

Morphological and Anatomical Investigations on the *Saponaria kotschy* Boiss. (Caryophyllaceae)

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Abstract: The morphological, anatomical and micromorphological features of *Saponaria kotschy* Boiss. have been studied on plants collected from Osmangazi University-Meşelik Campus, Eskişehir. *S. kotschy* is an endemic species and a new record from Eskişehir. In general, the results obtained from morphological studies were consistent with the description given in the Flora of Turkey, except for the calyx, as the calyx of *S. kotschy* flowers not only had glandular hairs but also eglandular hairs. The anatomical studies on cross-sections of the root, stem, leaves and surface sections of leaves were presented and compared with previous findings. Furthermore, the micromorphological properties of the seed, leaves and pollen grains have been investigated by SEM and illustrations provided.

Key Words: *Saponaria kotschy*, endemic, morphology, anatomy, SEM

Saponaria kotschy Boiss. (Caryophyllaceae) Üzerinde Morfolojik ve Anatomik Araştırmalar

Özet: Bu çalışmada *Saponaria kotschy* Boiss.'in morfolojik, anatomik ve mikromorfolojik özellikleri araştırılmıştır. Eskişehir Osmangazi Üniversitesi Meşelik Kampüsünden toplanan *S. kotschy* endemik bir tür olup Eskişehir için yeni kayıttır. Morfolojik sonuçlar genelde Flora of Turkey ile uyum içindedir. Ancak *S. kotschy*'de kaliks sadece glandular değil eglandular tüyleri de bulundurmaktadır. Anatomik çalışmalar için kök, gövde ve yaprak enine kesitleri ile yaprak yüzeysel kesitleri incelenmiş ve sonuçlar ortaya konulmuştur. Ayrıca *S. kotschy*'nin tohum, yaprak ve polenleri mikromorfolojik olarak incelenmiştir.

Anahtar Sözcükler: *Saponaria kotschy*, endemik, morfoloji, anatomi, SEM

Introduction

The genus *Saponaria* L. belongs to the *Caryophyllaceae* family and is represented by 23 taxa (18 species), of which 12 are endemic in Turkey. *Saponaria kotschy* Boiss. is an endemic species (Davis 1967, 1988) and is a new record from Eskişehir. This species was first collected in İçel, Gülek by Kotschy and was described by Boissier in 1843.

Saponaria species contain triterpenoid natural products, including the saponins. For example, *Saponaria officinalis* L. possesses saponin-rich rhizomes and leaves which could be used as a substitute for soap (Baytop, 1999). The local name "Sabunotu" (Soapweed) for this species also reflects the meaning of saponin, because saponins are so named because of their soaplike, detergent properties. This species is common in Turkey and has been widely cultivated as an ornamental plant.

The saponins and chemical contents of *S. kotschy* were determined by Sezik and Türköz (1987). In addition, *Saponaria* species have also been used for pharmacological purposes (Metcalf and Chalk, 1950).

Some anatomical properties of the *Caryophyllaceae* family and the genus *Saponaria* were reported by Metcalfe and Chalk (1950). In addition, the pollen morphologies of some *Saponaria* taxa in Turkey were determined by Arkan and İnceoğlu (1992). However, so far there have been no detailed anatomical studies on *Saponaria* species which are naturally distributed in Turkey.

In this research the morphological, anatomical and micromorphological features of *S. kotschy* were studied in order to provide more detailed descriptions for future works.



Figure 1. *Saponaria kotschyi* (Bar: 8 cm).

Materials and Methods

S. kotschyi was collected from Eskişehir's (B3) Osmangazi University Meşelik Campus in June 1999 (E. Ataşlar 112). Specimens for morphological studies were dried according to standard herbarium techniques and stored in the Osmangazi University herbarium (OUF 9053). The materials necessary for anatomical studies were preserved in 70% alcohol.

The taxonomic description of the plant was made according to Davis (1967) and also confirmed by the herbarium samples of the examined species in the ANK and GAZİ herbaria.

Anatomical investigations were performed on cross-sections of the root, stem and on leaves, and on surface sections of the leaves. The cross and surface sections were covered with glycerin-gelatine (Vardar, 1987). Photographs of the samples were taken using a Nikon Optiphot.

The seed, upper epidermis, lower epidermis and pollen grains of *S. kotschyi* were examined by a Jeol 5600 scanning electron microscope (SEM).

Morphological Results

Annual or biennial herb, divaricately branched from the base, with a thick indumentum of glandular and eglandular hairs covering the whole plant; stems procumbent or ascending, 20-30 cm. Basal leaves broad, obovate-spathulate, petiolate; cauline leaves oblong-lanceolate, subsessile. Corymbs many-flowered, loose. Pedicels 2-4 mm, erect-spreading. Calyx narrowly cylindrical, striate, 9-12 mm with very short acute teeth. Petals 13-15 mm, pink with an obovate, entire lamina which has a bipartite coronal appendage at the base and a narrow claw. Capsule narrowly oblong, c. 7 mm, attenuate at both ends. Seeds flat tubercled, 1-2 in the capsule, c. 1.6 x 1.8 mm. Fl. 5-9. Rocky slopes and screes, 850-1400 m (Figures 1-3).

Examined specimens: **C2** Burdur: Dirmil (Altınyayla) Gölhisar to Dirmil, 1250 m, 7.6.1996, N. & E. Özhatay, H. Duman, ISTE 72234! **C3** Antalya: Akseki Güzelsu to Sadıklar, roadside, 20.8.1995, 1100 m, A. Duran 3224! **C4** Aksaray-Ulukışla road, 850 m, 24.6.1993, meadowland, Z. Aytaç 5857! Konya: Sarıveliler to

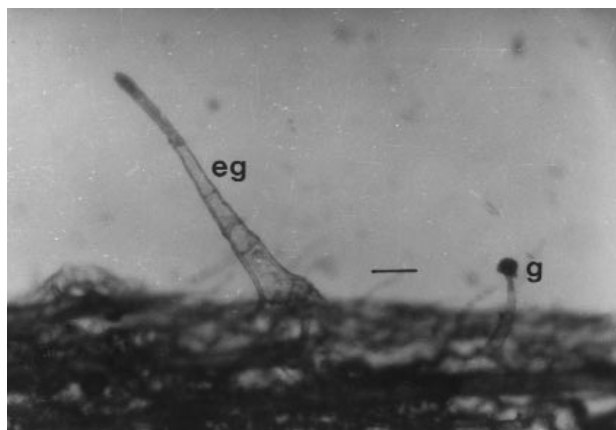


Figure 2. *Saponaria kotschyi*. Trichomes of calyx: eg) Eglandular hair, g) Glandular hair (Bar: 50 μ m).

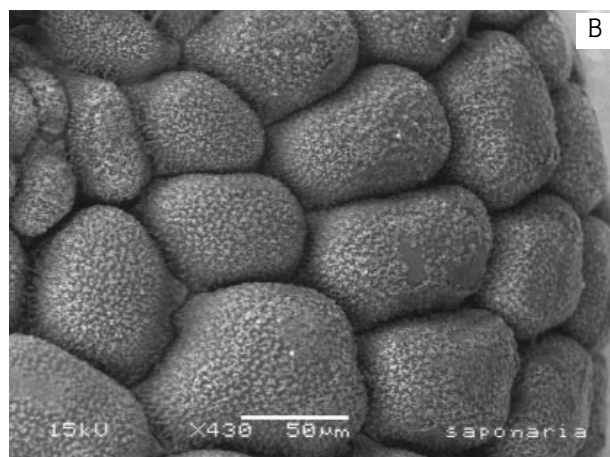
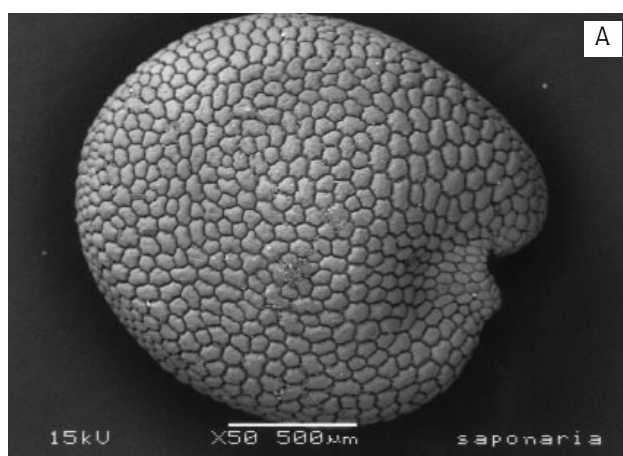


Figure 3. *Saponaria kotschyi*. A-B) Photomicrographs of seed under SEM (Bar: A 500 μ m, B 50 μ m).

Ermenek, roadside, 1500-1600 m, 27.6.1994, M. Koyuncu & C. Erdurak! C5 Adana: Pozantı Karakuz, 920 m, 18.7.1995, serpentine, Z. Aytaç 7105 & N. Adıgüzel!

Pollen Morphology

Pollen grains are spheroidae, 36 μ m diameter, periporate, 12-pored. Operculum 3 μ m diameter with spinulate. The exine sculpture is granulatae-microechinatae-microperforatae (Figure 4).

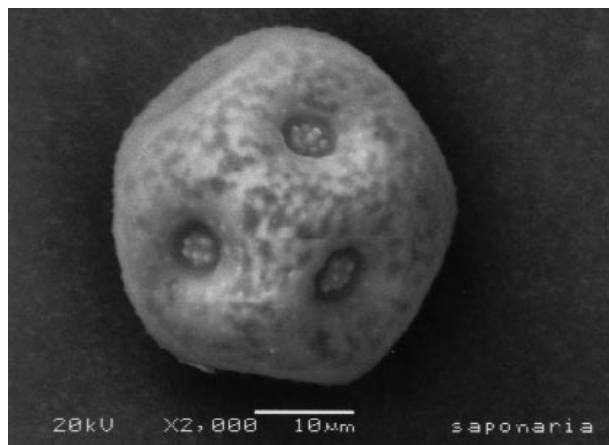


Figure 4. *Saponaria kotschyi*. Pollen grain under SEM (Bar: 10 μ m).

Anatomical Results

Root

The transverse section taken from the middle part of the root was observed as follows (Figure 5):

Root is biennial or perennial and shows secondary growth. The upper surface is covered with a thin periderm. The primary cortex consists of parenchyma. Parenchyma has druse crystals. Phloem is 4-6 layered and consists of irregular or rectangular cells. The cambium is 1-2 layered and consists, of small irregular cells. The xylem, which extends all around the primary xylem, comprises trachea and tracheids. The trachea are orbicular or ovoid cells, while the tracheids are polyhedral cells. Rays are not distinguishable. The primary xylem is filled root centre.

Stem

The transverse section taken from the middle part of the stem was observed as follows (Figure 6):

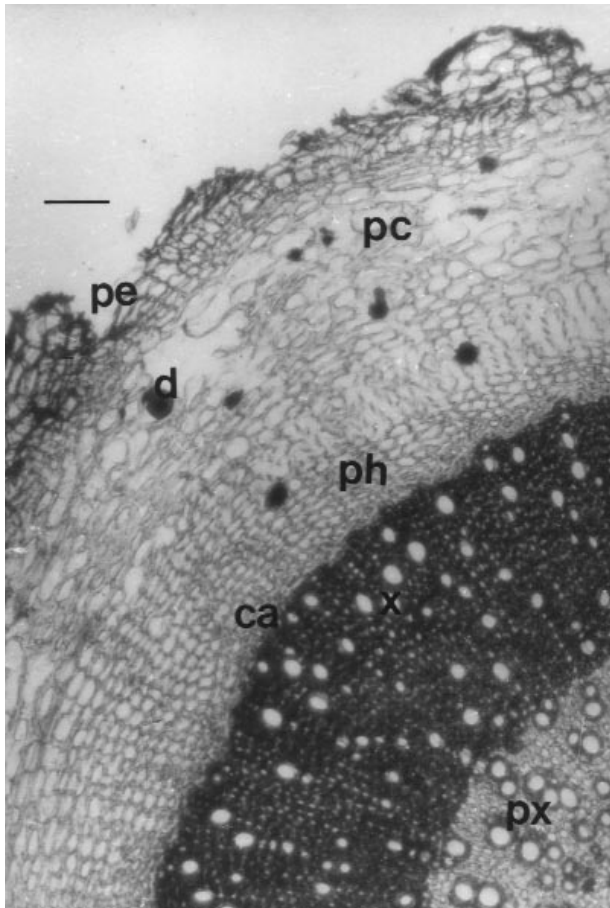


Figure 5. *Saponaria kotschyi*. Cross-section of root: pe) Periderm, pc) Primary cortex, ph) Phloem, ca) Cambium, x) Xylem, px) Primary xylem, d) Druse crystal (Bar: 50 μ m).

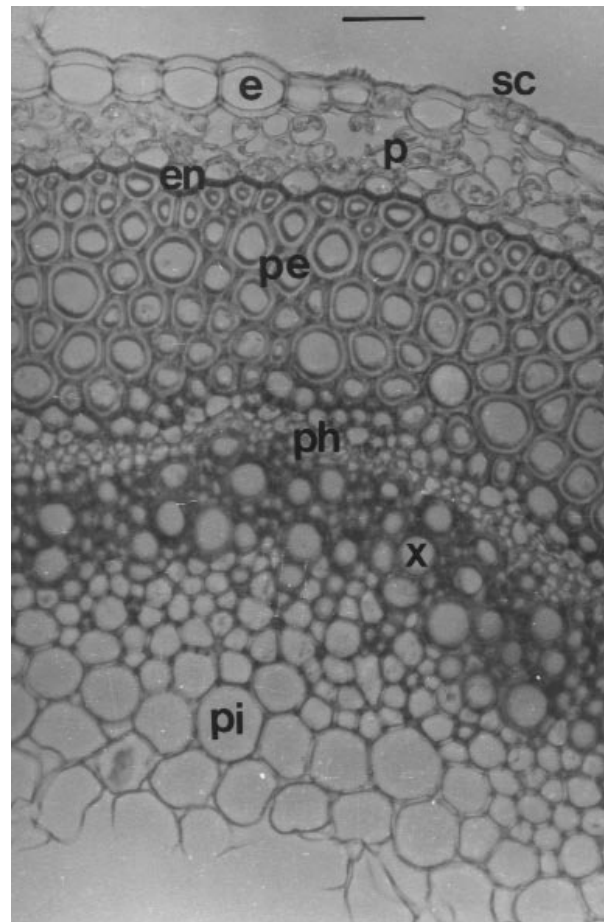


Figure 6. *Saponaria kotschyi*. Cross-section of stem: e) Epidermis, sc) Stoma cell, p) Parenchyma, en) Endodermis, pe) Pericycle, ph) Phloem, x) Xylem, pi) Pith (Bar: 25 μ m).

The epidermis is composed of almost square or rectangular cells, has compactly arranged cells and bears stomata. The upper surface is covered with a relatively thick cuticle and contains eglandular and glandular hairs. The cortex is 2-3 layered and consists of parenchyma with chloroplasts. The single-layered endodermis consists of ovoid cells. The pericycle is wide and consists of 4-5 layered sclerenchyma cells. The phloem is 2-3 layered and consists of irregular cells. The cambium is not distinguishable. The xylem is composed of trachea and tracheids. The trachea consist of large orbicular cells. The tracheids consist of irregular cells. The pith consists of large orbicular or polyhedral parenchymatic cells. These cells underlie the xylem and are thin-walled.

Leaf

The transverse section of the lamina and the midrib and surface preparations of both epidermises revealed the following elements (Figures 7-9):

In transverse section, the upper and lower epidermises comprise uniseriate, large oval and orbicular cells, thin lateral walls. Both epidermises are covered with a thin cuticle. Covering trichomes are dense on the lower surface. There are eglandular and glandular hairs. The stomata type is caryophyllaceous and they occur on the surfaces of both sides, being more abundant on the upper surface. They are located on the same level as the epidermal cells. The whole of the mesophyll is composed of 4-layered palisade tissue. Palisade tissue has druse

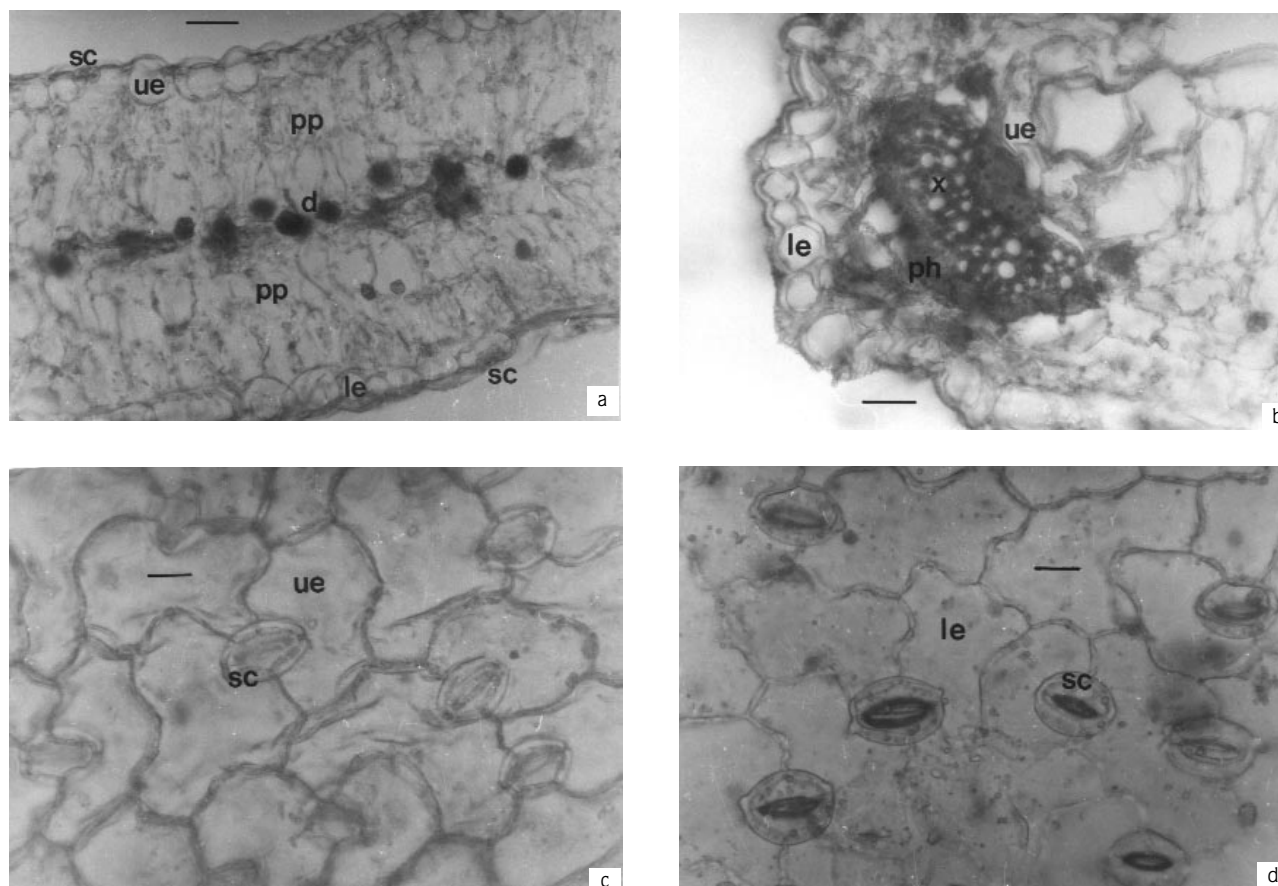


Figure 7. *Saponaria kotschy*. A) Cross-section of leaf, B) Central vessel, C) The stomata from upper epidermal peelings of leaf, D) The stomata from lower epidermal peelings of leaf, ue) Upper epidermis, le) Lower epidermis, sc) Stoma cell, pp) Palisade parenchyma, d) Druse crystal, ph) Phloem, x) Xylem (Bar: A-B 25 μ m, C-D 10 μ m).

crystals. The mid-rib is developed. The xylem is towards the upper surface and the phloem towards the lower surface.

Discussion

S. kotschy has been investigated morphologically, anatomically and micromorphologically (by SEM) in order to assist in identification and solve some systematic problems.

The results obtained from morphological studies were generally consistent with the description given in the Flora of Turkey, except for the calyx, as the calyx of *S. kotschy* had both glandular and eglandular hairs. However, previously it had been reported as having only glandular hairs in the *Saponaria* determination key in the

Flora of Turkey. This feature is a diagnostic value between *S. kotschy* and *S. prostrata* (Davis 1967).

The anatomical analysis given in this work provides the first detailed description of *S. kotschy*. Analysis of the root cross-section showed that the root is covered externally by a layer of brown cork cells; the secondary phloem consists of sieve tubes and paranchyma cells; rays are absent. These results are consistent with the description given by Metcalfe and Chalk (1950). However, the xylem consists mainly of paranchyma cells in contrast to those described by Metcalfe and Chalk (1950).

The analysis of the stem cross-section, as illustrated in Figure 6, showed that the cortex is narrow and the endodermis frequently well distinguished. The pericycle is characterised by a sclerenchymatous ring whose width

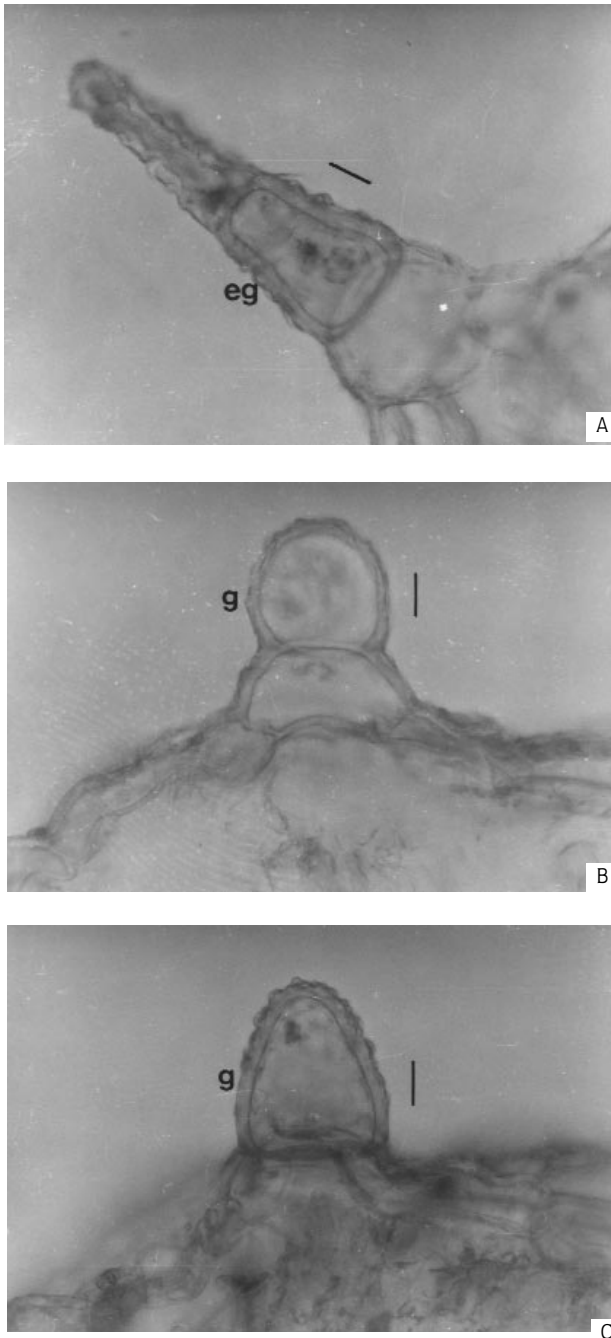


Figure 8. *Saponaria kotschy*. A-C) Hair types of leaf: eg) Eglandular hair, g) Glandular hair (Bar: 10 μ m).

varies between different genera and species of the *Caryophyllaceae* family. The xylem and phloem also form a continuous ring in certain *Saponaria* species. These results are consistent with the description given by Metcalfe and Chalk (1950). In addition, there were no calcium oxalate crystals in the stem.

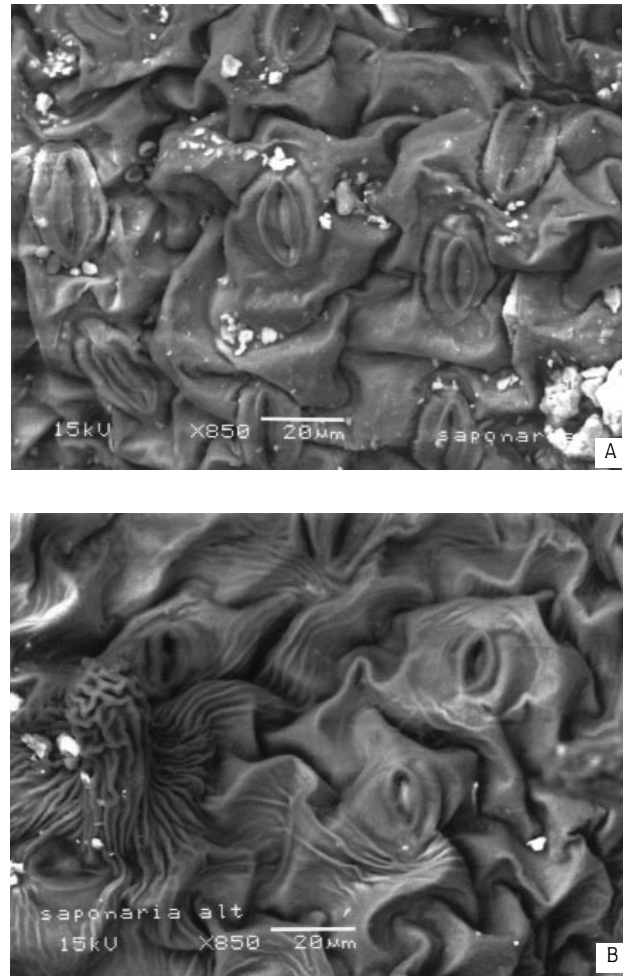


Figure 9. *Saponaria kotschy*. A) Photomicrographs of upper epidermis under SEM, B) Photomicrographs of lower epidermis under SEM (Bar: 20 μ m).

Anatomical studies on the leaf surface section by SEM showed that the stomata are caryophyllaceous type and are present on both the top and bottom surfaces of the leaf. In the cross-section, the mesophyll consists only of palisade paranchyma, and calcium oxalate is present in the form of large, conspicuous cluster crystals. These anatomical features observed on the leaves are consistent with those of Metcalfe and Chalk (1950). Furthermore, Metcalfe and Chalk reported a collenchymatous pseudo-hypoderm in *Saponaria*, but this feature has not been detected in *S. kotschy*.

The morphological features of pollen grains observed by SEM were similar to those given by Arkan and Inceoğlu (1992). However, the determination of the seed

dimension and seed micromorphology with this work present the first data available in the literature.

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