

MORPHOLOGICAL AND ANATOMICAL CHARACTERISTICS OF ENDEMIC *SALVIA HUBERI* HEDGE IN TURKEY

CANAN OZDEMIR AND YASIN ALTAN

Department of Biology, Faculty of Art and Science, Celal Bayar University, Manisa-Turkey

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Abstract

The morphological and anatomical features of *S. huberi* an endemic member of the genus *Salvia* in Turkey have been examined in this study. The characters such as the structure of the vascular bundles of the petiole and the number of pith rays can be helpful to distinguish the species of *Salvia* from each other. In addition, the differences in the anatomy of hair morphology may be helpful to account for the anatomical knowledge of the genus.

Introduction

The genus *Salvia* L. (Lamiaceae) consists of more than 900 species which are distributed all over the world (Standley and Williams 1987). Most of *Salvia* species are considered to be very important for its essential oils. Glandular hairs found in all species of *Salvia* are responsible for the secretion of essential oils. Aroma in these oils are used in making cigarettes, liquor, perfumes and also products in food industry (Cobanoglu 1998).

Literature is available on economical importance of *Salvia* genus (Cobanoglu *et al.* 1992, Nakipoglu 1993, Alberto *et al.* 2003). But no detailed external and internal morphological study had been carried out earlier. Therefore, the present study was undertaken to give a detailed account of the internal and external morphological characters of *S. huberi* which is endemic in Turkey.

Materials and Methods

The specimens of *S. huberi* Hedge were collected from following natural population: A8 Erzurum: Oltu, Bahcecik Village, Oba Yayla, rocky area 1800 - 2000 m, 05.08.1996, Altan 6261. Specimens were kept in the herbarium at Celal Bayar University. Morphological illustration was prepared to show the flowering stages of the plant. Anatomical sections of the plants were taken from its root, stem, leaves and petiole. Flowers were kept in a mixture of 70% alcohol and glycerol (1 : 1), and dyed in sartur reactive (Celebioglu and Baytop 1949). Measurements were taken using ocular-micrometer.

Results and Discussion

External morphological characteristics: Plant is 10 - 35 cm in length, slightly ascending. Its stem is branched at the base. The lower part of stem is densely covered by hairs. These hairs give gray-white colour to stem. The leaves are linear-lanceolate with two pairs of basal leaf. The margin of leaf is finely serrate. The flowers are zygomorphic and are arranged as verticillate. Corolla is coloured as dark-pink and violet-blue. The lower part of corolla tube is narrow. The upper lip of corolla is slightly curved. The lower lip of corolla has three lobules. Corolla is 12 - 14 mm in length and the tube of corolla is about 8 mm long. Fertile stamens are two in number, connective is shorter than filament.

Pedice is 2 - 5 mm in length. The shape of the calyx is campanulate and its upper lip is tridentate and lower lip is bidentate. Bracts have different shapes from ovate, acuminate to linear.

The venation of leaves is clear. There is a single basic vein at the middle of leaf. The venation of the species is pinnate. There are many glandular hairs on the upper and lower surface of leaves. Seed is colored as dark-brown and rounded as angled (Figs. 1, 2).



Figs. 1-2: 1. General appearance of *Salvia huberi* (Altan 6261). 2. a. habit ($\times 1.3$), (b) leaf ($\times 0.6$), c. corolla ($\times 0.6$), d. calyx ($\times 0.1$), e. bract ($\times 0.5$), f. the venation of leaf ($\times 0.4$), g. stamen ($\times 0.2$), h. seed ($\times 0.1$).

Internal morphological characteristics:

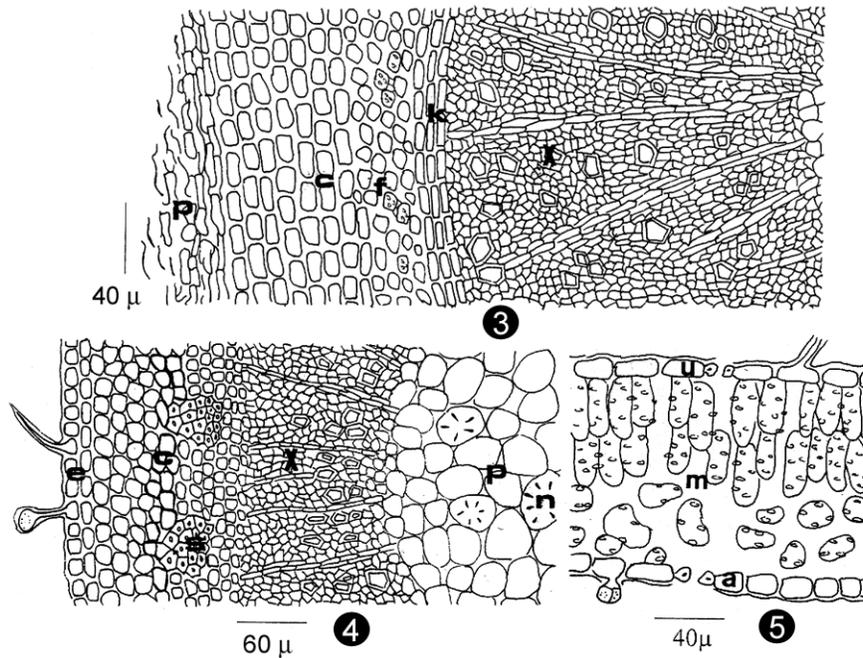
Root: There is periderm layer on the outer surface of root. Its cells are crushed, break up and sometimes fall out. Parenchymatous cortex is present under peridermic. The breadth of its cells is bigger than the length. These cells have regular layers. Phloem occupies a large area. Cambium cells are distinguishable. Pith region is narrow because of xylem that occupies pith region (Fig. 3).

Stem: It is covered by regular two layers of epidermal cells. The first layer cells of epidermis have nearly the same length and breadth (Table 1). Second layer cells are slightly flattened.

Epidermal cells are surrounded by a thin and slightly undulated cuticle. There are hairs on epidermis and most of them are glandular. The glandular hairs are capitate with head cell. Sometimes outer part of head cell does not break up (Fig. 7a). Sometimes cuticle breaks up and secretion comes out of outer part of head cells (Fig. 7b). Furthermore, there are capitate glandular hairs which have a cup-like head cells (Fig. 7c). These capitate hairs have various numbers of head cells, stalk cells and base cells. In addition stalk cells are not present in some of them (Fig. 7). Cortex is 2-5 layered and parenchymatous. Cells of cortex are ovoidal. There is 1 - 2 layered collenchyma tissue. There is a sclerenchymatous sheath on the phloem part which occupies a small region. Cambium is not distinguishable and the pith region is large. There is starch grain in some cells of the pith (Fig. 4).

Table 1. Measurements of morphological characters of *Salvia huberi*.

	Broad (μ)	Length (μ)		Broad (μ)	Length (μ)
Root			Leaf		
Peridermis cell	10 - 40		Upper epidermis cell	21 - 40	11 - 32.4
Cortex cell	10 - 25	5 - 20	Lower epidermis cell	11 - 54	8 - 21.6
Diameter of pith cell	20 - 30				
Stem			Petiole		
Cuticle	5 - 13.5		Abaxial cell	10 - 20	10 - 20
Epidermis cell	16 - 27	8 - 16	Adaxial cell	10 - 20	10 - 20
Cortex cell	10 - 20		Cortex cell	10 - 30	
Diameter of pith cell	21.6 - 81				



Figs. 3-5: 3. Cross-section of root of *Salvia huberi*. p. peridermis, c. cortex, f. phloem, k. cambium, x. xylem. 4. Cross-section of stem of *Salvia huberi*. p. epidermis, c. collenchyma, s. sclerenchyma, p. pith region, x. xylem, n. starchy grain. 5. Cross-section of leaf. u. upper epidermis, m. mesophyll, l. lower epidermis.

Leaf: The upper epidermis consists of flat-ovoidal cells and the lower epidermis is made up of cells having same length and breadth. Stoma cells are present both in upper and lower epidermis. Pallisade parenchyma cells are two layered. Glandular and aglandular hairs are present on both upper and lower epidermis. Most of glandular hairs are 1 type capitate hairs and they have two head cells (Fig. 5).

Petiole: Petiole is covered by regular two layered epidermal cells. Epidermis is followed by cortex where cells are ovoidal in shape. There is a single large vascular bundle on median region of petiole. Two and three small bundles are also present near this bundle. The vascular bundles are collateral. There are sclerenchymatous cells over phloem (Fig. 6).

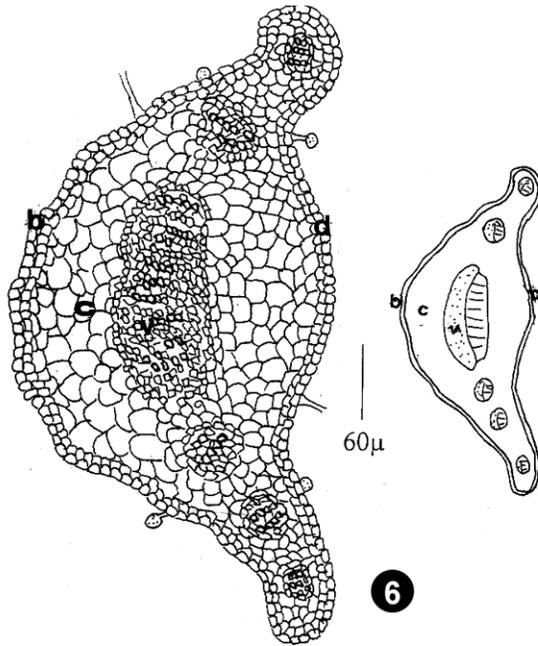


Fig. 6. Cross-section of petiole of *Salvia huberi*. b. abaxial epidermis, c. cortex, v. vascular bundle, d. adaxial epidermis.

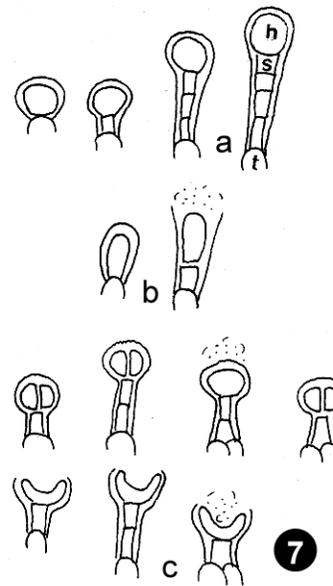


Fig. 7. Glandular hair different parts of *Salvia huberi*. a. type I hair, b. type II hair, c. type III hair, h. head cell, s. stalk cell, t. base cell.

There are a lot of glandular and aglandular hairs on epidermal cells. Glandular hairs are I, II, III type capitate glandular hairs. These hairs have 1 - 2 head, 1 - 2 stalk and 1 base cells. Furthermore, there are capitate hairs which have no stalk cells (Fig. 7, Table 2).

Calyx, corolla and bract of the flowers have got various glandular hairs. These glandular hairs are more variable and greater in number in calyx than at the other parts of plant (Table 2).

No information on *S. huberi* was found in literature except general taxonomic properties (Davis 1982, Donmez 2001). The morphological properties of *S. huberi* presented here showed

some similarities and differences compared to those observed in literature. Consequently several different observations related to corolla and calyx of this taxon drew our attention. In the first description of *S. huberi* (Davis 1982) the length of corolla and calyx was mentioned as 15 - 20 mm and 7 - 11 mm, respectively. Later on the length of corolla and calyx was mentioned as 12 - 14 mm and 7 - 11 mm, respectively (Davis *et al.* 1988, Donmez 2001). The present findings showed lengths of corolla and calyx are 12 - 14 mm and 5 - 10 mm, respectively.

Cobanoglu (1998) observed sclerenchyma cells over cortex in the root of *S. trichoclada*. But this feature was not found in the root of *S. huberi*. Metcalfe and Chalk (1972) stated that the rays consist of 2 - 12 or more layers of cells in Labiatae. It is reported that *S. sclarea* L. has 1 - 8 rays of cells and *S. forskahlei* L. has 25 - 40 rays of cells (Ozdemir and Senel 1999, 2001). In this study it was observed that these rays consist of 1 - 3 layers of cells in cross-section of stem. This feature can be used as a species distinguishing character because the number of rays is different in different species. Metcalfe and Chalk (1972) pointed out that presence of collenchyma in each corner of stem of Lamiaceae family (Metcalfe and Chalk 1972). In this study, we also observed the same feature on the stem. These collenchymatous cells are sometimes crushed along the radial axis on stem of *S. huberi*.

Table 2. Glandular hair type of different organs of *Salvia huberi*.

	Type 1			Type 1			Type 1		
	Head cell	Stalk cell	Base cell	Head cell	Stalk cell	Base cell	Head cell	Stalk cell	Base cell
Stem	1	-	1	1	-	1	1	2	1
	1	1	1	1	1	1			
	4	3	1						
Leaf	1	-	1	1	-	1			
	1	1	1	1	1	1			
	2	1	1						
Petiole	1	1	1	1	-	1	1	2	1
	2	2	1				1	1	1
Bract	1	-	1	1	-	1			
	1	1	1	1	1	1			
	2	1	1						
Calyx	1	-	1	1	-	1	1	1	2
	1	3	1				1	2	1
	1	3	1						
	1	4	1						
	1	2	2						
	2	1	1						
	2	1	2						
Corolla				1	-	1			

There is a single large bundle in the centre of *S. huberi* petiole. Furthermore, there are five other small bundles, two of which are located on one side and three on the other side. Nakipoglu and Oguz (1990) studied seven species of *Salvia* and divided vascular bundles in the petiole into

two types. They pointed out that in the Lamiaceae the structure of the vascular bundles in the petiole is important from taxonomic point of view.

A large number of highly variable glandular hairs were observed in vegetative and reproductive organs of *S. huberi* during this study. Classification of glandular hairs was made according to classification of Werker *et al.* (1985) and Ozdemir and Senel (1999, 2001). Several authors reported that genus *Salvia* has more glandular hairs than other genera of the same family Werker *et al.* (1985), Kesercoglu and Nakipoglu (1992), Cobanoglu *et al.* (1992), Vural and Adiguzelli (1996). It was observed that *S. huberi* has capitate glandular hairs, but no peltate glandular hairs.

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