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The morphological, anatomical, palynological, seed micromorphological studies and its taxonomical significance in *Delphinium turcicum* (*Ranunculaceae*), a local endemic spurless species for Türkiye

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Abstract
In this study, species of *Delphinium turcicum* (*Ranunculaceae*), which is endemic to Türkiye, for its morphological, anatomical, palynological, micromorphological and taxonomical significance was investigated. Additionally, *Delphinium venolusum*, which is a similar species of *Delphinium turcicum*, was studied. Anatomic structure descriptions of these species and seed descriptions of *Delphinium turcicum* were given for the first time in this work. In addition, the comparison of these species contributes to the solution of taxonomic problems. Features of anatomic structures (root, stem, and leaf sections) were shown. Also, these structures were discussed taxonomic significance. The similarities and differences between *D. turcicum* and *D. venulosum* were revealed in this study. In palynological investigations; polar, equatorial, exine, intine, colpus length and width were measured. Polar/Equatorial (P/E) ratio and pollen ornamentation were determined. The pollen grains of these two species are spherical and isopolar symmetrical. Pollen types have determined as monad for *D. turcicum* and *D. venulosum* species. Pollen aperture types are tricolpate. Pollen exine ornamentations are microechinate. In this work photographs of pollen and seed were taken by using light microscopy and scanning electron microscopy (SEM). Seed micromorphological characteristics were given for both species. Seeds are subglobose and have continuous rings of transversal squamulose for both species. Seed ornamentations have continuous rings of transversal squamulose and generally erect papillae.

Keywords: Anatolia, anatomy, morphology, palynology, *Pseudodelphinium*, taxonomy

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Türkiye için lokal endemik bir tür olan mahmuzsuz *Delphinium turcicum*'un (*Ranunculaceae*) morfolojik, anatomik, palinolojik, tohum mikromorfolojik çalışmaları ve taksonomik önemi

Özet
Bu çalışmada Türkiye endemiği olan *Delphinium turcicum* (*Ranunculaceae*) türünün morfolojik, anatomik, palinolojik, mikromorfolojik ve taksonomik önemi araştırılmıştır. Ayrıca *Delphinium turcicum*'un benzer bir türü olan *Delphinium venolusum* çalışılmıştır. Bu türlerin anatomik yapılarının tanımları ve *Delphinium turcicum* taksonu için tohum tanımları ilk kez bu çalışmada verilmiştir. Ek olarak bu türlerin karşılaştırılması taksonomik problemlerin çözümüne katkı sağlamaktadır. Bu makalede anatomik yapıların (kök, gövde ve yaprak kısımları) özellikleri gösterilmiştir. Ayrıca bu yapıların taksonomik önemi tartışılmıştır. Bu çalışmada *D. turcicum* ve *D. venulosum* arasındaki benzerlikler ve farklılıklar ortaya konmuştur. Palinolojik araştırmalarda; polar, ekvatoral, ekzin, intin, kolpus uzunluk ve genişlikleri ölçülmüştür. Polar/Ekvatoral (P/E) oranı ve polen ornamentasyonu belirlenmiştir. İncelenen bu iki türün polenleri sferik (küresel) ve izopolar simetriye sahiptir. Polen tipi *D. turcicum* ve *D. venulosum* türleri için monad olarak tespit edilmiştir. Polen apertür tipleri trikolpattır. Polen ekzin ornamentasyonları ise mikroekinattır. Bu çalışmada ışık mikroskobu ve taramalı elektron mikroskobu (SEM) kullanılarak polen ve tohum fotoğrafları çekilmiştir. Tohum mikromorfolojik özellikleri verilmiştir. Tohumlar subglobozdur ve her iki tür için de sürekli enine skuamüloz halkalara sahiptir. Tohum ornamentasyonları ise, sürekli enine skuamüloz halkalara ve genellikle dik papillalara sahiptir.

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Anahtar kelimeler: Anadolu, anatomi, morfoloji, palinoloji, *Pseudodelphinium*, taksonomi

1. Introduction

The *Ranunculaceae* family has approximately 2.500 species and 59 genera in the world [1]. *Ranunculaceae* is distributed from the Mediterranean Basin to Korea, Japan, Siberia, and North America [2]. In Türkiye, the family is described with 230 species and more than 19 genera [3].

The tribe of *Delphinieae* (subfamily *Ranunculoideae*) contains 700 species and its constitutes about 25% of all species diversity in this family [3].

The genus *Delphinium* has 33 taxa, which 17 of them are endemic in Türkiye [3]. *Delphinium* sensu lato including *Consolida* and *Aconitella* sensu [4] contains 58 species [5], making it one of Türkiye's most species rich angiosperm genera.

Consolida has been set apart from *Delphnium* by De Candolle because it has single spurred petals, one follicle, one year life cycle and *Consolida* has created in distinct section. Later, *Consolida* has presented as another genus by Gray in 1821 [6; 7]. However, in the study based on phylogenetic analysis, *Consolida* is included in *Delphinium* [4]. *Consolida* seperated from *Delphinium* relatives in the early to middle Miocene, a period of increasing aridity, caused primarily by a decrease in sea level in the Mediterranean and desertification in Asia [8]. It was stated that the species of the *Delphinium* genus found in Türkiye are mostly interconnected hybrid species. Because of all these reasons, this genus is difficult to taxonomically classify [9].

Palynology, anatomy, and morphology studies on the *Ranunculaceae* family have been undertaken to help categorization within this family [10]. In addition, seed morphology ensure a significant resource of phylogenetic data and karyological analysis in taxonomic descriptions of the species [10].

Plant taxonomy and phylogenetic inference rely heavily on data on seed macro- and microstructure [10].

Vural et al. [11] reported a new taxons from Türkiye in the Karapınar basin of Konya province. As a result of field studies, it was reported that first time *Pseudodelphinium turcicum* H.Duman, Vural, Aytaç & Adıgüzel and this species doesn't spread outside of Karapınar. According to Vural et al. [11], the single population of *Pseudodelphinium turcicum* known to date was collected for the first time in 1997. The inflorescences are racemose, with pubescent bracts and bracteoles similar to the leaves. Flowers are actinomorphic with five free petaloid tepals, numerous free stamens, sepal and spur absent, perianth uniseriate, and three free carpels longitudinally striate [11].

Recently, based on the results of Espinosa et al. [12] in terms of phylogenetic markers, a different set of analyses and following molecular evidence, *P. turcicum* has been regarded as a species of *Delphinium*. Additionally, in the light of these molecular phylogenetic analyses, *Pseudelphinium* was found to be highly similar to the *Delphinium venulosum* Boiss. and *Delphinium virgatum* Poir. *Pseudodelphinium turcicum* was transferred to the genus *Delphinium* and given the scientific name *Delphinium turcicum* (H.Duman, Vural, Aytaç & Adıgüzel) F.Espinosa by Espinosa et al. [12; 14], Espinosa and Myreya [13] and Xiang et al. [15].

The morphological, anatomical, palynological and, seed characteristics of *D. turcicum* are determined in this study. Anatomical structures, detailed seed micromorphology and all structures belonging to pollen morphology with measurements have been given for the first time. Also, *D. venulosum*'s anatomical, palynological, and seed micromorphological were described. Anatomical measurements and descriptions of *D. venulosum* were presented for the first time in this work. According to this information, *D. venulosum* and *D. turcicum*, which are sister species, were revealed in terms of anatomical, palynological, micromorphological similarities and differences. Also, these species have been discussed systematically.

The microscopic procedures are used for the determinate of species in different plant groups by using seed morphological, anatomical, and palynological characters [16; 17]. These features limit the species within the genus. Also, it will provide diagnostic characters for the species studied.

The purpose of this study is to specify and compare the pollen and seed morphology, anatomy, and micromorphology of *D. turcicum* and *D. venulosum* species. It also reveals the taxonomic importance of these species within the family. In addition, all structural features are presented together with measurements.

2. Materials and methods

Delphinium turcicum sample materials were collected from Konya, Karapınar Village in 2016 (KNYA Herb. number: 29.400) Specimens of *Delphinium venulosum* were collected from Konya, Selçuklu, and the Northwest slopes in 2021 (KNYA Herb. number: 29.401). The specimens collected were deposited at KNYA. The collected plant samples were dried according to common herbarium techniques. During the field study, root, stem and leaf parts were taken into 70% ethyl alcohol and it used for anatomical studies.

For anatomical studies, samples were embedded in paraffin wax and then approximately 10 µm thick sections were taken with a Leica RM2125RT rotary microtome. These samples were stained with the fastgreen-safranin staining method and it made into a fixed preparation using entellan [18]. Measurements and photos were taken using a Leica DM1000 binocular light microscope and a Leica DFC280 camera. For the anatomical studies of *D. turcicum*; C4 Konya; Karapınar, Merdivenli Village, step, 22.06.2016, O.Tugay 12.852 registered samples were used. For the

anatomical studies of *D. venulosum*; C4 Konya; Selçuklu, North West slopes, 1100 m, 03.08.2021, O.Tugay 18.927 & D.Ulukuş registered samples were used.

For palynological examinations; pollen samples was provived from a herbarium specimens. Pollen specimens were prepared according to the Wodehouse technique [19]. A Leica DM 1000 brand microscope was used for the morphological examination of the pollen. In light microscopy (LM) studies, pollen grains were dissected from herbarium samples and it placed on clean microscope slides. Safranin and glycerine-gelatin were mixed into the pollen before it was scattered with a clean pin. The pollens were photographed with a spot in-sight color digital camera on a LEICA DM1000 microscope with a digital imaging system, which is a Leica Application Suite program equipped with an apochromatic 100x oil immersion objective [20]. Morphological observations were carried out under the microscope in the LM of Selcuk University. The polar length (P), the equatorial length (E), for the pollen dimensions, polar axis (P), equatorial axis (E), colpus length (Clg), colpus width (Clt), exine and intine were measured under a light microscope (1000 ×) with 20-30 pollen grains per species. P/E rations were calculated using Image Tool software. For the investigation of pollen surface ornaments, they were photographed using the SEM (Scanning Electron Microscope) located in Selcuk University Campus Technopolis Building Advanced Technology Research and Application Center (ILTEK) and in the Electron Microscopy Laboratory of Gazi University. For Scanning Electron Microscopy (SEM), pollen grains were mounted on double-sided carbon tape affixed to aluminum stubs, covered with gold with an Hummle VII sputter coater, and photographed at a magnification of ×2000 to ×7000 with a JEOL-5600. Punt et al. [21] terminology was used for pollen morphology.

The same method was used in seed and pollen micromorphology studies. Minimum-maximum range, mean, standard deviations of seed length and width, and length/width rate were determined. Stearn [22] terminology was used for seed ornamentation.

3. Results

Taxonomy

Delphinium turcicum (H.Duman, Vural, Aytaç & Adıgüzel) F.Espinosa

Type: Türkiye, C4 Konya: Karapınar to Konya road, 30 km, Merdivenli village, 1020 m, dry plain steppes, growing with Peganum harmala communities, 28.07.1998, H.Duman 6824 & Z.Aytaç (holotype: GAZI, isotypes: ANK, HUB).

Glaucous, virgate, 3-24 cm. Stem simple or branched above, striate. Median cauline leaves shortly petiolate (to 6 millimeter), cuneate, divided with 3 linear–lanceolate, 7 × 3 mm or simple, upper cauline leaves entire, linear-oblanceolate, all leaves acute. Racemes 3–10 flowered, approximately 5 cm, pubescent; bracts like upper leaves, bracteoles similar to bracts, pedicels 2-8 mm. Flowers actinomorphic. Perianth uniseriate. Sepal absent. Petals 5, free, violet, purple, green and dark yellow, lanceolate to oblong or oblanceolate, 5–8 × 2-3 mm. Nectary absent. Stamens numerous (11–17), anthers 1 mm. Follicles 3, greenish, 5–7 × 2.5 mm, striate; style 1–2 mm, glabrous. Seeds 7–9 in each follicle, about 1.5 mm, blacklish, subglobose, 4–7 uninterrupted circles of transversal scales [11].

Distribution - habitat: *Delphinium turcicum* is local endemic species distributing at Konya: Karapınar to Konya road, 30 km, Merdivenli village, 1020 m (Fig. 1 and Fig. 2).

Anatomical Properties

For the transverse sections of the root, stem, and leaf of the species, significant properties were observed. The measurements of the anatomical characters of *D. turcicum* and *D. venulosum* are given in Table 1.

Root anatomy:— *D. turcicum* and *D. venulosum* have epidermis cells 1-layered and these cells of shape are rectangular. There is a cortex layer below the epidermis. The cortex layer is consists of rectangular parenchymatic cells. This layer is 5–6 layers for both *D. turcicum* and *D. venulosum*. The vascular tissue consists of phloem and xylem. The metaxilem cells located in the core region (Fig. 3).

Stem anatomy:— *D. turcicum* and *D. venulosum* have epidermis cells 1-layered. Under the epidermis are 3–4 layers of cortex parenchyma, vascular tissue and pith region in the center. Epidermis cells are rectangular. The cortex parenchyma cells have irregular shapes. Under the cortex layer are 8–11 rows of sclerenchyma cells both of this species. The stem has a colleteral vascular bundle. The outermost sclerenchyma cells are consist of the outer phloem, cambium, xylem, inner phloem and pith region. Around of the sclerenchyma fibers has respectively the outer phloem and inner phloem (Fig. 4).

Leaf anatomy:— The leaf of *D. turcicum* and *D. venulosum* are consist of upper epidermis, mesophilic layer (2-layer palisade parenchyma, 2-layer sponge parenchyma and 2-layer palisade parenchyma) and lower epidermis. It is a mesophile type of equifacial leaves for both of *D. turcicum* and *D. venulosum* (Fig. 5).

Pollen:— Pollen types have determined as monad for *D. turcicum* and *D. venulosum* species. The pollen grains of these two species are spherical and isopolar symmetrical. The polar axis (P) was calculated as 21.75–23.39 μm for *D. turcicum* species and 17.42–22.84 μm for *D. venulosum* species. Equatorial Axis (E): 21.91–23.07 μm for *D. turcicum* and 18.21–23.57 for *D. venulosum*. P/E ratio is of *D. turcicum* 0.83–0.93 μm and 0.80–1.06 μm of *D. venulosum*. Pollen aperture types are tricolpate in both of *D. turcicum* and *D. venulosum*. Colpus length (Clg) is 12.97–15.00 μm for *D. turcicum* and 10.76–15.05 for *D. venulosum*. Colpus width (Clt) is 13.19–14.54 μm for D. *turcicum* and 10.93–14.58 for *D.venulosum*. Exine thickness was measured at 0.40–0.53 μm for *D. turcicum* and 0.13–0.52 for *D. venulosum*.

Intine thickness was calculated at 0.23–0.54 µm for *D. turcicum* and 0.10–0.34 for *D. venulosum*. For both species; the equatorial and polar regions of the pollen was found microechinate (Figs. 6-7).

Seed micromorphology:— Each follicle of *D. turcicum* contains 8–10 seeds. The seed shape of *D. turcicum* is subglobose, open-mouthed, circular, and the seed color is blackish. It was measured at 0.69–1.28 mm in length and 0.80–1.34 mm in width. Hilum's position is basal. The seed's surface sculpturing is striped. The cell shape is long and rectangular. The seed layer is 4–7 uninterrupted circles of transversal squamulose, with the umbilical orifice occupying one half and 1/3 of the total seed volume. The exotesta layer is rectangular in shape and it has a thick outer wall. The seed surface is ornamented with spherical to stick-shaped papillae that are usually erect (Fig. 8).

Each follicle of *D. venulosum* contains 8–10 seeds. The seed shape of the *D. venulosum* species is subglobose, circular. The seed color is dark brown to black. It was measured at 1.03–1.23 mm in length and 1.11–1.21 mm in width. Hilum's position is basal with wrinkled. The seed layer is 6–8 helicoidal rings of continuous lamellae with minutely undulating margins because of the digitiform ends of the rectangular formed cells. Seed surface ornamentation is medium density spherical to stick shaped generally erect papillae (Fig. 8).

Table 1. Comparative anatomy of the root, stem and leaves *D. turcicum* and *D. venulosum*

		D. turcicum				***D. venulosum***			
		Width (µm)		**Length (µm)**		**Width (µm)**		**Length (µm)**	
		min-max	mean± SD	min-max	mean± SD	min-max	mean ± SD	min-max	mean ± SD
Root	**Epidermis cell**	8.03-12.85	10.38 ± 1.49	23.39-47.13	34.4 ± 8.30	18.75-57.37	42.02 ± 12.04	11.3-30.89	-20.34 ± 5.7
	Cortex cell	5.68-12.95	9.02 ± 2.38	10.29-19.61	15.32 ± 3.11	18.75-49.65	32.81 ± 7.77	8.82-19.86	14.51 ± 4.8
	Phloem	4.54-11.36	8.09 ± 2.16	4.68-17.19	15.32 ± 3.11	3.93-11.81	6.14 ± 2.05	3.94-11.82	8.21 ± 2.21
	Xylem	6.12-28.76	15.72 ± 7.10	12.50-21.85	17.01 ± 2.92	5.51-30.73	13.24 ± 6.66	7.09-29.95	18.76 ± 6.77
	Core cell	4.54-11.36	18.66 ± 7.36	4.68-17.19	15.92 ± 5.76	6.3-44.13	21.22 ± 10.64	5.51-35.86	18.47 ± 9.55
Stem	**Epidermis cell**	7.15-12.73	9.76 ± 1.79	7.09-28.78	18.10 ± 7.18	17.47-34.02	27.17 ± 5.94	9.19-20.22	15.79 ± 4.94
	Cortex cell	6.52-34.02	21.12 ± 9.65	23.33-50.24	37.08 ± 9.24	8.66-43.21	17.90 -+ 7.29	7.72-28.37	17.41 ± 7.08
	Sclerenchyma	24.55-79.21	50.03 ± 18.43	38.36-68.57	53.41 ± 10.64	38.62-98.1	56.63 +- 20.10	32-78.34	53.92 ± 19.44
	Phloem	20.87-54.34	40.09 ± 11.50	21.12-48.54	35.51 ± 8.73	20.22-25.22	22.02 +- 1.99	10.24-12.61	11.53 ± 1.09
	Xylem	6.20-11.33	8.96 ± 1.62	4.96-11.30	7.99 ± 1.97	3.86-22.06	9.13 ± 5.28	6.06- 15.44	6.58 ± 3.27
	Core	19.97-52.87	34.99 ± 11.20	20.27-46.9	35.55 ± 8.27	34.48-74.45	47.40 ± 12.61	33.1 -74.48	51.77 ± 11.71
Leaves	**Upper epidermis cell**	30.53-52.55	41.50 ± 7.52	16.54-42.29	30.32 ± 8.38	22.37-50.34	39.15 ± 9.4	16.55-55.01	37.22 ± 9.62
	Lower epidermis cell	14.49-41.56	27.53 ± 8.22	14.79-40.26	27.50 ± 8.96	16.78-58.18	41.03 ± 12.45	22.37-50.34	38.46 ± 6.41
	Palisade parenchyma	4.71-69.05	36.75 ± 21.05	16.64-63.60	38.7 ± 16.39)	4.89-13.28	9.99 ± 2.96	26.57-60.83	40.38 ± 7.56
	Sponge Parenchyma	4.28-21.27	13.76 ± 5.72	3.95-14.14	8.71 ± 3.31	10.48-44.05	21.57 ± 7.45	11.18-42.35	23.36 ± 7.51

Abbreviations: Mean: Average, SD: Standart deviation, Min: Minimum, Max: Maximum, µm: Micrometer

Table 2. Comparative pollen morphology of *D. turcicum* and *D. venulosum* showing mean value ± standard deviation, and the range in parenthesis. All measurements are in µm except P/E

Species	**Polar axis (P)**	**Equatorial axis (E)**	**P/E**	**Colpus length**	**Colpus width**	**Exine thickness**	**Intine thickness**
D. turcicum	22.57 ± 0.49 (21.75-23.39)	22.49 ± 0.29 (21.91-23.07)	0.88 (0.83-0.93)	13.98 ± 0.51 (12.97-15.00)	13.86 ± 0,34 (13.19-14.54)	0.46 ± 0.07 (0.40 - 0.53)	0.38± 0.10 (0.23 - 0.54)
D. venulosum	20.68±1.37 (17.42-22.84)	20.64±1.70 (18.21-23.57)	0.91 (0.80-1.06)	12,51±1.29 (10.76-15.05)	13.25±1.17 (10.93-14.58)	0.21±0.07 (0.13-0.52)	0.19±0.06 (0.10-0.34)

Table 3. Comparative seed morphological characteristics of *D. turcicum* and *D. venulosum*

Species	Seed shape	Seed width (mm)	Seed length (mm)	Number of seed layer	Seed color	Seed surface ornamentation
D. turcicum	Subglobose	0.80–1.34	0.69–1.28	4–7	Blackish	Spherical to stick shaped usually erect papillae
D. venulosum	Subglobose	1.11–1.21	1.03–1.23	6–8	Dark brown to black	Spherical to stick shaped generally erect papillae

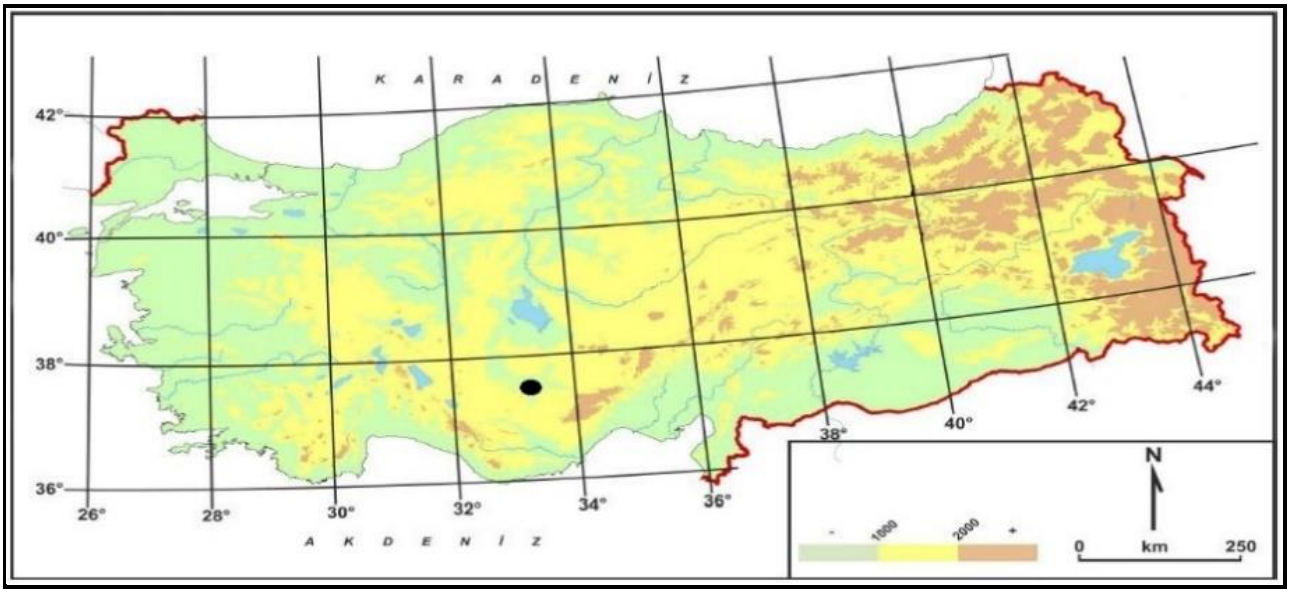

Figure 1. Distribution map of *Delphinium turcicum* in Türkiye.

Figure 2. A−B. General view and flowers of *Delphinium turcicum* (Photos: Prof. Dr. Osman TUGAY).

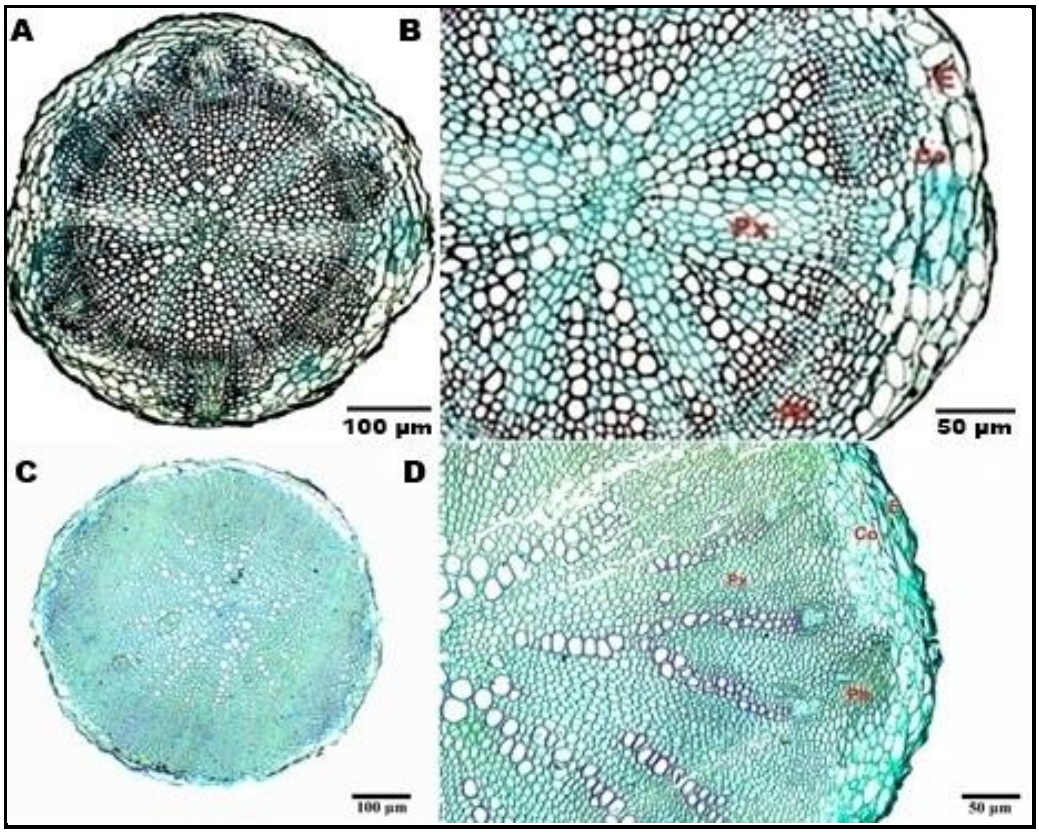

Figure 3. Transverse section of the root. **A−B**. *Delphinium turcicum;* **C−D.** *D. venulosum*
E: Epidermis, Co: Cortex, Px: Protoxylem, Ph: Phloem.

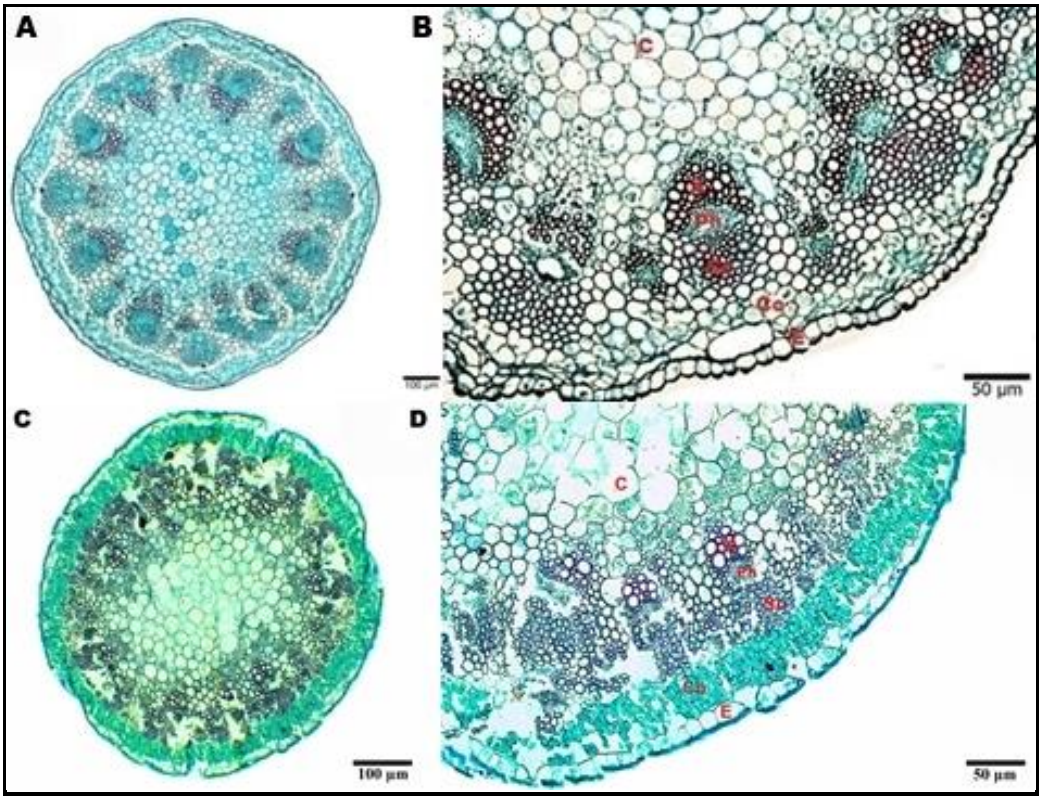

Figure 4. Transverse section of the stem. **A−B.** *Delphinium turcicum;* **C−D.** *D. venulosum*
X: Xylem, Ph: Phloem, Sc: Sclerenchyma, Co: Cortex, E: Epidermis, C: Core.

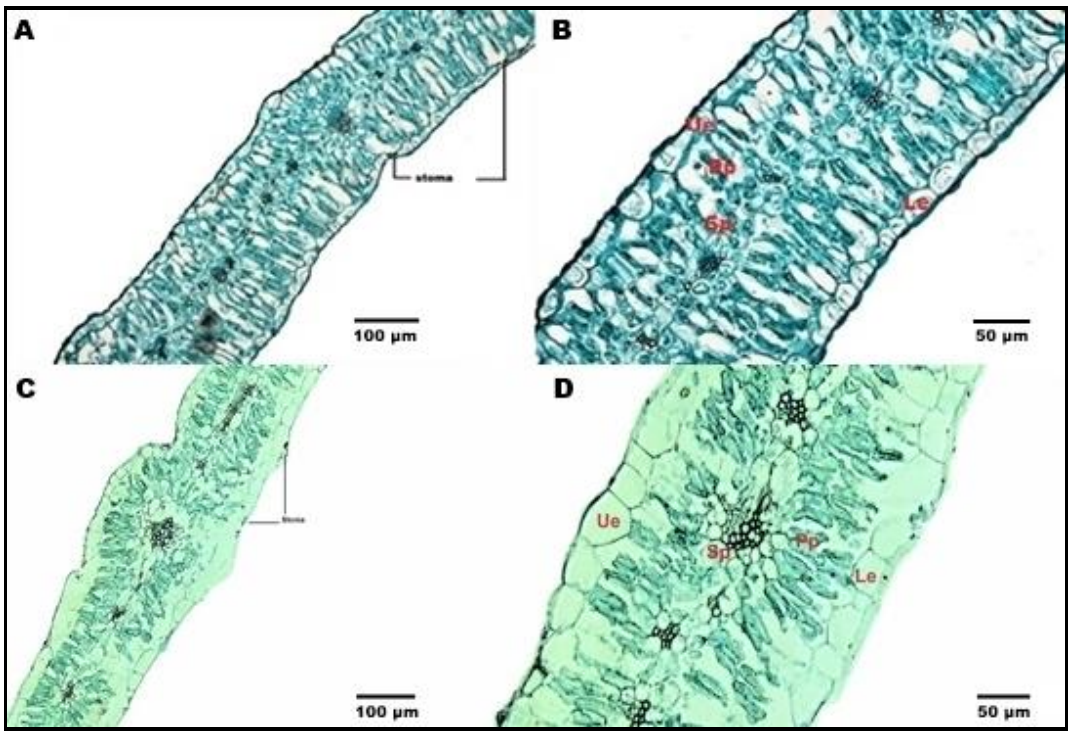

Figure 5. Transverse section of the lamina. **A−B.** *Delphinium turcicum;* **C-D.** *D. venulosum*
Ue: Upper epidermis, Le: Lower epidermis, Pp: Palisade parenchyma, Sp: Sponge parenchyma.

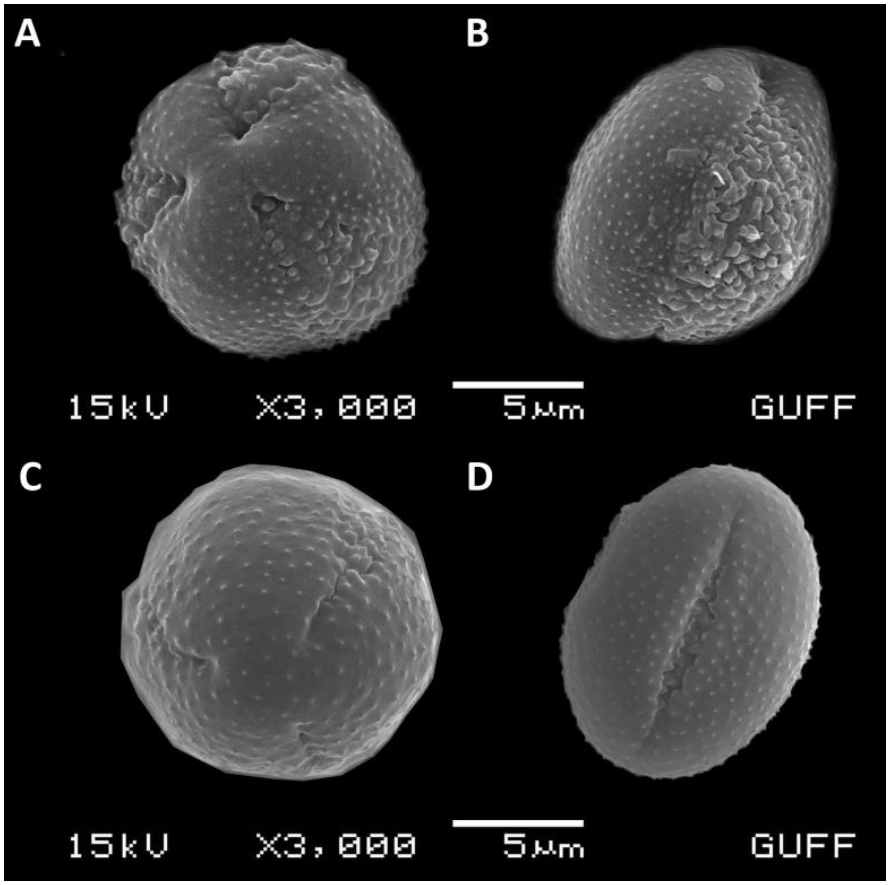

Figure 6. SEM micrographs of the pollen grains. **A−B.** *Delphinium turcicum* (O.Tugay 12.852); **C−D.** *D. venulosum* (O.Tugay 18.927 & D.Ulukus) polar and equatorial view.

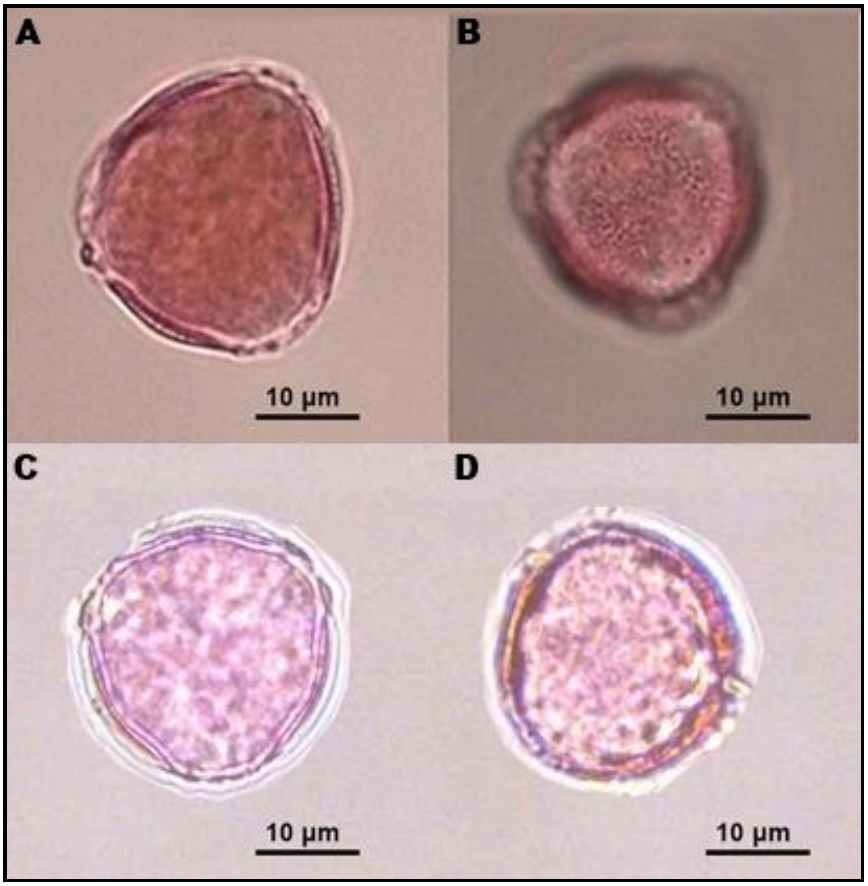

Figure 7. Light micrographs of the pollen grains **A−B.** *Delphinium turcicum* (O.Tugay 12.852); **C−D.** *D. venulosum* (O.Tugay 18.927 & D.Ulukus).

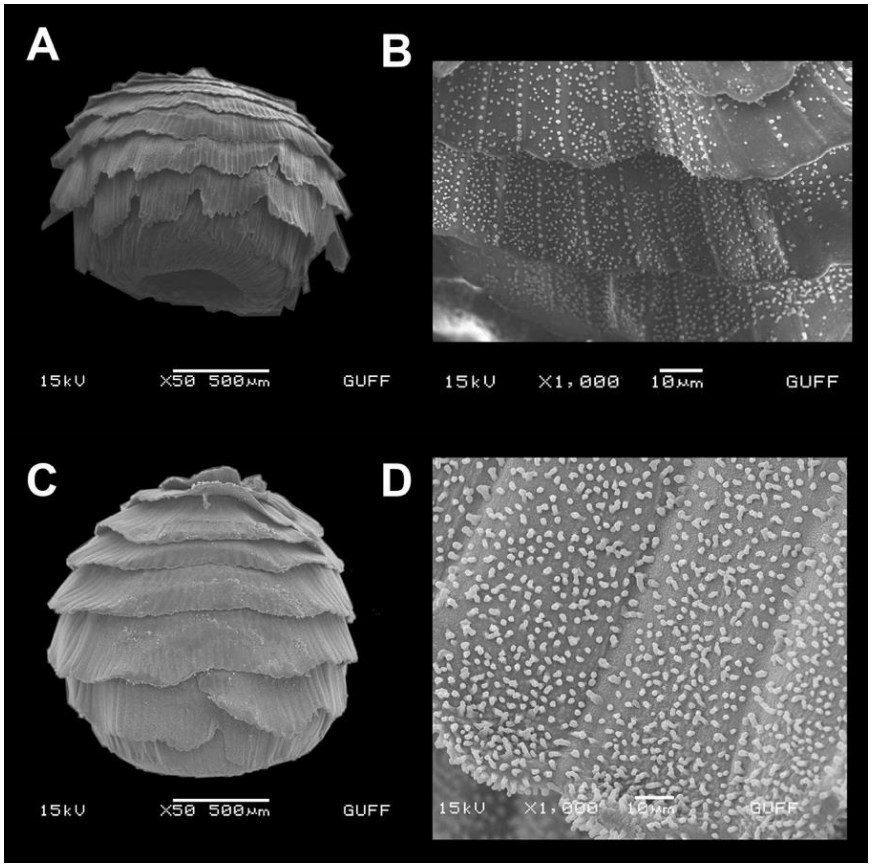

Figure 8. SEM microphaps of the seed general view and sculpture structure **A−B.** *Delphinium turcicum* (O.Tugay 11.104) **C−D.** *D. venulosum* (O.Tugay18.927 & D.Ulukus).

4. Conclusions and discussion

In this study, morphological, anatomical, palynological, seed morphological and micromorphological data of *D. turcicum*, which is endemic to Türkiye, were obtained. In our results, anatomical, palynological, and seed features of *D. turcicum* species were given for the first time. In addition, anatomical, palynological and seed characterization of *D. venulosum* was investigated. In this work, the anatomical study of *D. venulosum* was reported for the first time. Data on pollen and seed studies are presented in comparison with other similar *Delphinium* species.

The root epidermis, the cortex cells and the apex (nucleus) cells of *D. venulosum* are larger and wider than *D. turcicum.* The xylem and phloem cells of *D. turcicum* are approximately same size comperad to *Delphinium* species. Cortex and phloem cells are larger in *D. turcicum* compared to *D. venulosum*. The sclerenchyma and xylem cells are usually the same size for both species.

When the leaf anatomy; the lower epidermis of *D. venulosum* is wider than *D. turcicum*. In *D. turcicum*, the palisade parenchyma is approximately 4 times larger than *D. venulosum*. Sponge parenchyma of *D. venulosum* is larger than *D. turcicum*. As a result, all this information provides data of taxonomic importance for the root and stem. For the leaf anatomy; datas of epidermis width, cortex and phloem cells, size difference of palisade and sponge parenchyma were determined as distinctive.

D. venulosum and *D. virgatum* pollen grains, which are sisters to *D. turcicum*; have a length of 22–31 μm, pollen shapes are spherical, tricolpate pollen grains and pollen ornaments are microechinate. The pollen of *D. turcicum* is heteromorphic; long (22–31 μm), both di- and tricolpate pollen grains were observed [13]. According to Espinosa et al. [13] pollen grains of *D. turcicum* are both di- and tricolpate 22–31 long. However, in our study, only tricolpate was observed among the pollen grains of *D. turcicum*. The pollen length of *D. turcicum* was measured at 21–23 μm. We think that this situation is caused by environmental factors. Our findings are generally consistent with the reporting of Espinosa et al. [13].

The seeds of the *D. turcicum* are blacklish subglobose, It was measured as 0.69–1.28 mm in length and 0.80–1.34 mm in width. Seed surface sculpturing is striped. Seeds have 4–7 layer continuous rings of transversal squamulose. Seed surface ornamentation is spherical and mostly erect papillae. According to Vural et al. [12], *D. turcicum* has seeds eight-ten for every follicle, 2 mm, blackish, subglobose, 5–8 uninterrupted circles of transversal concrescent scales, umbilical orifice occupying one half, 1/3 of the sum seed size. However, in our study, the number of seed layers for *D. turcicum* was determined as 4–7.

Our study, *D. venulosum* seeds are detected as 8–10 in each follicle. The seed shape of the *D. venulosum* species is subglobose, seed color is dark brown to black. It was measured as 1.03–1.23 mm in length and 1.11–1.21 mm in width. Seed layer is 6–8 helicoidal rings of continuous lamellae. Seed surface ornamentation is medium density spherical to stick shaped generally erect papillae. According to Ilarsan et al. [5], *D. venulosum* brown subglobose seeds of $1.34 \pm 0.03 \times 1.40 \pm 0.04$ mm with 7–9 helicoidal rings of continuos lamellea with minutely undulate margin, due to the digitiform ends of the rectangular-shaped cells. Faces with medium-density sphaerical to stick-shaped usually erect papillae. Seeds are deep crateriform hilum with wrinkled and crested cells. In our study, the seed size was determined to be smaller, but considering that the seed size of the genus *Delphinium* is generally less than 1.5. It is consistent with other results. However, it should not be ignored that there are differences in seed size between different populations of the same species, which can cause differences according to habitat conditions.

Compared to *D. venulosum*, it was observed that the granulation on the wing part of the seed layers was less in *D. turcicum*. Other structures and measurements for the seeds of both species shows similar characteristics. This work approves the former molecular studies. These two species have like characters in terms of anatomical and seeds micromorphological characters.

Morphological, palynological, leaf epidermis and anatomical characters are the most important features in *Ranunculaceae* taxonomy [23]. Although there are many publications on *Delphinium* L. (sensu lato), detailed data for anatomy and seed studies are scarce [10; 24]. Morphological, anatomical, palynological and seed differences are very important for taxonomic descriptions. Consequently, it is predicted that the information acquired with this work will contribute to the literature.

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