distant. **Bracts** c. 4-7 x 4-5 mm. **Pedicels** 2-4 mm, erect. **Calyx** tubular-campanulate, 10-11, c. up to 12 mm at fruit, yellowishgreen, glandular-pubescent, many sessile glands; upper lip recurved, teeth mucronate. **Corolla** white with yellowish lower lip, many sessile glands, 15-24 mm; tube abruptly broadened above, squamulate; upper lip strongly falcate-compressed. **Stamens** B. Chromosome count: 2n=20.

The **pollen** of *S. vermifolia* is isopolar and prolate with $P = 33.57 \pm 4.80 \mu m$ and $E = 30.79 \pm 3.20 \mu m$. The aperture is mostly hexacolpate (rarely heptacolpate to octacolpate) and the colpi $= 29.01 \pm 4.31 \times 4.47 \pm 0.65 \mu m$. The exine is $1.21 \pm 0.19 \mu m$ thick and the intine is $0.64 \pm 0.14 \mu m$. Its ornamentation is bireticulate.

*Fl. 6-7. Igneous and serpentine slopes, c. 1450 m.*

C. Anatolia. B6 Sivas: Ulaş Kurtlukaya to Boğazdere: left side of road. 39 23 142 N 36 55 898 E, 1495 m, 20 vii 2008, SBagherpour 521! B6 Sivas to Tecer, 26 km S. of Sivas, c. 1450 m, Hub.-Mor. 15311!

Very distinctive on account of the linear leaves, but within the *S. candidissima* complex.

**Endemic. Ir.-Tur. element.** Treat category: EN

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*Figure 4.377.* General appearance of *S. vermifolia* Hedge & Hub.-Mor.
Map 44.345. *S. vermicifolia* distribution map.


Biennial or short-lived perennial with erect rather coarse quadrangular, stems to 100 cm, much branched above, pubescent to hirsute below, glandular above. Leaves simple, broadly ovate to ovate-oblong, c. 8-14 x 5-10 cm, cordate, pubescent, crenate-erose; petiole 3-9 cm. Inflorescence paniculate, many-flowered; Verticillasters 2-6-flowered, distant. Bracts ± exceeding flowers, pink to mauve or white, membranous, ovate, acuminate, 15-35 x 10-25 mm. Pedicels 2-3 mm, erecto-patent. Calyx ovate-campanulate, c. 10 mm, to 13 mm in fruit, scabrid, with sessile glands; upper lip tridentate, mucronate. Corolla with a lilac or pale blue upper lip and cream lower lip 20-30 mm; tube abruptly ventricose, strongly squamulate; upper lip falcate. Stamens B. Nutlets rounded trigonous, 3 x 2 mm. Chromosome count: 2n=22.

The pollen of *S. sclarea* is isopolar and oblate-spherical with P = 32,64±1,22 μm and E = 34,58±1,87 μm. The aperture is hexacolpate and the colpi = 26,8±1,84 x 5,37±0,56 μm. The exine is 1,12±0,17 μm thick and the intine is 0,67±0,13 μm. Its ornamentation is reticulate.
**Fl: 5-8. Rocky igneous slopes, mixed deciduous and coniferous woodland, shale banks, fields, roadsides, s.l-2000 m.**

**Type:** Described from Syria and Italy (Hb. S-LINN. 42/45!).

**Lectotypus:** Luis Rosúa & Blanca, Taxon 35: 719. 1986.

Tokat: Tokat to Sivas, Kızılınış pass, slopes and shrubs, 1200 m, 10 vii 2006, E.Karabacak 4898! Sivas: Sivas to Tokat, Çamlıbel pass, 6 vii 1992, Kartal! A7 Trabzon: Kalanema De. nr Aktsche Abad (Akçaabat), Hand.-Mazz. 328 Giresun: between Şebinkarahasar and Kelkit, 3 km before Konaklı village, soil slopes, 1536 m, 11 vii 2006, E.Karabacak 4957! Gümüşhane: Torul to Hamsıköy old road, rocky slopes, 1281 m, 12 vii 2006, E.Karabacak 5001! Gümüşhane: 40 km from Gümüşhane to Bayburt, Güvercinlık Mvk., 1850 m, 9 vii 1987, Coşkun & S.Kurucu! A8 Bayburt: Erzurum to Bayburt, 1250 m, Stainton & Henderson 6160!

Distinctive on account of its habit and the large coloured bracts, often exceeding the flowers; a fairly oligomorphic species. Hedge (in Rechinger, Fl. Iranica 150: 452. 1982) indicated the inadequate 42.45 (LINN) as the type, but Rosúa & Blanca argued that this collection conflicted with Linnaeus’ protologue (and was also identifiable as *S. argentea* L. 1762). They therefore designated Burser material, from Italy, as the lectotype.

**Throughout most of Europe, S.W. & C. Asia.** Threat category: LC
Figure 4.388. General appearance of *S. sclarea* L.
4.2.4 **Section Plethiosphace Benth.**:

Perennial, rarely annual herbs. Calyx campanulate; upper lip concave and 2-sulcate in fruit. Upper lip of corolla straight or falcate; tube not hairy-ringed. Connective longer than filament; arms unequal, the sterile arm shorter, flattened distally.

Species for Sect. *Plethiosphace*:


Perennial herb. **Stems** 25-57 cm, ascending-erect, branched above or not, eglandular-pubescent. **Leaves** simple, narrowly oblong to oblong-lanceolate, ± cordate, 2-11 x 0.7-3 cm, rugulose, pubescent with numerous sessile glands, crenulate; **petiole** 1-10 cm. Verticillasters 2-6-flowered, ± approximating. **Bracts** ovate-acuminate, 2-15 x 2-10 mm. Pedicels 0.5-2 mm. **Calyx** tubular campanulate, 5-7 mm, to c. 8 mm in fruit, pubescent with numerous sessile glands (rarely with some capitate glandular hairs). **Corolla** purpure to violet blue, 10-17 mm; tube c. 6 mm, ventricose, not squamulate;
upper lip falcate. **Stamens** B. Nutlets rounded trigonous, ovoid, 2 x 1.5 mm. Chromosome count: unknown.

The **pollen** of *S. dichroantha* is isopolar and prolate with \( P = 41.30 \pm 2.89 \mu m \) and \( E = 39.06 \pm 2.04 \mu m \). The aperture is hexacolpate and the colpi = 34.33 ± 3.31 x 4.33 ± 0.50 µm. The exine is 1.36 ± 0.14 µm thick and the intine is 0.70 ± 0.08 µm. Its ornamentation is bireticulate.

*Fl. 7-9. Steppe, clearings in forest, fallow fields, roadsides, 810-1800 m.*

Type not indicated [Turkey C2 Mugla: inter Baschibunar (Başpınar) et Gurdef (Girdev), 19 vii 1882, Luschan] (holo. WU! photo E!).

**N.W., S.W. & C. Anatolia.** A3 Bolu: Abarit G., 6 viii 1941, B. Post! A4 Bolu: Gerede to Aktaş, 1150m, Ketenoğlu 350! A4/5 Kastamonu: Kastamonu to Taşköpru, Hırıhasan köyü, 22 viii 1956, Ozen! B2 Kiitahya: Domanic, 900 m, D. 36429. B3 Eskisehir: 2 km W. of Oklubali ovey to Inonu, 810m, Buttler 13725! B4 Konya: 2 km E. of junction to Zaferiye köyü on way to Ilgin, 1060 m, Buttler 20004! B4 Konya: Bayşehir to Ilgin yolu before Aşağıçigil 38 01 021 N 31 53 868 E, 1386 m, 27 vii 2005, SBagherpour 214! B4 Konya: Zaferiye köy 2 km E. Of Zaferiye köy toward Ilgin Bulasan near river 38 17 533 N 32 00 983 E, 1023 m, 27 vii 2005, SBagherpour 215! B4 Konya: Cihanbeyli roadside 38 38 117 N 32 55 858 E, 884 m. SBagherpour 202.!


Endemic. Ir.-Tur. element. Related to the E. Anatolian *S. nemorosa*, but without the prominent violet bracts of that species and often with a greyish-white indumentum. Two anomalous specimens are from B7 Elazig: Elazig, viii 1944, Sayi! and C3 Isparta: d.
Sutciiler, Sarp Da., D. 15810! Both have a dense glandular calyx indumentum and appear to be intermediate between *S. dichroantha* and *S. virgata*.

**Endemic. Ir.-Tur. element.** Treat category NT

**Figure 4.399.** General appearance of *S. dichroantha* Stapf.

**Map 44.367.** *S. dichroantha* distribution map.

Perennial usually coarse herb. **Stems** erect, (10-)30-100 cm, much branched above or not, indumentum variable, pilose to tomentose, glandular or eglandular. **Leaves** simple, distributed over stem or rarely restricted to basal rosettes, ovate-oblong to broadly ovate, 3.7-30 x 2-15 cm, eglandular-pilose with numerous sessile glands, cordate, rugulose, erose, crenate; serrate to subentire; **petiole** 1-15 cm. Inflorescence a widely branched panicle with long ± slender secondary branches; **verticillasters** 2-6-flowered, distant, rarely condensed. Bracts ovate-acuminate, 2-10 x 2-9 mm. **Pedicels** 1-3 mm. **Calyx** ± tubular campanulate, 5-10 mm, to 10-12 mm in fruit with a strongly recurved bisulcate upper lip, glandular or eglandular pilose. **Corolla** violet-blue to lilac, rarely white, 12-20 mm; tube 7-9 mm, ventricose, not squamulate; upper lip falcate. Stamens B. Nutlets rounded trigonous, ovoid, 2.5 x 2 mm. Chromosome count: 2n = 16.

The **pollen** of *S. virgata* is isopolar and oblate with P = 36.20 ±1.51 µm and E = 42.30 ±3.58 µm. The aperture is hexacolpate and the colpi = 29.75 ±1.08 x 3.71 ±0.33 µm. The exine is 1.28 ±0.31 µm thick and the intine is 0.62 ±0.06 µm. Its ornamentation is bireticulate.

*Fl.* 5-9. **Scrub, woodland, meadows, fallow fields, roadsides etc., s.l.-2300 m.**

Described from cultivated material; no type indicated. **Throughout most of Turkey, Islands.** A1 **Kirkilareli:** Saray to Vize, A. Baytop! A1 Keşan to Enez 30 km to Enez, 40 40 571 N 26 20 785 E, 132 m, 03 vi 2008, SBagherpour 457! A1 **Kocaeli:** Karamürsel to Yalova, 50 m, Hub.-Mor. 17197! A1 **Çanakkale:** Kazdağ to Çanakkale inside the old city of Troy 39 57 401 N 26 14 468 E, 26 m. SBagherpour 456. A2 **Istanbul:** Kilyos, Demiriz 260! A2 **Istanbul:** Kayişdag, W. slopes, Demiriz 3849! A3
Bilecik: 2 km S.W. of Aktaş, on road to Kayabeli, 480 m, Buttler & Erben 17991! A4 Kastamonu: Daday to Efia, 1100 m, Coode & Yalt! A5 Sinop: Sinop, 5 m, Tobey 1033! A6 Tokat: Tokat to Artova, 750 m, Hub-Mor. 13045! A7 Sivas: Suşehri to Zara, 1400 m, D. 32699. A8 Coruh: above Arrvin, 900 m, D. 29748. A9 Kars: Benliah-met to Kağızman, Kotek, 1500 m, D. 46668. B1 İzmir: İzmir to Manisa, N. of Bornova, 70 m, Hub.-Mor. 2506! B2 Kütahya: plain of Simav, 750 m, E. Anglia Expcd. C2! B3 Eskişehir: 30 km from Eskişehir to Bursa, 860 m, Simon 69-184. B3 Ankara: From Nallıhan 47 km to Beypazarı, 40 08 677 N 31 28 713 E, 652 m, 31 v 2006, SBagherpour 239! B4 Ankara Hills above Kalecik 4 km to Gülköy, 40 05 067 N 33 22 060 E, 1500 m, 18 vii 2008, SBagherpour 507! B5 Kırşehir: Kırşehir 40 km to Kayseri, 38 53 558 N 35 06 893 E, 1150 m. SBagherpour 467! B5 Kayseri: Kayseri Ali daği, 38 40 437 N 35 33 451 E, 1600 m. SBagherpour 472! B5 Yozgat: 5 km past Şarkışla toward Akçakışla, 39 24 588 N 36 23 970 E, 1588 m. SBagherpour 486! B6 Sivas to Ulaş roadside, 39 27 489 N 37 01 047 E, 1373 m, 20 vii 2008, SBagherpour 520! B6 Maraş; Elbistan to Gürün, 1200 m, Stn. & Mend. 5663! B7 Gümüşane; Erzincan to Kelkit, 2100 m, D. 31904. B8 Mus; Mus, to Bingöl, 20 km W. of Muş, 1420 m, Hub.-Mor. 10760! B9 Bitlis: Corgih to Bitlis, 2280 m. Tong 312! Cl Aydın: 7 V m N. of Kuşadası, 27 v 1935, Reese! C2 Antalya: Elmali to Avlan G., Khan et al. 166! C3 Konya: Konya to Bayşehir just pass the dam roadside, 37 53 221 N 32 15 267 E, 1350 m. SBagherpour 210! C3 Isparta: Barla, Khan et al. 349! C5 Adana: Kozan to Feke, 300 m, Hiib.-Mor. 15318! C6 Hatay: Antakya to Cebeli Kası, 12 km E. of Antakya, 350 m, Hub.-Mor. 11872! C9 Hakkari: Zap gorge, 3 km below Hakkari, 1400 m, D. 45469.


Variable, particularly with regard to degree of branching, leaf shape and margin, and type and density of overall indumentum. Although no definite examples of hybrids with the related S. nemorosa and S. dichroantha have been recorded, it would be surprising if they do not exist in Turkey.
**Ir.-Tur. element**, penetrating into Medit. territories. Treat category **LC**

**Figure 4.40.** General appearance of *S. virgata* Jacq.


Perennial herb with erect **stems** c. 50 cm, branched above, ± densely eglandular or glandular-pilose below, glandular-pilose above. **Leaves** simple, ovate-oblong, 3.5-14 x 1.5-6.0 cm, somewhat thick-textured, softly pilose above and below, cordate-truncate, crenulate to subentire; **petiole** 1.5-7 cm. **Verticillasters** 4-6-flowered, distant. Bracts ovate-acuminate, 4-10 x 3-6 mm. Pedicels 1-3 mm. **Calyx** ovoid-infundibular, 6-8 mm, glandular-pilose; upper lip tridentate, shortly mucronate, recurved in fruit. **Corolla** pale lilac with white lip, 10-17 mm; tube 10 mm, not annulate, gradually widening above, pilose-fasiculate; upper lip falcate. **Stamens** B. Nutlets ovate-trigonous, c. 1.5 x 1 mm. Chromosome count: 2n = 18.

The **pollen** of *S. halophila* is isopolar and oblate with P = 35.09 ±3.04 μm and E = 40.44 ±2.05 μm. The aperture is hexacolpate and the colpi = 29.68 ±1.98 x 3.68 ±0.38 μm. The exine is 1.11 ±0.20 μm thick and the intine is 0.69 ±0.09 μm. Its ornamentation is bireticulate.

Fl. 7-10. Salt steppe, 950-1000 m.
Type: [Turkey B4] Nigde: 2 km E. of Sultanhani, between Aksaray and Konya, south of the Tuz Golil, 950 m, salt marsh (now dry), 31 viii 1957, Davis & Hedge, D. 32815 (hdlo. E! - 2n = 18; iso. BM! K!).

C. Anatolia. B4 Konya: Cihanbeyli: Gölyazı Kuşabaşı, 38 32 244 N 33 23 323 E, 910 m, 23 vii 2005, SBagherpour 203! B4 Konya: Sultani-Ani 35 km to Aksaray, 38 15 197 N 33 34 712 E, 915 m, SBagherpour 204! B4 Konya: Sultanhanı to Aksaray, 44 km to Aksaray, 6 km to new salt factory "Balküpü tuz factory", 38 15 197 N 33 34 712 E, 1000 m, 23 vii 2008, SBagherpour 534! B4 Konya: Cihari beyli, 1000 m, Khan et al. 441! Nigde: S.W. of Tuz G., Wagenitz &Beug 316! C4 Konya: Konya to Kadinhan, D. 14771.

Endemic. Ir.-Tur. element. Related to S. virgata but lower growing, with ± thick leaves with subentire margins and later flowering; the chromosome number is also different.

Endemic. Ir.-Tur. element. Treat category EN

Figure 4.401. General appearance of S. halophila Hedge.
Map 44.389. *S. halophila* distribution map.


Perennial herb. **Stems** 30-60 (-100) cm, many, erect, branched above, eglandular-pilose to pubescent with short hairs, occasionally retrorse, or longer spreading hairs. **Leaves** simple, oblong-lanceolate, cordate, 3.5-10 x 1.2-4 cm, pubescent with few to many sessile glands, serrulate to crenate. **Petiole** 1-3.5 (-4.5) cm. **Inflorescence** paniculate. **Verticillasters** many, c. 6-flowered, approximating, showy. **Bracts** ovate, acuminate, 5-10 x 3-6 mm, purplish or violet. **Pedicels** 2-3 mm. **Calyx** tubular-campanulate, c. 6 mm, to 8 mm in fruit, pilose to villous with sessile glands; upper lip strongly recurved in fruit. **Corolla** purple to violet-blue, 10-12 mm; tube ventricose, not squamulate; upper lip slightly falcate. **Stamens** B. **Nutlets** rounded trigonous, ± ovoid, c. 2 x 1.5 mm. Chromosome count: 2n=12.

The **pollen** of *S. nemorosa* is isopolar and oblate with \( P = 35.44 \pm 2.93 \) \( \mu m \) and \( E = 40.95 \pm 3.62 \) \( \mu m \). The aperture is often hexacolpate (rarely octacolpate) and the colpi \( = 29.34 \pm 2.94 \times 4.81 \pm 0.75 \) \( \mu m \). The exine is \( 1.37 \pm 0.14 \) \( \mu m \) thick and the intine is \( 0.79 \pm 0.15 \) \( \mu m \). Its ornamentation is bireticulate.
Fl: (5) 6-9, rocky slopes in steppe, fallow fields, sloping meadows, waste ground and marshy clay, 1000-2830 m.

**Type Specimen:** ‘Tartaria’ (Tartary), Gerber (?) (Hb. Linn. 42/14). For a note on nomenclature see Notes R.B.G. Edinb. 23:563-566 (1961).


An overall review of this widespread species together with the narrow splits off it (such as *S. tesquicola* Klokov & Pobed., *S. deserta* Schang and *S. pseudosylvestris* Stapf) is needed, but the characters used (mostly of indumentum) to recognise these segregate species scarcely justify specific separation. Not very common in Central Anatolia, mostly an Eastern Anatolia species.

**C. Europe, Balkans, S. & C. Russia, Crimea, Caucasus, Iran, Afghanistan and Persia.** Treat category LC
Figure 4.412. General appearance of *S. nemorosa*. 
Map 44.40. *S. nemorosa* distribution map.


Perennial herb with a woody rootstock; stems erect, 10-80 cm, often branched above, eglandular-pilose below, usually thickly glandular-pilose above. Leaves mostly basal, variable, entire to pinnatifid with wide lobes, narrow oblong to ovate, 4-10 x 1.5-7 cm, eglandular-pubescent with sessile glands, crenate to erose; petiole 1.2-8 cm. Verticillasters 4-10-flowered, inflorescence distant or condensed above. Bracts ovate-acuminate, shorter than the calyx 3-6 x 4-7 mm; bracteoles present. Pedicel 2-3 mm. Flowers hermaphrodite or female, sometimes cleistogamous. Calyx ± campanulate, 5-8 mm, to 8-10 mm in fruit, and broadening, with villous glandular and eglandular hairs; upper lip shortly tridentate, broadly bisulcate. Corolla blue, lilac or purple, 6-16 mm; tube ventricose, not squamulate, 6-7 mm; upper lip ± straight to subfalcate. Stamens B.
Nutlets rounded trigonous, oblong, c. 2 x 1.5 mm. Chromosome count: 42, 46, 48, 59, 60 and 64.

The pollen of *S. verbenaca* is isopolar and prolate with \( P = 53.17 \pm 4.7 \) µm and \( E = 49.94 \pm 3.45 \) µm. The aperture is hexacolpate and the colpi = 46.9±5.51 x 4.7±0.41 µm. The exine is 0.81±0.15 µm thick and the intine is 0.76±0.08 µm. Its ornamentation is bireticulate.

*Fl: 3-11 , Banks, in Quercus macchie, deciduous woodland, road- and fieldsides, s.1,-900 m.*

**Type:** Described from Europe, cultivated plant form Uppsala (Hb. Linn. 42/20 photo!)


A polymorphic species with numerous variants. Very variable in indumentum, leaf shape and degree of lobing. Gynodioecism is frequent.


**Medit. element.** Treat category LC
Figure 4.423. General appearance of *S. Verbenaca.*
4.2.5 **Section Hemisphace Benth.:**

Perennial herbs. Calyx tubular or campanulate, deflexed in fruit. Upper lip of corolla more or less straight; tube hairy ringed. Connective longer than filament and not articulated with it; arms unequal, the sterile arm shorter, subulate.

Species for sect. Hemisphace:


Perennial herb; **stems** erect or ascending, 15-80 cm, many, branched above or not, pilose to villous below with sessile glands. **Leaves** simple, ovate to oblong, 2.5-15 x 2-9 cm, or lyrat with one or two pairs of unequal basal lobes, pilose to villous with many sessile glands, subentire to serrate, ovate-triangular, cordate to truncate or rounded at base, acute, petiole 1.5-10 cm. **Verticillasters** (8-)15-40-flowered, clearly distant. **Bracts** ovate-acuminate, c. 6 x 3 mm, deciduous. **Pedicels** 2-7 mm, some ± deflexed. **Calyx** tubular, 5-6 mm to c. 7 mm in fruit with a bisulcate upper lip, violet-blue, pilose to villous or scabridulous with sessile glands, teeth mucronate. **Corolla** violet-blue, lilac, rarely white; c. 12 mm; tube straight, c. 8 mm with a V-shaped annulus; upper lip straight, narrowed at base. **Stamens** C. **Nutlets** c. 2.2 x 1.3 mm. Chromosome count: 16.
1. Leaves broadly ovate, clearly cordate; stem, leaf and calyx indumentum of villous soft hairs; plant to c. 70 cm, much branched subsp. *verticillata*

2. Leaves oblong, elliptic, or oblong-ovate, rounded or subcordate; indumentum of short ± scabridulous hairs; plant 15-50 cm, little branched subsp. *amasiaca*

   The pollen of *S. verticillata* subsp. *amasiaca* is isopolar and prolate with $P = 32.13 \pm 0.98 \mu m$ and $E = 33.28 \pm 1.60 \mu m$. The aperture is hexacolpate and the colpi $= 26.32 \pm 1.46 \times 6.48 \pm 1.06 \mu m$. The exine is $1.22 \pm 0.24 \mu m$ thick and the intine is $0.55 \pm 0.16 \mu m$. Its ornamentation is bireticulate.


**Type:** [Turkey A5 Amasya] Amasia: in rupestribus ad 4-600 m, 11 vi 1899, Bornmuller 611.

   *Fl:* 5-9, *In a wide variety of habitats: rocky slopes, Stipa steppe, sandy banks, meadows, Quercus and Pinus woods, fields and roadsides, 20-2300 m.*


Bulgaria, Caucasia, Iran, N. Iraq. **Irano-Turanian element.** By far the commoner subspecies in Anatolia. Treat category **LC**
Figure 4.434. General appearance of *S. verticillata* subsp. *amasiaca*.

Map 44.402. *S. verticillata* subsp. *amasiaca* distribution map.
42. *S. russellii* Benth. In DC., Prodr. 12:357 (1848)

Perennial herb. **Stems** 20-60 cm, erect, usually simple, many, arising from a woody rootstock, eglandular-pubescent. **Leaves** simple, linear-oblong, sometimes sublyrate or deeply lobed at base, 5-8 x c. 1 cm, rugulose, cuneate, eglandular-pilose especially on veins and with numerous sessile glands; petiole 2-8(-10) cm. **Verticillasters** 20-30-flowered, clearly distant. **Bracts** c. 6 x 2 mm, ovate-acuminate. **Pedicels** 2-6 mm, erectopatent. **Calyx** tubular, c. 6 mm, purplish-blue, eglandular spreading pilose and with sessile glands, ovate in fruit with a concave-bisulcate upper lip, teeth not mucronate. **Corolla** violet-blue, c. 10 mm, tube straight with an inverted V-shaped annulus; upper lip straight, compressed, narrowed at base. **Stamens** C. **Nutlets** ovate, 2.5 x 1.5 mm. Chromosome count: Unknown.

The pollen of *S. russellii* is isopolar and prolate with $P = 28.42 \pm 0.87 \, \mu m$ and $E = 30.72 \pm 1.00 \, \mu m$. The aperture is hexacolpate and the colpi = 23.95 ± 0.99 x 3.67 ± 0.80 \, \mu m. The exine is 1.03 ± 0.11 \, \mu m thick and the intine is 0.59 ± 0.08 \, \mu m. Its ornamentation is bireticulate.

**Fl**: 5-7, Rocky slopes, grassy meadows amongst Quercus, fallow and cultivated fields, 100-1600 m.

**Type**: [Syria] prope Aleppo, *Russell* (holo. BM)

Kahramanmaraş: Göksun to Elbistan, 1400 m, Stainton & Henderson 5593 B7 Tunceli: above Pertek, 1600 m, rocky igneous slopes, P.H.Davis 31054 & I.C.Hedge (ANK!) B8 Siirt: N. of Sason, Sason Da., Batman, 1000 m, Watson 5597 B9 Van: Erek Da., 2200 m, Nabelek 1598 C2 Burdur: Tefenni to Yeşilova, 1100 m, Dudley (P.H.Davis 35297) C5 Adana: d. Saimbeyli, Doğanbeyli to Akçal, fallow fields (steppe), 1300 m, 12 vii 1952, P.H.Davis 19893, Dodds & R.Çetik! C6 Gaziantep: Gaziantep, 850 m, Balls 1166 C7 Urfa: N. of Urfaj Hand.-Mazz. 1911. C8 Mardin: Mardin station to Kızıltepe, 600 m, P.H.Davis 28637 C9 Hakkari: Çukurca, 1200m, P.H.Davis 44820.

Syrian Desert, N. Iraq, N.W. Iran. **Ir.-Tur. element.** Treat category **LC**

Figure 4.445. General appearance of *S. russellii* Bentham.
4.2.6 Section Horminum (Moench) Dumort:

Annuals. Calyx tubular, deflexed in fruit. Upper lip of corolla more or less straight; tube not hairy ringed. Connective longer than filament; arms unequal, the sterile arm shorter and more or less distally.

Species for Sect. Horminum:


Annual herbs. **Stems** simple or branched, 7-50 cm, erect, glandular-pilose or eglandular-pilose, with or without a coma of violet, green, pink or white sterile bracts. **Leaves** simple, oblong or ovate, c. 5 x 2.5 cm, regularly crenate, rounded or cordate at base, obtuse, pubescent; petiole 2-5 cm. **Verticillasters** 4-8-flowered, distant or approximating. **Bracts** broadly ovate, c. 10 x 10 mm; bracteoles present. **Pedicels** 2-5 mm, erect, flattened. **Calyx** tubular, 7-10 mm, to c. 12 mm in fruit and strongly deflexed, eglandular-pilose or glandular; upper lip ± truncate. **Corolla** lilac-purple to white, generally upper lip of corolla lilac-purple, lower lip of corolla white-lilac, 12-18 mm; tube straight, glabrous within; upper lip broad, ± falcate. **Stamens** B. **Nutlets** oblong-elliptic, 3 x 1.5 mm. Chromosome count: 2n = 16.
The pollen of *S. viridis* is isopolar and prolate-spherical with \( P = 39.34 \pm 3.00 \) µm and \( E = 38.34 \pm 5.73 \) µm. The aperture is hexacolpate and the colpi = 33.82 ±2.52 x 5.13 ±0.85 µm. The exine is 1.14 ±0.13 µm thick and the intine is 0.58 ±0.07 µm. Its ornamentation is bireticate.

*Fl. 3-7. Rocky slopes, macchie with Cistus, phrygana, sand-dunes, fields and waste ground, s.l.-1300 m.*

**Turkey-in-Europe, Outer, C. & S.E. Anatolia; Islands.** A1 Tekirdağ: Tekirdağ to Silivri, c. 15 m, Dudley (P.H.Davis 34697) Tekirdağ: 15 km from Tekirdağ to Silivri, road and field side, 11 m, 28 v 2006, E.Karabacak 4489! Tekirdağ: Marmara Ereğlisi, Silivri to Tekirdağ road, German Site environs, dry meadows, 23 m, 30 v 2006, E.Karabacak 4529! Çanakkale: Eceabat, Gelibolu Peninsula, 2 km from Havuzlar to Behramlı, roadside, 6 m, 21 v 2006, E.Karabacak 4463! Çanakkale: Eceabat, Gelibolu Peninsula, near Behramlı village, Sarlayandere, roadside, scrubs, 63 m, 21 v 2006, E.Karabacak 4469! Çanakkale: Gelibolu, between Kavak and Şarköy, raodside, 15 m, 28 v 2006, E.Karabacak 4477! A1 Çanakkale: Erenköy, Sintenis 1883:73 Çanakkale: Güzelyalı, Pinus brutia forest and roadside, 50 m, 18 v 1997, T.Tütenocaklı (CBB!) Çanakkale: Çanakkale Onsekiz Mart University, Terzioğlu Campus, macchie with Cistus, 100 m, 24 iv 2002, E.Karabacak & T.Tütenocaklı (CBB!). A2 İstanbul: Halkalı station, 20 m, H.Demiriz 4776 A2 İstanbul: Caddeboştu, 15 m, H.Demiriz 380 İstanbul: Halkalı, E slopes of Halkalı Train Station, dry meadows, stony slopes, 21 m, 30 v 2006, E.Karabacak 4526! A2 İstanbul: Constantinopol, auf Anhöhen um die Stadt (on hills around the city), gemein (common), Mai (May), Dr. Noë (ANK!) A2: İstanbul: Pendik, 24.v.1931, K.Krause 3221! Bursa: Mustafa Kemalpaşa, 10.v.1945, B.Kasaplıgil (ANK!) Bursa: Orhangazi to Gemlik, 3.v.1950, A.Berk 2478! A3 Bolu: nr Seben, 600m, Kühne 2212 Bolu: Seben, Karakirli mount, Çeltik stream, rocks, stony places, 735 m, 29 vi 1999, N.AKSOY 1665 ! A4 Zonguldak: Karabük to Safranbolu, 450 m, P.H.Davis 37949 Karabük: Cumayıni Industrial Area, steppe, 700 m, 21 vi 1985, M.Demirörs 1549! Kastamonu: Karaçomak dam, S of Yüklük hill, 920 m, 7 vii 1982, H.Sakallıoğlu 536! Kastamonu: Daday environs, 700 m, 1 vi 1978, O.Ketenoğlu 1203! Kastamonu: Ilgaz to Tosya road, 4 km before Tosya, near Akçakavak village, roadside, stpe with Artemisia, 800 m, 10 vii 2006, E.Karabacak 4831! Ankara: Ayaş, road and field sides,
The only annual species of *Salvia* in Turkey. There are several apparently distinctive forms based on coma features. In Turkey, the most frequent is that with a prominent violet coma; less frequent are those in which the coma is absent or is white, green or pink. The violet form is often called var. *horminum* (L.) Batt. & Trab.

Most of the Mediterranean area, Crimea, Cyprus, Caucasia, Iran (except C.), N. Iraq. **Medit. element.** Treat category **LC**
Figure 4.456. General appearance of *S. viridis* L.
Map 44.424. *S. viridis* distribution map.
CHAPTER 5

CONCLUSION

In conclusion, *Salvia* taxa were exposed to extensive morphological analysis. They were studied according to their root, stem, leaves, essential characters of flowers, and reproductive organs. This information includes indumentum characteristics, inflorescence shapes, nutlet observations and measurements all of which were recorded in the infragenic description of each *Salvia*. The data deficient descriptions were completed and stem, leaf, calyx, corolla dimensions were updated.

Anatomical section preparations of distinctive parts of the plants were observed for taxonomic evaluation. For the first time, the anatomical characteristics of *S. vermifolia* endemic to Turkey were examined in detail, and identified subsessile, capitate glandular and non-glandular trichomes on stems, leaves blades and petioles, as well as, size, shape, colour and sculpturing pattern of the nutlets were clarified (Bagherpour et al., 2010).

Pollen features of *Salvia* were studied. Statistical analysis were done on each set of data and the results were tabulated in tables 3.1 and 3.2. For the first time each species pollen data was provided in the description.

When the species were detected, the area of occupancy and distribution, populations and their size and the number of mature individuals were documented. Threat categories were re-evaluated using IUCN Red List Categories Version 3.1 (2001). In final assessment, of the 43 *Salvia* species in Central Anatolia only 4 are from the Mediterranean origin, 2 are multi regional or from unknown origins and the remainder
are Irano-turanian based (% 85.7). Endemic Central Anatolian taxa of *Salvia* consist of 2 CR (Critically Endangered), 7 EN (Endangered), 8 VU (Vulnerable), and 9 NT (Near Threatened).

Geographic locations of all *Salvia* species distributed in Central Anatolia were obtained, their habits were photographed and their phenological and distribution characteristics of were updated. For the first time, GPS coordinates and soil characteristics of each species were recorded. On a field trip conducted in Yenipazar, South of Yozgat, one taxon was re-discovered after 116 years (Bagherpour et al., 2009) and two new records *S. nemorosa* and *S. tobeyi* were found in Kayseri and Ankara, respectively.

We found three major areas of distributions of *Salvia* in Central Anatolia. These areas are: Ankara Beypazari, Kayseri- Pinarbashi and the greater Sivas area. Therefore, three areas were recommended for conservation.

According to the soil analysis collected from suitable habitats for taxa of *Salvia* (Table 3.4), they generally prefer clayish soil which are slightly alkali (Ave. pH 7.83) with low organic content (Ave. 1.99%). The preferred N and CaCO$_3$ content of the soil was 0.13% and 20.71% respectively. The average amounts of P and K present were 4.82 and 151.52 ppm respectively. Salt concentration in Central Anatolia varies from 0.01 to 0.07%. The higher concentration of salt around Salt Lake (Tuz Gölü) produces a habitat in which only a limited number of plants (*S. halophila*) can adapt and survive. Cluster analysis of relationship of *Salvia* species to soil type was graphed. The endemic species such as *S. cryptantha* and *S. wiedemannii* share the same soil type with *S. aethiopis* and *S. syriaca* (none endemics); however they limit themselves to Central Anatolia borders. This fact shows the effect of climate on restrictions of endemics to Central Anatolia.

For the first time sectional delimitation was presented to place each taxon in its proper position. This included the detailed work of character analysis, measurements, data tabulation and evaluation of all species. The presented revision is based on and ordered according to the numeric analysis of the 43 species found in the Central Anatolia. The
species key specific to Central Anatolia is presented. This work would afford future taxonomist the ability to recognize species relationship with confidence. The unique inferagenic classification is also a first for Central Anatolia.

While observing the results of cluster analysis it was noticed that S. anatolica indeed is not related to S. bracteata which belongs to section Salvia as described by Hamzaoğlu (2005), but the numeric results placed it in section Hymenosphae in the same section as S. blepharochlaena. The habit of S. anatolica resembles S. blepharochlaena and not at all to S. bracteata. Therefore re-evaluation of S. anatolica is recommended.

Multivariate analysis has been conducted on the basis of the S. 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 (Kahraman, Celep, Doğan, Bagherpour, 2010). 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.

Finally an expanded description of each species is presented utilizing the information gathered in the field and the laboratory.

As the result of this research thirteen publications were presented.
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