

**ANATOMY AND GLANDULAR TRICHOME MICROMORPHOLOGY OF
SCUTELLARIA ORIENTALIS L. SUBSP. *PINNATIFIDA* EDMONDTSON
(LAMIACEAE)**

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Abstract

The anatomy and glandular trichome micromorphology of *Scutellaria orientalis* subsp. *pinnatifida* Edmondson (Lamiaceae) were investigated to comprehend the important characteristics for systematic purposes. Some anatomical characters such as often 1 rarely 2 - 3 rowed pith rays in roots, the quadrangular stem and 5 - 6 layered collenchyma cells groups on the corners of stem, cruciferae stoma type and bifacial leaf, one small subsidiary bundle in the wings and one big vascular bundle in the center of petiole were found in *S. orientalis* subsp. *pinnatifida*. These characters provide important information of taxonomical significance. Four different glandular trichome types were determined on the stems, vegetative and reproductive organs of the plant. These glandular trichome types are peltate (type I), type II A, type II B and type II C capitate glandular. Type II A capitate glandular trichomes were seen on all organs of *S. orientalis* L. subsp. *pinnatifida*, but peltate, type II B and type II C capitate glandular trichomes were observed only on vegetative organs of *S. orientalis* subsp. *pinnatifida*.

Introduction

The Lamiaceae is a large family which consists of a large number of species. This family has 240 genera and 3000-3200 species in the Mediterranean region (Valant-Vetschera *et al.* 2003). Davis (1982) reported that Lamiaceae family has 45 genera and about 546 species distributed in Turkey. Turkey is accepted as a gene center for this family (Başer 1993). This family also has great importance due to its economic values. Many species of this family are aromatic and often used as herb spices, folk medicines and fragrances (Werker *et al.* 1985). Turkish people consume many species of the family as herbal teas. Some species are used in cosmetic industry. Many species are used against some disease as medicinal plants traditionally and some of the others are used for ornamentation (Baytop 1984).

Many members of Lamiaceae have glandular trichomes that produce oil. The oils that secreted by glandular trichomes are the most characteristic features of Lamiaceae (Ascensão *et al.* 1995). These glandular trichomes are significant taxonomic characters and play important role for pollination in the Lamiaceae (Navarro and El Oualidi 2000). It was reported that the morphological characteristics of the trichomes separate plants at subgeneric or subspecific level (Giuliani and Bini 2008, Serrato-Valenti *et al.* 1997).

Scutellaria L. is a very important genus in this family. This genus has approximately 300 species (Pool 2006). In Turkey, *Scutellaria* consists of 24 species and 13 subspecies. *Scutellaria orientalis*, consists of 16, of which 6 are endemic to Turkey (Davis 1982) and are used as a tonic, astringent and hemostatic plant in Turkey (Baytop 1984). One of the subspecies of *S. orientalis* is *S. orientalis* subsp. *pinnatifida* Edmondson. In spite of the large species diversity of *Scutellaria*, there are a few studies about this genus. According to the available literature data, the anatomy and glandular trichome micromorphology of *S. orientalis* subsp. *pinnatifida* have not been examined as yet. The authors investigated the anatomy of the vegetative and reproductive organs

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and micromorphology of glandular trichomes of this plant. It was aimed at evaluating the usefulness of anatomical and glandular trichome micromorphological characters for systematic purposes.

Materials and Methods

Plant specimens were collected during the flowering period from natural populations in Amasya (Ferhat mountain, North slopes, 550 m, May 2011). The specimens were kept as a herbarium material. Flora of Turkey was used for its taxonomical description (Davis 1982). The plant materials were fixed in 70% alcohol for anatomical and glandular trichome properties. Transverse sections for anatomical preparation of root, stem, leaf, petiole, calyx and corolla were made by hand using commercial razor blades. Fifty specimens were examined in the study. Sartur reactive was applied to the sections for investigation of some anatomical tissues easily (Çelebioğlu and Baytop 1949). A Leica ICC50 HD binocular light microscope, a Leica Digital Camera and X10 - X40 objectives were used for measurements to determine the minimum and maximum values as well as width and length measurements in various tissues. Preparations were photographed with a Leica ICC50 HD binocular light microscope and a Leica Digital Camera. The glandular trichomes were obtained from vegetative and reproductive organs of the plant by transverse and surface sections. The glandular trichome preparations were prepared by hand using commercial razor blades under a Leica ICC50 HD binocular light microscope. The glandular trichome types and distributions were described in this study as well. These trichome types studied in here were classified according to Metcalfe and Chalk (1972) and Navarro and El Oualidi (2000).

Results and Discussion

The root surface of *Scutellaria orientalis* subsp. *pinnatifida* is covered by multilayered peridermis cells. Beneath the peridermis, there is a cortex layer and its cells are $20 - 52.5 \times 15 - 37.5 \mu\text{m}$ (Table 1). The xylem tissue exists beneath the phloem part. The vascular bundle is collateral in the centre. The pith has parenchymatous ovoidal cells. The pith rays in this species are often 1, rarely 2 - 3 layered rectangular cells (Fig. 1a). In recent years, the anatomical characters of plants have been used for systematic purpose (Agbagwa and Ndukwu 2004). Metcalfe and Chalk (1972) stated that Lamiaceae family has some important anatomical information. The root of species in Lamiaceae has 2 - 12 or more rowed pith rays. The pith rays found in the root of *S. orientalis* L. subsp. *pinnatifida* were composed of often 1, rarely 2 - 3 layered rectangular cells. These findings are in agreement with those of Metcalfe and Chalk (1972) and previous studies (Baran and Özdemir 2009, Kahraman *et al.* 2010b).

The stem of *S. orientalis* subsp. *pinnatifida* is quadrangular and consists of 5-6 layered collenchyma on the corners (Fig. 1b). The surface of stem is covered by periderm. The dimensions of the periderm cells are $10 - 27.5 \times 12.5 - 25 \mu\text{m}$ (Table 1). Cortex consists of 4-7 layered parenchymatous cells. The vascular bundle is below the cortex. Xylem and phloem are confined to collateral bundles. The pith has parenchymatous cells. According to Metcalfe and Chalk (1972), the members of Lamiaceae family have quadrangular stem with well-defined collenchyma on the corners of stem. The present study on transverse sections of the stem of *S. orientalis* L. subsp. *pinnatifida* showed that the species has quadrangular stem consisting of 5-6 layered collenchyma on the corners. Quadrangular stem and well-defined collenchyma in the four angles of stem were observed in other members of Lamiaceae (Kahraman *et al.* 2010b).

In the leaves, the epidermis is single layered on upper and lower surfaces. There are glandular and eglandular hairs on epidermis. The cuticle is $2.5 - 10 \mu\text{m}$ thick. Just beneath the upper

epidermis cells, there are 1 - 2 rowed palisade parenchyma cells (Fig. 1c). The dimensions of the palisade parenchyma cells are $7.5 - 15 \times 27.5 - 55 \mu\text{m}$ (Table 1). Mesophyll consists of the palisade and spongy cells. Beneath the palisade cells, there are 1 - 2 layered spongy cells. Vascular bundle is in the centre and surrounded by parenchymatous cells. The stoma is cruciferae type and presents on upper and lower surfaces of the leaf (Fig. 1d). The type of the vascular bundle is collateral. Bifacial leaf type was found in another species of Lamiaceae family (Metcalf and Chalk 1972, Özdemir and Şenel 1999). The stoma is cruciferae type in this study in contrast to other studies on the members of Lamiaceae (Inamder and Bhatt 1972).

Table 1. Anatomical characteristics of *S. orientalis* subsp. *pinnatifida*.

	Width (μm)		Length (μm)	
	Minimum - Maximum		Minimum - Maximum	
Root anatomy				
Peridermis cell	12.5 - 22.5		17.5 - 25	
Parenchyma cell	20 - 52.5		15 - 37.5	
Trachea cell	7.5 - 22.5		7.5 - 22.5	
Pith cell	15 - 47.5		15 - 47	
Stem anatomy				
Cuticle	5 - 10			
Peridermis cell	10 - 27.5		12.5 - 25	
Parenchyma cell	10 - 47.5		10 - 25	
Trachea cell	7.5 - 47.5		10 - 37.5	
Pith cell	25 - 82.5		15 - 77.5	
Leaf anatomy				
Cuticle	2.5 - 10			
Adaxial epidermis cell	17.5 - 50		12.5 - 30	
Abaxial epidermis cell	7.5 - 27.5		10 - 17.5	
Parenchyma cell	7.5 - 15		27.5 - 55	
Petiole anatomy				
Adaxial epidermis cell	12.5 - 27.5		10 - 25	
Abaxial epidermis cell	12.5 - 22.5		10 - 20	
Parenchyma cell	20 - 37.5		17.5 - 37.5	
Trachea cell	5 - 15		7.5 - 12.5	
Calyx anatomy				
Adaxial cuticle	1.25 - 5			
Adaxial epidermis cell	10 - 37.5		12.5 - 20	
Abaxial cuticle	1.25 - 2.5			
Abaxial epidermis cell	10 - 37.5		12.5 - 20	
Parenchyma cell	12.5 - 30		12.5 - 27.5	
Corolla anatomy				
Adaxial cuticle	2.5 - 3.7			
Adaxial epidermis cell	15 - 27.5		15 - 35	
Abaxial cuticle	2.5 - 5			
Abaxial epidermis cell	10 - 25		15 - 30	
Parenchyma cell	15 - 45		15 - 40	

A transverse section of the petiole shows that both adaxial and abaxial epidermis cells of *S. orientalis* subsp. *pinnatifida* are single layered. There is a 2 - 3 layered collenchyma in the area between the corners. Cortex cells are parenchymatous. Chlorenchymatic cells are seen at the each corners as well. There is one small subsidiary bundle in the wings and one big vascular bundle in the center of petiole (Fig. 2e). Petiole has a total of 3 vascular bundles. The cambium is located between the xylem and phloem. The vascular bundle is collateral. Metcalfe and Chalk (1972) reported that the vascular bundles in the petiole of the species in the Lamiaceae are very important because they could be used as a diagnostic character. The structure of petiole shows differences between genera and species (Baran and Özdemir 2009). Besides, useful anatomical petiole characters were determined in designated taxonomical structures of some species (Olowokudejo 1987). Calyx and corolla of the species consists of wholly parenchymatous cells (Fig. 2f, g).

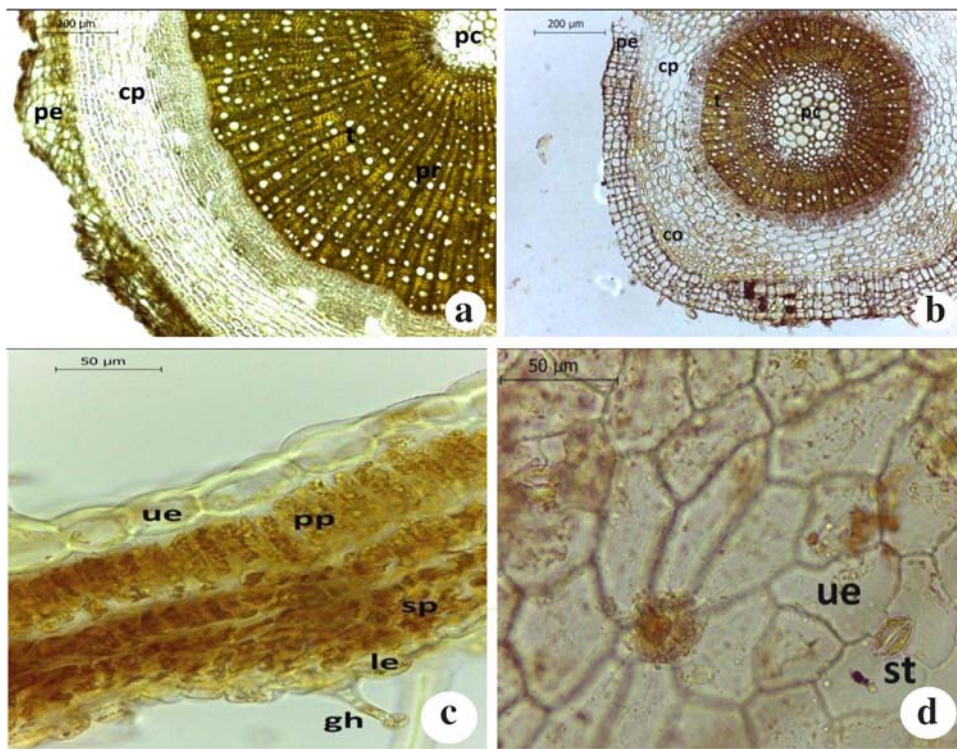


Fig. 1. Cross section of root (a) and stem (b) of *S. orientalis* L. subsp. *pinnatifida* pe : periderm, cp : cortex parenchyma, pr: pith rays, t: trachea, pc: pith cell, co : collenchyma, t : trachea. Cross section of leaf (c) and surface section of *S. orientalis* L. subsp. *pinnatifida* (d) ue: upper epidermis pp: palisade parenchyma sp: spongy parenchyma le: lower epidermis, gh: glandular hair st: stoma.

Glandular Trichome Micromorphology: *S. orientalis* L. subsp. *pinnatifida* has the various glandular trichomes on stem, leaf, petiol, calyx and corolla. These peltate hairs have four or six periphery cells and one center cell. There are two different glandular trichome types on the stems, leaf, petiole, calyx and corolla of *S. orientalis* subsp. *pinnatifida*. These are peltate glandular trichomes (type I) and type II capitate glandular trichomes (Table 2). Type I is the typical peltate glandular trichome which has a basal epidermal cell, a very short monocellular stalk and a broad, round multicellular secretory head consisting of four or six cells in the single shield (Fig. 3a,b).

Another glandular hair type is type II capitate glandular trichome. This type is composed of a basal epidermal cell, unicellular to multicellular stalk cell and a large unicellular, bicellular or multicellular secretory head. Type II capitate trichomes can be subdivided into three subtypes. These are type II A, type II B and type II C capitate glandular trichomes (Fig. 3c,d,e,f). Type II A capitate trichome has unicellular or bicellular head and stalk of one, two or three cell (Fig. 3c,d). Type II B capitate trichome is a cup-shaped unicellular head and one to two-celled stalk (Fig. 3e). Type II C capitate trichome has a hemispherical unicellular head and a unicellular or bicellular stalk (Fig. 3f).

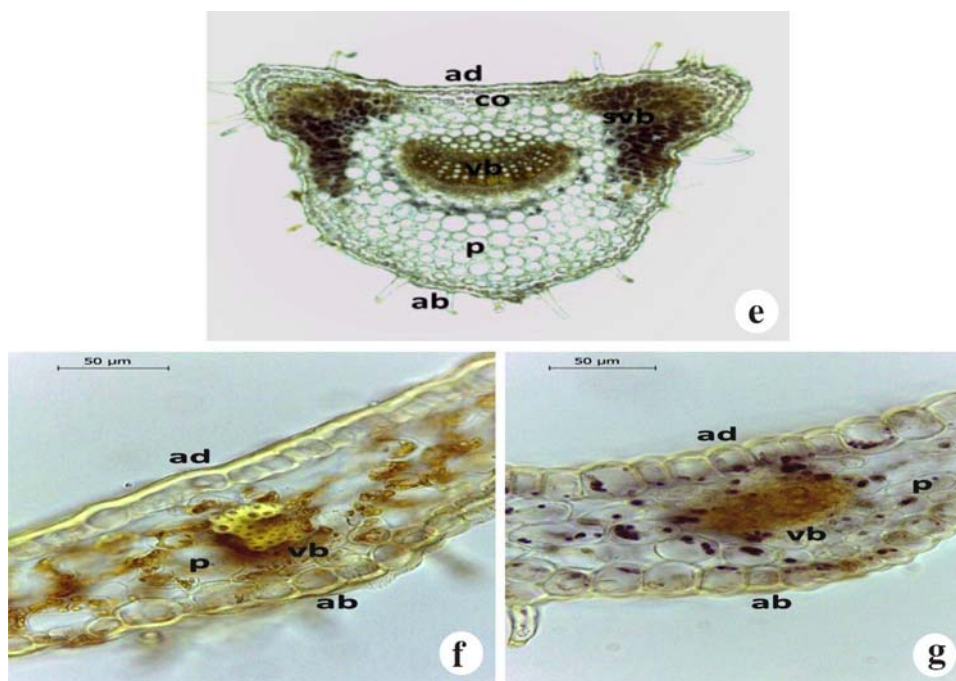


Fig. 2. Cross section of petiole (e). ab: abaxial epidermis. ad: adaxial epidermis svb: subsidiary vascular bundle. vb: vascular bundle. p: parenchyma co:collenchyma. Cross section of calyx (f) and corolla (g) of *S. orientalis* L. subsp. *pinnatifida* ab: abaxial epidermis, ad: adaxial epidermis, vb: vascular bundle p: parenchyma.

The most important features of Lamiaceae taxa are glandular trichomes distributed in vegetative and reproductive organs (Werker 2006). These trichomes are source of etheric oils and their structures have been examined anatomically and micromorphologically (Vrachnakis 2003). The morphology, distribution and frequency of glandular trichomes are used as taxonomic characters at subfamily level in the Lamiaceae (Ascensao *et al.* 1995). It was also reported that the morphological characteristics of the trichomes in Lamiaceae separate plants at subgeneric or subspecific level (Giuliani and Bini 2008, Serrato-Valenti *et al.* 1997). According to Hallahan (2000), peltate trichomes in Lamiaceae have a large head of several secretory cells (up to 16). A wide short stalk and a basal epidermal cell. In this study, *S. orientalis* subsp. *pinnatifida* has peltate trichomes which have a basal epidermal cell, a very short monocellular stalk and a broad, round multicellular secretory head consisting of four or six cells in the single shield, which is in

Table 2. Types of glandular trichomes and their localization in *S. orientalis* subsp. *pinnatifida* Edmondston.

Organ	Capitate type II									Peltate type I	
	Type II A			Type II B			Type II C			Center cell	Periphery cell
	Head cell	Stalk Cell	Base Cell	Head cell	Stalk cell	Base cell	Head cell	Stalk cell	Base cell		
Stem	1	3	1	1	2	1	1	1	1	1	4
	1	2	1	-	-	-	-	-	-	-	-
	-	-	-	-	-	-	-	-	-	-	-
	-	-	-	-	-	-	-	-	-	-	-
Leaf	1	3	1	1	2	1	-	-	-	1	4
	2	2	1	-	-	-	-	-	-	1	6
	1	2	1	-	-	-	-	-	-	-	-
	1	1	1	-	-	-	-	-	-	-	-
Petiole	1	3	1	1	2	1	1	2	1	1	4
	1	2	1	1	1	1	-	-	-	-	-
	1	1	1	-	-	-	-	-	-	-	-
Calyx	2	2	1	-	-	-	-	-	-	-	-
	1	2	1	-	-	-	-	-	-	-	-
	1	3	1	-	-	-	-	-	-	-	-
Corolla	2	2	1	-	-	-	-	-	-	-	-
	2	3	1	-	-	-	-	-	-	-	-
	1	2	1	-	-	-	-	-	-	-	-

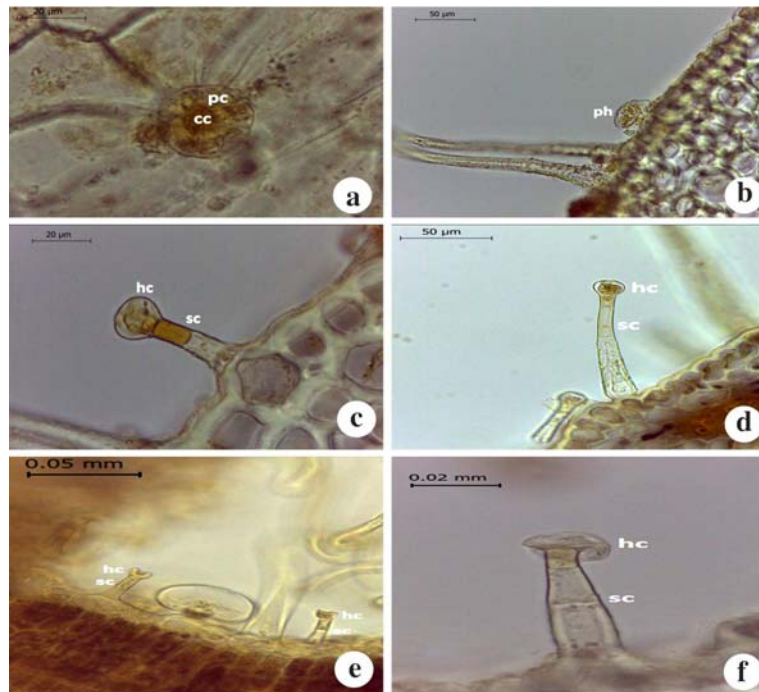


Fig. 3. Peltate glandular trichomes of *S. orientalis* subsp. *pinnatifida* on the surface section of leaf (a) and cross section of petiole (b), cc: center cell, ph: peltate hair, pc: peryphery cell Type II A capitulate glandular trichome on petiole (c) and on corolla (d) hc:head cell sc: stalk cell Type II B capitulate glandular trichome on leaf (e) and Type II C capitulate glandular trichome on petiole (f).

is in agreement with previous studies (Serrato-Valenti *et al.* 1997, Corsi and Bottega 1999, Hallahan 2000). Navarro and El Oualidi (2000) stated that capitate glandular trichomes significant taxonomic characters and play important role for pollination in the Lamiaceae. These trichomes vary in structure and size. In this study, there are three types of capitate glandular trichomes on the several organs of the plant. Type II A capitate glandular trichomes were seen on all organs of *S. orientalis* subsp. *pinnatifida*, but type II B and type II C capitate glandular trichomes were observed on only vegetative organs of the plant. Type II A and type II B capitate glandular trichomes were seen in other members of Lamiaceae (Serrato-Valenti *et al.* 1997, Corsi and Bottega 1999). Type II C capitate glandular trichome found in this study was observed in *Salvia chrysophylla* as well (Kahraman *et al.* 2010a). As a result, anatomical and glandular trichome micromorphological features of *S. orientalis* subsp. *pinnatifida* were studied. According to the results, anatomical and glandular trichome micromorphological features of this plant provide useful characters for distinguishing species in *Scutellaria* genus.

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