

Morphological and Anatomical Study on Endemic *Saponaria Pamphylica* Boiss. & Heldr. (Caryophyllaceae)

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Abstract

In this study, morphological and anatomical characteristics of *Saponaria pamphylica* Boiss. & Heldr., an endemic species, were investigated. Capsule and seed properties of the species haven't been defined systematically in Flora of Turkey. Therefore, anatomical and morphological study was done by investigating undefined properties. Morphologically, it was observed that the species has a perennial root system, the herbaceous stem is cylindrical, leaves are simple, glabrous on the both surfaces, capsules are oblong-cylindrical, articulate, many seeds, seeds are colliculate. Anatomical properties on transverse and surface sections of the root, stem and leaf were investigated. In the anatomical investigations it has been observed that root showed secondary thickening, pericycle characterised by a sclerenchymatous ring on the stem, epidermis has eglandular and glandular hairs on the upper part of the stem, mesophyll consists of 4-layered palisade parenchyma cells and root, stem and leaves have druse crystals. Transverse and surface sections of the root, stem and leaf were also photographed. Additionally, seeds and pollens of the species were examined by scanning electron microscope (SEM).

Key words: *Saponaria pamphylica*, systematics, endemic, morphology, anatomy, SEM.

INTRODUCTION

The genus *Saponaria* L. belongs to Caryophyllaceae family and is represented by 21 taxa (18 species), 11 of which are endemic in Turkey [1, 2, 3, 7]. However, *S. chlorifolia* (Poir.) Kunze, an endemic species, has been altered as *Cyathophylla chlorifolia* (Poir.) Bocquet & A.Strid [11]. Therefore, number of taxa is 20 (17 species) and number of endemic taxa is 10. Caryophyllaceae family contains ornamental garden plants. *Saponaria* species contains saponin and has been used for medicinal purposes in the past [9]. In Turkey, species of the genus *Saponaria* grow to 2400 m, in many various fields as rocky slopes, screes, forest, waste places, roadsides, streamsides, damp woods, shady places, fallow fields, scrub, salt marshes, rocky igneous, shaley slopes and disturbed habitats [4,7]. *S. pamphylica* was first collected by Heldreich in Marla (Akseki) and Adalia (Antalya) and described as a new species by Boissier and Heldreich in 1849 [7]. This species is an endemic taxon for Turkey and East Mediterranean phytogeographic region element according to its distribution, altitude and habitat. Morphological and anatomical structure of *S. pamphylica* has not been studied in detail before. Extensive descriptions of the morphological and anatomical characteristics of this species have been given in this study.

MATERIALS AND METHODS

Plant samples were collected from Altınbeşik Cavern National Park (İbradı-Akseki/Antalya) in July 2004, August

2004 (with capsules) and June 2005 (Çinbilgel 2473, 2496, 2545). The samples collected by Hasan Özçelik from Akseki were also examined (Özçelik 9018). At least triplicate of the transverse and surface sections were taken by hand from at least triplicate of fresh plant specimens for anatomical studies. Additionally, many morphological properties were determined from specimens dried according to standard herbarium techniques and from fresh specimens. Biometric measurements were done using digital compass. The taxonomic description of the species was widen according to Flora of Turkey [7].

General views of *S. pamphylica* were photographed (Fig. 1). Anatomical observations were performed on the transverse sections of the root, stem and leaves, and on the surface sections of the leaves. The transverse and surface sections were covered with Entellan (Merck) [6]. The microscopical photographs of the samples were taken using a Canon Photographer. Additionally, seed and pollen of *S. pamphylica* were displayed by Scanning Electron Microscope (SEM).

Distribution of *Saponaria pamphylica* in Turkey: Antalya, Konya, Niğde, Isparta (Fig. 2).

Examined specimens

C3: İbradı, Ormana village, Altınbeşik Cavern National Park, road of İnönü hill, roadside, 952 m, N 37°04'59"-E 31°35'60", 16.vii.2004, Çinbilgel 2473 & Eren; ibid., 18.viii.2004, Çinbilgel 2496; ibid., 25.vi.2005, Çinbilgel 2545. C3: Akseki, Akseki-Seydişehir road, Alacabel region, openings in forest, 1800 m, 20.vii. 2000, Özçelik 9018.

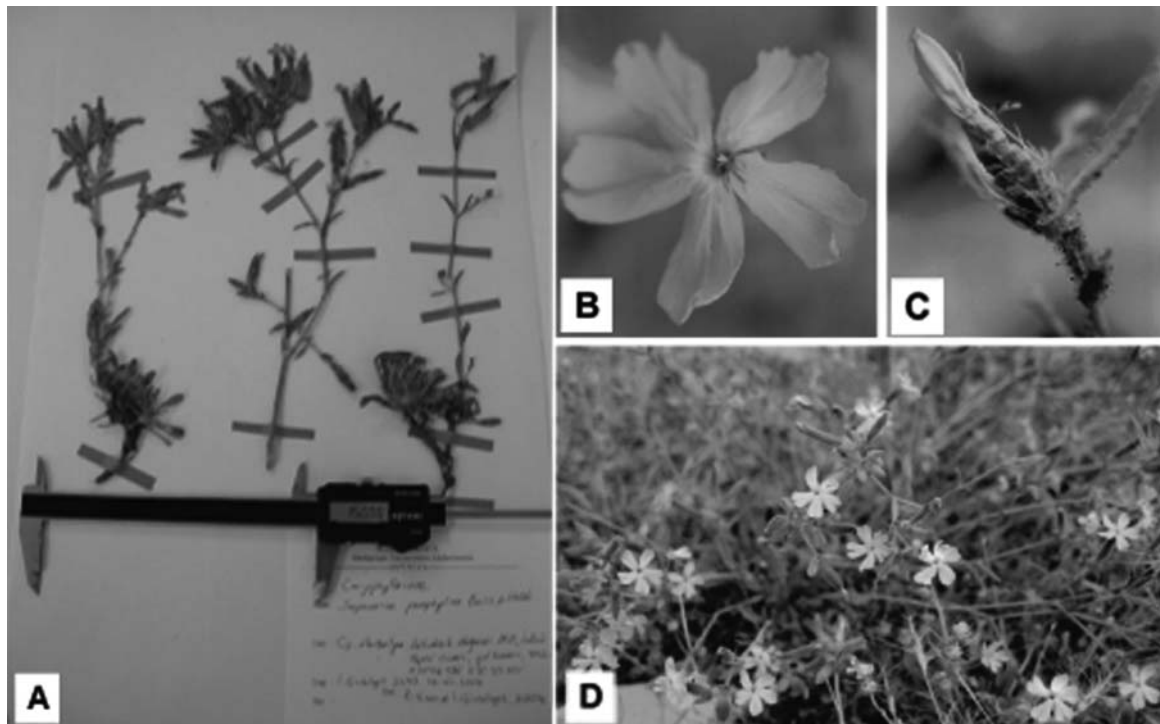


Figure 1. A-D. *Saponaria pamphylica*.

RESULTS

Morphological Properties

Root cylindrical, bright brown. Ascending, many-stemmed perennial with simple, erect and cylindrical branches up to 38 cm, glabrous below, glandular and eglandular haired above. Leaves attenuate at each end, 1-nerved. Basal leaves oblong-obovate to spatulate, entire, glabrous, 14.14-70.34x2.20-4.59 mm. Stem leaves oblong-elliptic, entire, glabrous, 8.90-64.33x2.23-8.25 mm. Inflorescence few-flowered, condensed. Pedicels 1.20-6.90 mm (with capsule up to 9.67 mm), erect. Calyx densely glandular hairs, cylindrical to oblong-cylindrical, up to 25.48 mm, with acuminate teeth, calyx teeth 3-4 (4.64) mm. Petals up to 34 mm, rose, linear, cuneate, bilobed to the

middle, with 2 linear scales at the base of the lamina. Anthers white. Anthophores 2.21-2.73x1.20-2.52 mm. Capsules shorter than the calyx, oblong-cylindrical, 7.24-18.02 x 1.34-3.73 mm, articulate, with many seeds (about 20). Seeds black, 1.71-1.86 x 1.76-1.96 mm, colliculate. Comparisons of examined specimens with Flora of Turkey are given in the Table 1. Scanning electron microscopic views of the seed were shown in Figure 3.

Pollen Morphology

Pollen grains are spheroidal, with isopolar symmetry, size middle, average 42.795 μm diameter, periporate; numbers of pores are 11-12, average diameter 5.9 μm . Operculum with 10-12 spinulate. The exine ornamentation is spinulate (spinulosus) and microperforate (Fig. 4).

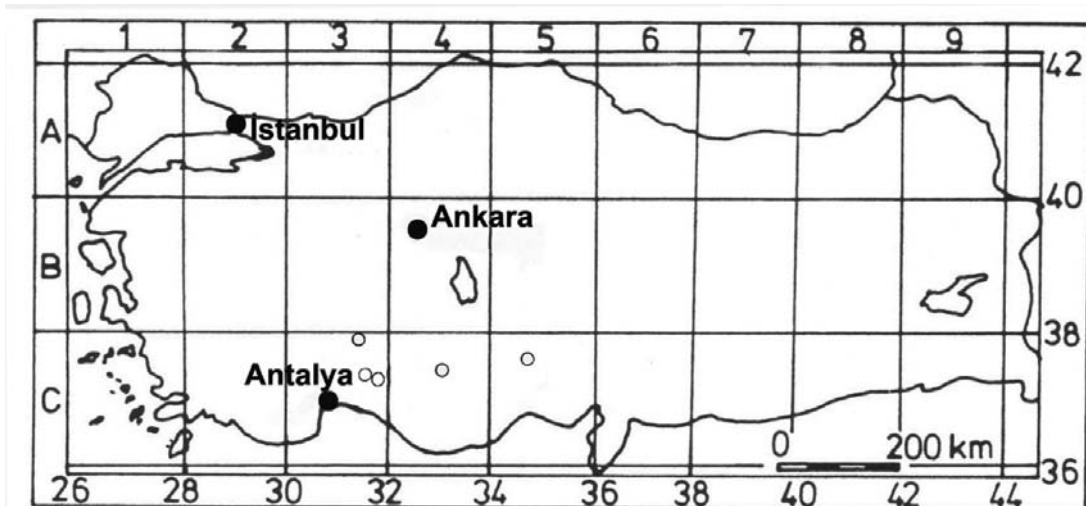


Figure 2. Distribution of *Saponaria pamphylica* (o) in Turkey.

Anatomical Properties

Root

Root is perennial. The transverse section of the root was observed as follows (Fig. 5). The root shows secondary thickening. Periderm is multi-layered on the surface of the root. Cortex layer consists of parenchymatic cells and has druse crystals. Phloem consists of irregular or rectangular cells. Cambium is 2-3 layered and distinguishable. Rays are not distinguishable. Xylem consists of primary and secondary xylem and has trachea and tracheids. The pith containing parenchymatic cells is filled root centre.

Stem

The transverse section taken from the lower part of the stem was observed as follows (Fig. 6). The epidermis is composed of compactly arranged square or rectangular cells. Cuticle layer is thin. Epidermis has stomata. Cortex is consists of 3-4 layered parenchymal cells with chloroplasts. Mono-layered endodermis consists of ovoid cells. Pericycle consists of 8-9 layered sclerenchyma cells have simple pits. Phloem is 2-3 layered and consists of irregular cells. Tracheas consist of large orbicular cells. The pith consists of large orbicular parenchymatic cells with thin cell walls and has druse crystals.

The upper part of the stem consists of epidermis has glandular and glandular hairs with 3-4 cells different from the lower part of the stem (Fig. 7).

Leaf

The transverse section of the leaf was observed as follows (Fig. 8). The upper and lower epidermis is monolayered and consists of rectangular or ovoid cells. Both epidermises are covered with a thin cuticle and have not hairs. The stomata are located on the same level as the epidermal cells and they occur on the surfaces of both sides. Mesophyll is consists of 4-layered palisade parenchyma cells. Palisade tissue has druse crystals. The mid-rib is developed. The xylem towards the upper surface and the phloem towards the lower surface.

On the surface section of the leaf, stomata were observed usually diasitic type and being more abundant on the upper surface (Fig. 8).

DISCUSSION

Distribution of *S. pamphylica* exists in Antalya, Konya, Niğde and Isparta provinces of Turkey [3,7,10]. Its flowering time is between June and August and its habitat is roadsides and rocky slopes. The species is East Mediterranean phytogeographic region element according to the distribution, altitude and habitat. This taxon belongs to LC category according to IUCN risk categories [5, 8].

Capsule-seed properties and other some morphological characters of this taxon haven't been defined by Flora of Turkey. These characters have been provided by this study. There are some differences between the Flora of Turkey and our findings, thus these differences have been detailed in Table 1. In this way, description of this species has been widen.

Table 1. Comparisons of examined specimens with Flora of Turkey.

	Properties declared in Flora of Turkey [7]	Properties of examined specimens in this study
Root	unspecified	cylindrical, bright brown
Stem	with simple, erect branches up to 30 cm, glabrous below, glandular above	ascending, with simple, erect, cylindrical branches up to 38 cm
Leaves	oblong-elliptic, attenuate at each end, 1-nerved	attenuate at each end, 1-nerved. Basal leaves; oblong-obovate to spatulate, entire, glabrous, 14.14-70.34x2.20-4.59 mm. Stem leaves; oblong-elliptic, entire, glabrous, 8.90-64.33x2.23-8.25 mm
Pedicels	1-2 mm, erect	1.20-6.90 mm (with capsule up to 9.67 mm), erect
Calyx	narrowly cylindrical, c. 21 mm, with narrowly lanceolate, acuminate teeth	densely glandular hairs, cylindrical to oblong-cylindrical, up to 25.48 mm, with acuminate teeth, calyx teeth 3-4 (4.64) mm
Petals	rose, linear, cuneate, bilobed to the middle, with 2 linear scales at the base of the lamina	up to 34 mm, rose, linear, cuneate, bilobed to the middle, with 2 linear scales at the base of the lamina
Anters	unspecified	white
Anthophores	unspecified	2.21-2.73x1.20-2.52 mm
Capsules & Seeds	unknown	shorter than the calyx, oblong-cylindrical, 7.24-18.02 x 1.34-3.73 mm, articulate, with many seeds (about 20); seeds black, 1.71-1.86 x 1.76-1.96 mm, colliculate

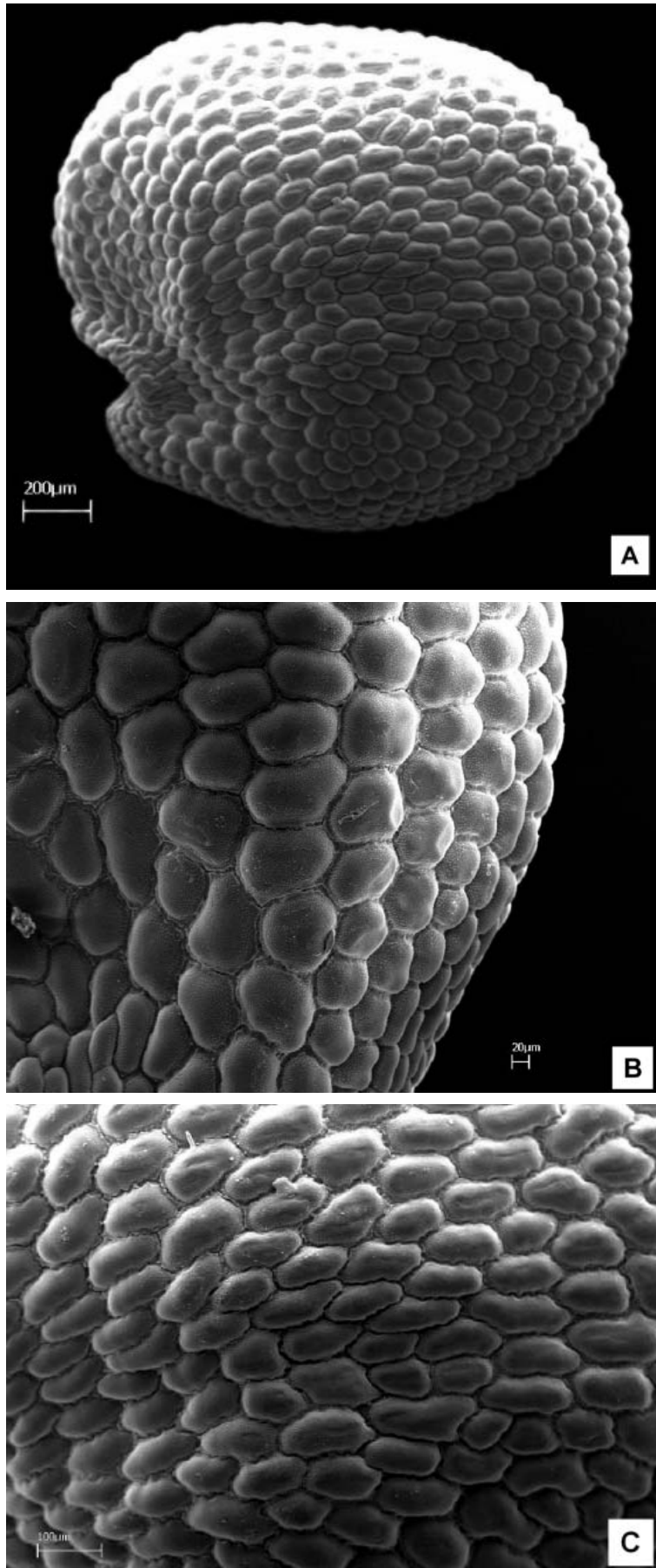


Figure 3. A-C. Seed of *Saponaria pamphylica* under SEM.

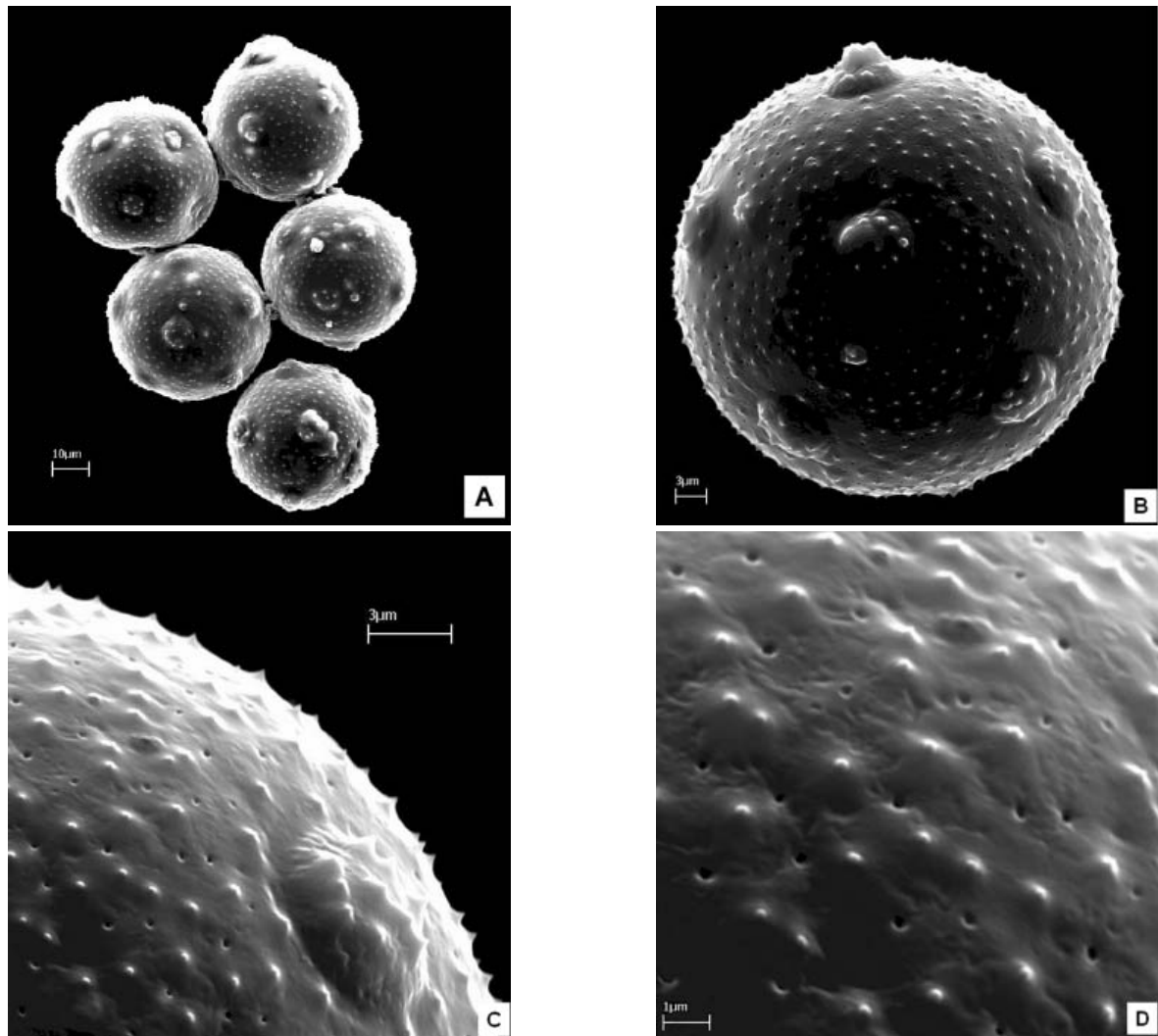


Figure 4. A-D. Pollen grains of *Saponaria pamphylica* under SEM.

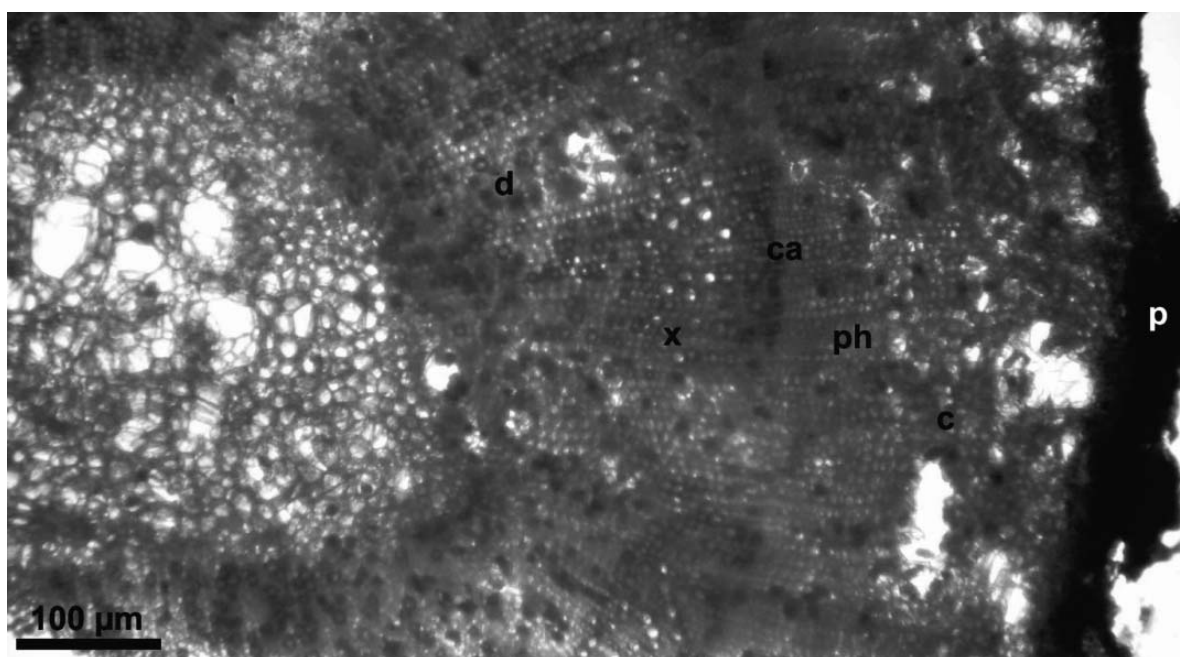


Figure 5. The transverse section of the root. d: druse crystal, x: xylem, ca: cambium, ph: phloem, c: cortex, p: periderm.

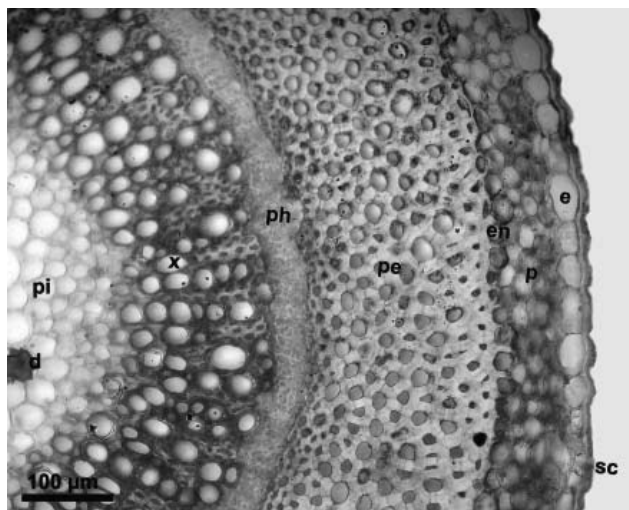


Figure 6. The transverse section of the lower part of the stem. pi: pith, d: druse crystal, x: xylem, ph: phloem, pe: pericycle, en: endodermis, p: parenchyma, e: epidermis, sc: stoma cell.

Seed ornamentation of *S. pamphylica* is so similar to *S. kotschyi*. However, Ataşlar [2] indicated that seed ornamentation of *S. kotschyi* is flat tubercled. According to our study, seed ornamentation of *S. pamphylica* has been defined as colliculate.

Our pollen findings of *S. pamphylica* clearly support Arkan and İnceoğlu [1] view with the exceptions of average pollen diameters, pore numbers and pore diameters. According to Arkan and İnceoğlu [1], average pollen diameter was 48.67 µm, pore numbers were 10-11 and pore diameter was 10.64 µm. On the other hand, in our study, average pollen diameter and average pore diameter have been found 42.79 µm and 5.90 µm, respectively and pore numbers have been found 11-12.

Observations of the root transverse section showed that root covered externally by a layer of brown cork cells, secondary phloem consisting of sieve tubes and parenchyma, xylem composed mainly of parenchyma, but including scattered vessels, which are solitary or tending to be in radial rows, rays are absent. These findings are consistent with the description given by Metcalfe and Chalk [9].

The analysis of the transverse section of the stem showed that cortex is frequently narrow, endodermis is frequently well defined and pericycle characterised by a sclerenchymatous ring as Metcalfe and Chalk [9]. reported. Inner part of the sclerenchymatous ring and the part towards the phloem more strongly lignified and composed of cells with narrower lumina than the middle part of the sclerenchymatous ring in contrast to the reports of the Metcalfe and Chalk [9]. Calcium oxalate, in the form of large cluster crystals, occurs, in root, stem and leaves of the *Saponaria pamphylica*.

Anatomical analysis of the transverse and surface sections of the leaf showed that stomata is generally of the caryophyllaceous type but sometimes tending to be of the cruciferous type (Fig. 8). Stomata is generally present on both surfaces of the leaves. Vascular bundles are not usually accompanied by sclerenchyma. These findings reported also Metcalfe and Chalk [9]. Although a collenchymatous pseudohypoderm in *Saponaria* described

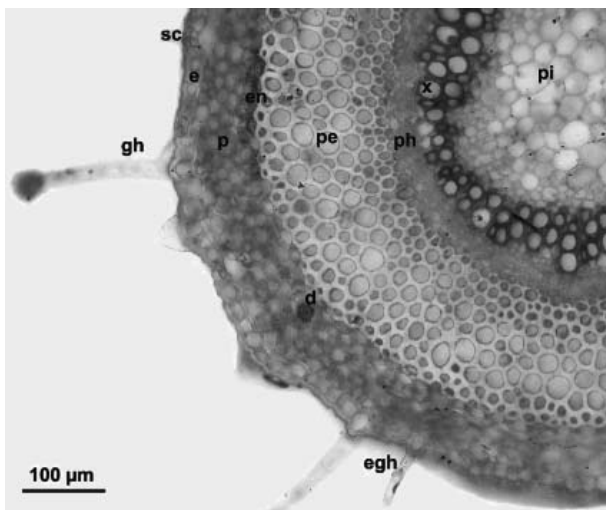


Figure 7. The transverse section of the upper part of the stem. pi: pith, x: xylem, ph: phloem, pe: pericycle, en: endodermis, d: druse crystal, p: parenchyma, e: epidermis, sc: stoma cell, gh: glandular hair, egh: eglanular hair.

by Metcalfe and Chalk [9], there was not such tissue in our observations.

In our study, we determined that *Saponaria pamphylica* has some similar anatomical properties with *Saponaria kotschyi*. However, the upper part of the stem of *Saponaria pamphylica* has eglanular and glandular hairs with 3-4 cells different from the lower part of the stem. The lower part of the stem is glabrous. Besides, leaves are glabrous.

Acknowledgements

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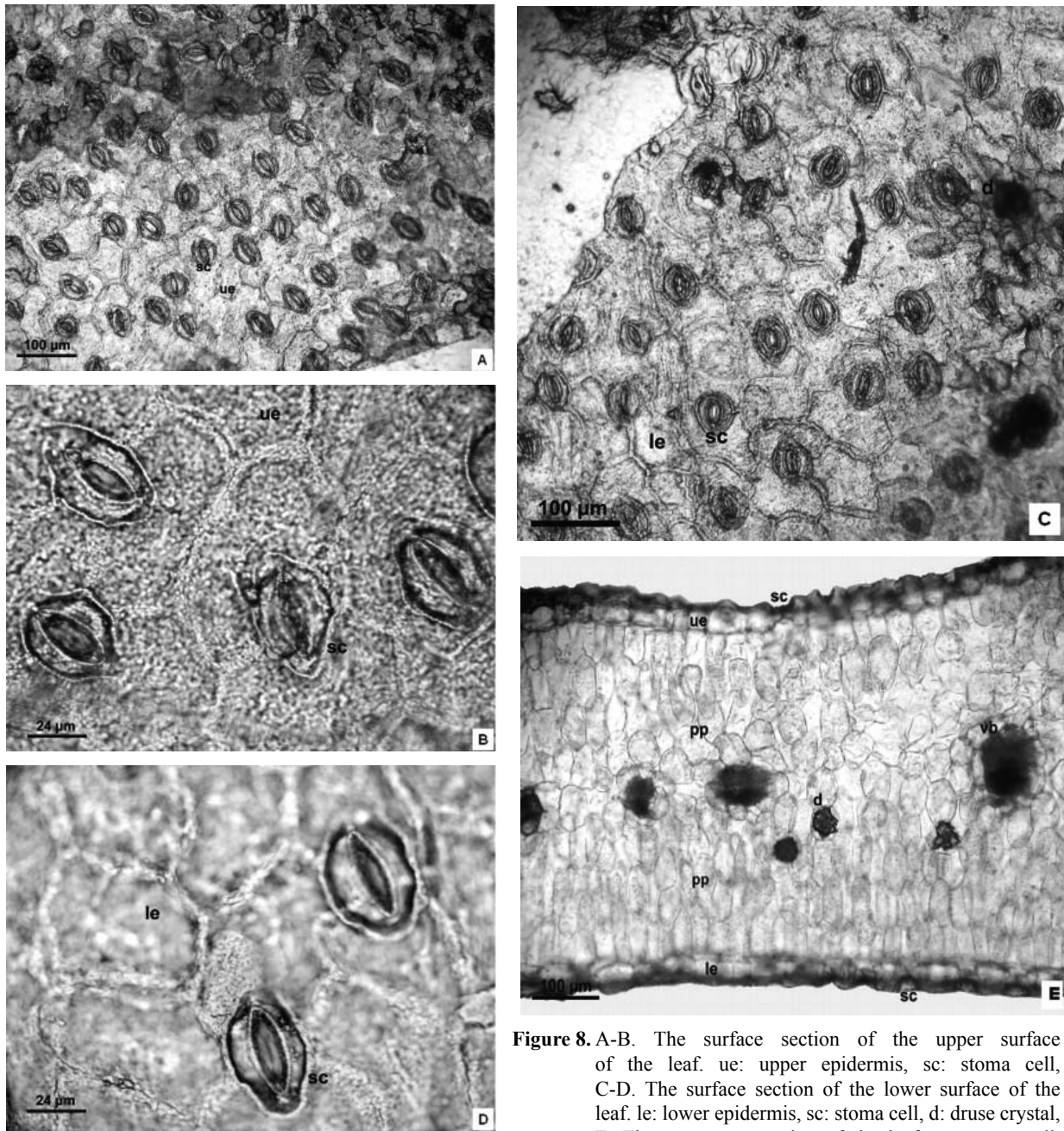


Figure 8. A-B. The surface section of the upper surface of the leaf. ue: upper epidermis, sc: stoma cell, C-D. The surface section of the lower surface of the leaf. le: lower epidermis, sc: stoma cell, d: druse crystal, E. The transverse section of the leaf. sc: stoma cell, ue: upper epidermis, pp: palisad parenchyma, d: druse crystal, vb: vascular bundle, le: lower epidermis.

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