

## ANATOMICAL CHARACTERISTICS OF TURKISH ENDEMIC *STACHYS RUPESTRIS* MONTBRET ET AUCHER EX BENTHAM (LAMIACEAE)

BAŞTÜRK KAYA, MUHİTTİN DİNÇ, SÜLEYMAN DOĞU \*

**Abstract.** *Stachys rupestris* Montbret et Aucher ex Benthams, is an endemic species that show deploying at Middle Taurus and Amanos mountains in Turkey. In this study, the stem and leaf anatomy of the individuals that were collected from Mersin-Aslanköy were investigated. The obtained data from the anatomical studies shows that *S. rupestris* represents the anatomical characteristics of Lamiaceae family. The stem in primer structure is quadrangular, with a vascular bundle at each corner and it has collenchyma layer in rich. The leaf and stem epidermises are covered by long and short glandular trichomes. Leaves are amphistomatic and dorsiventral; and the mesophyll are formed of 3-4 layered palisade parenchyma at the upper part and 3-4 layered spongy parenchyma – at the lower part.

**Key words:** *Stachys rupestris*, anatomy, Turkey

Department of Biology Education, Ahmet Keleşoğlu Faculty of Education, Necmettin Erbakan University, 42090 Meram, Konya, Turkey; \*suleymandogu@gmail.com

### Introduction

*Stachys* L. is one of the largest genera of Labiatae family which contains about 300 species. These plants occur primarily at the temperate regions of Mediterranean and South-West Asia and have secondary center of distribution in North and South America, and South Africa. Turkey has one of the richest diversity of *Stachys* with 91 species (HEYWOOD 1993; HICKEY & KING 1997; ÖZHATAY *et al.* 2011). There are represented two main centers of the genus diversity. One of them is in Southern and Eastern Anatolia, Caucasia, Northwestern Iran and Northern Iraq, and the other is located in Balkan peninsula. Central part of Taurus mountains is a remarkable centre with a number of *Stachys* endemics and local endemics (BHATTACHARJEE 1980, 1982; DAVIS *et al.* 1988).

The genus *Stachys* in Turkey is represented by 91 species (116 taxa) belonging to 15 sections and 2 subgenera. 55 taxa (47.4 %) are endemics of Turkey (BHATTACHARJEE 1982; DAVIS *et al.* 1988; SUMBUL 1990; GEMICI & LEBLEBICI 1998; DUMAN 2000; DİNÇ & DOĞAN 2006; IÇLİM *et al.* 2008; DAŞKIN *et al.* 2009; AKÇİÇEK 2010;

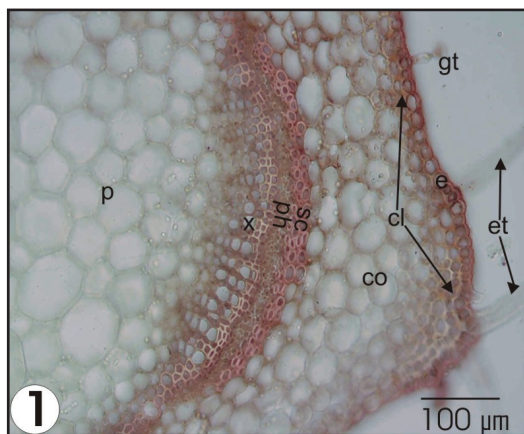
YILDIRIMLI 2010; YILMAZ *et al.* 2010; DIRMENCI *et al.* 2011; ÖZHATAY *et al.* 2011).

Although there are some anatomical, palynological and morphological studies related to *Stachys* species growing in Turkey, however there no any investigations on *S. rupestris* Montbret et Aucher ex Benthams. Therefore, in this study the anatomical characteristics of *S. rupestris* are reported for the first time.

### Material and methods

The samples of *S. rupestris* were collected from Aslanköy district of Mersin province (Turkey, C5 MERSİN: Aslanköy, Cocakdere, Şahinkayası, pine forest, forestry land, 1550-1600 m, 04.07.2003, M. Dinç 1944 & H.H. Doğan).

Some of the samples were preserved by taking them to the %70 alcohol for next anatomical studies. Anatomical studies were made on leaf and upper stem cross sections, as well as on leaf surface sections. The surface sections from the leaves were covered with glycerin gelatin. The cross sections of the leaves and stems were covered with glycerin gelatin stained with basic fucsin (VARDAR 1987). Photos of slides were made under Olympus BX-50 microscope.



**Fig. 1.** Cross-section of the stem: **e** – epidermis; **et** – eglandular trichome; **gt** – glandular trichome; **cl** – collenchyma; **co** – cortex; **sc** – sclerenchyma; **ph** – phloem; **x** – xylem; **p** – pith.

The stomatal index and stomatal index rate were calculated as described by MEIDNER & MANSFIELD (1968).

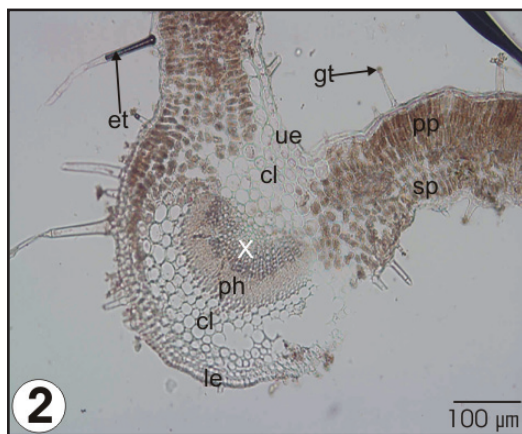
## Results

### Stem

The upper part of the stem is quadrangular on cross section, with more or less pronounced angles. The stem is covered by a thick layer of cuticle, and the indumentum consist of glandular and non-glandular trichomes. Non-glandular trichomes are very long and mostly multicellular. Glandular trichomes are shorter and built from 1-3 cell only. The epidermis is one-layered, consist of cells with thickened external walls. Subepidermal multi-layered collenchyma is formed by 2-3 raw cell layers along the straight sides of the stem and 5-6 raw cell layers – at the corners.

Below the collenchyma, the cortex from compact parenchyma is represented. It consists of 5-7-layered rectangular parenchymatic cells. After the cortex there is endodermis consisting of one layer of cells. The pericycle is in cylinder made of sclerenchyma elements, interrupted in a few places by several parenchyma cells.

Vascular tissues form four or six bundles, making almost a cylinder, which is most pronounced in the angles. Phloem and xylem elements are distinguishable in the bundles.

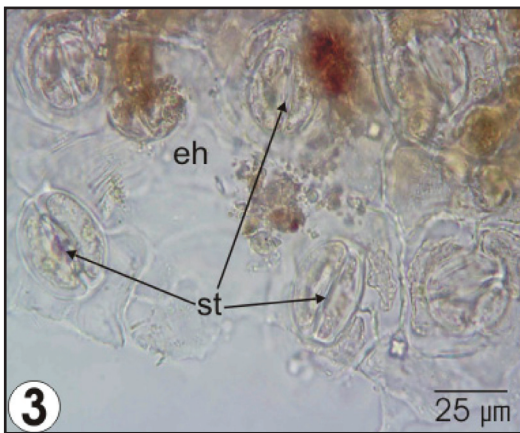


**Fig. 2.** The cross-section of the leaf: **ue** – upper epidermis; **le** – lower epidermis; **cl** – collenchyma; **ph** – phloem; **x** – xylem; **pp** – palisade parenchyma; **sp** – spongy parenchyma; **gt** – glandular trichome; **et** – eglandular trichome.

Phloem is surrounded by the sclerenchymatic pericycle outside. Cambium between the phloem and xylem is indistinguishable. Pith region occurs under the xylem elements and occupies a considerable part of the stem. The region is filled with large parenchyma medullar cells (Fig. 1).

### Leaf

The leaf is covered by thick layer of cuticle, and the indumentum is built of glandular and non-glandular trichomes of the same type and distribution as in the stem. The cuticle on the leaf upper epidermis is thicker than that on the lower epidermis. Both upper and lower epidermises of the leaf are single-layered, and upper epidermal cells are two to three times larger than lower ones (Fig. 2). The outer epidermal cell walls are thickened. The anticlinal upper and lower epidermal cell walls are undulating with shallow and deep amplitudes. There are cuticular thickenings in the form of long parallel striae on the upper and lower surfaces. There is a sub-epidermal multi-layered collenchyma which is formed of 6-8 raw cells under the both epidermises in the leaf cross section; dominated by the central nerve. Vascular bundles in the midvein is larger than the lateral ones and all vascular bundles are surrounded by a parenchymatic bundle sheath.



**Fig. 3.** The upper surface of the leaf: **st** – stoma; **eh** – epidermal cell.



**Fig. 4.** The lower surface of the leaf: **st** – stoma; **eh** – epidermal cell.

The leaves are amphistomatic (Figs. 3 & 4). The anomocytic stomata are about on the same level with the epidermal cells. Their frequency on the upper surfaces varies from 320 to 400 per mm<sup>2</sup>, and that on the lower surfaces varies from 280 to 400 per mm<sup>2</sup>.

The leaves are of dorsiventral anatomical structure. Namely, the mesophyll is clearly differentiated into palisade and spongy parenchyma. The palisade parenchyma consists of three to four layers of densely compacted, elongated cells under the upper epidermis. The spongy parenchyma consists of two to three layers of globular cells with intercellular spaces under the lower epidermis. However, the palisade parenchyma occupies about 60% of the mesophyll. The palisade tissue is about 3/2 times as thick as the spongy tissue.

### Discussion

METCALFE & CHALK (1950) reported that the stems of the family Lamiaceae species are rectangular and that the collenchymatic tissue covers broad area at the corners, and developed sclerenchymatic tissue surrounding the vascular tissue. The same results were obtained during the anatomical studies on Labiatae members in Turkey (KAYA *et al.* 2000; KANDEMİR 2003; UYSAL 2003; DİNÇ & ÖZTÜRK 2008). These characteristics are observed in *Stachys rupestris* as well. The sclerenchyma forms a continuous

ring-shaped tissue or separate bouquets in the primer stem anatomy of Labiatae members. The ring shaped sclerenchymatic tissue outside the vascular tissue is characteristic not only for *S. rupestris*, but was also reported for *Cyclotrichium origanifolium* (Labill.) Manden. & Scheng., *Salvia hypargeia* Fich. & C.A. Mey., *Stachys thirkei* C. Koch, *S. cretica* L. subsp. *smyrnaea* Rech. f., *S. yildirimlii* M. Dinç and *S. cydni* Kotschy ex Gemici & Leblebici which are previously investigated Labiatae species in Turkey (KAYA *et al.* 2000; UYSAL 2002, 2003; KANDEMİR 2003; DİNÇ & ÖZTÜRK 2008)

### References

- AKÇIÇEK E. 2010.** A new subspecies of *Stachys cretica* (section *Eriostomum*, Lamiaceae) from Turkey. *Turk. J. Bot.* **34**: 131–136.
- BHATTACHARJEE R. 1980.** Taxonomic studies in *Stachys* L. II: A new infrageneric classification of *Stachys* L. *Notes R.B.G. Edinburgh* **38**: 65–96.
- BHATTACHARJEE R. 1982.** *Stachys* L. In: DAVIS P.H. (ed.), *Flora of Turkey and East Aegean Islands*. Vol. 7: 199–262. Edinburgh Univ. Press., Edinburgh.
- DAŞKIN R., YILMAZ Ö., KAYNAK G. 2009.** *Stachys ketenoglui* sp. nov. (sect. *Infrarosularis*) (Labiatae/Lamiaceae) from South Anatolia, Turkey. *Nord. J. Bot.* **27**: 238–242.
- DAVIS P.H., MILL R.R., TAN K. 1988.** *Stachys* L. In: DAVIS P.H., MILL R.R., TAN K. (eds), *Flora of Turkey and the East Aegean Islands*. Vol. **10** (Suppl.): 204–206. Edinburgh Univ. Press, Edinburgh.

- DINÇ M., DOĞAN H.H. 2006.** *Stachys yildirimlii* M. Dinç (Lamiaceae), a new species from South Anatolia, Turkey. *Ann. Bot. Fennici* **43**: 143–147.
- DINÇ M., ÖZTÜRK M. 2008.** Comparative morphological, anatomical, and palynological studies on the genus *Stachys* L. sect. *Amblesia* Benth (Lamiaceae) species in Turkey. *Turk. J. Bot.* **32**: 113–121.
- DIRMENCI T., YILDIZ B., AKÇIÇEK E., MARTIN E., DÜNDAR E. 2011.** *Stachys vuralii* (Lamiaceae), a new species from North Anatolia, Turkey. *Ann. Bot. Fennici* **48**: 401–408.
- DUMAN H. 2000.** *Stachys* L. In: GÜNER A., ÖZHATAY N., EKİM T. BAŞER K.H.C. (eds), Flora of Turkey and the East Aegean Islands. Vol. **11** (Suppl.): 204–206. Edinburgh Univ. Press, Edinburgh.
- GEMICI Y., LEBLEBİCİ E. 1998.** A new species from Southern Anatolia: *Stachys cydni* Kotschy ex Gemici & Leblebici. *Turk. J. Bot.* **22**: 359–362.
- HEYWOOD V.H. 1993.** Flowering plants of the world. University Press, London.
- HICKEY M., KING C. 1997.** Common families of flowering plants. Cambridge University Press, Cambridge.
- IÇLİM A., ÇENET M., DADANDI M.Y. 2008.** *Stachys marashica* (Lamiaceae), a new species from Turkey, *Ann. Bot. Fennici* **45**: 151–155.
- KAYA A., BAŞER K.H.C., SATIL F., TÜMEN G. 2000.** Morphological and anatomical studies on *Cyclotrichium origanifolium* (Labill.) Manden. & Scheng. (Labiatae). *Turk. J. Bot.* **24**: 273–278.
- KANDEMİR N. 2003.** The morphological, anatomical and karyological properties of endemic *Salvia hypargeia* Fich. & Mey. (Lamiaceae) in Turkey. *Pak. J. Bot.* **35**: 219–236.
- MEIDNER H., MANSFIELD T.A. 1968.** Physiology of stomata. McGraw-Hill, London.
- METCALFE C.R., CHALK L. 1950.** Anatomy of the dicotyledons. I. Oxford University Press, London.
- ÖZHATAY F.N., KÜLTÜR Ş., GÜRDAL M.B. 2011.** Checklist of additional taxa to the supplement Flora of Turkey V. *Turk. J. Bot.* **35**: 589–624.
- SÜMBÜL H. 1990.** Two new species from South Anatolia, *Turk. J. Bot.* **22**: 359–362.
- UYSAL İ. 2002.** *Stachys cretica* L. subsp. *smyrnaea* Rech Fil. Endemik taksonunun morfolojisi, anatomisi ve ekolojisi üzerinde araştırmalar. *Ekoloji* **11**: 16–20.
- UYSAL İ. 2003.** *Stachys thirkei* C.Koch (Kekikgiller) türünün morfolojisi, anatomisi ve ekolojisi üzerine araştırmalar. *Ot Sistematik Botanik Dergisi* **10**: 129–141.
- VARDAR Y. 1987.** Botanikte preparasyon tekniği: 25–26. Ege Üniversitesi Fen Fakültesi Baskı işleri.
- YILDIRIMLI Ş. 2010.** Some new taxa, records and taxonomic treatments from Turkey. *Ot Sistematik Botanik Dergisi* **17**: 1–114.
- YILMAZ Ö., DAŞGIN R., KAYNAK G. 2010.** *Stachys pseudobombycina* sp. nov. (Lamiaceae) from south Anatolia. *Nord. J. Bot.* **28**: 341–343.