

Leaf, stem and root anatomy of *Consolida thirkeana* (Boiss.) Bornm. (Ranunculaceae)

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ABSTRACT: *Consolida thirkeana* (Boiss.) Bornm. (Ranunculaceae) is endemic to Turkey and described by laciniae linear leaves, pale lilac flowers, sessile follicles and called as “boz mahmuz”. Plant material was collected from Ayaş (Ankara-Turkey). The transverse sections of leaf, stem and root were examined anatomically in this study. The leaf is monofacial and has a 1-layer epidermis. Ranunculaceous stomata and unicellular non-glandular hairs were observed in the epidermis. The stem is characterized by a 1-layer of epidermis, glandular and non-glandular hairs. Cortex parenchyma contains dense starch. Pericyclic sclerenchymatous ring and concave xylem are observed. The root has periderm, pericyclic sclerenchymatous ring and vessels embedded in sclerenchymatous pith cells.

KEYWORDS: *Consolida thirkeana*; Ranunculaceae; leaf; stem; root; plant anatomy; Turkey.

1. INTRODUCTION

The Ranunculaceae family includes 52 accepted genera and its species are distributed worldwide, family members are most common in the temperate and cold areas of the northern hemisphere. This family, which are usually perennials herbs, rarely woody climbers have bisexual flower. The flowers are actinomorphic or zygomorphic. Achenes, follicles or baccate are fruit types of family [1-6].

The family contains alkaloids, flavonoids, phenolic acids, phytosterols, fatty acids and essential oils. Some members are medically important plants and have insecticidal, antiparasitic, antimicrobial, antiviral, antitumor and antioxidant activities [3, 7, 8].

Consolida (DC.) S.F. Gray genus includes annual herbs. Leaves are lacinate. Zygomorphic flowers born in a racemes or panicles have 2 seriate perianth; outer segments as sepals and inner segments as petals. This genus is spread from the West Mediterranean to Central Asia and Anatolia is accepted the center of diversity [2].

Consolida thirkeana (Boiss.) Bornm. is endemic to Turkey and described by laciniae linear leaves, pale lilac flowers and sessile follicles [2]. According to recent reports, the accepted name is *Delphinium thirkeanum* Boiss., which is basionym. Also, *Aconitella thirkeana* (Boiss.) Soják, *Aconitopsis thirkeana* (Boiss.) Kem.-Nath and *Consolida thirkeana* (Boiss.) Bornm. are synonyms [5, 9-10]. According to Güner et al. (2012) [11], *C. thirkeana* is an endemic species that grows in Turkey, called as “boz mahmuz”, and its synonyms are *Delphinium thirkeanum* and *Aconitella thirkeana*. In this study, anatomical features of leaf, stem and root of *C. thirkeana* were investigated. Transverse and surface sections were examined with the help of a light microscope and detailed photos were taken.

2. RESULTS

2.1. Leaf anatomy

Transverse section of leaf was observed as in Figure 1. The leaf is monofacial. Upper and lower epidermis are similar and consist of a single cell layer. The shape of cells is ovoid and the outer wall is very thick. There are dense non-glandular hairs (unicellular, silicified) and stomata on both the upper and lower epidermis. In addition, the epidermis is covered with a very thin cuticle layer. The mesophyll consists of tightly arranged parenchymatous cells. The palisade parenchyma consists of 1-layer, long-cylindrical, thin-walled cells. The cells of the spongy parenchyma between the palisade layers are isodiametric, thin-walled, 2-6 rows and contain abundant starch. The vascular bundles are surrounded by a compactly arranged bundle sheath.

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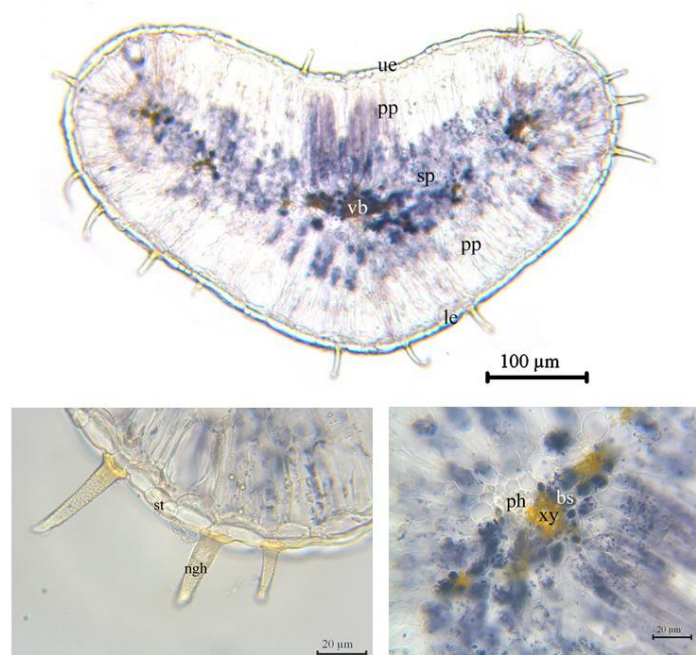


Figure 1. Transverse section of leaf; bs: bundle sheath, le: lower epidermis, ngh: non-glandular hair, pp: palisade parenchyma, ph: phloem, sp: spongy parenchyma, st: stomata, ue: upper epidermis, vb: vascular bundle, xy: xylem.

Surface sections of leaf were observed as in Figure 2. The upper and lower epidermal structures are similar. The cells of epidermis with sinuous anticlinal walls contains ranunculaceous stomata and non-glandular hairs.

2.2. Stem anatomy

Transverse section of stem was observed as in Figure 3. Epidermis is covered with thin cuticle layer. Its cells are single-layered, square-rectangular, outer wall is very thickened, side walls are thin, intracellular space is very narrow. Trichomes consist of glandular (with a long stalk) and non-glandular (unicellular, silicified) type. Stomata is observed. Cortex parenchyma cells are longitudinally elongated, thin-walled, dense starchy, consists of 3-5 rows of cells. Collateral type vascular bundles are arranged in a circle. Xylem is concave where adjoining the phloem. Phloem are bounded externally by pericyclic sclerenchyma ring. Rays consist of 3-5 rows of cells laterally. Pith cells are thin-walled, rounded, starchy, parenchymatous cells and intracellular spaces are large.

2.3. Root anatomy

Transverse section of root was observed as in Figure 4. The transverse section of root consists of the periderm, the pericyclic derivatives and the vascular tissues. The root consists of phellem layers outward and 1-layered phellogen and phelloderm inward. Phellogen and phelloderm layers usually are imperceptible. The phellem is composed of 1-4 layers of cells having an isodiametric shape or elongated one. Cortex parenchyma cells are almost absent. Under the single-row endodermis there is the pericycle forming a sclerenchyma ring. The vessels of root are embedded in lignified cells. A sclerenchymatous cap is present immediately on the outside of the phloem. Polyarch xylem is branched into 12-15 radial multiples. The cambium is not distinguishable.

3. DISCUSSION

Expose the anatomical structure of plant organs is of great importance in distinguishing taxonomically confused species. *Consolida* and *Delphinium* species are morphologically confused with each other [8]. The anatomical studies conducted until now consist of generalizations on the Ranunculaceae family by revealing the anatomical features of certain taxa [3, 12]. In addition, there is no detailed anatomical study on the *Consolida* species until now. With other taxonomic characters, the anatomical features knowledge is required for *Consolida* taxa. In this study, the anatomical structures of *C. thirkeana* leaf, stem and root were examined in detail. This study is also the first anatomical study for *C. thirkeana*.

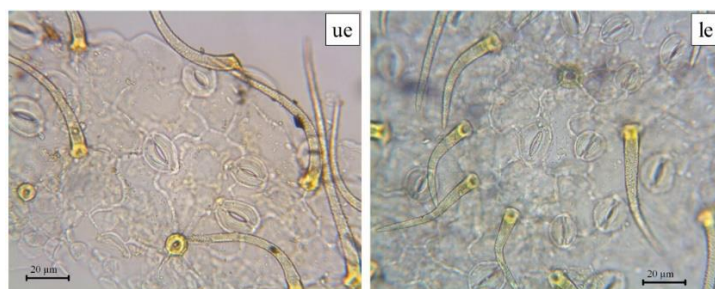


Figure 2. Surface sections of leaf; ue: upper epidermis, le: lower epidermis.

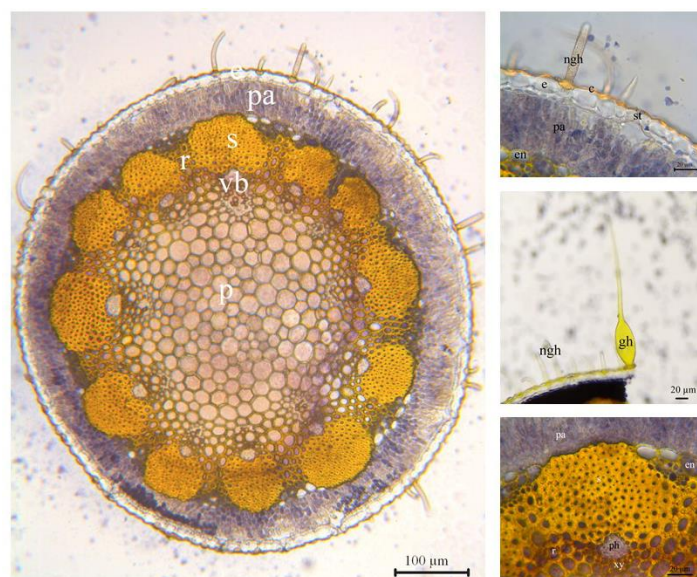


Figure 3. Transverse section of stem; c: cuticle, e: epidermis, en: endodermis, gh: glandular hair, ngh: non-glandular hair, p: pith, pa: cortex parenchyma, ph: phloem, r: ray, s: sclerenchyma, st: stomata, vb: vascular bundle, xy: xylem.

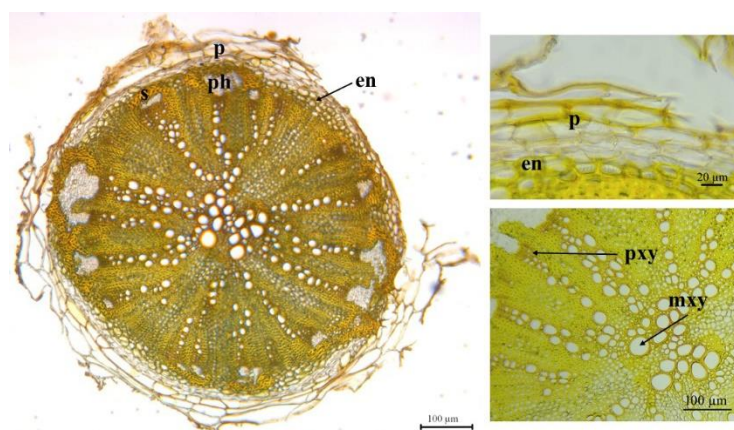


Figure 4. Transverse section of root; en: endodermis, mxy: metaxylem, p: periderm, ph: phloem, pxy: protoxylem, s: sclerenchyma.

The leaf transverse section of the *C. thirkeana* indicated that, the leaf is a monofacial leaf. Single layer, tightly arranged palisade parenchyma cells form a ring under the epiderma in the mesophyll layer of the leaf. The cells of the spongy parenchyma between the two palisade layers contain abundant starch. Palisade parenchyma cells are low in starch, compared to sponge parenchyma. But, highly starch concentration observed in the palisade parenchyma of the main vessel zone. Furthermore, the main vessel is surrounded by a ring containing abundant starch, which a bundle sheath. According to Metcalfe (1965) [13], the Ranunculaceae family has the characteristics of a monofacial or centric leaf. Epidermis has ranunculaceous stomata, glandular and non-glandular hairs. In addition, the lower epidermal cell anticlinal walls are sinuous.

Except for the presence of glandular hair, these data of Metcalfe (1965) [13] agree with our findings. In addition, our results showed that the upper epidermis was also sinuous.

The results show that the stem of *C. thirkeana* is characterized by a monolayer epidermis with stomata, glandular and non-glandular hairs, a regular ring forming cortex parenchyma and sclerenchyma clusters. According to Metcalfe (1965) [13], the stem of the Ranunculaceae family has a collateral-type vascular bundle with concave xylem and pericyclic sclerenchyma ring. In addition to this information, our results showed that glandular hairs with a long stalk on the stem.

The *C. thirkeana* root, characterized by the periderm layer, pericycle sclerenchyma ring and vessels embedded in the sclerenchymatous pith according to results, is branched into 12-15 radial multiples polyarch xylem. Roots of Ranunculaceae family, especially *Ranunculus*, is known as tetrarch [12, 14]. However, it is known that the number of xylem arms, which indicates the initial number of protoxyleme arms, is related to root viability and size [14]. According to the information about Ranunculaceae root by Metcalfe (1965) [13]; cambium is unclear and pith become sclerenchymatous. The results of root investigation of *C. thirkeana* support this.

4. CONCLUSION

In this study, the anatomical features of the leaf, stem and root of *Consolida thirkeana* were revealed. These anatomical features can be helpful information in taxonomic classification. Accordingly, the leaf is monofacial. The upper and lower epidermis are sinuous and have stomata and non-glandular hairs. Palisade is 1-layer and tightly arranged. Cortex parenchyma of stem in a regular ring form and contains richly starch. Pericyclic sclerenchymatous ring and concave xylem are important features of the stem. Glandular and non-glandular hairs on the stem are found. The root has periderm and include pericyclic sclerenchymatous ring. Vessels are embedded in sclerenchymatous pith cells in the polyarch root.

5. MATERIALS AND METHODS

The plant material was collected from Ayaş (Ankara/Turkey) in 2020. A voucher specimen was deposited in the Ankara University Faculty of Pharmacy Herbarium (AEF 30483) in Turkey. The samples for anatomical studies were preserved in 70% alcohol.

The transverse and surface sections were cut by hand with razor blade into microscopic preparation form. The *Sartur* solution [15] was used in microscopic examinations. The anatomical analysis and the microphotographs were taken using the Leica DM 4000B.

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