

MORPHOLOGICAL AND ANATOMICAL INVESTIGATIONS ON SOME SPECIES OF *COLCHICUM* L.

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Abstract

Some morphological and anatomical characteristics of *Colchicum szovitsii* Fisch. & Mey., *C. triphyllum* G. Kunze, *C. burtii* Meikle (endemic), *C. umbrosum* Steven and *C. bornmuelleri* Freyn (endemic) were observed. The specimens were collected from Eskişehir, Central Anatolia. The determination of the anatomical characteristics present the first data available in the literature. In anatomical studies, transverse sections of leaf and root have been examined.

Introduction

The genus *Colchicum* L. in its most inclusive sense (incl. *Merendera* Ramond and *Bulbocodium* L.) includes c. 90 species, which are very unevenly distributed in data references. The Balkan Peninsula is very rich in these species, though the majority of them are centered in Greece (30 species including The Aegean Islands). Only Turkey has more species (Baytop 1987). The high species frequency and endemics (c. 35%) of *Colchicum* (incl. *Merendera* Ramond) in Turkey indicates this region as a major centre of diversity and speciation of the genus (Persson 1999-2001, Akan and Fatil 2005).

Colchicum was given its scientific name because of the large number of species are growing in the Kolshik region of the Eastern Black Sea (Baytop and Mathew 1984). Some sources give the Turkish name of *Colchicum* as 'Acı çiğdem' (Bowles 1952, Baytop 1994).

In the *Colchicum* species there are two alkaloids: colchicine and democolchine. These are known since ancient times, and their biological efficiency applies to a wide range of fields. The colchicine alkaloids were first extracted from the plant's corms in the 17th century, and then from the plants' seeds in the 18th century. They were used as medicines, particularly as pain killers in the treatment of gout and rheumatism (Çelebioğlu 1949, Fell and Ramsden 1967, Baytop 1999). There have been no reports to date including the anatomical data on some *Colchicum* species growing in Turkey.

In the present study, the anatomical characters of the different parts of *C. szovitsii* Fisch., *C. triphyllum* G. Kunze, *C. burtii* Meikle (endemic), *C. umbrosum* Steven and *C. bornmuelleri* Freyn growing in Turkey were recorded to contribute to the Flora of Turkey.

Materials and Methods

Plant materials were collected from four different localities in Eskişehir and they were identified as herbarium materials. The specimens were stored at Eskişehir Osmangazi University Herbarium (OUFE). Identification was made according to Flora of Turkey (Persson 2000). Five

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samples of each specimens were measured for morphological studies. Their general apperances, internal and external segments, ginekeum, stamen and pistils were drawn using a Wild M5A stereomicroscope.

For anatomical studies, samples were collected from plantation areas and preseved in 70% alcohol. The root, stem and leaves of the mature and flowered plants were used. Investigations were performed on the cross-section and surface section of the leaves and cross-sections of the flowering stem from the middle area. These sections were pointed by Sartur reagent and then covered with glycerin-gelatin. The anatomical structures of the roots and leaves were drawn using a Leitz SM-LUX binocular microscope. In anatomical studies, an Olympus BX 51 trinocular microscope and a digital camera were used.

C. szovitsii Fisch. & Mey. B3 Eskişehir: Seyitgazi-Şükranlı around, N 39° 22' 96.7"-E 30° 70' 30.9", 1237 m, 12.ii.2010, OUFE 16430. *C. triphyllum* G. Kunze B3 Eskişehir: Seyitgazi-Cevizli road, N 39° 40' 05.3"-E 30° 71' 11.0"-E, 1186 m, 12.ii.2010, OUFE 16431. *C. burtii* Meikle B3 Eskişehir: Seyitgazi-Gökçeğüney road, N 39° 19' 47.6"-E 30° 69' 0.1"-E 1234 m, 12.ii.2010, OUFE 16432. *C. umbrosum* Steven B3 Eskişehir: Türkmen Dağı-Gölcükyayla-Çobançeşmesi around, N 39° 47' 05.5"-E 30° 34' 58.0", 1619 m, 19.iii.2010, OUFE 16433. *C. bornmuelleri* Freyn B3 Eskişehir: Seyitgazi-Bardakçı road, N 39° 32' 60.0"-E 30° 79' 54.6", 1042 m, 12.ii.2010, OUFE 16434.

Results and Discussion

This study was aimed at comparing the morphological and anatomical features of the 5 species with a view to establishing further proof of their taxonomical identity. The illustrations of each species are shown in Figs 1 - 5. The morphological differences between the species are summarized in Table 1.

Descriptions of the taxa have been defined in more detail than those in Flora of Turkey and also lacking the knowledge on the properties habit and perianth have been completed. On the other hand, all detailed figures which help to define the taxa have been given first time in this study.

The epidermis is composed of a single layer of cells. It is covered with a thin or thick cuticle. There are 1 - 2 exodermis under the epidermis. The cortex, located immediately under the exodermis, is 3 - 7 layered and consists of large hexagonal or polyhedral parenchymatous cells. The endodermis is located under the cortex tissue and are rectangular cells. The pericycle is below the endodermis. The central part has vascular bundles with clearly differantiable xylem and phloem. The metaxylem is located in the centre of vascular bundle (Figs 6, 8, 10, 12, 14,16-20), (Table 2).

In the cross-section of the leaves, the cuticle is on the outer layer and it was determined that the upper and lower epidermis layers are similar. The epidermis cells are isodiametric and oval. The outside walls are thicker than the internal and lateral walls. Both epidermal surfaces are covered with thick or thin cuticle. The stomata is anomocytic type and located slightly upper than the epidermal cells level. The leaf is isolateral. The palisade parenchymatic cells are 2 - 4 layered, with chloroplast in abundance. The spongy parenchymatic cells are 1 - 4 layered. The vascular bundle is collateral type. The xylem is towards the upper surface and the phloem towards the lower surface (Figs 7, 9, 11, 13, 15 - 20), (Table 3).

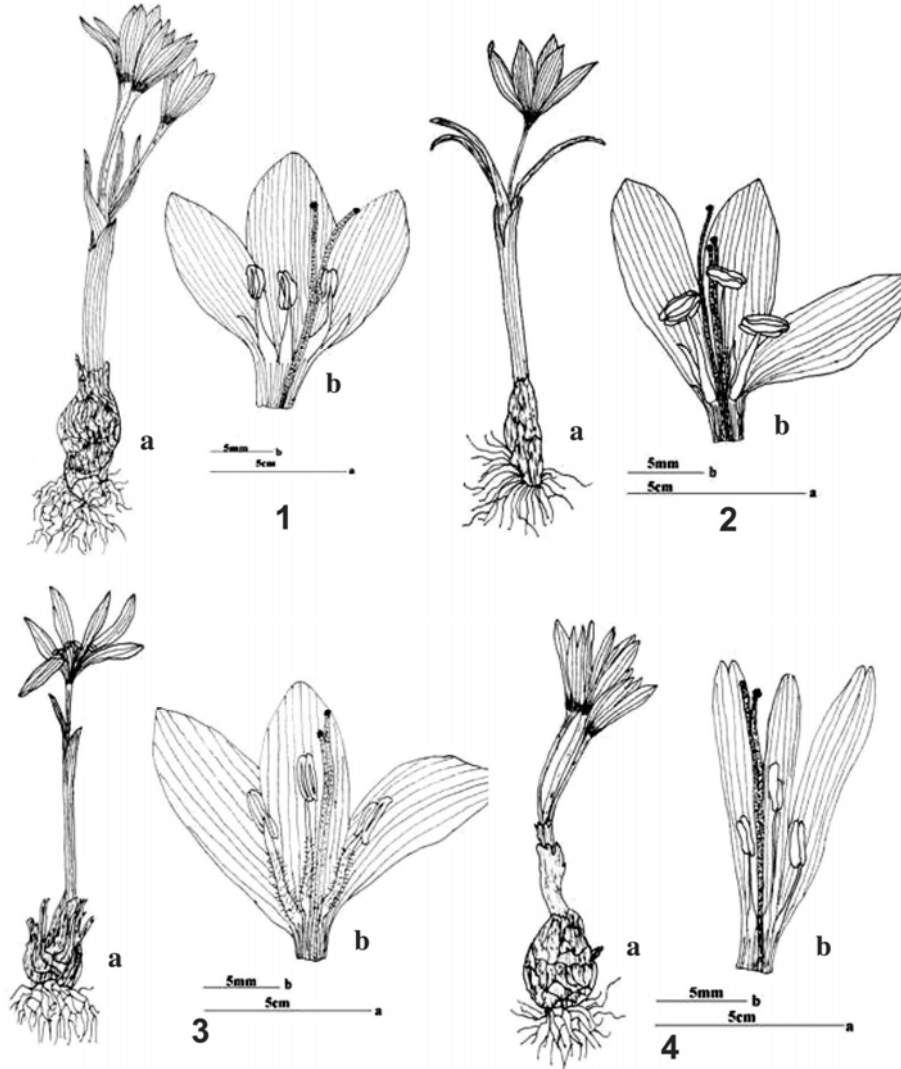
Among the five species included in this study, two (*C. burtii* and *C. bornmuelleri*) were endemic (Davis 1984).

The morphological findings in quantitative morphological data are mostly similar to the relevant descriptions in the Flora of Turkey. But some of our findings are different from that book and these discrepancies are presented in Table 1. As seen in the table, the dimensions of the corms

Table 1. The comparison of morphological characteristic between present study and Flora of Turkey with respect to *Colchicum* species.

	Flora of Turkey Present study	Flora of Turkey Present study	Flora of Turkey Present study	Flora of Turkey Present study	Flora of Turkey Present study	Flora of Turkey Present study	Flora of Turkey Present study	Flora of Turkey Present study	Flora of Turkey Present study
	Flora of Turkey Present study	Flora of Turkey Present study	Flora of Turkey Present study	Flora of Turkey Present study	Flora of Turkey Present study	Flora of Turkey Present study	Flora of Turkey Present study	Flora of Turkey Present study	Flora of Turkey Present study
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	Flora of Turkey Present study	Flora of Turkey Present study	Flora of Turkey Present study	Flora of Turkey Present study	Flora of Turkey Present study	Flora of Turkey Present study	Flora of Turkey Present study	Flora of Turkey Present study	Flora of Turkey Present study
<i>C. szovitsii</i>	Flora of Turkey Present study	Flora of Turkey Present study	Flora of Turkey Present study	Flora of Turkey Present study	Flora of Turkey Present study	Flora of Turkey Present study	Flora of Turkey Present study	Flora of Turkey Present study	Flora of Turkey Present study
	1.5-3 (-4) × (1)-2-3	2-3	(12-) 16-21 (-25) × (1)-2-3,5	(1-) 2-5 (-7)	2-3	2-3	2-3	2-3	2-3
<i>C. triphyllum</i>	Flora of Turkey Present study	Flora of Turkey Present study	Flora of Turkey Present study	Flora of Turkey Present study	Flora of Turkey Present study	Flora of Turkey Present study	Flora of Turkey Present study	Flora of Turkey Present study	Flora of Turkey Present study
	2.5-4 × 2-1,5	2-3	(5-) 12-17 × 1-2,5	3-4	2-3	2-3	2-3	2-3	2-3
<i>C. burtii</i>	Flora of Turkey Present study	Flora of Turkey Present study	Flora of Turkey Present study	Flora of Turkey Present study	Flora of Turkey Present study	Flora of Turkey Present study	Flora of Turkey Present study	Flora of Turkey Present study	Flora of Turkey Present study
	1.5-2(-2.5) × 1-1,5	3 (-4)	11-15 × 0.5-0.8 (-1,2)	1-4 (-6)	3 (-4)	3 (-4)	3 (-4)	3 (-4)	3 (-4)
	2-1.5 × 1	3	(3,5-) 7-10 × 0.2- 0.3-0.5-07	2-4	3	3	3	3	3
	3-5 × 1.5-2	(2-) 3(-4)	10-15 × 0.8-1	1-3 (-4)	(2-) 3(-4)	(2-) 3(-4)	(2-) 3(-4)	(2-) 3(-4)	(2-) 3(-4)
<i>C. umbrosum</i>	Flora of Turkey Present study	Flora of Turkey Present study	Flora of Turkey Present study	Flora of Turkey Present study	Flora of Turkey Present study	Flora of Turkey Present study	Flora of Turkey Present study	Flora of Turkey Present study	Flora of Turkey Present study
	1.5-2.2 × 1-1,7	2-3	(2,5-) 5-6 × 0.3-0.7	1-3	2-3	2-3	2-3	2-3	2-3
	1.5-3 × 1.2-2.5	3-4 (-5)	(8-) 12-15 (-17) × (-1) 1,3-2(-2,7)	1-3(-6)	3-4 (-5)	3-4 (-5)	3-4 (-5)	3-4 (-5)	3-4 (-5)
<i>C. bornmuelleri</i>	Flora of Turkey Present study	Flora of Turkey Present study	Flora of Turkey Present study	Flora of Turkey Present study	Flora of Turkey Present study	Flora of Turkey Present study	Flora of Turkey Present study	Flora of Turkey Present study	Flora of Turkey Present study
	2 × 1-2	3-4	(5-) 7-10 × 0.5-1-2	1-4	3-4	3-4	3-4	3-4	3-4
	2.5-4.5 × 2.5-4	3-4	17-25 × 2.6-4.5	1-3 (-6)	3-4	3-4	3-4	3-4	3-4
	4-5 × 2-3	4-6	(9,5-) 10-19 × 4-5.5	1-4	4-6	4-6	4-6	4-6	4-6

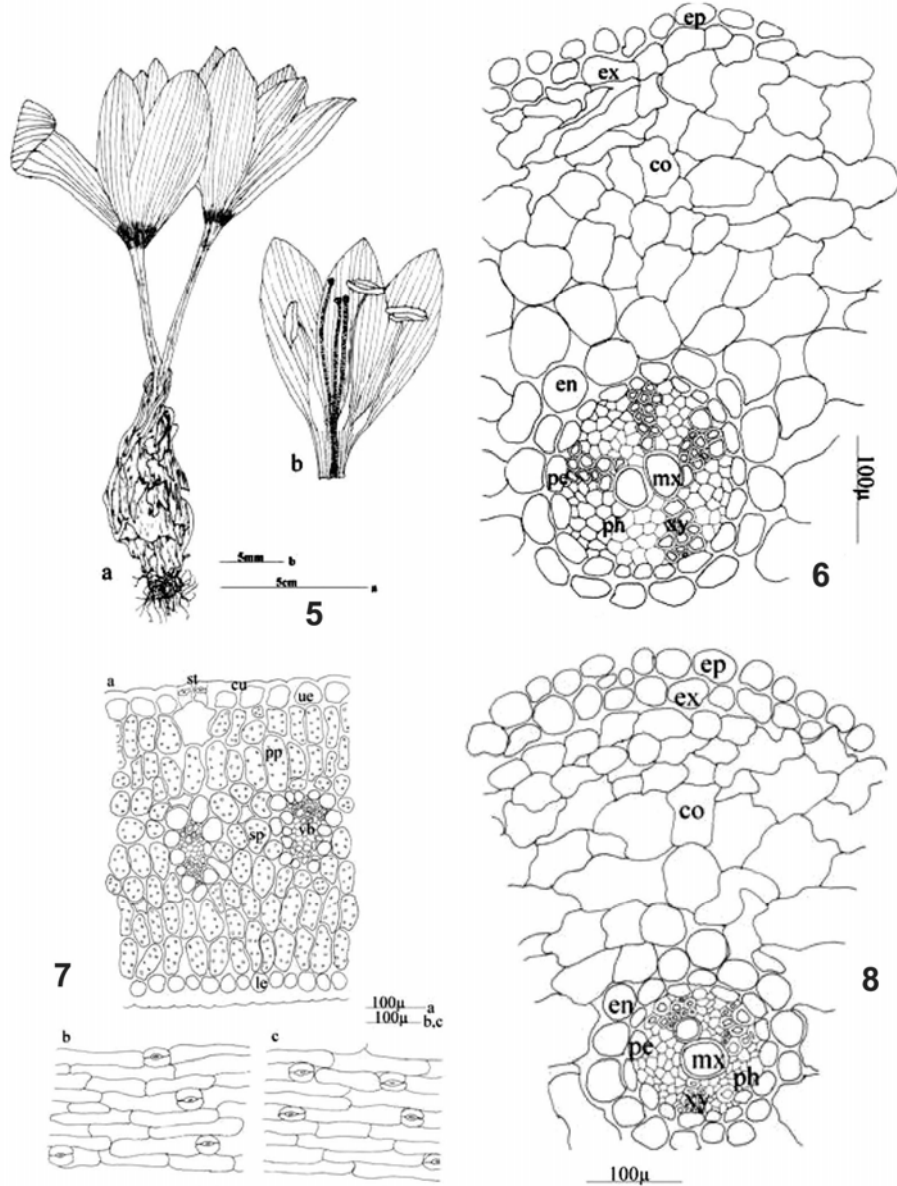
are not same as those given in Flora of Turkey. According to our results, leaf length specially show remarkable differences among the species. Because of the morphological similarities the definition of diagnostic characters has difficulties. This situation is in general accordance with previous reports stating taxonomic problems of this genus (Davis 1984). Our research shows that despite a limited area coverage, morphological results Davis's (Davis 1984) compatible with the findings of a variation limit.



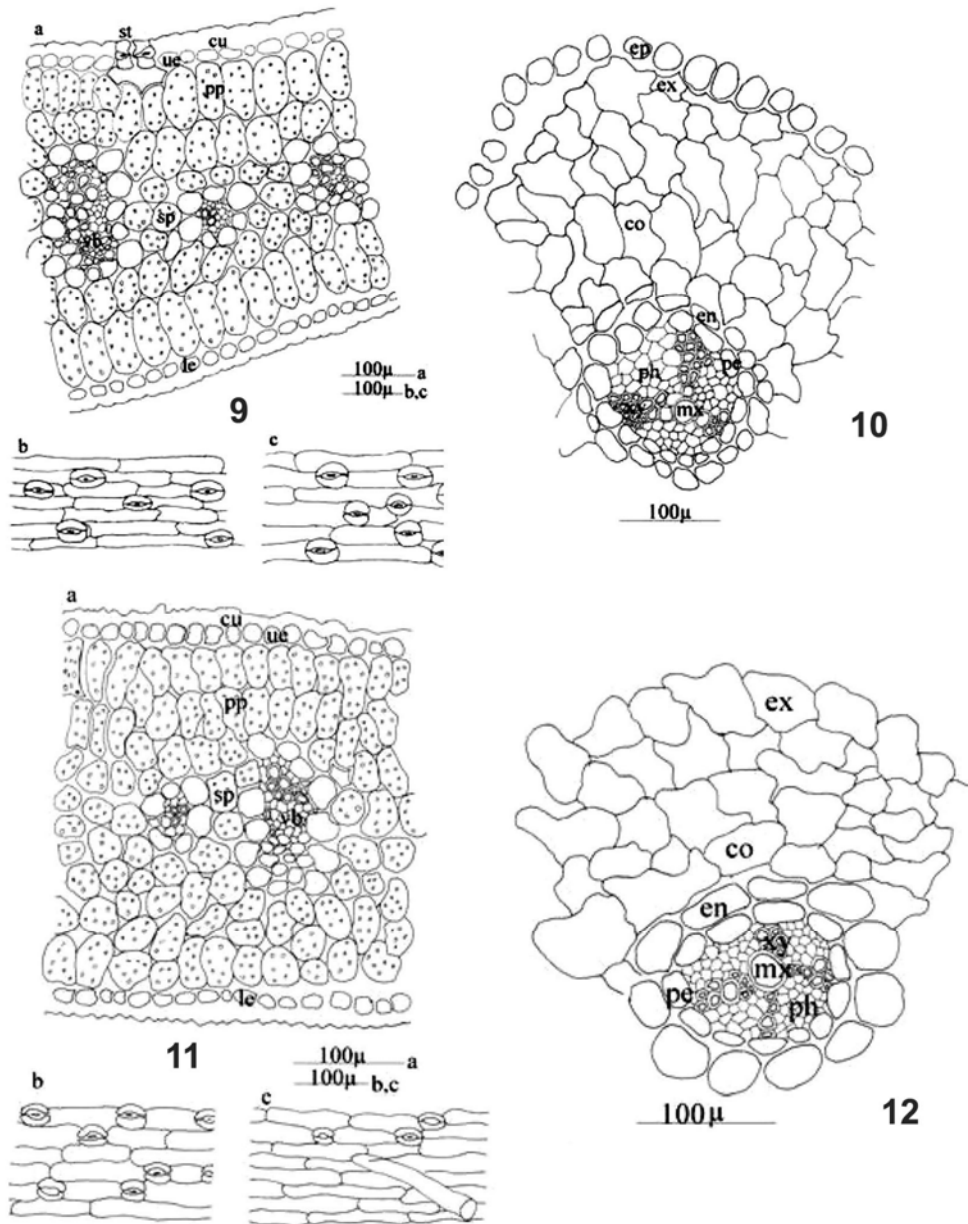
Figs 1-4: 1. *Colchicum szovitsii*: (a) habit, (b) perianth. 2. *Colchicum triphyllum*: (a) habit, (b) perianth. 3. *Colchicum burtii*: (a) habit, (b) perianth. 4. *Colchicum umbrosum*: (a) habit, (b) perianth.

The morphological and anatomical structures of the *C. triphyllum*, *C. burtii*, *C. umbrosum* and *C. bornmuelleri* are described in our study. The morphological measurements of the *C. szovitsii* is similar to that of given in the Flora of Turkey (Davis 1984). The cortex in the radix has 3 - 7

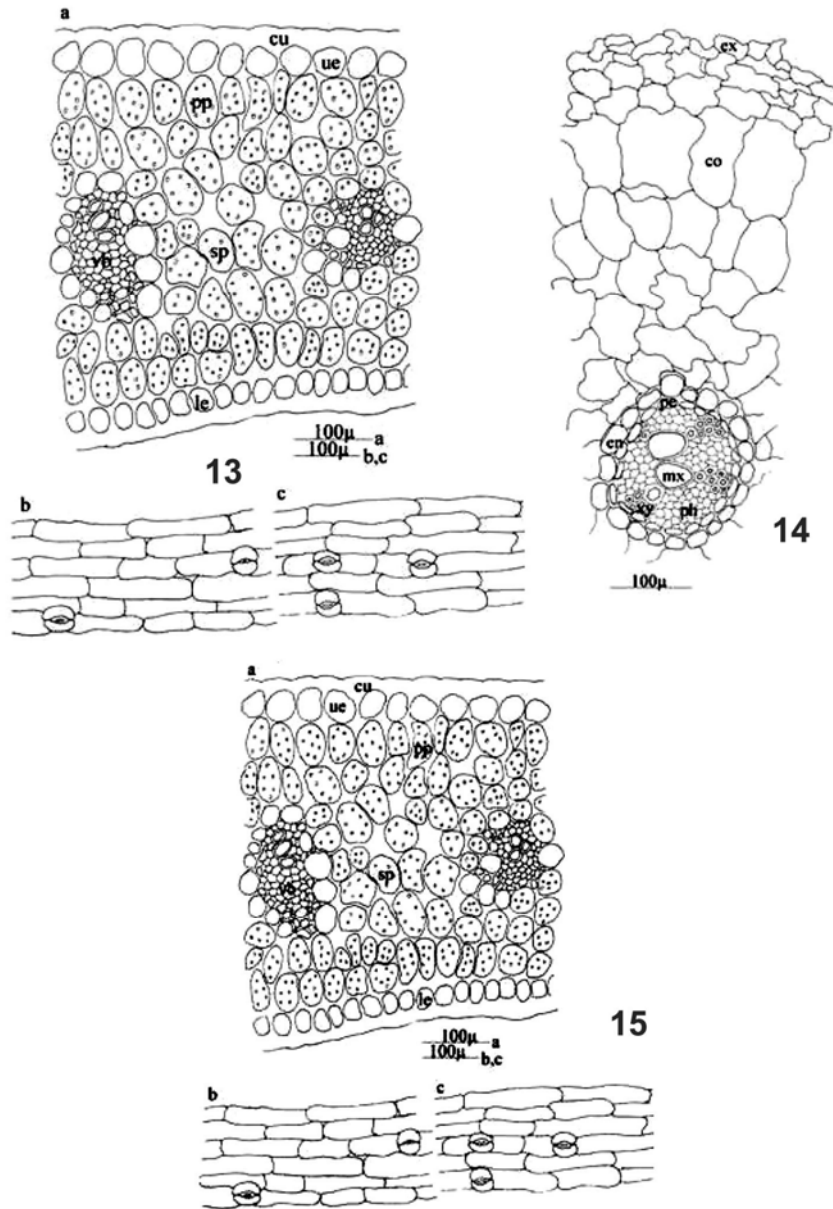
layers and it shows differences among the species. In *C. burtii* we observed rafid crystals. The xylem is tetrark in *C. szovitsii*, *C. umbrosum* and *C. bornmuelleri* but it is triarc in the remaining two species. Metaxylem is 1 in *C. burtii* and *C. umbrosum* while it is 2 in the other three species.



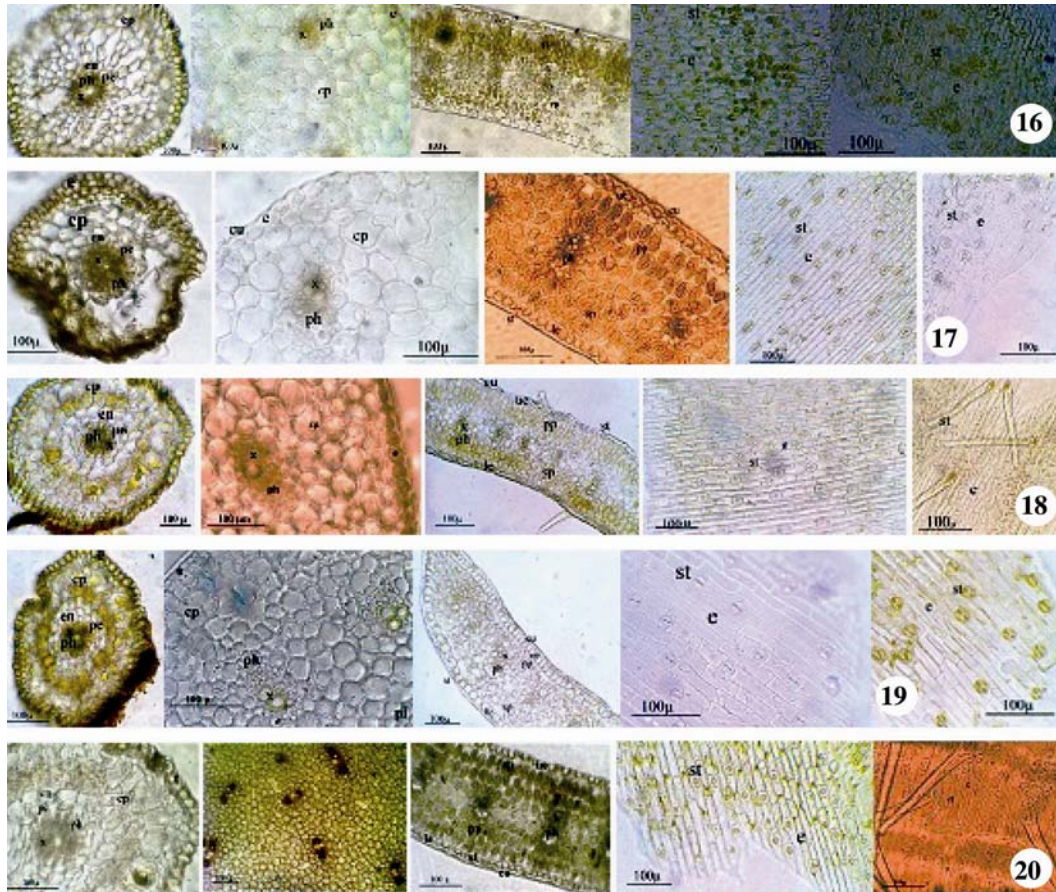
Figs 5-8: 5. *Colchicum bornmuellerii*: (a) habit, (b) perianth. 6. *Colchicum szovitsii*: Cross section of root. ep- epidermis, ex- exodermis, co- cortex, en- endodermis, pe- peryscl, ph- phloem, xy- xylem, mx- metaxylem, 7. *Colchicum szovitsii*: Cross-section of leaf, b: A view of the stomata from upper epidermal peelings, c: A view of the stomata from lower epidermal peelings; cu- cuticula, ue- upper epidermis, st- stomata, pp- palisade parenchyma, sp- spongy parenchyma, vb- vascular bundle, le- lower epidermis. 8. *Colchicum triphyllum*: Cross-section of root; ep- epidermis, ex- exodermis, co- cortex, en- endodermis, pe- peryscl, ph- phloem, xy- xylem and mx- metaxylem.



Figs 9-12: 9. *Colchicum triphyllum*: Cross section of leaf, b: A view of the stomata from upper epidermal peelings. c: A view of the stomata from lower epidermal peelings. cu- cuticula, ue- upper epidermis, st- stomata, pp- palisade parenchyma, sp- spongy parenchyma, vb- vascular bundle, le- lower epidermis. 10. *Colchicum burtii*: Cross section of root. ep- epidermis, ex- exodermis, co- cortex, en- endodermis, pe- peryscl, ph- phloem, xy- xylem, mx- metaxylem. 11. *Colchicum burtii*: a: Cross section of leaf. b: A view of the stomata from upper epidermal peelings; c: A view of the stomata from lower epidermal peelings. cu- cuticula, ue- upper epidermis, st- stomata, pp- palisade parenchyma, sp- spongy parenchyma, vb- vascular bundle, le- lower epidermis. 12. *Colchicum umbrosum*: Cross section of root. ex- exodermis, co- cortex, en- endodermis, pe- peryscl, ph- phloem, xy- xylem and mx- metaxylem.



Figs 13-15: 13. *Colchicum umbrosum*: Cross section of leaf, b: A view of the stomata from upper epidermal peelings. c: A view of the stomata from lower epidermal peelings. cu- cuticula, ue- upper epidermis, st- stomata, pp- palisade parenchyma, sp- spongy parenchyma, vb- vascular bundle, le- lower epidermis. 14. *Colchicum bornmuelleri*: Cross section of root. ex- exodermis, co- cortex, en- endodermis, pe- peryscl, ph- phloem, xy- xylem, mx- metaxylem. 15. *Colchicum bornmuelleri*: Cross-section of leaf, b: A view of the stomata from upper epidermal peelings; c: A view of the stomata from lower epidermal peelings; cu-ncuticula, ue- upper epidermis, st- stomata, pp- palisade parenchyma, sp- spongy parenchyma, vb- vascular bundle, le- lower epidermis.



Figs 16-20: 16. *Colchicum szovitsii*: Cross section of root, stem, leaf, upper surface section of the leaf, lower surface section of the leaf. 17. *Colchicum triphyllum*: Cross section of root, stem, leaf, upper surface section of the leaf, lower surface section of the leaf. 18. *Colchicum burtii*: Cross section of root, stem, leaf, upper surface section of the leaf, lower surface section of the leaf. 19. *Colchicum umbrosum*: Cross section of root, stem, leaf, upper surface section of the leaf, lower surface section of the leaf. 20. *Colchicum bornmuelleri*: Cross section of root, stem, leaf, upper surface section of the leaf, lower surface section of the leaf.

Table 2. The comparison of anatomical characteristics of root in *Colchicum* species.

	Exodermis	Cortex	Raphide crystal	Xylem	Metaxylem
<i>C. szovitsii</i>	1 - 2 layered	4 - 7 layered	Absent	Tetraarch	2
<i>C. triphyllum</i>	1 - 2 "	4 - 6 "	"	Triarch	2
<i>C. burtii</i>	1 - 2 "	4 - 5 "	Present	"	1
<i>C. umbrosum</i>	Absent	3 - 6 "	"	Tetraarch	1
<i>C. bornmuelleri</i>	1 - 2 layered	5 - 6 "	"	"	2

In the root cortex of all species, round paranchima cells with disordered cell wall were observed. There were also lots of intercellular spaces among the cells in the cortex. The vascular bundles were in large number and scattered. The central cylinder consisted of a thin cell wall and irregular rounded cells.

The leaf mesophyll in all the taxa was isolateral, anamostic stomata and collateral vascular bundles. Also, the upper epidermal cells were larger than basal cells. The number of palisade and spongy parenchyma cells was different among the species.

Table 3. The comparison of anatomical characteristics of leaf in *Colchicum* species.

	Cuticle	Stomata type	Leaf type	Palisade parenchyma	Spongy parenchyma	Vascular bundle type
<i>C. szovitsii</i>	Thick	Anomocytic	Isolateral	2-3 layered	3-4 layered	Collateral
<i>C. triphyllum</i>	Thin	"	"	2-3 "	3-4 "	"
<i>C. burtii</i>	"	"	"	2-4 "	2-4 "	"
<i>C. umbrosum</i>	"	"	"	2-3 "	2-3 "	"
<i>C. bornmuelleri</i>	Thick	"	"	2-3 "	1-2 "	"

Our observations on *C. szovitsii* were mostly similar to that of the previous study, but in this study, triarc xylem, cortex with 4-5 cell layered and more cells in mesophyll were found additionally (Akan and Fatil 2005). In the red data book (Ekim *et al.* 2000) the endemic species *C. bornmuelleri* and *C. burtii* fall into the LR category (Lc). The results of this study might contribute to the Flora of Turkey.

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