

**A MORPHOLOGICAL, ANATOMICAL AND PALYNOLOGICAL
INVESTIGATION ON *DELPHINIUM CILICICUM* P.H. DAVIS & KIT TAN
AND *D. PETRODAVISIANUM* ILARSLAN & KIT TAN**

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Keywords: Anatomy; *Delphinium*; Ranunculaceae; Morphology; Micromorphology; Palynology; Turkey.

Abstract

In the present study, the morphological, anatomical and palynological properties of endemic species *Delphinium cilicicum* P.H. Davis & Kit Tan and *D. petrodavisianum* İlarşlan & Kit Tan belonging to the genus *Delphinium* L., Ranunculaceae of Turkey were investigated. *D. cilicicum* and *D. petrodavisianum* are very similar morphologically. However, in our studies, it has been determined that there are some differences between the two species in terms of morphological, anatomical and palynological aspects. Based on the data obtained, the similarities and differences between two species were revealed. The cross-sections taken from the roots of two species have peridermis, cortex, vascular tissue and central region, in cross sections taken from the stem have epidermis, cortex, vascular bundle, and pith. In cross sections taken from the sepal and petal have lower and upper epidermis, parenchyma cells and tracheal cells. Through cross-sections of fruit, it was observed that there were two seeds in the fruit and the fruit wall was determined in two species. In palynological research, pollen size, P/E ratio, colpus size, intine-exine thicknesses, amb diameter and distance between colpus were measured. It was revealed that *D. cilicicum* and *D. petrodavisianum* had tricolpate, oblate-spheroidal pollen grains. The results obtained from the pollen grains were similar to each other in examined species. The fruits and seeds of two species were examined using SEM microscopy. Micromorphological differences and similarities were determined. The fruits of the species are follicle and globose. The seeds are yellowish brown, sub pyramidal and fine-grained ornamented.

Introduction

Ranunculaceae is a family within the Ranales order of the plant kingdom of different medicinal plants of zygomorphic or actinomorphic symmetry (Soydan, 2009). It was first recognized in 1789 as a cosmopolitan family (Menemen and Uzel, 2016). Ranunculaceae means "small frog" implying its amphibian properties (Simpson, 2012). Ranunculaceae is represented by 58 genera and 1758 species worldwide (Seçmen *et al.*, 1995). This family has 18 genera and 204 species in our country and the endemism ratio is 25.6% (Güner *et al.*, 2012). Ranunculaceae includes various plant species with both advanced and primitive properties; advanced properties are finely divided leaves, thyrus, unisexual and zygomorphic flowers, special spur sepals and petals, syncarpy and achene fruits (Agnihotri *et al.*, 2014). The genus *Delphinium* L. is represented by about 370 species in the world. It spreads along cold and temperate belts of the northern hemisphere and highlands of Africa (Wilde, 1931). *Delphinium* is represented by 31 species in total in Turkey, 17 of which are endemic (Ertuğrul, 2012). *Delphinium* species is adapted to Turkish name with 'hezaren' (Güner *et al.*, 2012). Species of *Delphinium* flowers are known to

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adapt to form, color, function and blossoming phenology closely and depend on pollination with queen bumblebees (*Bombus* Latr. spp.) and hummingbird (Macior, 1975). Pollen grains are transferred to female organs via water, wind and animals. The surface of pollen grain carried by wind and water is generally smooth, while the surface of that carried by animals like insects or birds in various ornaments and is sinuous. The pollen grains attach to either animals or sinuous surfaces of the female organ's 4 stigma (Yakar and Bilge, 1987). Furthermore, in some studies not only natural but also commercial pollen grains have been used, and some differences between these two types of pollen grains have been observed (Candan and Çali, 2015). *D. cilicicum* endemic to Turkey is known as "Toros hezareni" (Güner *et al.*, 2012). It was first introduced to the world of science by Dr. P. H. Davis and Dr. Kit Tan in 1988. *D. petrodavisanum* specific to Turkey is known as "Gökçe hezareni" (Güner *et al.*, 2012). *D. petrodavisanum* species was first collected and introduced to the world of science by R. Ilarslan (Tan and Ilarslan, 1990). *D. cilicicum* and *D. petrodavisanum* taxa are perennial plants. Their flowers are dark or pale blue. It is known that both taxa are close relatives, although there are some differences in their properties (Fener and Aykurt, 2019).

This study aimed to examine macro-morphological, palynological and anatomical characteristics of *D. cilicicum* and *D. petrodavisanum* taxa in Turkey. Anatomical similarities and differences have been mentioned. Pollen grains of the species in question were examined under light and scanning electron microscopes and pollen morphologies were revealed.

Material and Methods

Plant samples of *D. cilicicum* species was collected on 24 July 2020 from Yelatan village (2-3 km north of Yelatan, stony, inclined slopes, height: 1400 m) of Çamardı District of Niğde Province. The samples of *D. petrodavisanum* taxon was collected on 26 July 2020 in Eğiste village (ancient road between Eğiste bridge and Eğiste village, broken serpentine, oak spaces, height: 1290 m) of Hadim District of Konya Province in their natural habitats during blossoming and fruiting periods under field conditions (Figure 1). Before collecting plant samples, the species are photographed. Collected samples were pressed with the traditional pressing technique, dried, and stored in herbarium of Selçuk University Faculty of Science Department of Biology (KNYA). Some of the specimens were transferred to plastic bottles filled with 70% percent ethyl alcohol in field conditions.

Root, stem, flower and fruit of *D. cilicicum* and *D. petrodavisanum* were used for anatomical studies. Anatomical studies were completed in 5 stages. These stages are dehydration (removal of water), paraffin saturation, paraffin embedding, sectioning and staining. The method conducted by Johansen (1940) was used for anatomical study.

Pollen materials to be used in palynological studies were obtained from herbarium samples. According to the Wodehouse method, reference pollen preparations were made for each species (Wodehouse, 1935). Equatorial (E) and polar (P) axes, colpus length and width of pollen grains were measured. P/E ratios of examined species' pollen grains were calculated and pollen shapes were determined. In addition, exine and intine thicknesses were measured.

Stereo microscope, light and scanning electron microscope were used for fruit and seed morphology, and micromorphology. They were examined and their photos were taken. Fruit and seed ornamentation, and general appearance were examined with SEM microscope.

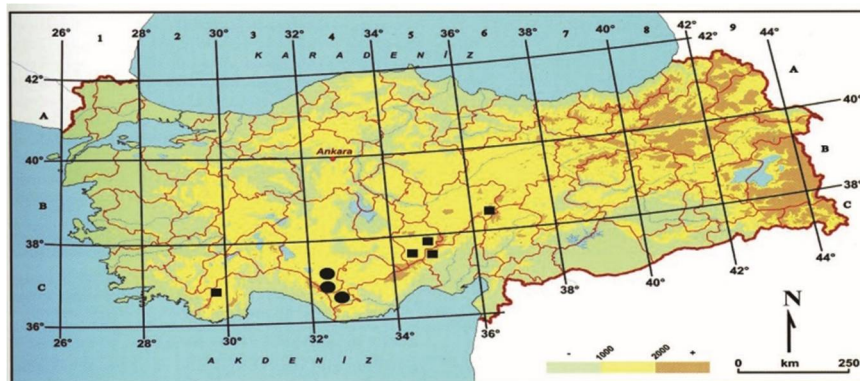


Fig. 1. Distribution map *D. cilicicum* (■) and *D. petrodavisanum* (●) in Turkey

Results and Discussion

Anatomical Studies

Root Anatomy

In both species, the protective layer around outermost part of the root is found to be made of peridermis elements. The average thickness of peridermal protective tissue of *D. cilicicum* is $56.99 \pm 7.78 \mu\text{m}$ and $75.15 \pm 5.94 \mu\text{m}$ in *D. petrodavisanum*. Cortex parenchyma is between the peridermis layer and conducting tissue, and is made of parenchymal rectangular cells. Cortex tissue thickness is $33.71 \pm 13.89 \mu\text{m}$ in *D. cilicicum* and $85.16 \pm 10.70 \mu\text{m}$ in *D. petrodavisanum*. Vascular tissue is made of phloem, which is located below the cortex and xylem elements that contain tracheid cells. Sap cells are observed in the central area, and the average thickness is $41.80 \pm 15.64 \mu\text{m}$ and $16.20 \pm 52.92 \mu\text{m}$ in *D. cilicicum* and *D. petrodavisanum*, respectively.

Stem Anatomy

In the cross sections of the stems of both species, the epidermis, cortex, vascular bundle and pith region were observed from the inside out. Outermost epidermal layer cells of *D. cilicicum* are simple, cubic, and rectangular, while they are oval shaped in *D. petrodavisanum*. Dimensions of epidermal cells are $12.47\text{-}21.76 \times 2.51\text{-}33.27 \mu\text{m}$ and $5.52\text{-}15.75 \times 8.20\text{-}22.30 \mu\text{m}$ in *D. cilicicum* and *D. petrodavisanum* species, respectively. Cuticle thickness are $8.23 \pm 1.56 \mu\text{m}$ and $9.70 \pm 1.28 \mu\text{m}$ in *D. cilicicum* and *D. petrodavisanum*, respectively. The average cortical layer thicknesses are $14.43 \pm 2.75 \mu\text{m}$ and $14.43 \pm 2.75 \mu\text{m}$ in *D. cilicicum* and *D. petrodavisanum*, respectively. Vascular bundles are made of phloem and xylem elements. The average dimensions of tracheid cells of xylem elements are $18.92 \pm 6.65 \mu\text{m}$ and $3.36\text{-}20.61 \mu\text{m}$ in *D. cilicicum* and *D. petrodavisanum*. Pith regions of both species are round, oval or polygonal and made of parenchymal cells.

Flower Anatomy

The outermost ring of the flower is the sepal. The average sepal thicknesses are $55.03 \pm 19.83 \mu\text{m}$ and $113.93 \pm 42.99 \mu\text{m}$ in *D. cilicicum* and *D. petrodavisanum*, respectively. Sepal cells of both species are oval, rectangular and cubic, and tracheid cells are apparent. The average dimension of sepal cells in *D. cilicicum* is $17.69 \pm 7.37 \mu\text{m}$ and cell width is $8.76 \times 28.25 \mu\text{m}$, while they are $31.78 \pm 13.86 \mu\text{m}$ and $17.44\text{-}57.68 \mu\text{m}$ in *D. petrodavisanum*. Cells are surrounded

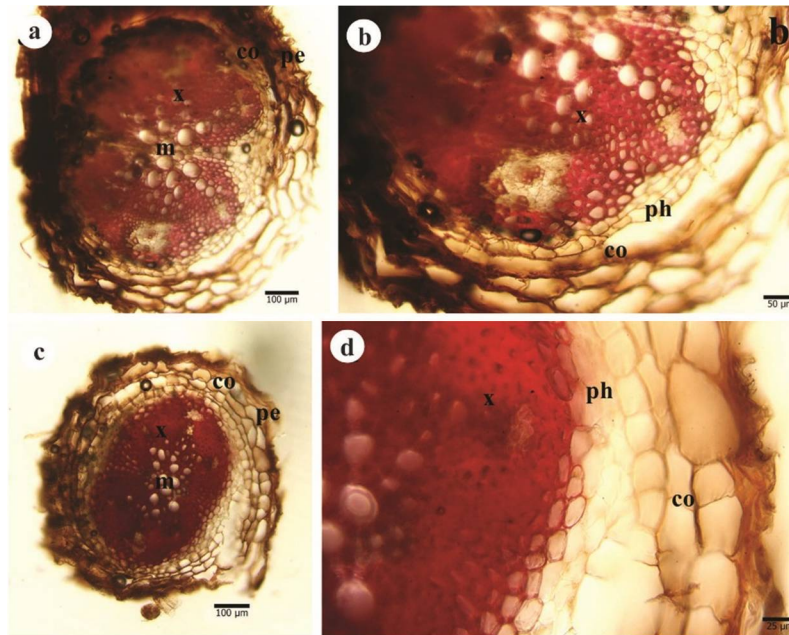


Fig. 2. The root microphotographs of cross sections of *D. cilicicum* (a-b) and *D. petrodavisanum* (c-d) species. a-c: general view of roots; b-d: details of cortex and phloem; pe: peridermis, co: cortex, ph: phloem, x: xylem, m: center of roots.

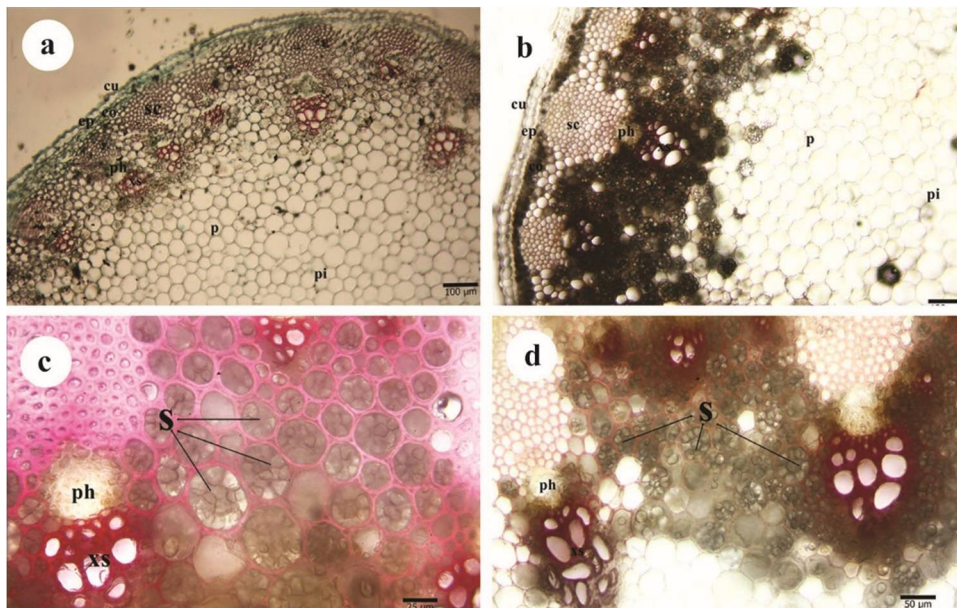


Fig. 3. The stem microphotographs of cross sections of *D. cilicicum* (a,c) and *D. davisianum* (b,d) ep: epidermis, cu: cuticle, co: cortex, ph: phloem, xs: xylem, sc: sclerenchyma, p: pith cell, pi: pith region, s: starch grains,

by two layers of the epidermis. Dimensions of inner epidermal cells are $10.89-12.78 \times 13.56-21.31 \mu\text{m}$ and those of outer epidermal cells are $6.45-20.41 \times 9.16-24.71 \mu\text{m}$ in *D. cilicicum*, while they are $8.28-17.02 \times 23.78-34.59 \mu\text{m}$ and $12.02-18.24 \times 19.39-31.45 \mu\text{m}$ in *D. petrodavisanum*, respectively.

The colorful structure of the flower is the petal. The average petal thickness is $209.49 \pm 43.85 \mu\text{m}$ and parenchyma cell is $24.02 \pm 12.99 \mu\text{m}$ in *D. cilicicum*, while they are $117.30 \pm 63.56 \mu\text{m}$ and $20.20 \pm 9.73 \mu\text{m}$ in *D. petrodavisanum*, respectively. The parenchymal cells in both species are round and oval. Cells are surrounded by outer and inner epidermis. Dimensions of inner epidermal and outer epidermal cells in *D. cilicicum* are $4.88-14.19 \times 9.96-22.32 \mu\text{m}$ and $9.22-24.5 \times 8.4-32.19 \mu\text{m}$ respectively, while they are $4.92-12.01 \times 8.37-20.17 \mu\text{m}$ and $8.07-13.63 \times 8.14-24.12 \mu\text{m}$ in *D. petrodavisanum*, respectively.

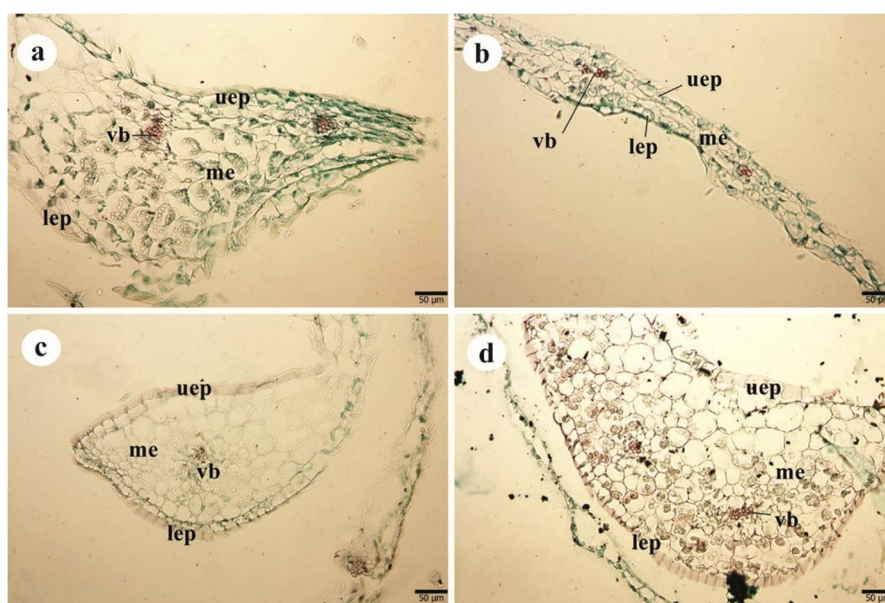


Fig. 4. The anatomical flower parts of *D. cilicicum* (a,c) and *D. petrodavisanum* (b,d). (a,b): the cross section of sepals, (c,d): the cross sections of petals. uep: upper epidermis, lep: lower epidermis, me: mesophyll, vb: vascular bundle.

Fruit Anatomy

Fruit in both species is spheroidal and contains two seeds. *D. cilicicum* has a fruit wall with an average thickness of $169.68 \pm 8.26 \mu\text{m}$ at the outermost and it is $153.30 \pm 17.79 \mu\text{m}$ in *D. petrodavisanum*. Starch grains are observed in cross-sections of the fruit wall. Dimension of mesocarp cell is $20.76-32.91 \times 24.06-43.97 \mu\text{m}$ in *D. cilicicum* and $17.59-38.05 \times 21.33-66.78 \mu\text{m}$ in *D. petrodavisanum*.

Palynological Results

Pollen types of *D. cilicicum* and *D. petrodavisanum* species are monad. The aperture type of pollen grains of this species is tricolpate. Palynological observations and calculations revealed that pollen shape is oblate-spheroidal in both species.

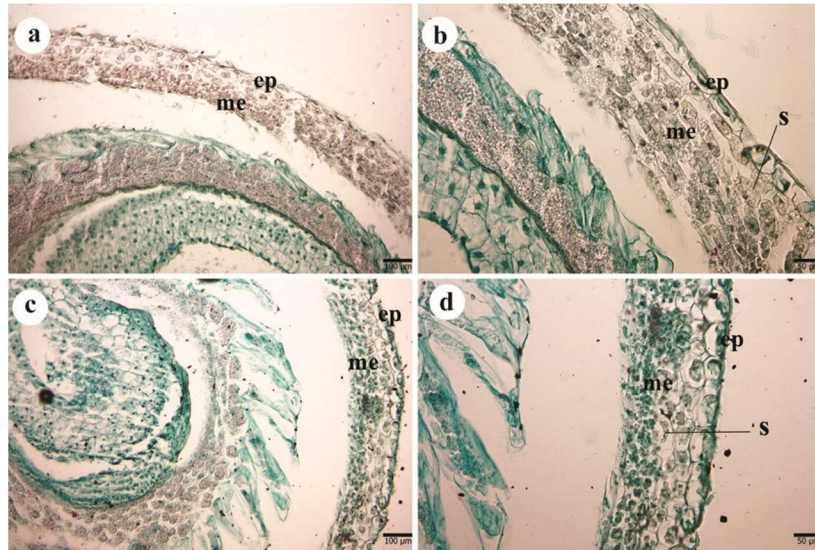


Fig. 5. The section microphotographs of fruit of *D. cilicicum* (a,b) and *D. petrodavisanum* (c,d). ep: epidermis, me: mesophyll, s: starch grains

The polar axes (P) and equatorial axes (E) dimensions of both species are very close, and the AMB shapes of both species are triangular. Exine structure is tectate and exine sculpture is scabrate-perforate in both species. In addition, clg, clt, amb diameter, the distance between colpus, intine and exine thicknesses are very close (Table 1).

Table 1. The comparative palynological characters of *D. cilicicum* and *D. petrodavisanum*.

Palynological characters/Species	<i>D. cilicicum</i>	<i>D. petrodavisanum</i>
Pollen Type	Monad	Monad
Aperture	Tricolpate	Tricolpate
Polar Axes (P)	20.66 ± 1.48 µm	22.31 ± 1.09 µm
Equatorial Axes (E)	21.88 ± 1.57 µm	23.01 ± 1.09 µm
P/E	0.94	0.96
Pollen shape	Oblate-spheroidal	Oblate-spheroidal
Colpus length (Clg)	17.38 ± 1.55 µm	18.07 ± 1.06 µm
Colpus width (Clt)	8.18 ± 1.20 µm	8.96 ± 1.60 µm
Apocolpium (t)	5.07 ± 2.00 µm	3.92 ± 0.74 µm
AMB	11.80 ± 2.33 µm	10.78 ± 1.68 µm
AMB shape	Triangular	Triangular
Exine	1.59 ± 0.34 µm	1.67 ± 0.38 µm
Intine	0.64 ± 0.14 µm	0.64 ± 0.13 µm
Exine structure	Granulate	Granulate
Exine sculpture	Scabrate-perforate	Scabrate-perforate

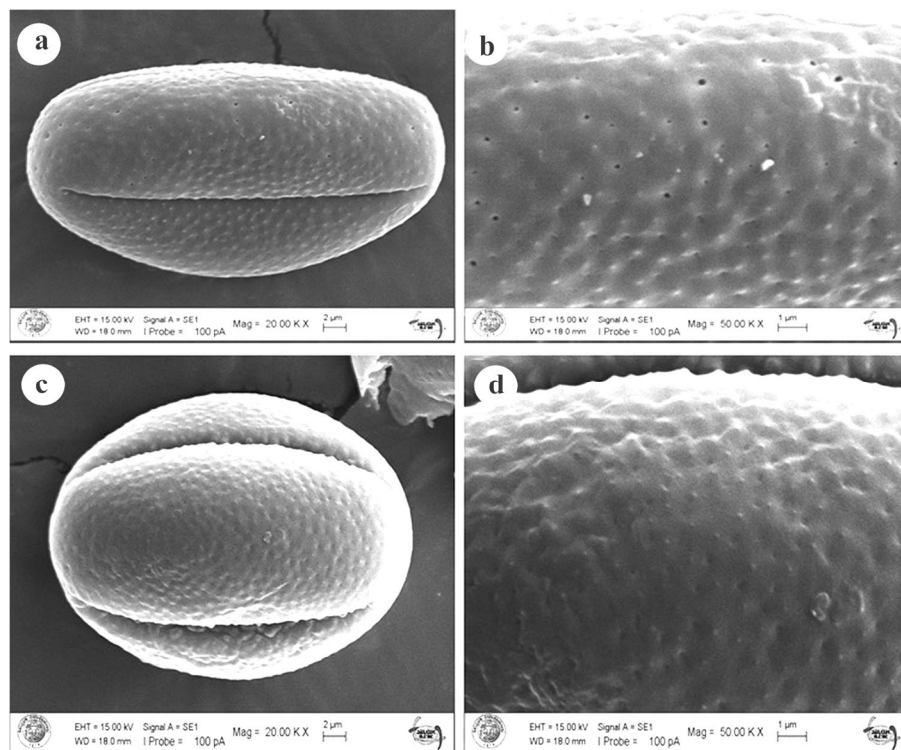


Fig. 6. The SEM micrographs of pollen grains of *D. petrodavisanum* (a-b) and *D. cilicicum* (c-d). (a,c) Equatorial views, (b,d) exine sculpturing

Fruit Micromorphology

Both fruits are follicle type with 2 seeds and the fruit shape is globose. Fruit width and length of *D. cilicicum* are 3.23 ± 0.66 mm and 4.13 ± 0.52 mm, while those of *D. petrodavisanum* are 3.24 ± 0.65 mm and 4.16 ± 0.54 mm, respectively. The fruit surface is wavy ornamental in *D. cilicicum* (Figure 7a,b), and papillate-striate ornamental in *D. petrodavisanum* (Figure 7 c,d).

Seed Micromorphology

Seeds of both species are tawny, and sub-pyramidal. There are longitudinal papillary rectangular cells on seed surfaces. These cells are short and in the form of irregular protrusions, seed coat ornamentation is rugose. Seed dimension is 1.18×0.6 mm in *D. cilicicum* and 1.20×0.9 mm in *D. petrodavisanum*.

It was observed that the peridermis layer and cortex tissue of *D. petrodavisanum* taxon are thicker than *D. cilicicum* taxon. The average peridermis thicknesses are 75.15 ± 5.94 μ m in *D. petrodavisanum* and 56.99 ± 7.78 μ m in *D. cilicicum*. Cell dimensions are 7.54 - 17.67×14.56 - 33.56 μ m and 11.50 - 25.71×18.65 - 40.16 μ m in *D. cilicicum* and *D. petrodavisanum*, respectively. The average cortex tissue thicknesses are 85.16 ± 10.70 μ m and 33.71 ± 13.89 μ m in *D. petrodavisanum* and *D. cilicicum* taxa, respectively. The pith area is prominent and wide in both taxa and is made of rounded cells. Cell widths are 16.2 - 52.92 μ m 20.99 - 66.64 μ m in *D. petrodavisanum* and *D. cilicicum*, respectively.

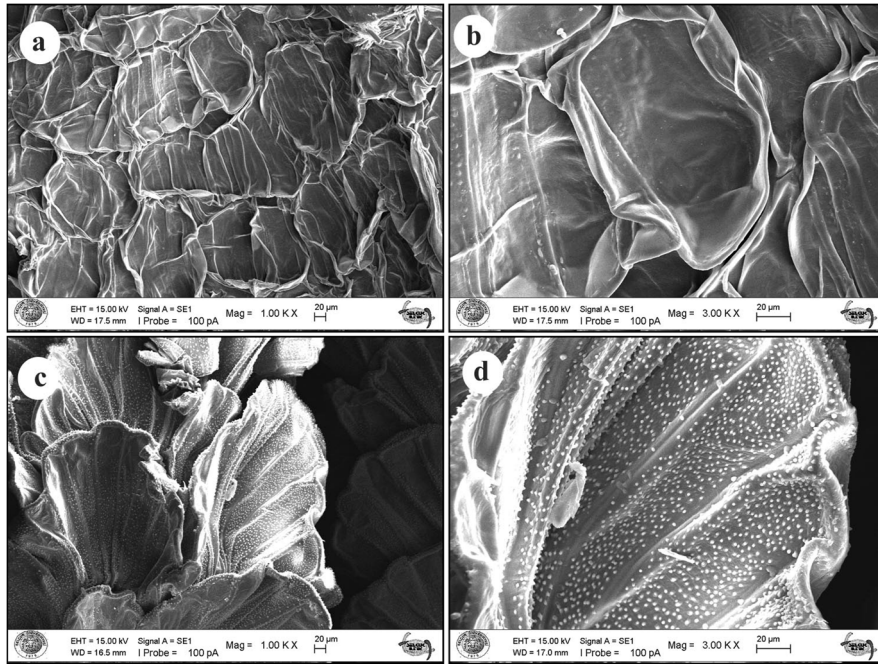


Fig. 7. The SEM micrographs of fruits of *D. cilicicum* (a,b) and *D. petrodavisanum* (c,d). a-c: general views of fruits, b-d: fruit coat ornamentations in detail.

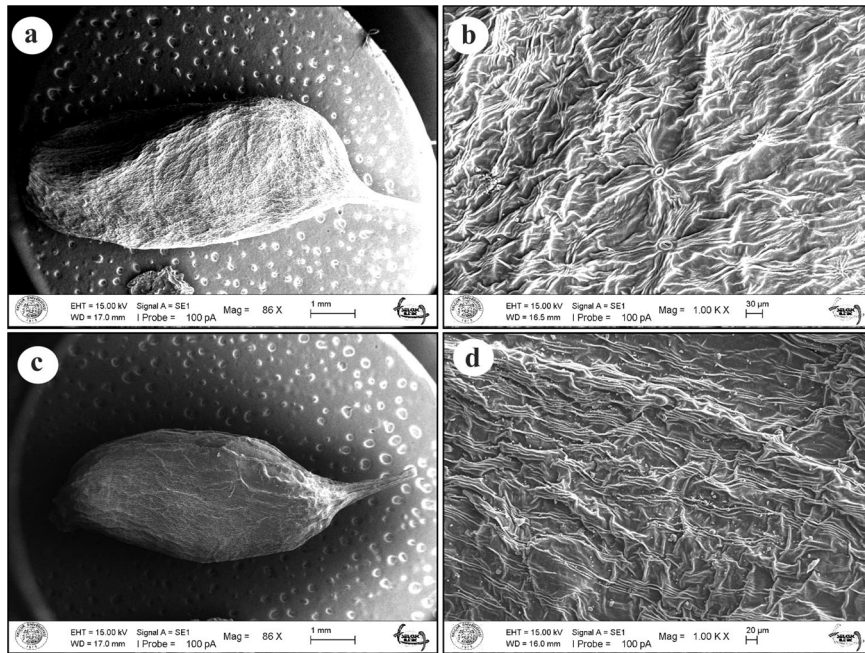


Fig. 8. The SEM micrographs of seeds of *D. cilicicum* (a,b) and *D. petrodavisanum* (c,d). a-c: general views of seeds, b-d: seed coat ornamentations in detail.

Anatomical studies conducted on root, stem, flower (sepal & petal) and fruit segments of both taxa are shown in Table 2.

Table 2. The comparative anatomical data of *D. cilicicum* and *D. petrodavisanum* taxa.

Organ	Tissue	Anatomical data of <i>D. cilicicum</i>					
		Length (μm)			Width (μm)		
		Min	Max	Mean \pm SD	Min	Max	Mean \pm SD
Root	Peridermis thickness	46.62	69.61	56.99 \pm 7.78			
	Cortex tissue				14.98	57.05	33.71 \pm 13.89
	Cortex cells	7.54	17.67	13.14 \pm 3.66	14.56	33.56	23.67 \pm 7.20
	Pith region (parenchyma cells)				20.99	66.64	41.80 \pm 15.64
	Epidermis	12.47	21.76	17.25 \pm 3.14	2.51	33.27	15.24 \pm 7.46
	Cuticle thickness	6.24	11.81	8.23 \pm 1.56			
Stem	Trachea				8.31	27.83	18.92 \pm 6.65
	Cortex thickness	9.4	20.31	14.43 \pm 2.75			
	Pith region cells				31.72	72.46	49.65 \pm 13.41
	Collenchyma cells				5.91	9.13	7.32 \pm 1.33
	Sclerenchyma				5.41	20.57	10.73 \pm 3.58
Fruit	Fruit wall thickness	161.46	178.79	169.68 \pm 8.26			
	Mesocarp cells	20.76	32.91	26.82 \pm 5.24	24.06	43.97	36.008 \pm 8.07
	Petal	162.17	280.1	209.49 \pm 43.85			
Flower (petal)	Parenchyma cells				9.47	42.3	24.02 \pm 12.99
	Upper epidermis	9.22	24.5	15.69 \pm 5.83	8.4	32.19	20.04 \pm 7.60
	Lower epidermis	4.88	14.19	10.57 \pm 2.92	9.96	22.32	17.86 \pm 4.21
Flower (sepal)	Sepal	35.18	92.59	55.03 \pm 19.83			
	Parenchyma cells				8.76	28.25	17.69 \pm 7.37
	Upper epidermis	6.45	20.41	13.23 \pm 5.03	9.16	24.71	16.97 \pm 6.94
	Lower epidermis	10.89	12.78	11.75 \pm 0.70	13.56	21.31	16.13 \pm 3.45

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Anatomical data of <i>D. petrodavisanum</i>					
Length (μm)			Width (μm)		
Min	Max	Mean \pm SD	Min	Max	Mean \pm SD
66.62	87.97	75.15 \pm 5.94			
			62.97	95.76	85.16 \pm 10.70
11.50	25.71	18.34 \pm 5.46	18.65	40.16	28.22 \pm 7.36
			16.2	52.92	30.12 \pm 10.71
5.52	15.75	9.60 \pm 2.65	8.20	22.30	14.87 \pm 4.57
7.50	11.85	9.70 \pm 1.28			
			3.36	20.61	10.20 \pm 5.09
13.93	26.98	20.17 \pm 4.3			
			16.44	58.84	35.62 \pm 14.25
			7.13	12.15	9.78 \pm 1.81
			3.66	12.39	8.39 \pm 2.52
130.52	182.8	153.30 \pm 17.79			
17.59	38.05	25.15 \pm 7.50	21.33	66.78	40.11 \pm 12.93
62.98	218.86	117.30 \pm 63.56			
			9.94	34.52	20.20 \pm 9.73
8.07	13.63	11.46 \pm 2.12	8.14	24.12	15.65 \pm 6.15
4.92	12.01	7.15 \pm 2.64	8.37	20.17	13.68 \pm 3.89
72.53	205.38	113.93 \pm 42.99			
			17.44	57.68	31.78 \pm 13.86
12.02	18.24	15.78 \pm 2.15	19.39	31.45	26.01 \pm 8.71
8.28	17.02	13.34 \pm 2.70	23.78	34.59	29.17 \pm 3.94

In *D. petrodavisianum*'s stem, the epidermis is made of protective single cubic, rectangular or oval-shaped cells, with a cell dimension of $5.52-15.75 \times 8.20-22.30 \mu\text{m}$. Dimension of single epidermal cell in *D. cilicicum* is $12.47-21.76 \times 2.51-33.27 \mu\text{m}$. *D. cilicicum*'s cells have a similar shape to *D. petrodavisianum*'s but are larger. Cuticle layers are almost the same. The average thicknesses of a cuticle layer is $9.70 \pm 1.28 \mu\text{m}$ and $8.23 \pm 1.56 \mu\text{m}$ in *D. petrodavisianum* and *D. cilicicum*, respectively. The cortex layer is right under epidermis. There are single thin collenchyma cells in cortex layer of *D. petrodavisianum* and their dimensions vary between $7.13 \mu\text{m}$ and $12.15 \mu\text{m}$. The average cortex layer thickness is $20.17 \pm 4.30 \mu\text{m}$. There are single, very thin and clear collenchyma cells in the cortex layer of *D. cilicicum*, whose dimension is $7.32 \pm 1.33 \mu\text{m}$. The thickness of average cortex layer is $14.43 \pm 2.75 \mu\text{m}$. As these cells are faint, the cortex layer of *D. cilicicum* is thinner than *D. petrodavisianum*.

Vascular bundles are made of phloem and xylem elements. The phloem is over the xylem. Dimensions of tracheid cells, elements of xylem, are $3.36-20.61 \mu\text{m}$ and $8.31-27.83 \mu\text{m}$ in *D. petrodavisianum* and *D. cilicicum*, respectively. Tracheid is more apparent in *D. cilicicum*. Furthermore, sclerenchymatic cells of bundles of taxa are almost the same with dimensions $5.41-20.57 \mu\text{m}$ and $3.66-12.39 \mu\text{m}$ in *D. cilicicum* and *D. petrodavisianum*, respectively. The pith area is prominent and wide and made of oval or polygonal parenchymal cells. Cells closer to the xylem are small, and those close to pith are larger. The average cell dimensions are $35.62 \pm 14.25 \mu\text{m}$ and $49.65 \pm 13.41 \mu\text{m}$ in *D. petrodavisianum*, and *D. cilicicum*, respectively (Table 2). Starch grains are observed on stem sections of both taxa.

There are 2 seeds inside the fruit. The average fruit wall thicknesses are $169.68 \pm 8.26 \mu\text{m}$ and $153.30 \pm 17.79 \mu\text{m}$ for *D. cilicicum* and *D. petrodavisianum*, respectively. Starch grains are observed in fruit wall cross sections. Dimensions, the average width and length of *D. cilicicum* mesocarp cells are $20.76-32.91 \times 24.06-43.97 \mu\text{m}$, $36.0 \pm 8.07 \mu\text{m}$, and $26.82 \pm 5.24 \mu\text{m}$, respectively. Dimensions, the average width and length of *D. petrodavisianum* mesocarp cells are $17.59-38.05 \times 21.33-66.78 \mu\text{m}$, $40.11 \pm 12.93 \mu\text{m}$ and $25.15 \pm 7.50 \mu\text{m}$, respectively. The fruits of both species are similar. The average sepal thickness of *D. cilicicum* is $55.03 \pm 19.83 \mu\text{m}$ and $113.93 \pm 42.99 \mu\text{m}$ in *D. petrodavisianum*, respectively. Sepal cells of both species are oval, rectangular and cubic, and tracheid cells are apparent. The average dimension of sepal cells in *D. cilicicum* is $17.69 \pm 7.37 \mu\text{m}$ and cell width is $8.76 \times 28.25 \mu\text{m}$, while they are $31.78 \pm 13.86 \mu\text{m}$ and $17.44-57.68 \mu\text{m}$ in *D. petrodavisianum*. Cells are surrounded by 2 layers of the epidermis. Dimensions of inner epidermal cells are $10.89-12.78 \times 13.56-21.31 \mu\text{m}$ and those of outer epidermal cells are $6.45-20.41 \times 9.16-24.71 \mu\text{m}$ in *D. cilicicum*, while they are $8.28-17.02 \times 23.78-34.59 \mu\text{m}$ and $12.02-18.24 \times 19.39-31.45 \mu\text{m}$ in *D. petrodavisianum*, respectively. Sepal of *D. petrodavisianum* is thicker than *D. cilicicum*.

The average petal thickness is $209.49 \pm 43.85 \mu\text{m}$ and the parenchymal cell is $24.02 \pm 12.99 \mu\text{m}$ in *D. cilicicum*, while they are $117.30 \pm 63.56 \mu\text{m}$ and $20.20 \pm 9.73 \mu\text{m}$ in *D. petrodavisianum*, respectively. Parenchymal cells in both species are round and oval. Cells are surrounded by outer and inner epidermis. Dimensions of the inner and outer epidermis cells in *D. cilicicum* are $4.88-14.19 \times 9.96-22.32 \mu\text{m}$ and $9.22-24.5 \times 8.4-32.19 \mu\text{m}$, respectively, while they are $4.92-12.01 \times 8.37-20.17 \mu\text{m}$ and $8.07-13.63 \times 8.14-24.12 \mu\text{m}$ in *D. petrodavisianum*, respectively. The petal of *D. cilicicum* is thicker than *D. petrodavisianum*.

Fruits of *D. cilicicum* and *D. petrodavisianum* are follicle and globose. Sometimes, when follicles become fully mature and open, all seeds in the fruit will not be developed. There are two seeds in the fruit. Seeds of both species are tawny and sub-pyramidal. The seed dimensions of both species are very similar. They are $1.18 \times 0.6 \text{ mm}$ in *D. cilicicum* and $1.20 \times 0.9 \text{ mm}$ in *D. petrodavisianum*. There are longitudinal papillary rectangular cells on seed surfaces. These cells

are short and in the form of irregular protrusions with scaly surfaces and fine-grained ornamentation without well-developed wings. Seed coat ornamentation is rugose in both species.

Seeds of *D. cilicicum* species are tawny, sub-pyramidal with a dimension of 1.20×0.7 mm and there are rectangular cells on a seed surface. *Delphinium* seeds have been studied before by (İlarsan et al., 1997). In this study seeds of *D. iris* species are clear dark brown, sub-pyramidal with dimension 1.1×1.0 mm without longitudinal wings, and they have rectangular cells and irregular scale covered wide crater hilum with side scales and high-density spherical papilla. In the same study, various seeds of species of *Delphinium* genus were examined and seeds of *Delphinium* genus were divided into 4 main groups; sub-pyramidal, sub-globose, e-sub-pyramidal and sector-spheroidal. *Delphinium* species in our study have similar seed micromorphologies.

When *D. cilicicum* and *D. petrodavisanum* were morphologically compared, their plant size, immunofluorescence, and dimensions of the spur, sepal and petal were found different, while flower color and bract dimensions were similar. Anatomical studies on root have revealed that peridermis layer and cortex tissue are thicker, cortex cells are larger in *D. petrodavisanum* taxon, and pith area is made of round and larger cells in *D. cilicicum* taxon.

Anatomical studies on the stem have revealed that there is an epidermis made of protective single cubic, rectangular or oval cells in the outermost layer of the stem. Epidermis cells of *D. cilicicum* are larger than *D. petrodavisanum* cells, the cuticle layer is almost the same, the cortex layer of *D. cilicicum* is thinner than *D. petrodavisanum*, the tracheid is more apparent in *D. cilicicum*, sclerenchymatic cells of bundles are similar in both taxa, and pith region is wide in both taxa, cells are round, oval or polygonal, and there are starch grains in stem cross sections.

Anatomical studies have shown that the fruits of both taxa are very close, have two seeds, fruit walls are prominent and wide, and furthermore, and have starch grains in cross-section of the wall. Flowers of both taxa are very close, however, sepal of *D. petrodavisanum* is thicker than *D. cilicicum*, and the petal of *D. cilicicum* is thicker than *D. petrodavisanum*.

Palyнологical studies on pollen have revealed that the pollen type of both *Delphinium* species is monad, the aperture type is tricolpate, and pollen shape is oblate-spheroidal. In both species, Polar axis (P) and Equatorial axis (E) dimensions are very similar, AMB shape is triangular, exine structure is tectate and exine is scabrate-perforate, clg, clt, amb diameters, intercolpus distance, intine and exine thicknesses are very close.

Micromorphological studies on fruit and seed have revealed that fruits of *D. cilicicum* and *D. petrodavisanum* are follicular and globose. In both species, seeds are two per fruit; brown and sub-pyramidal, dimensions are very close. The seed surface has longitudinal papillary rectangular cells with a scaly surface and fine-grained ornamentation. However, fine wings are not observed, both species are similar in terms of fruit and seed.

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