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## The Morphological, Anatomical and Karyological Properties of *Salvia sclarea* L.

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**Abstract:** The morphological, anatomical and karyological properties of *Salvia sclarea* L. were investigated. In addition, glandular and eglandular hairs were examined and classified. In the morphological study it was observed that the species have a perennial root system. The herbaceous stem is rectangular. Leaves are simple. Glandular and eglandular hairs are present on both surfaces of the leaves. Inflorescence is compound raceme. In anatomical studies, the internal morphological features of root, stem, leaf, petiole and flower were determined. The chromosome morphology of this species was examined and the diploid chromosome number was found to be  $2n=22$ .

**Key Words:** *Salvia sclarea*, Morphology, Anatomy, Karyology.

### *Salvia sclarea* L.'nin Morfolojik, Anatomik ve Karyolojik Özellikleri

**Özet:** Bu çalışmada *Salvia sclarea*'nin morfolojik, anatomik ve karyolojik özellikleri incelendi. Aynı zamanda salgı tüyleri ile örtü tüyleri incelenerek sınıflandırıldı. Morfolojik çalışmada türün çok yıllık kök sistemine sahip olduğu, otsu gövdenin dört köşeli olduğu, yaprakların basit tipte olduğu, salgı ve örtü tüylerinin yapraklarının her iki yüzeyinde de bulunduğu ve çiçek durumunun bileşik rase-moz olduğu belirlendi. Anatomik incelemelerde kök, gövde, yaprak, petiol ve çiçeğin iç morfolojik özellikleri tespit edildi. Kromozom morfolojisi araştırılarak diploid kromozom sayısının  $2n=22$  olduğu gözlemlendi.

**Anahtar Sözcükler:** *Salvia sclarea*, Morfoloji, Anatomi, Karyoloji.

### Introduction

The genus *Salvia* L. with over 900 species is probably the largest member of the family *Lamiaceae*, and is found in both subtropical and temperate parts of the world (1). In Turkey, it is represented by 86 species (2). Some of these are shrubby or subshrubby and perennial.

*Salvia* species contain monoterpene with antiseptic characteristics (3). In recent studies on this plant species, it has been observed that the compounds decrease DNA synthesis in the cell. This feature is important in the diagnosis and treatment of cancer (3). Many species of the *Lamiaceae* are aromatic and are often used as herbs, spices, folk medicines and fragrances (4). In addition, *Salvia* species are grown in parks and gardens as ornamental plants (3).

Essential oil, which gives off a fragrance, is a characteristic feature of many species of *Salvia*. For this reason, it is widely used in perfumery and as a sweetener in the food industry (5). In the literature, it has been reported that *Salvia sclarea* L. is often used as a source of fragrance (3).

Studies on the anatomy of this genus are limited. Recent studies have been done on the anatomical structure of the secretory hair of *Salvia* species (4, 5), but the anatomical structure of *Salvia sclarea* has not been studied. Many authors have mentioned the chromosome numbers of different species of *Salvia* (6, 7, 8). However, no detailed work on the karyotype of any species is available. This may be due to the very small size of the chromosomes.

There are several reports on the cytology and anatomy of this genus in Turkey. Nakipoğlu has reported the chromosome number and morphology in nine *Salvia* species (9, 10). The anatomical and cytological characters of seven *Salvia* species have been investigated by Nakipoğlu and Oğuz (11). Çobanoğlu (12) and Çobanoğlu et al. (13) have determined anatomical, morphological and cytological properties of some Turkish *Salvia*. The chromosome counts of many species of *Salvia* in Turkey are also unknown. Therefore, the purpose of this paper is to investigate the morphological, anatomical and karyological features of *S. sclarea*.

### Materials and Methods

Plant samples were collected from natural populations between 1994-1995. Specimens were preserved in the herbarium at Ondokuz Mayıs University, Education Faculty. Samples were collected from the following locations:

A5 Samsun: Çakallı Karadağ passage, rocky area 900m, 2.7.1995 Özdemir 026.

A5 Samsun: Ladik station environs, road side 800m, 24.6.1994 Özdemir 027. Taxonomical description of the plants was done according to Davis (2). Fresh samples were used in each case for experimental analysis and

measurements. Anatomical studies were carried out on fresh samples or samples kept in alcohol. The paraffin method (14) was used for preparing a cross section of plants root, stem, leaves, petiole and flowers.

Squash techniques (15) were used for karyological analysis. Chromosome morphology was determined according to Levan et al. (16).

### Morphological Properties

**Root:** The root of the taxon is 15-70 cm length taproot in shape. Pale-brown hard bark is present on the root (Figure 1).

**Stem:** The stem is 50-100 cm tall and very clear rectangular in shape. Stem is erect, ascending, and it is branched toward the top. The upper part of stem is covered by glandular hair which has essential oil. The lower part of stem is pubescent to hirsute. This hair gives gray-white color to stem (Figure 1).

**Leaf:** Leaves are simple and broad. They are ovate to ovate-oblong. Glandular and eglandular hair is present on both upper and lower epidermis of leaves. The venation is clear at the leaf. There is a single vein at the middle of leaf. The venation of taxon is pinnate. The edge of leaves are crenate-erose. The petiole is 3-9 cm length. Glandular and eglandular hair is present on the surface of petiole (Figure 1).

Table 1. Measurements of various tissue of *Salvia sclarea*.

	Broad ( $\mu$ ) min max	Length ( $\mu$ ) min max		Broad ( $\mu$ ) min max	Length ( $\mu$ ) min max
ROOT			LEAF		
Periderm cell	20-75	12-38	Cuticle	2.5-3	
Parenchyma cell	12-50	7.15	Upper epidermis cell	12-50	8-45
Cambium cell	15-30	10-17	Lower epidermis cell	8-35	7-25
Secondary ray	12-90		Palisade parenchyma cell	7-20	20-58
Primary ray	10-25		Spongy parenchyma cell	6-40	
Diameter of trachea	60-110				
Diameter of pith cell	-	-			
STEM			PETIOLE		
Epidermis cell	5-38	7-25	Adaxial cell	5-38	10-40
Peridermis cell	9-25	8-20	Abaxial cell	4-25	10-40
Parenchyma cell	10-50	5-45	Cortex cell	12-65	
			Diameter of trancheal elements	3-24	
Pith ray	8-20				
Diameter of tracheal elements	25-40				
Diameter of pith cell	20-160				



Figure 1. General appearance of *Salvia sclarea* (Özdemir 026)  
1. Leaf 2. bract 3. flower

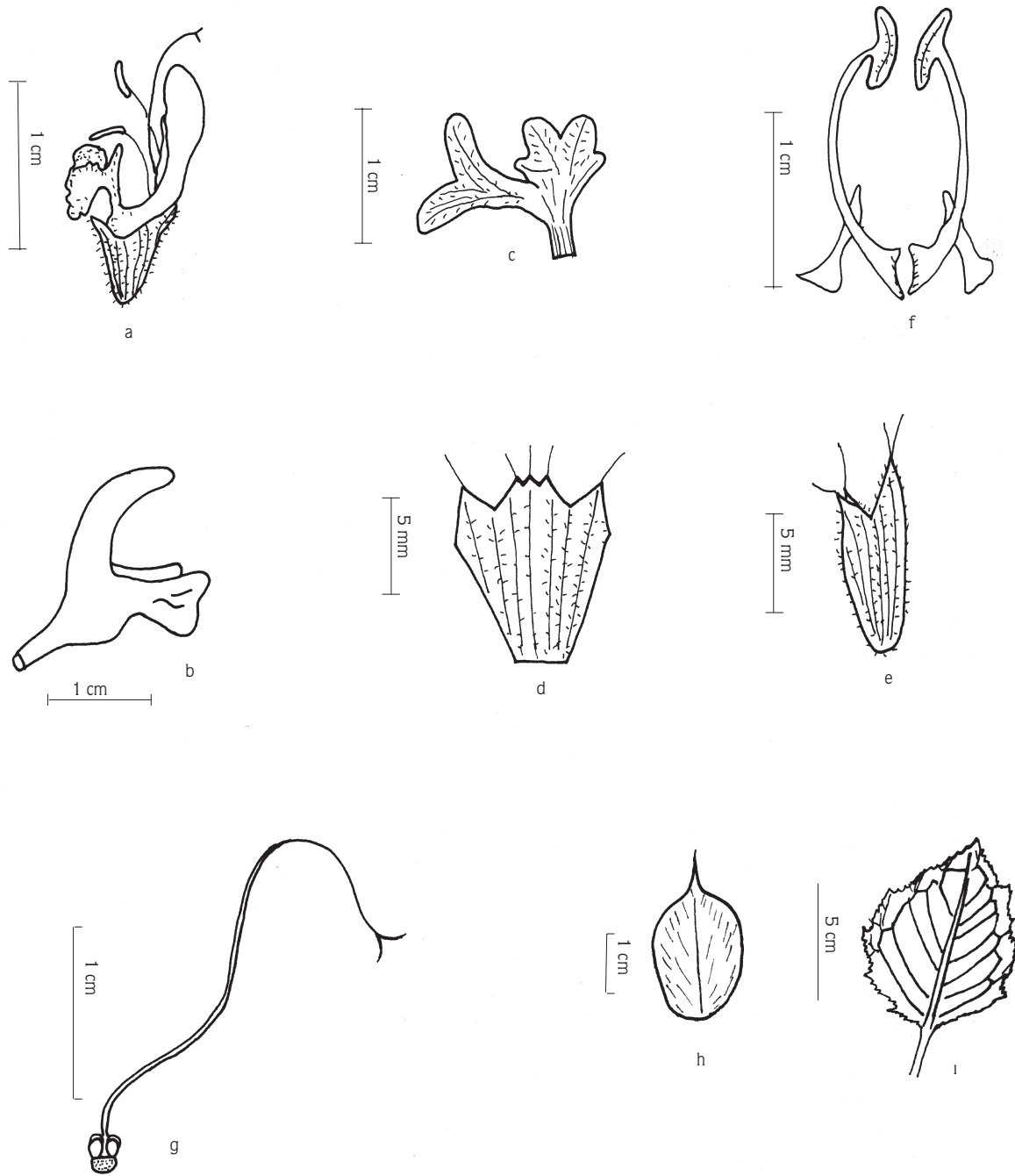


Figure 2. The flower segments of *Salvia sclarea* (Özdemir 026)  
 a. longitudinal view of flower  
 b-c. corolla d-e. calyx f. stamens  
 g. pistil h. bract i. venation of leaf

**Flower:** Inflorescence is paniculate, flowers are zygomorphic symmetric. The flowers are arranged verticillately on plant and 2-6 flowers are present at verticillares. Flowers are at the base of bracts. Pedicel is 2-3 mm length. The upper lip of calyx is tridentate,

mucronate and lower lip is bidentate. The shape of the calyx is ovate-campanulate. Calyx has numerous glandular and hard eglandular hair. Corolla is 20-30 mm length. Upper lip is lilac, lower lip is cream. The lower part of corolla tube is squamulate. The upper lip of corolla has

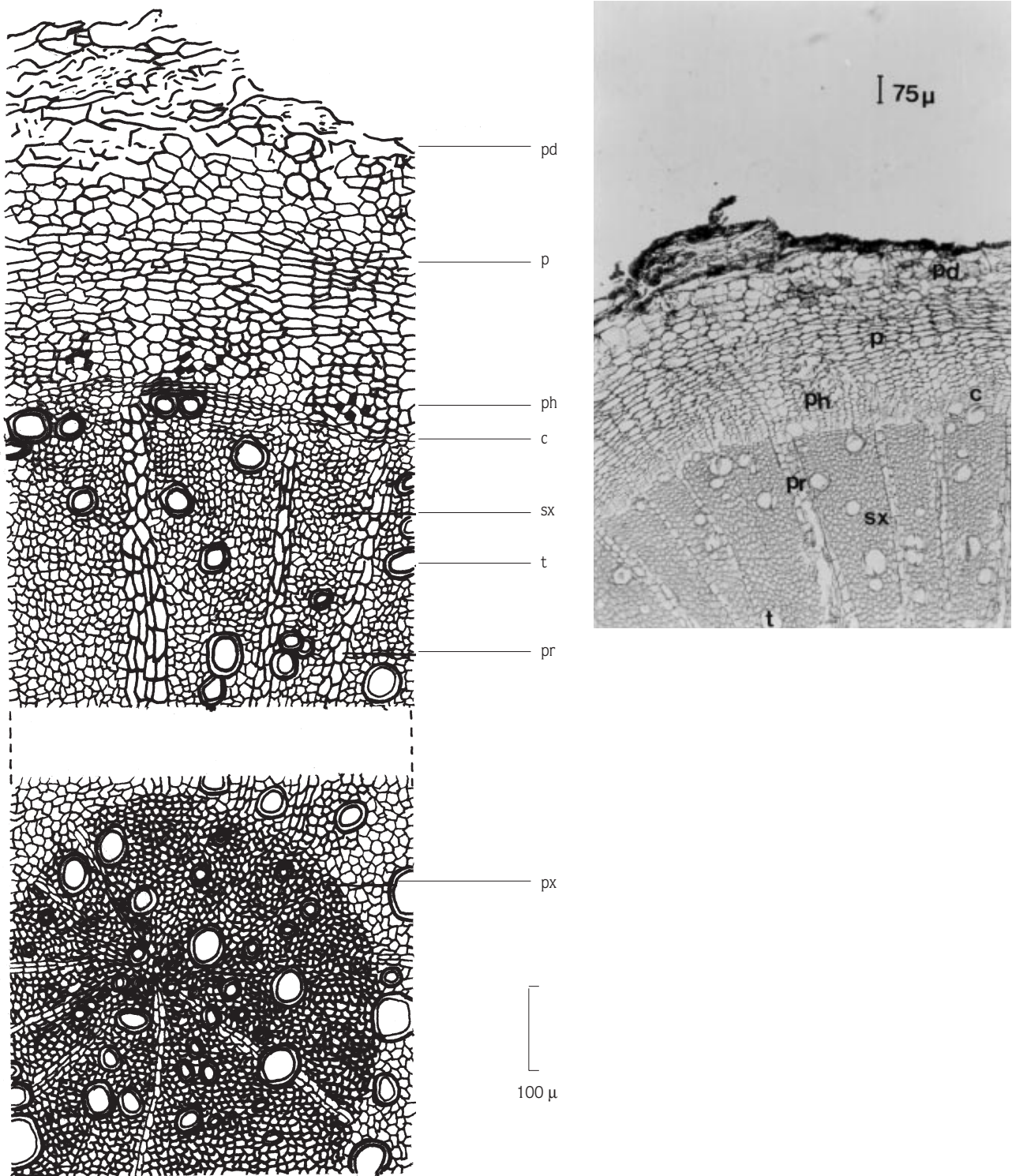


Figure 3. Cross-section of root of *Salvia sclarea* (Özdemir 026)  
 pd peridermis pr pith ray p parenchyma t trachea ph phloem  
 sx secondary xylem c cambium px primary xylem

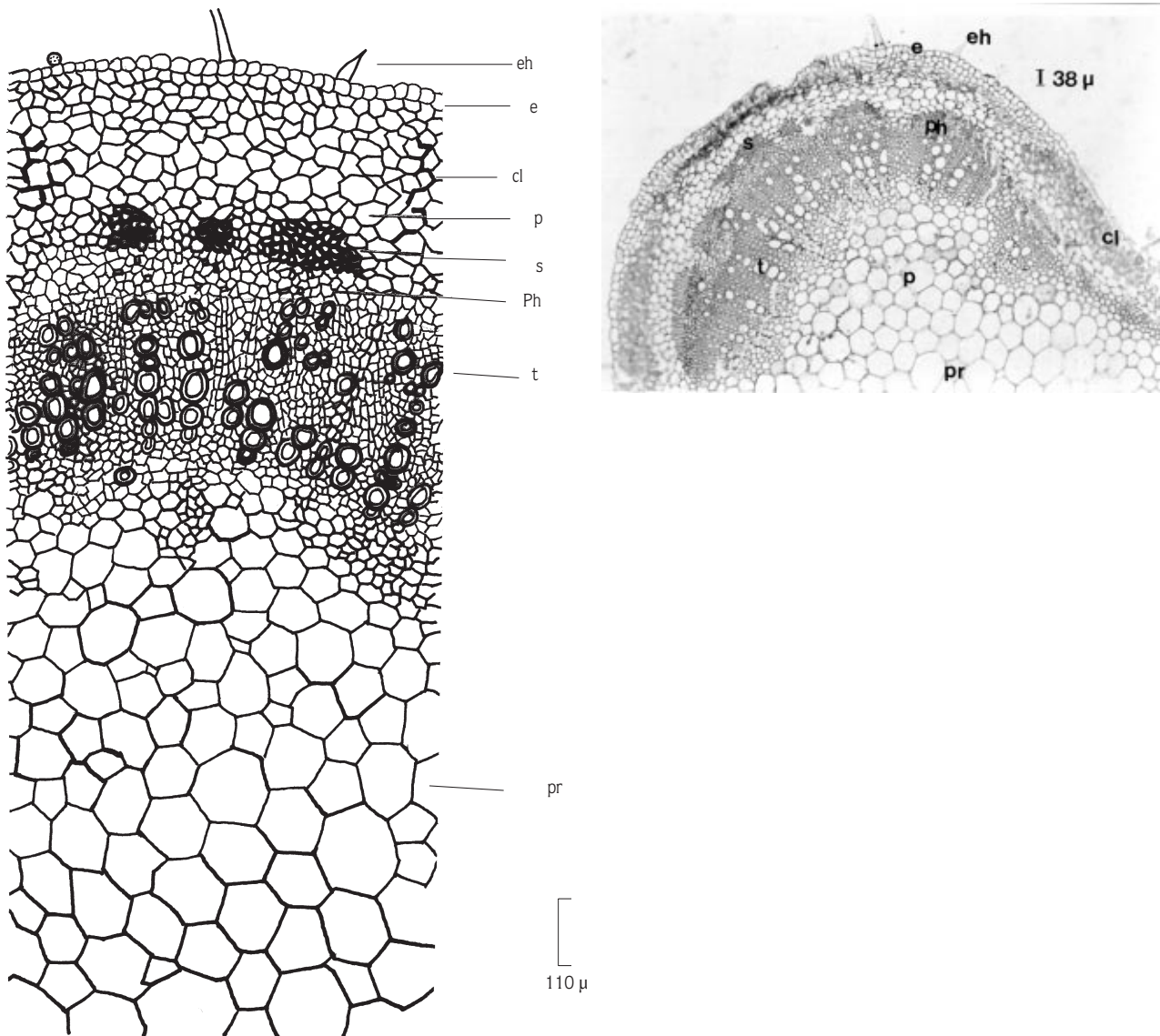


Figure 4. Cross-section of stem of *Salvia sclarea* (Özdemir 026)  
 e epidermis s sclerenchyma cl collenchyma ph phloem  
 t trachea eh eglandular hair pr pith region p parenchyma

two lobules and is falcata in shape. Stamens are B type. The filament is 10-15 mm length and anther is 2-4 mm length. The stigma is bifurcate and 15-35 mm length. Bracts are membranous, ovate, acuminate and mauve colored. Bracts are 15-35 x 10-25 mm (Figure 2). Fruit type is nutlet. Seed is colored clear brown and rounded as trigonous. Species is distributed at the 2000 m height, rocky, igneous slopes, mixed deciduous and coniferous woodland, shale banks, field road sides.

### Anatomical Properties

**Root:** Periderm rows are on the outer surface of root. Cortex is multilayered and parenchymatic. Parenchymatic cells are 7-15 x 12-50 μ. Cell size is larger in primary cortex than in secondary cortex. In the pith a primary xylem tissue is present. Secondary xylem rays are 1-3 layered but sometimes 8 and are heterogenous. Primary xylem rays are 1-2 layered (Figure 3).



**Stem:** Epidermis is single layered. Shape of this cell is hexagonal or ovoidal. There are glandular and eglandular hairs on epidermis. Most are glandular. They are unicellular or multicellular. Collenchyma is 3-5 layered and located under epidermis. Collenchyma presents particularly at the angle of stem. Cortex is 5 layered and paranchymatic. Cells of cortex are angular or ovoidal 10-50 x 5-45  $\mu$ . There is a sclerenchymatic sheath on the phloem part. Cambium is not distinguishable. The pith is large and consists of paranchymatic cells (Figure 4).

**Leaf:** There is a single-layered epidermis on upper and lower surface of leaf. The shape of epidermal cell is irregular. Thickness of cuticle is 2.5-3 $\mu$ . Stoma cells are present both upper and lower epidermis. Leaf is bifacial. Palisade parenchyma cells are 2-3 layered. Angular collenchyma surrounds the median vein. Glandular and eglandular hair are present on both upper and lower epidermis. Most of them are glandular hair. Glandular hair is unicellular or multicellular. Stoma type is diacytic (Figure 5).

**Petiole:** Petiole is covered by ovoidal and hexagonal epidermal cells. Epidermal cells are 4-25 x 10-40 $\mu$  in abaxial surface and 5-38 x 10-40 $\mu$  in adaxial surface. There are a lot of glandular and eglandular hairs on epidermal cells. Most of them are glandular. Eglandular hair is multicellular (1-6) and maximum length is 180 $\mu$ . Parenchymatic cortex is present under epidermis. Cortex is 20-22 layered. There are two large vascular bundles on median region of petiole. A small bundle is also present near these bundles. Type of vascular bundle is collateral (Figure 6).

### Hair Properties

As shown in figure 7, *S. sclarea* has the various glandular and eglandular hair at stem, leaf, petiole, flower and pedicel. The glandular hair is more variable

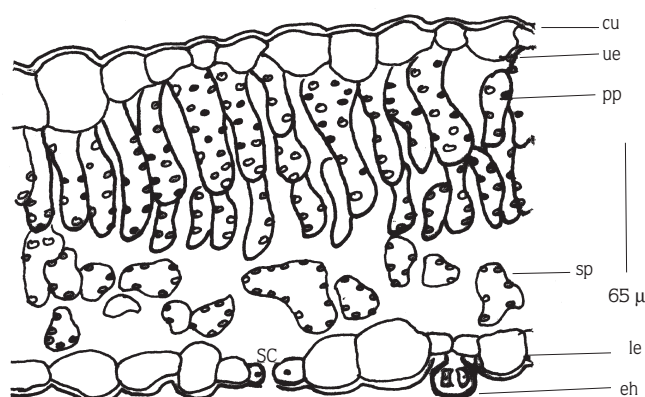


Figure 5. Cross-section of leaf of *Salvia sclarea* (Özdemir 026)  
cu cuticle pp palisade parenchyma ue upper epidermis sp spongy parenchyma  
eh eglandular hair le lower epidermis sc stoma cell

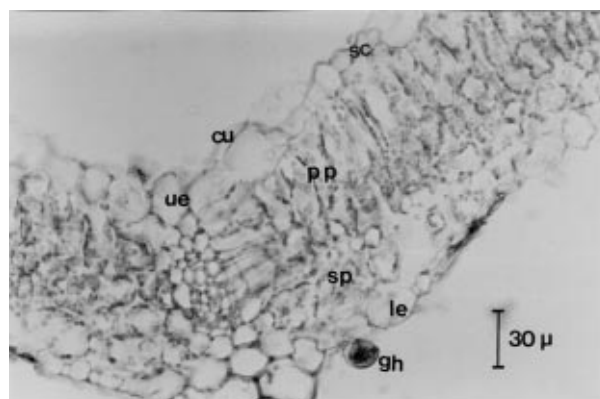
and greater in number at flowers and leaves than at the other parts of plant. There are capitate hairs, which have head cells, and peltate hairs, which have no head cells, on the flowers and leaves. There are 2-4 central cells and peripheral cells in different numbers at peltate hair. The secretion at outer part of head cell as this head cell does not break up at some of the capitate glandular hairs. However, there are also secretions at outer part of head cell as the cuticle breaks up. Furthermore, there are capitate glandular hairs which have a cup-like head cell. Capitate glandular hair has various numbers of base cells and stalk cells. In addition, stalk cells are not present in some of them. Different numbers of tall and more glandular hair were seen in with our study. This glandular hair has 1-3 base cells and 1-7 hair cells (Table II).

### Karyological Properties

The chromosome numbers of species were determined to be  $2n=22$  (Figure 8). The 9th chromosome is submedian centromeric and all of the other chromosomes are median centrometric (Figure 9). The chromosome lengths are about 0.2-16 $\mu$ . The longest arm is 1 $\mu$  and the shortest arm is 0.1  $\mu$  in length. The mean total length of chromosomes was found to be 0.8 $\mu$ . Chromosomes of this species are very small (Table III). No satellite was observed on karyotypes of this species.

### Results and Discussion

It was determined that morphological characters such as the number of fertile stamen, type of stamen, properties of glandular and eglandular hairs, shape of corolla and calyx structure of bract have taxonomical value. No information on *S. sclarea* was found in the





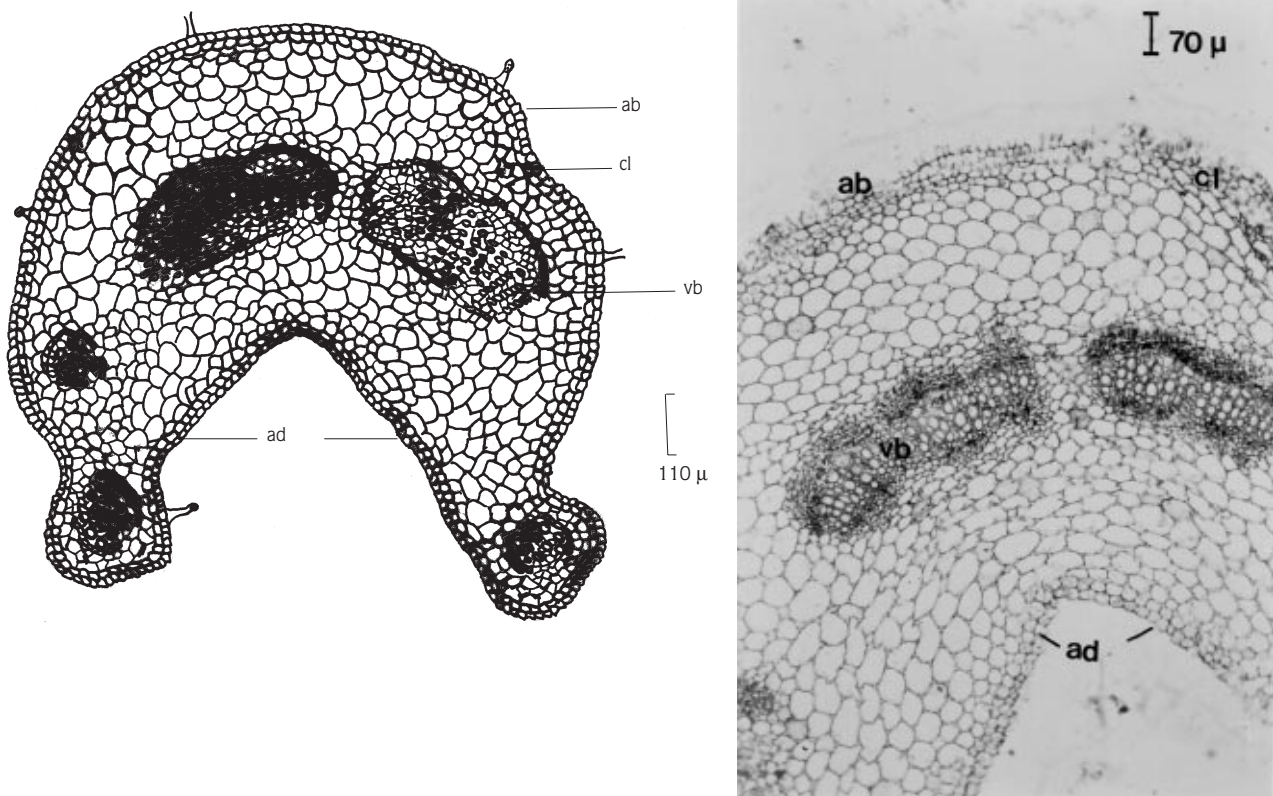


Figure 6. Cross-section of petiole of *Salvia sclarea* (Özdemir 026)  
 ab abaxial epidermis ad adaxial peridermis cl collenchyma cells vb vascular bundle

Table 2. Hair type of various organs of *Salvia sclarea*.

	Glandular Hair									Eglandular Hair			
	Capitate						Peltate			Center cells	Periphery cells	Base cells	Hair cells
	Head cells	Type I Stalk cells	Base cells	Head cells	Type II Stalk cells	Base cells	Head cells	Type III Stalk cells	Base cells				
Stem	1	-	1	1	1	1	1	1	1			1	1
	1	2	1	1	2	1						1	3
	2	-	1									1	4
Leaf	1	1	1				1	1	1	4	8	1	1
	1	2	1				1	2	1	4	10	1	2
	1	3	1				1	4	1			1	3
	2	1	1									1	4
	2	-	2									1	5
Petiole												1	1
	1	1	1	1	-	1	1	2	1			1	1
	1	2	1	1	3	1	1	3	1			1	2
				1	-	1	1	4	1			1	3
Flower												1	1
	2	-	2				1	1	1	4	8	3	2
	1	2	1				1	2	1	2	6	2	3
							1	2	2	4	12	1	1
Pedicel												1	1
	1	1	1	1	-	1	1	1	1			1	1
	1	2	1	1	1	1	1	2	1			2	1
	1	3	1	1	2	1	1	1	2			1	7

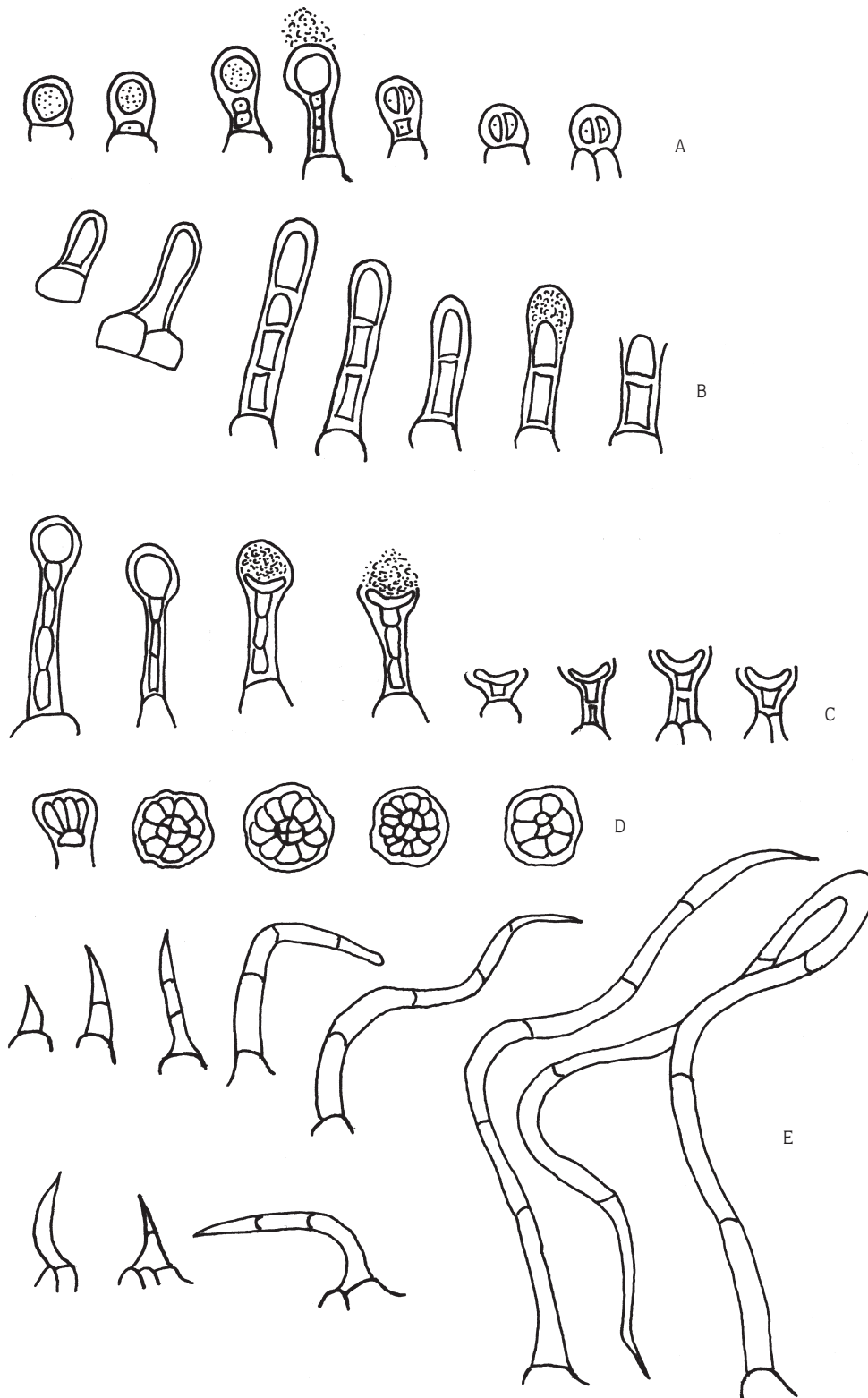


Figure 7. Glandular and eglandular hair in different parts of *Salvia sclarea* (Özdemir 026)  
 A,B,C, capitulate hairs D- peltate hairs E- eglandular hair  
 (A: type I hair B: type II hair C: type III hair)

Table 3. Chromosome type and length of *Salvia sclarea*.

Chromosome Number	Total length (C) $\mu$	Long arm length (L) $\mu$	Short arm length (S) $\mu$	Arm ratio R=L/S	Centromeric Index I:(S/C). 100 $\mu$	Centromere position
1	1.6	1.0	0.6	1.60	37.50	Median (m)
2	1.1	0.6	0.5	1.20	45.45	Median (m)
3	1.0	0.5	0.5	1.00	50.00	Median (M)
4	0.9	0.5	0.4	1.25	44.44	Median (m)
5	0.8	0.4	0.4	1.00	50.00	Median (M)
6	0.8	0.5	0.3	1.66	37.50	Median (m)
7	0.7	0.4	0.3	1.33	42.85	Median (m)
8	0.6	0.3	0.3	1.00	50.00	Median (M)
9	0.6	0.4	0.2	2.00	33.33	Submedian (sm)
10	0.5	0.3	0.2	1.50	40.00	Median (m)
11	0.2	0.1	0.1	1.00	50.00	Median (M)

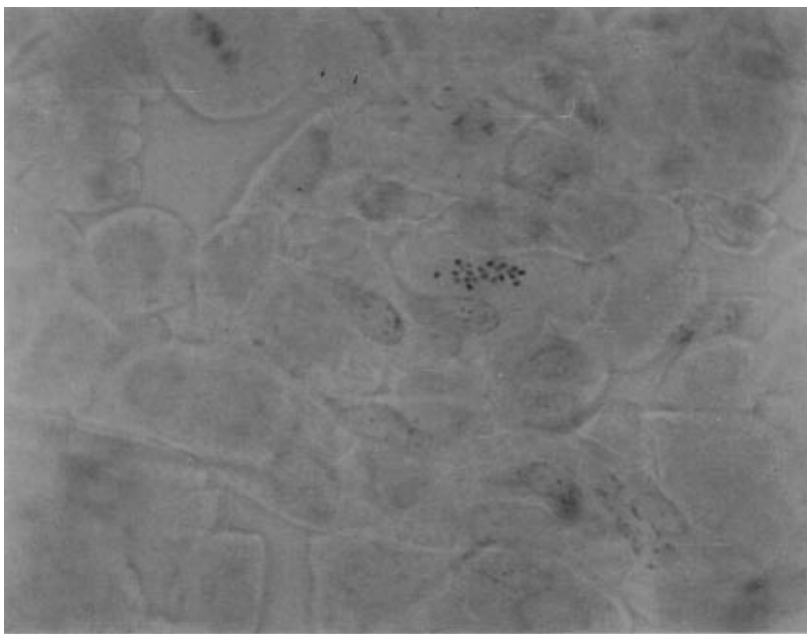


Figure 8. Mitotic metaphase chromosomes in root tip cells of *Salvia sclarea* (Özdemir 026)

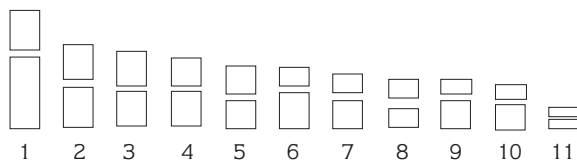


Figure 9. Idiogram of the chromosome complement of *Salvia sclarea*

literature except some data on the etheric oil and glandular hair properties of this species (4). As regards results presented here, the morphological properties of *S. sclarea* showed some similarities and differences compared to other findings in the flora of Turkey.

*S. sclarea* bracts have some different characteristics from other species of *Salvia* such as mauve coloration, membranous structure, and acuminate and broadly ovate shape. Because of these features they can be used as ornamental plants. Moreover, the bracts are a taxonomical feature that is used to determine the species.

Metcalf and Chalk (17) gave information about general anatomical characteristics of *Salvia* genus, pointing out that the family to which the species belongs has a rectangular stem that helps us to recognize that they belong to a different species. They also remarked that there were collenchyma in each corner. The same researchers stated that the rays consist of 2-12 or more lines of cells in this family. In this study it was discovered that these rays consist of 1-8 line cells. Because the number of rays is different in every species, this can be used as a species-distinguishing feature.

There are marked groups of sclerenchyma over phloem on the stem of *Salvia sclarea*. Researchers have stated that there are groups of sclerenchyma on the border of primary and secondary cortex on the stem of *Salvia palaestina* Benth (12). On the other hand, some other researchers have observed cells of sclerenchyma surrounding vessel elements on the herbaceous stem of *Salvia trichoclada* (13). The species, which has bifacial type of leaves have a diasytic type of stoma. It is stated by the researchers that mesophyll is completely paranchymatical and there are collenchyma both under and over the median vein in species of *Salvia* (17). We found the same characteristics in our research.

These two researchers pointed out that in the *Lamiaceae* family, the structure of the vascular bundles in the petiole is important in terms of taxonomy. There are

two large bundles which are very close to each other, in the centre of petiole. There are three other small bundles, two of which located on one side and one on the other side. In most of the anatomical studies done on *Salvia*, it is stated that there are two petiole vascular bundles on the sides and one in middle. Nakipoğlu and Oğuz (11), who studied seven species of *Salvia*, divided vascular bundles of petiole into two types: species with and without basal leaves. Although *S. sclarea* is a species with basal leaves, the order of vascular bundles of petiole is different from the two types mentioned above.

Few studies have been done on the chromosomes of species of *Salvia* because, as has been pointed out, they have very small chromosomes (6, 7, 8). We had the same difficulty in studying with chromosomes. The chromosome number of these species was found to be  $2n=22$ . *S. sclarea* has two chromosome types, submedian and median. Hair which secretes etheric oil, characteristic of the *Lamiaceae* family, has been investigated by many researchers. *S. sclarea*, as stated in the literature, has more etheric oil than any other species. Classification of glandular and eglandular hair was done according to Werker (4). In this study, we observed that the number of base cells ranges from 1 to 3. Thus, in addition to the previous classification, the number of base cells of glandular and eglandular hair can be used as a new means of classification.

In our study, it was observed that *S. sclarea* had peltate hair on the leaves and flowers, but not on other parts. As stated in literature, this result support aroma which belongs to *S. sclarea* on the flowers. Since peltate hair exist on the leaves at *S. sclarea*, it can be thought that secretion in peltate hair gives the characteristic smell rather than capitata hair,

In conclusion, in this study *S. sclarea* has been investigated in details in terms of morphology, anatomy and karyology.

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