

**MORPHOLOGICAL AND ANATOMICAL INVESTIGATIONS ON  
ENDEMIC *SCUTELLARIA ORIENTALIS* L. SUBSP.  
*BICOLOR* (HOCHST.) EDMUND AND SUBSP.  
*SANTOLINOIDES* (HAUSSKN EX BORNM)**

**CANAN ÖZDEMİR AND YASIN ALTAN**

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

**Abstract**

Morphological and anatomical characteristics of *Scutellaria orientalis* L. subsp. *bicolor* (Hochst.) Edmund and subsp. *santolinoides* (Hauuskn ex Bornm) has been described which will help to distinguish them from each other.

**Introduction**

*Labiatae* are represented by 200 genera and about 3200 species in the world (Tavukçuoğlu *et al.*, 1996). This family is represented by 45 genera and about 546 species distributed in Turkey (Davis, 1982). Many species of this family are aromatic and are often used as herb spices, folk medicines and fragrances (Werker *et al.*, 1985). The source of this feature of *Labiatae* species is glandular hairs that secrete ether-rich oil (Kesercioğlu & Nakipoğlu, 1992; Özdemir & Şenel, 2001). The genus *Scutellaria*, comprises of 320 species. *Scutellaria orientalis* L., consists of 16 subspecies, of which 6 subspecies are endemic to Turkey (Davis, 1982), and are used as a tonic, astringent and hemostatic plant in Turkey (Baytop, 1984). The present report gives an account of the morphological and anatomical characters of *Scutellaria orientalis* subsp. *santolinoides* and subsp. *Bicolor*.

**Materials and Methods**

The specimens for this study were collected during its flowering period from Eastern Anatolia (Fig. 1). Specimens were preserved in the herbarium at Celal Bayar University, Science and Art Faculty. The samples were collected from the following localities:

*Scutellaria orientalis* subsp. *santolinoides*

B7: Erzincan: Keban dam environs, 1400m, 16.06.1980, Altan 3065 *Scutellaria orientalis* subsp. *bicolor*

A8: Erzurum: Tortum to Dikyar Köyü, Rocky slopes, 1500m, 12.08.1996, Altan 6652. In addition the distribution of the plants according to the this herbaria records and Flora of Turkey (Davis, 1982) is shown in Fig. 1.

Taxonomical description of the subspecies was made according to Davis (1982). The plant samples were fixed in 70% alcohol for anatomical studies. Paraffin method was used for preparing cross-sections of root, stem, leaf, bract, petiole and flowers (Algan, 1981). Transverse sections 15-20 µ were made using a sliding microtome and stained with safranin-Fast Green. Hand- cut sections were also made and stained with sartur reagent (Çelebioğlu & Baytop, 1949).

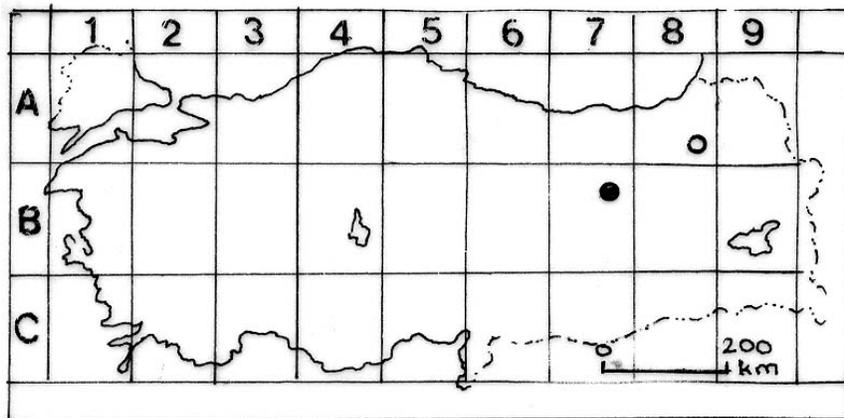


Fig. 1. Distribution of the plants in Turkey

• *Scutellaria orientalis* subsp. *santolinoides*, ° *Scutellaria orientalis* subsp. *bicolor*

## Results

### Morphological characters

*Scutellaria orientalis* L., subsp. *santolinoides* (Fig. 2): Stem 10-45 cm long, stiffly erect, rectangular in section. Leaves simple, narrowly linear to linear oblong in shape, with short petiole, dense at the base 12-28 x 4-7 mm. The adaxial surface of the leaves is green above, lanate and greenish below. Inflorescence oblong and lax spike. Bracts lanceolate, greenish. Calyx oblong, campanulate with glandular and aglandular pale green hairs, 2-3 x 1-3 mm in size. Corolla yellow 21-29 mm long, tube is straight. Stigma bifurcate 8-14 mm long.

*Scutellaria orientalis* subsp. *bicolor* (Fig. 3): Stem 25-40 cm long, sometimes branched in upper half, rectangular in section. Leaves simple, ovate 1-9 x 0.8-4.5 cm, petiole 1-3 cm long. Flowers at the base of pale green bracts. Calyx oblong, campanulate, 4-8 x 2-4 mm. Corolla tube straight, pale yellow or purplish-red with yellow-tipped lobes or with a yellowish-brown lower lip. Stigma bifurcate.

### Anatomical characters

#### *Scutellaria orientalis* subsp. *santolinoides*

**Root (Fig. 4):** Peridermis 1-4 layered, 5-30 x 5-25  $\mu$  in size, outer most cells dark, crushed and sometimes exfoliated. Cortex 4-5 layered, parenchymatic, ovoidal, 25-60 x 30-35  $\mu$  in size. Cambium ring 2-3 layered under cortex. Phloem elements are located in small region of root. The pith is occupied by xylem elements.

**Stem (Fig. 5):** Epidermis 2-4 layered, cells prismatic, thin walled, glandular and aglandular hairy outside. Cortex 7-10 layered, cells regular ovoidal in shape, sclerenchymatous sheaths under the parenchymatous cortex. The sclerenchymatous ring surrounds the vascular elements. Cambium between phloem and xylem. Cells 1-2 layered. The pith has parenchymatous ovoidal cells.



Fig. 2. General appearance of *Scutellaria orientalis* subsp. *santolinoides*  
a-general view of plant b- flower c- calyx d- leaf e- bract  
a: x 0.7; b: x 2.5; c: x 5; d: x 1.25 e: x 2.5



Fig. 3. General appearance of *Scutellaria orientalis* subsp. *bicolor*  
a-general view of plant b- flower c- calyx d- leaf e- bract  
a: x 0.8; b: x 2; c: x 2.5; d: x 0.7; e: x 5

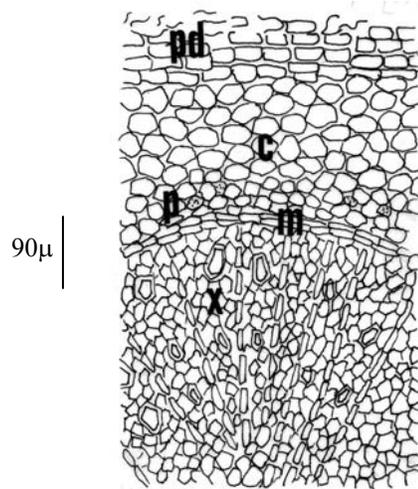


Fig. 4. Cross-section of root of *Scutellaria orientalis* subsp. *santolinoides*  
pd. peridermis c. cortex p. phloem x. xylem m. cambium

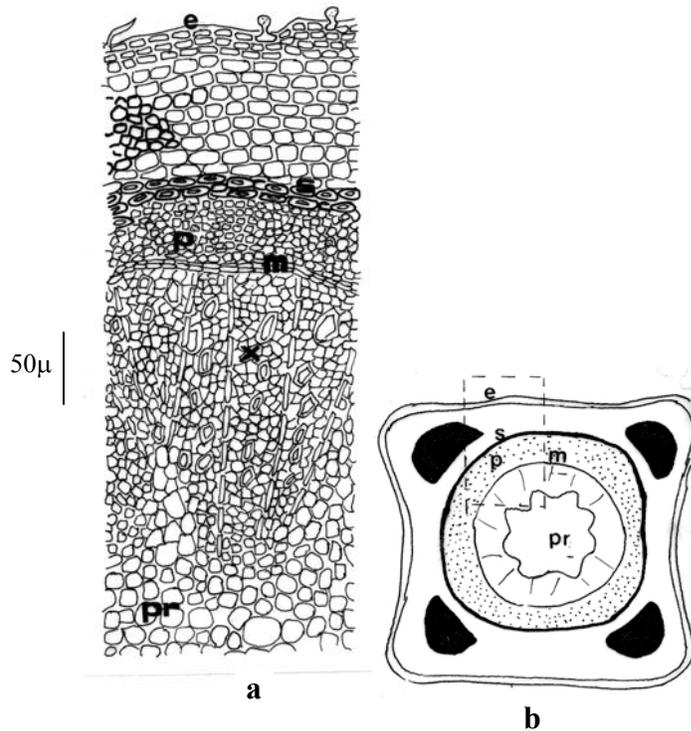


Fig. 5. a. Cross-section of stem of *Scutellaria orientalis* subsp. *santolinoides*  
b. Enlargement of the shown area of a.  
e. epidermis s. scleranchyma m. cambium p. phloem pr. pith region x. xylem

**Leaf (Fig. 6):** Epidermis single layered with flat-ovoidal cells on upper and lower surface of leaf, glandular and eglandular hairy on upper and lower epidermis most eglandular. Cuticle is 5-15  $\mu$  thick. Stoma cells present at lower epidermis. The leaf of the plant is bifacial. Palisade parenchyma cells 1-2 layered. Mesophyll parenchymatous.

**Petiole (Fig. 7):** Epidermis 1-layered, cell ovoid. Cortex parenchymatous 8-20 layered, cells ovoid. The two large vascular bundles present on median region of petiole and small vascular bundle is on single part of petiole, vascular bundles are surrounded by sclerenchymatic cells.

***Scutellaria orientalis* subsp. *bicolor***

**Root (Fig. 8):** Outer surface of root is covered by 1-2 layered peridermal cells, outer most cells dark crushed and sometimes exfoliated. Cortex 4-8 layered, 1-2 row of cortex cells flattened. Sclerenchymatic sheath present on the phloem part. Cambium not distinguishable. Xylem elements below phloem. The pith consists of parenchymatic, ovoidal cells.

**Stem (Fig. 9):** Epidermis 1-2 layered, cells thin walled, cuticle present on the epidermis are glandular and eglandular hairy. Cortex 5-6 layered. Sclerenchymatic ring present between cortex. Cambium cells are easily distinguishable, cells 1-2 layered. Pith has parenchymatous ovoidal cells.

**Leaf (Fig. 10):** Single layered epidermis on upper and lower surface of leaf, glandular and eglandular hairy, cuticle 5-8  $\mu$  thick. Stoma present on lower epidermis. The leaf of the plant is bifacial. Palisade parenchyma cells 1-2 layered. Mesophyll parenchymatous.

**Petiole (Fig. 11):** Epidermis, single layered. Parenchymatic cortex 8-10 layered, cells ovoid. Vascular bundles 2 in row, one very large, smaller one is on single part of petiole. The vascular bundles are surrounded by sclerenchymatic cells.

**Table 1. Measurements of cells of various tissue of *Scutellaria orientalis* subsp. *santolinoides* and subsp. *bicolor*.**

	<i>S.orientalis</i> subsp. <i>santolinoides</i>		<i>S.orientalis</i> subsp. <i>bicolor</i>	
	Breadth ( $\mu$ ) min max	Length ( $\mu$ ) min max	Breadth ( $\mu$ ) min max	Length ( $\mu$ ) min max
<b>Root</b>				
Peridermis cell	5-30	5-25	5-20	5-10
Parenchyma cell	25-60	10-35	15-50	10-35
Diameter of trache	15-40		10-30	
Diameter of pith cell	25-90		20-80	
<b>Stem</b>				
Epidermis cell	15-45	10-25	10-40	10-20
Parenchyma cell	25-60	5-25	20-50	10-25
Diameter of trache	15-25		15-20	
Diameter of pith cell	15-70		15-60	
<b>Leaf</b>				
Cuticle	5-15		2-6	
Upper epidermis cell	10-35	10-20	20-30	10-30
Lower epidermis cell	15-35	10-20	15-20	10-15

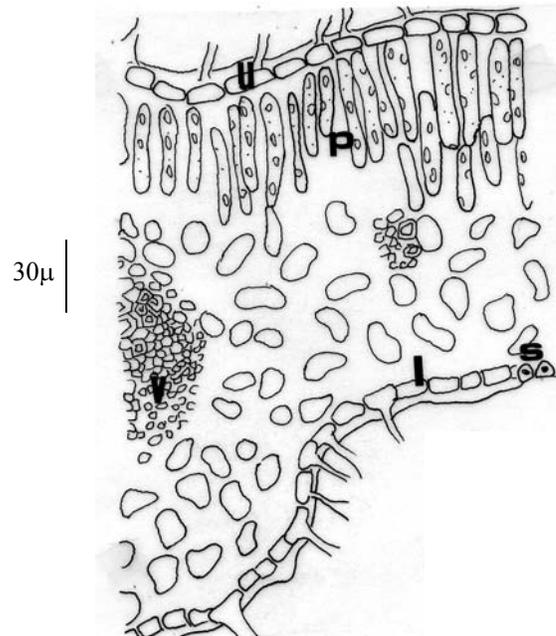


Fig. 6. Cross-section of leaf of *Scutellaria orientalis* subsp. *santolinoides*  
 p. palisade u. upper epidermis l. lower epidermis s. stoma v. vascular bundle

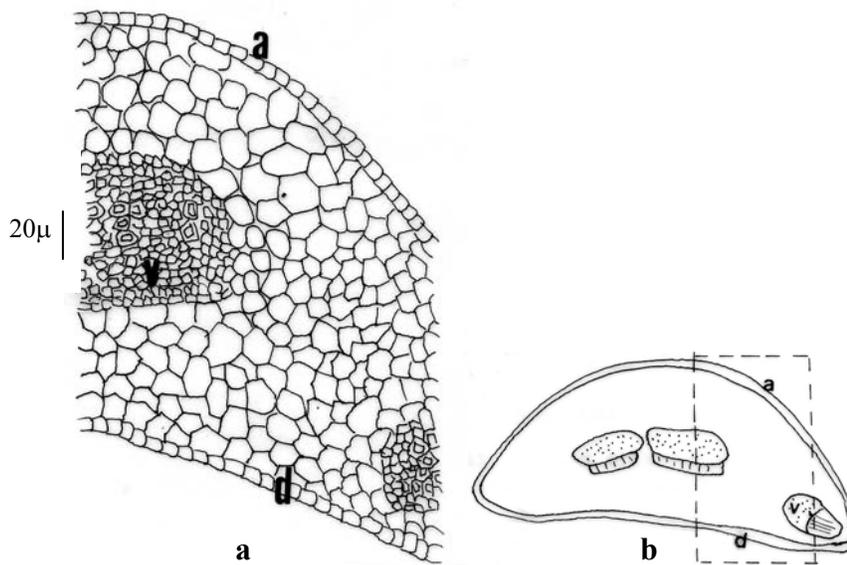


Fig. 7. a. Cross-section of petiole of *Scutellaria orientalis* subsp. *santolinoides*  
 b. Enlargement of the shown area of a.  
 a. abaxial epidermis d. adaxial epidermis v. vascular bundle

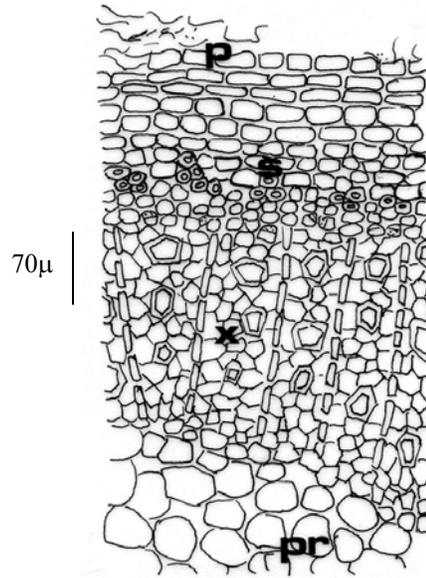


Fig. 8. Cross-section of root of *Scutellaria orientalis* subsp. *bicolor*  
p. periderm s. sclerenchyma pr. pith region x. xylem

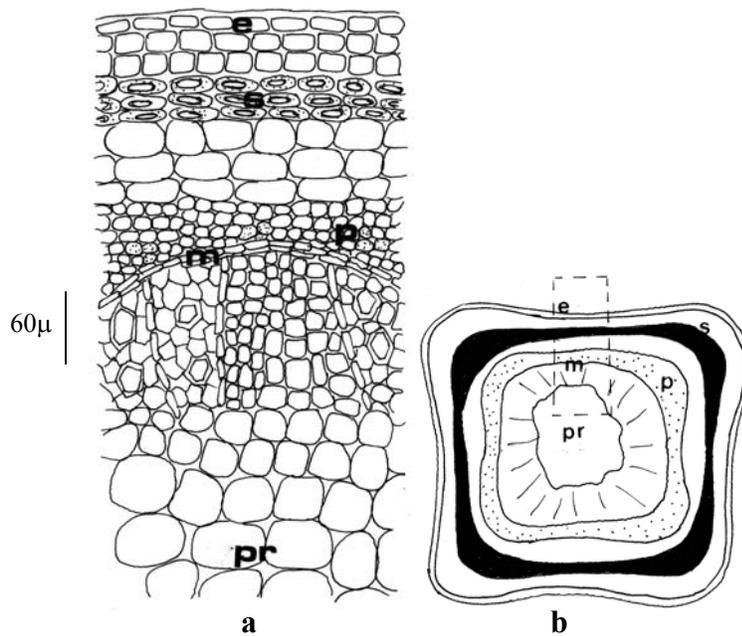


Fig. 9. a. Cross-section of stem of *Scutellaria orientalis* subsp. *bicolor*  
b. Enlargement of the shown area of a.  
e. epidermis s. sclerenchyma m. cambium p. phloem pr. pith region

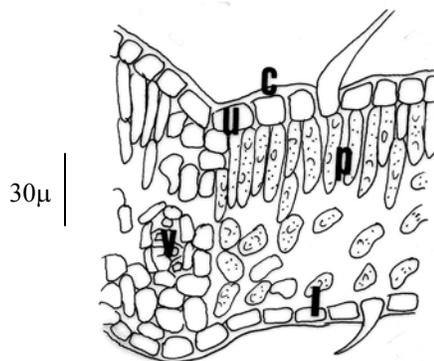


Fig. 10. Cross-section of leaf of *Scutellaria orientalis* subsp. *bicolor*  
 c. cuticle p. palisade paranchyma u. upper epidermis l. lower epidermis  
 v. vascular bundle

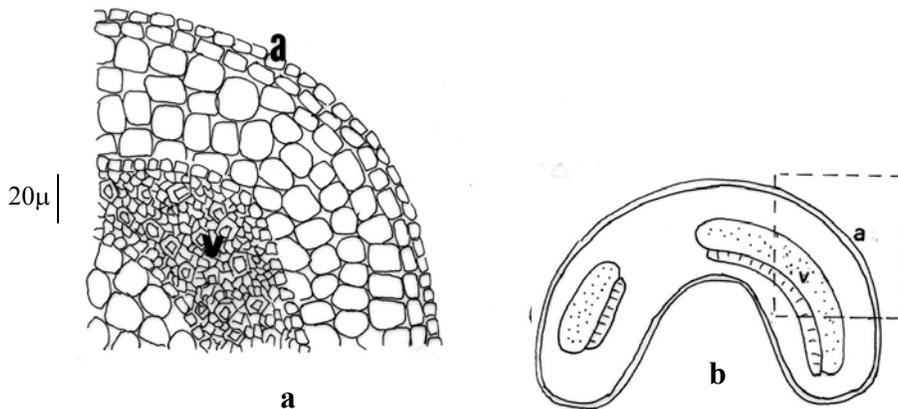


Fig. 11. a. Cross-section of petiole of *Scutellaria orientalis* subsp. *bicolor*  
 a. adaxial epidermis v. vascular bundle

### Glandular hair properties

In two subspecies almost all organs, vegetative and reproductive are covered by an indumentum of uniseriate, multicellular eglandular hairs and large numbers of greatly variable glandular hairs. Classification of glandular hairs of these subspecies has been made according to previous classification (Werker et al. 1985; Özdemir & Şenel 1999; 2001). These glandular hairs consist of capitate and peltate hairs. The capitate hairs, vary greatly in structure, size, proportions, occurrence on plant organs and manner of secretion. These capitate glandular hairs have head cells. In one case (Fig. 12, Type-I) the secretion of the material does not affect the wall. In the other case (Fig. 12, Type-II) the secretion is after the rupturing of the cell wall that become little elongated. In the third case (Fig. 12, Type-III) the secretion is after the rupturing of the cell wall but the cell wall become cup like. Capitate glandular hairs have various numbers of cells and stalk cells. Stalk cells not present in some of them.

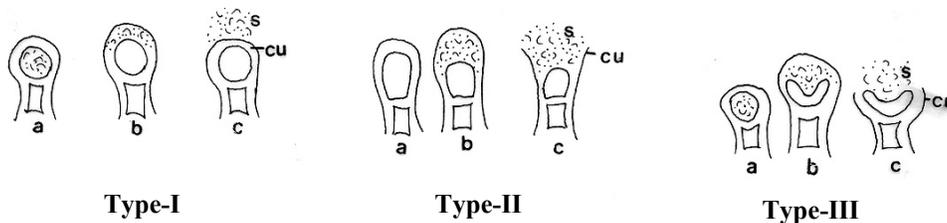


Fig. 12. The three types of capitate glandular hairs in the subspecies studied.

**Type I:** a. Before secretion b. Secretory materials are seen between cuticle and cell wall c. After secretion (Cuticle of head cell doesn't break)

**Type II:** a. Before secretion b. Secretory materials are seen between cuticle and cell wall (At the stage of cell; elevation of cuticle can be seen) c. After secretion (Cuticle of head cell breaks up) cuticle remains only on the head's lower part of outer walls

**Type III:** a. Before secretion b. Secretory materials are accumulated between cuticle and collapsed cell wall c. After secretion; cuticle of head cell breaks and the cup-like structure is formed (Werker *et al.*, 1985)

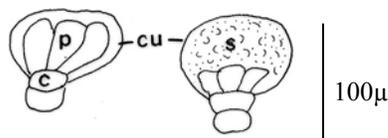


Fig. 13. The peltate glandular hairs.

c. central(stem) cell p. peripheral(secretory) cells cu. cuticle s. secretory material

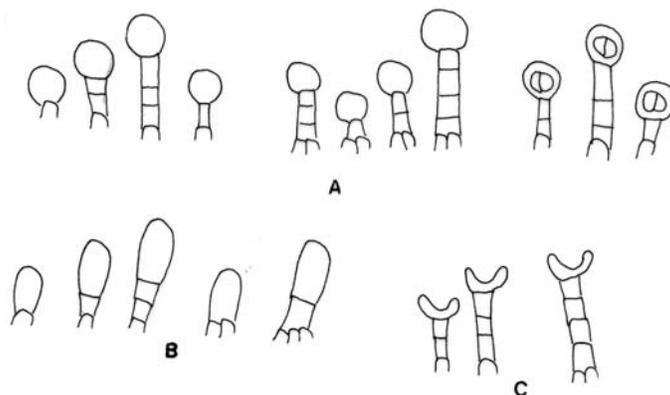


Fig. 14. Glandular hairs different parts of *S. orientalis* subsp. *santolinoides*  
(A: type I hair B: type II hair C: type III hair)

The peltate glandular hairs have a more or less flattened multicellular head of secretory cells, composed of central cells and peripheral cells. Materials are secreted from the head cells through their outer wall into a space elevation of their common cuticle together with an outer layer of the cell wall (Fig. 13).

In subsp. *santolinoides* the first, second and third type of capitate hairs are scattered on stem, leaf, petiole, bracts, pedicel, calyx and corolla. The first type capitate hairs have 1-2 head cells and 1-2 base cells, the second type capitate hairs have 1 head cell and 1-3 base cells (Fig. 14, Table 2).

**Table 2. Glandular hair type of various organs of *Scutellaria orientalis* subsp. *Santolinoides***

	Capitate hairs								
	Type I			Type II			Type III		
	Head cell	Stalk cell	Base cell	Head cell	Stalk cell	Base cell	Head cell	Stalk cell	Base cell
Stem	1	-	1	1	1	1	1	2	1
	1	2	1	1	-	2			
	2	1	1	2	-	1			
	1	1	2						
Leaf	1	1	1	1	-	1	1	2	1
	2	2	1	1	1	3			
	2	3	1						
	1	1	2						
	1	3	1						
Petiole	1	2	1						
	1	3	1						
Bract	1	-	1	1	2	1	1	3	1
	1	2	1						
	1	3	1						
Pedicel	1	-	1	1	-	1			
	1	-	1	1	-	1			
	1	2	1						
	1	3	1						
	1	4	2						
Calyx	1	1	1				1	2	1
	1	2	1						
	1	3	1						
	1	4	2						
Corolla	1	-	1						
	1	1	1						
	1	2	1						
	2	1	1						
	1	2	1						
1	3	2							

All the types of capitate hairs and peltate hairs have been observed on the various organs of subsp. *bicolor*. The peltate hairs scattered on leaf, bracts, pedicel and corolla. These peltate hairs have 1-4 central cells and 4-9 peripheral cells. The capitate hairs have various number of base cells and stalk cells in the this subspecies (Fig. 15, Table 3).

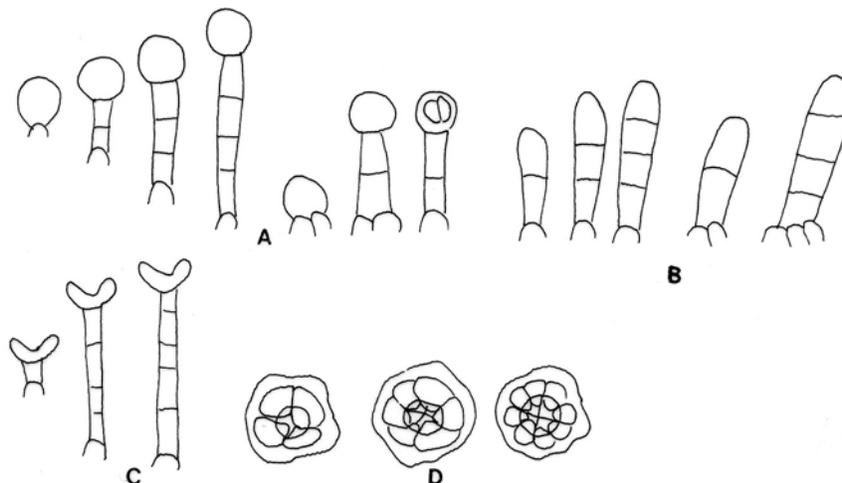


Fig. 15. Glandular hairs different parts of *S. orientalis* subsp. *bicolor*  
 A, B, C: Capitate hairs D: Peltate hairs  
 (A: type I hair B: type II hair C: type III hair)

**Table 3. Glandular hair type of various organs of *Scutellaria orientalis* subsp. *bicolor*.**

	Capitate hairs									Peltate hairs	
	Head cell	Stalk cell	Type I Base cell	Type II Head cell	Type II Stalk cell	Type II Base cell	Type III Head cell	Type III Stalk cell	Type III Base cell	Periphery cell	Center cell
Stem	1	-	1	1	1	1	1	4	1		
	1	2	1								
Leaf	1	-	2				1	1	1	1	4
	1	3	1							4	8
	1	5	1								
Petiole	1	1	1								
	1	2	1								
Corolla	1	-	1	1	1	2	1	1	1	1	4
	1	2	1	1	3	3	1	4	1	4	6
	1	3	1	1	2	1	1	5	1		
	1	2	2								
	2	2	1								

## Discussion

The anatomical characters *Scutellaria orientalis* subsp. *santolinoides* and subsp. *bicolor* are reported for the first time in the present paper. In this study we have tried to demonstrate the characteristics of the two subspecies evaluating the results obtained from morphological and anatomical investigations. Differences have been noted after comparing the results obtained from these subspecies.

*S. orientalis* subsp. *bornmuelleri*, subsp. *santolinoides* and subsp. *bicolor* are closely related to each other. But these subspecies are easily separable from each other with morphological and anatomical properties.

Subspecies *santolinoides* and *bicolor* have rectangular stem. This feature also can be easily seen in cross-section. Lower surface of leaves of subsp. *santolinoides* is lanate and greenish. Outer surface of leaves subsp. *bicolor* isn't lanate and greenish. The margin of leaf of subsp. *santolinoides* is deeply lobed but not in subsp. *bicolor*. In addition subsp. *bicolor* is much branched, while subsp. *santolinoides* is slightly branched. Thus these subspecies can be distinguished with these morphological differences.

In anatomical studies it has been determined that there is a sclerenchymatical sheath over phloem on the root of subsp. *bicolor*. But this feature has not been observed on the root of subsp. *santolinoides*. It has been determined that there is a clear sclerenchyma group and a ring consisting of sclerenchymatic cell and sclerenchymatical sheath on phloem in the stem of subsp. *santolinoides*. On the other hand, a sclerenchymatical sheath is seen in the stem of subsp. *bicolor*. Similar results were obtained for the root of *Origanum onites* L. (Gönüz & Özörgücü, 1999). Çobanoğlu (1988), Özdemir and Şenel (2001) have shown the same sclerenchymatic ring and sheath on root of *Salvia palaestina* Benth and *S. forskahlei* L.

It is stated by the researchers that mesophyll is completely parenchymatical and there are collenchyma both under and over median vein in species of *Salvia* (Metcalf & Chalk, 1950). We found the same characteristics in our research. The same researchers have emphasized that the distinctive feature of the *Labiatae* family is rectangular stem. In our research concerning this feature, it has been observed that in stem of subsp. *santolinoides* and *bicolor*.

There are large vascular bundles in the centre of the petiole of subsp. *santolinoides*. Further more, there is a small vascular bundle only on one side of petiole, while there are two vascular bundles in petiole of subsp. *bicolor*. One of these is very large. The order and number of petiole vascular bundles are different in the investigated subspecies. In the most of the anatomical studies done on *Labiatae*, it has been stated that the orders of petiole vascular bundles are different at the species. Çirig and Seçmen (1990) have pointed out that there are three vascular bundles in petiole of *Salvia kronenburgii* Rech. fil., two of which take place on the sides and the other is centre of petiole. Metcalfe & Chalk (1950) pointed out that in the *Labiatae* family, the structure of the vascular bundles in the petiole is important in terms of taxonomy (Metcalf & Chalk, 1950).

The subspecies were compared by studying glandular hairs on their vegetative and reproductive organs. It was found out in these observations that glandular hairs differ in variety and density according to the kinds of subspecies and organs related. While the bract, pedicel and calyx of subsp. *santolinoides* have glandular hair, the bract, pedicel and calyx of subsp. *bicolor* do not have glandular hairs. It was observed that subsp. *santolinoides* does not have peltate glandular hairs. But subsp. *bicolor* has peltate glandular hair. It can be stated that secretion in peltate hair gives the characteristic smell rather than capitate hair. The subsp. *bicolor* has the characteristic smell. Our result are supported by the reports of (Werker *et al.*, 1985) and (Özdemir & Şenel, 1999, 2001). Consequently, the anatomical and morphological characters help to distinguish the subspecies and members of *Labiatae* from each other. In addition to these features of anatomy and morphology, the differences in glandular hair are ancillary observations that generally serve to increase the anatomical knowledge of plants.

**References**

- Algan, G. 1981. Bitkisel Dokular İçin Mikroteknik, Fırat Üni. Fen Ed. Fak. Yay.Bot, No: 1, İstanbul.
- Baytop, T. 1984. Türkiye'de Bitkiler ile Tedavi. (Geçmişte ve Bugün) İstanbul Üniv. Yay. No: 40. İstanbul.
- Çelebioğlu, S. and T. Baytop. 1949. A new reagent for microscopical investigation of plant. Publication of the Institute of Pharmacognosy. No. 10,19: 3001. İstanbul
- Çiriğ. N. and O. Seçmen. 1990. *Salvia kronenburgii* Rech. Fil. Türü üzerinde morfolojik, taksonomik ve ekolojik çalışmalar. X. Ulusal Biyoloji Kongresi 325-330.
- Çobanoğlu, D. 1988. *Salvia palastina* Benthamin Morfolojik, ve Sitolojik Özellikleri. *Tr. J. Bot.*, 12: 215-223.
- Davis, P.H. 1982. *Flora of Turkey and the Aegean Islands*. Vol. 7 Edinburgh Univ. Press. Edinburgh.
- Gönüz, Ö. and B. Özörgücü. 1999. An Investigation on The Morphology, Anatomy and Ecology of *Origanum onites* L. *Tr. J. of Botany*, 23: 19-32.
- Kesercioğlu, T. and M. Nakipoğlu. 1992. Investigation on some *Salvia* L., species collected from Turkey. International Conference held on 28-31 January at New Delhi India. Recent Advances in Medicinal, Aromatic and Spice Crops, Vol. 2: 325-344 New Delhi. Edited by S.P. Raychaudhuri.
- Metcalfe, C.R. and L. Chalk. 1950. *Anatomy of Dicotyledons 2*. Clarendon Press. Oxford.
- Özdemir, C. and G. Şenel. 1999. The morphological, anatomical and karyological properties of *Salvia sclarea* L. *Tr. J. of Botany*, 23: 7-18.
- Özdemir, C. and G. Şenel. 2001. The morphological, anatomical and karyological properties of *Salvia forskahlei* L. *Indian Journal of Botany*, 19: 297-313.
- Tavukçuoğlu, S., Kaynak, G. and O. Tuyji. 1996. Uludağ'da Yayılışı olan *Thymus* L. Türleri Üzerinde Morfolojik ve Anatomik Araştırmalar. *Tr. J. of Botany*, 20: 59-71.
- Werker, E., Ravid, U. and E. Putievsky. 1985. Structure of glandular hairs and identification of the main components of their secreted material in some species of the *Labiatae*. *Israel Journal of Botany*, 34: 31-45.

(Received for publication 7 February 2004)