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Research Article

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An Anatomical Study on the Endemic Species *Ornithogalum sandrasicum* Yıld. (Asparagaceae)

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Abstract

In the present study, an anatomical examination of *Ornithogalum sandrasicum* Yıld., a species endemic to Turkey, was conducted. Cross-sections of the plant's vegetative parts were examined. The objective of this study was to ascertain the distinctive anatomical features that could be utilized as a taxonomic aid in distinguishing the *O. sandrasicum* species. The morphology and distribution of crystals can be regarded as taxonomic characteristics in the classification of plants. Raphid crystals were observed in stem and leaf sections. The number of vascular bundles in the stem, the number of cortex and sclerenchyma layers, and the distinction of mesophyll type in leaves can be used as diagnostic characteristics for *Ornithogalum* species.

Keywords: Anatomy, Asparagaceae, *Ornithogalum*.

1. Introduction

The genus *Ornithogalum* L., which encompasses approximately 200 species distributed across Asia, Europe, and Africa [1] and is represented by 62 taxa in Turkey, 31 of which are endemic [2], [3]. The total number of *Ornithogalum* taxa in Europe has been documented as 34 [4], 24 in Russia [5], 17 in Iran [6], 9 in Palestine [7], and 26 in the Balkans and Greece [8]. A comparison of the number of taxa in Turkey and the number of taxa in our country indicates that the diversity in our country is quite high. *Ornithogalum* has a long history in traditional medicine and is also used commercially in the ornamental [9]. Some species of the genus are of commercial importance in the cut-flower or potted plant trade, while others are toxic to animals and considered weeds [10], [11]. The natural habitats of these bulbous monocotyledonous plants exhibit significant heterogeneity. They bloom during the spring and summer months, and their pollination is facilitated by insects. These plants play a significant role as hosts for specific fly species, particularly those whose adult members feed on pollen and nectar, and whose larvae develop within the bulbs of these geophytes [12]. *Ornithogalum* poses a significant challenge to taxonomists due to the insufficient correlation between its morphology and the diversity in chromosome number and karyotype. A taxonomic classification system encompassing a substantial number of subgenera, sections, and series has been developed for this species. Consequently, distinguishing among species based on morphology appears to be both difficult and inadequate [13]. This study was conducted to identify distinctive anatomical features that can serve as a taxonomic aid in distinguishing *O. sandrasicum.*

2. Materials and Methods

The collection and diagnosis of study materials was conducted at an altitude of 1328 meter within the Muğla: Köyceğiz, Sandras Mountain, on the road from Yayla Village to Gökçeova Lake, slopes near the K.45 water reservoir, by Hasan Yıldırım at 19.04.2009, (H. Yıldırım 1563), (AEGEAN!), (Figure 1). For anatomical examinations, plant specimens were preserved in bottles containing 70% ethyl alcohol. Plant specimens can also be found in the Ege University Herbarium Sections of the plants were stained with safranin and fast green, as previously described by Bozdağ [14], from plant samples. The specimen was imaged using a Leica DM 3000 microscope. A meticulous examination was conducted to ascertain the dimensions of root, scape, and

leaf cells. After this, the min-max and standard deviations were meticulously calculated (Table 1).

3. Results and Discussion

3.1. Results

3.1.1. Root: The epidermis is comprised of a single layer, and it is covered by a thick cuticle. The cortex, characterized by its round and ellipsoid-shaped parenchymatic cells, exhibits a layered structure with seven to ten layers. The presence of intercellular spaces between cells has been observed. Four-sided wall thickening was observed in the single-layered endodermis. The pericycle is characterized by thin-walled cells, with cell sizes that are smaller than those observed in the endodermis. The specimen exhibits four to five protoxylem arms. A single metaxylem of considerable size was identified in the core of the root system (Fig. 2).

3.1.2. Scape: The outermost surface of the round and elliptical scape is covered by a thick cuticle layer. The cells of the epidermis are typically of a single row, and their morphology is characterized by a round-elliptic and rectangular form. The outer periclinal walls of the epidermal cells are thick, while the inner periclinal and anticlinal walls are thin. The epidermis layer is comprised of a parenchymatic cortex layer that contains four to five cell rows. These cells are characterized by thin-walled, round, and ellipsoid shapes. The presence of intercellular spaces has been observed. Raphid crystals were observed in the cortex layer. Sclerenchymatic tissue is comprised of 3-5 layers. The vascular bundles are arranged in three rows of rings. The quantity of vascular bundles was determined to be between 28 and 32. Collateral-type vascular bundles originate from sclerenchymatic tissue. The vascular bundles in the outermost ring exhibit a smaller size compared to the inner bundles. A parenchymatic core region is present at the center of the scape (Fig. 2,3).

3.1.3. Leaf: A notably substantial cuticle layer envelops the epidermis cells located on the leaf's external surface. The cells of the epidermis are typically single-layered, and their shape is often rectangular or oval. The leaf is characterized by its amphistomatic nature, exhibiting stomata of the amaryllis type and a mesophytic type. Substomatal spaces of considerable breadth were observed. The palisade parenchyma, located beneath the epidermis on the adaxial and abaxial surfaces of the leaf, consists of a single row of elongated, rectangular cells. These cells are characterized by an abundance of chlorophyll and are arranged in a dense pattern. The spongy parenchyma, characterized by its 2-5 cell rows, possesses a hollow structure, with cells that are round and fragmented in the middle section of the leaf. A substantial quantity of bundle-shaped raphid crystals was observed within the lacunae of the spongy parenchyma. Bundle sheath cells are present around the large vascular bundles. The presence of trichomes was observed at the extremities of the leaves (Table 1, Fig. 3,4).

3.2. Discussion

In the present study, the endemic *O. sandrasicum* species, which was discovered in 2009, was examined in detail anatomically. A comparison was made between the species under consideration and closely related taxa, including *O. comosum, O. armenicum*, and *O. alpigenum*, which are distributed in the Muğla region. An attempt was made to identify the similarities and differences between them. While 5-9 cell layers were observed in the root cortex of *O. alpigenum* [15], a 7-10-layered root cortex was identified in *O. sandrasicum*. The analysis revealed the presence of four to five protoxylem arms in both species. Upon examination of the scape cross-section of *O. sandrasicum*, the number of cortex cell rows was recorded as 4-5. The presence of 5-6, 6-7 cortex layers has been documented in *O. armenicum* and *O. comosum* species, respectively [16]. The sclerenchymatic tissue is observed as 3-5 layers in the species that was studied, while it is 3-4 in *O. armenicum*, 4-5 in *O. comosum* [16]. and 5-6 in *O. alpigenum* [15], The vascular bundles in the scape are arranged in three rings in all species. The number of vascular bundles was observed as 28-32 in *O. sandrasicum*, 18-22 and 16-20 in *O. armenicum* and O. comosum species [16], and 27-30 in *O. alpigenum* species [15]. The presence of both scattered and bundled raphid crystals has been observed in the scape of *O. sandrasicum*. Upon examination of leaf cross-sections, the presence of palisade sponge separation was observed in the mesophyll layer of all species. In *O. comosum*, palisade parenchyma is present only on the adaxial part [16], while in other species, palisade parenchyma is present on both surfaces. In a study conducted by Meriç et al. in 2011 [17], monotypic chlorenchyma without palisade-spongy separation was observed in the leaf mesophyll of *O. nutans* unlike that *O. sandrasicum.* In *O. boucheanum*, which was also examined in the same study, a single-layered palisade parenchyma was found on both the upper and lower sides. This finding is similar to the results of the present study. Spongy parenchyma was observed between the two palisade tissues. Our study of the mesophyll of the species revealed the presence of numerous large lacunae, with the majority exhibiting a dense accumulation of raphid crystals. Large lacunae were also reported in *O. comosum* [16]. The family under consideration contains raphid, styloid, and drus crystals [18]. In the case of *O. sandrasicum*, raphid crystals have been observed in the scape and leaf mesophyll. The morphology and distribution of crystals within a species are of significant importance because they are genetically controlled [19].

4.Conclusion

Consequently, the constancy of the crystal type and distribution can be regarded as a taxonomic character for the classification of species. The number of vascular bundles in the scape, the number of cortex and sclerenchyma layers, and the distinction of the mesophyll type in the leaf can be used as diagnostic characters for the *Ornithogalum* species.

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Table 1: Anatomical measurement values of *O. sandrasicum* species

	Width (µm)		Length (µm)	
	Min.- Max	**Mean ± S.D.**	**Min.- Max.**	**Mean ± S.D.**
Root				
Epidermis	12-17	14±2.1	8-12	10±1.4
Cortex	7-25	17±4.3		
Endodermis	6-11	9±2.3	5-8	7±1.7
Metaxylem	10-13	12±1.9		
Stem				
Cuticle	3-7	5±1.0		
Epidermis	5-15	12±5.4	5-10	7±1.1
Cortex	5-16	11±4.7		
Pith	5-18	14±7.2		
Leaf				
Adaxial Epidermis	5-10	7±3.0	3-6	5±1.2
Palisade	4-7	5±1.1	13-20	17±4.3
Spongy	4-10	7±1.9		
Lacun	10-23	17±3.7		
Abaxial Epidermis	4-8	6±1.2	3-6	5±1.3

Min: Minimum, Max: Maximum, SD: Standard Deviation



Figure 1. General appearance of *O. sandrasicum* in its natural habitat

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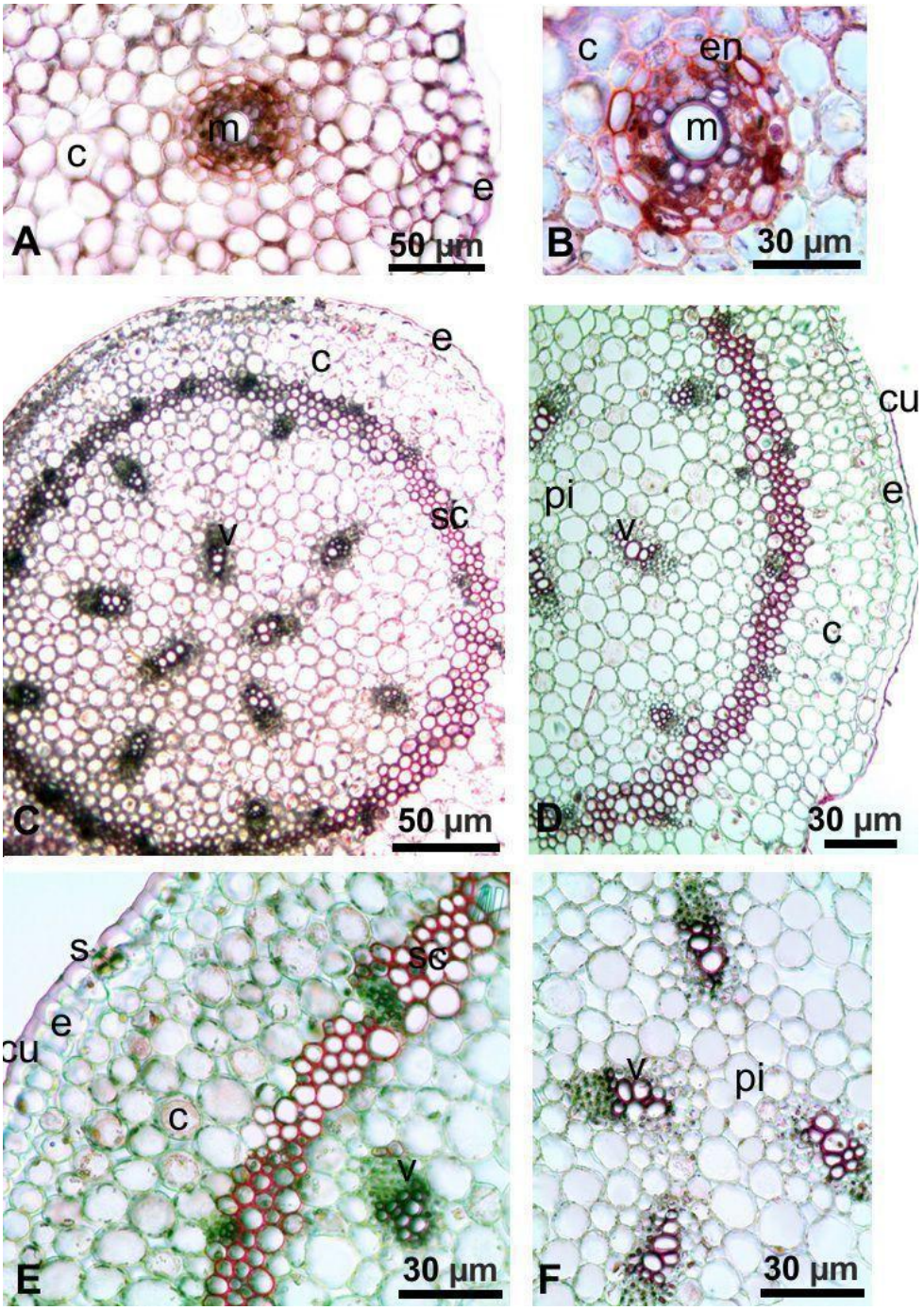


Figure 2: A, B: Root, C, D, E, F; Scape cross section of *O. sandrasicum*, c: cortex, cu: cuticle, e: epidermis, en: endodermis, m:metaxylem, pi: pith, s: stoma, sc: sclerenchyma, v: vascular bundle.

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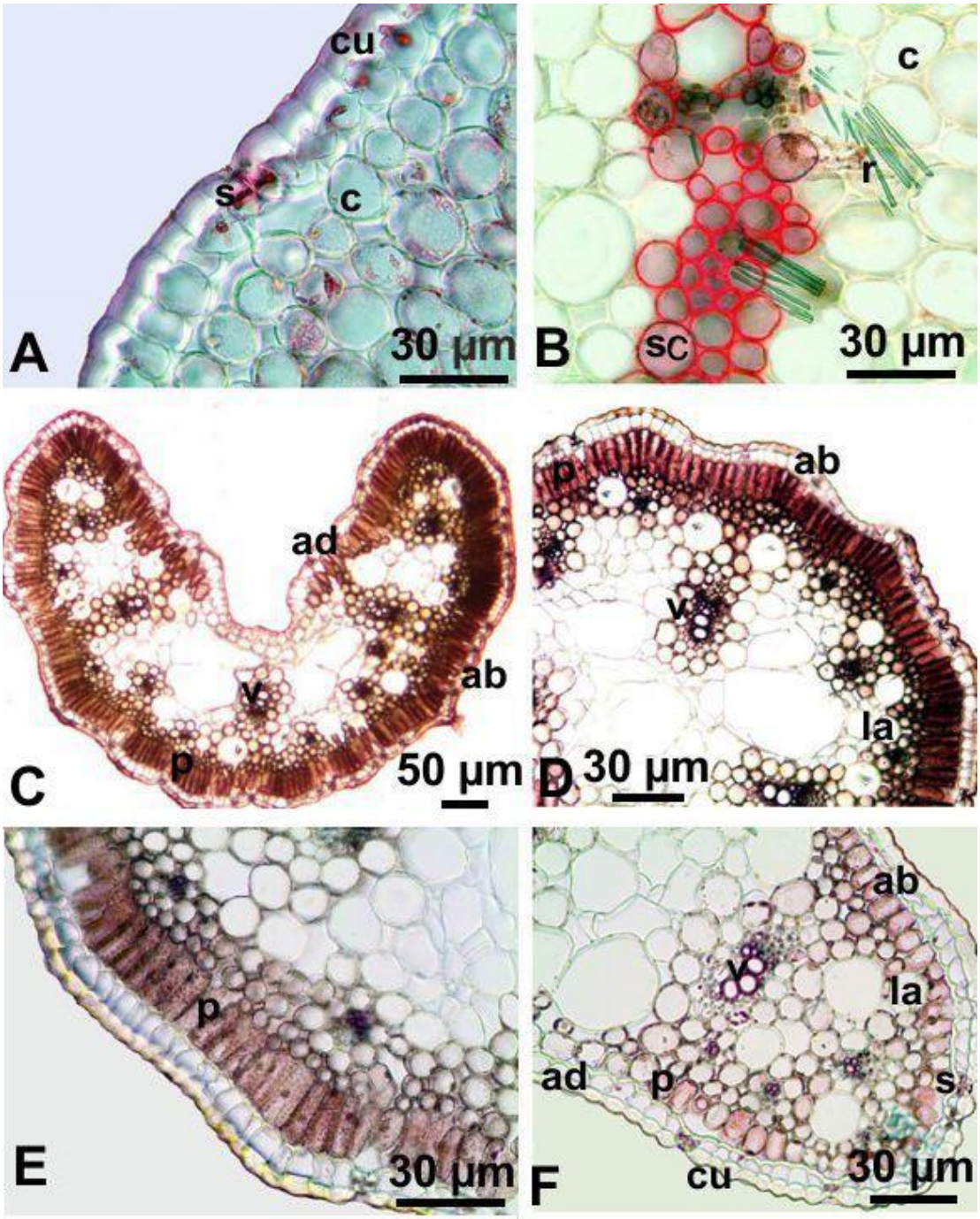


Figure 3: A, B: Scape, C, D, E, F; Leaf cross section of *O. sandrasicum*, ab: abaxial epidermis, ad: adaxial epidermis, c: cortex, cu: cuticle, e: epidermis, la: lacun, p: palisade, pi: pith, s: stoma, r: raphide crystal, sc: sclerenchyma, v: vascular bundle.

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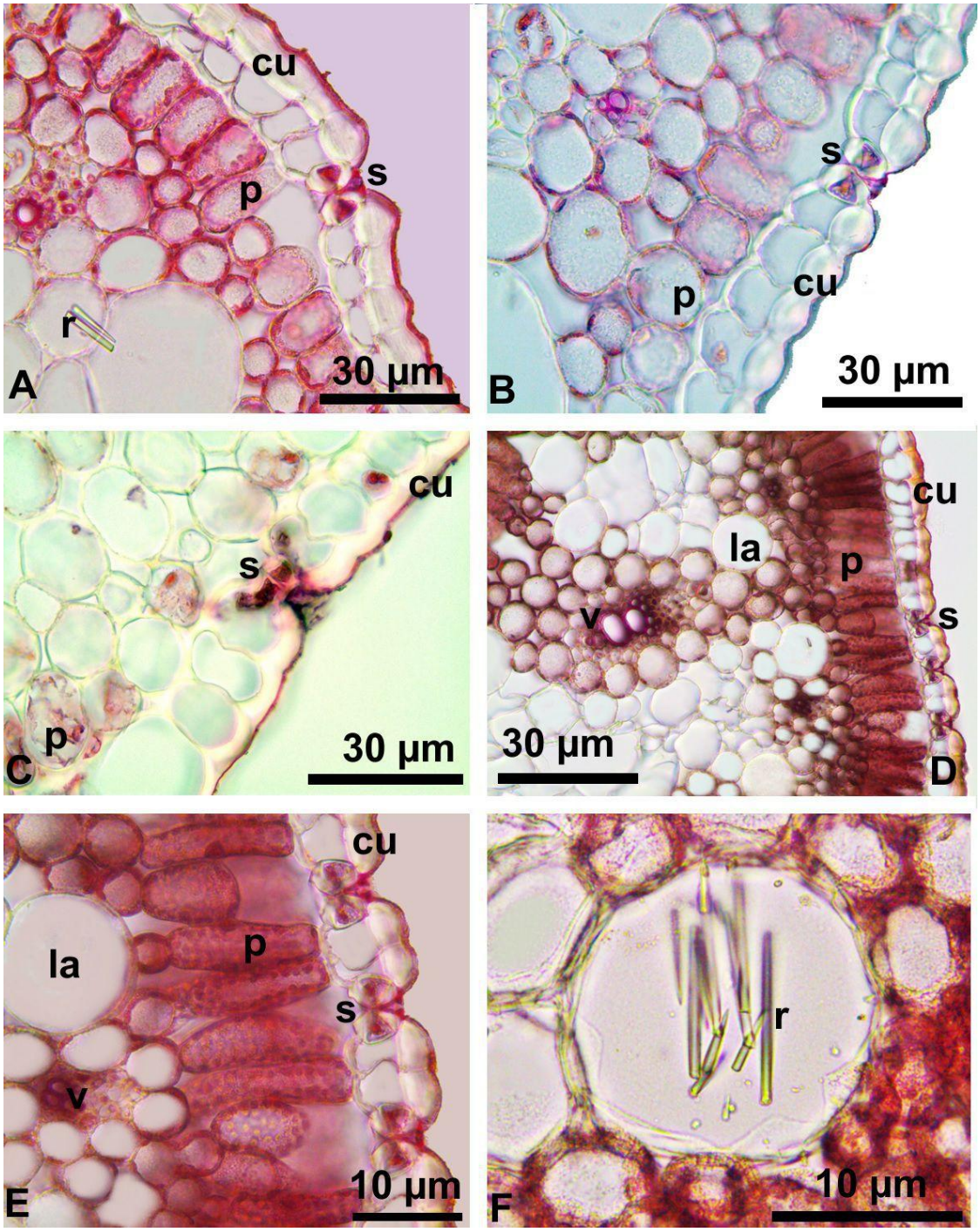


Figure 4: A, B, C, D, E, F; Leaf cross section of *O. sandrasicum*, cu: cuticle, la: lacun, p: palisade, s: stoma, r: raphide crystal, sc: sclerenchyma, v: vascular bundle.