

## SOME ANATOMICAL ASPECTS OF *TROLLIUS EUROPAEUS* L.

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**Abstract.** *Trollius europaeus* L. or 'the Globe-flower' is a perennial plant from Ranunculaceae family, which flowers between June and August. The roots are thin and show a primary structure. The central cylinder bears 4 xylem bundles (formed of vessels of various dimensions with very thickened and lignified walls) and 4 phloem bundles. The vascular bundles belonging to the stem, petiole and leaf of the analyzed exemplars of *Trollius europaeus* show similar anatomic characteristics. The foliar limb is hypostomatic, with bifacial-heterofacial structure and normal dorsiventrality.

**Keywords:** *Trollius europaeus* L., morphology, anatomy of vegetative organs.

**Rezumat. Aspecte morfo-anatomice la *Trollius europaeus* L.** *Trollius europaeus* L. sau "bulbuci" este o plantă perenă din familia Ranunculaceae a cărei floare persistă din iunie până în august. Rădăcinile sunt subțiri și au structură primară. Cilindrul central conține 4 fascicule de lemn (formate din vase de lemn de dimensiuni diferite, cu pereți îngroșați și lignificați) și 4 fascicule de liber. Fasciculele conducătoare din tulpină, pețiol și limbul foliar de la exemplarele analizate de *Trollius europaeus* L. prezintă structură asemănătoare. Limbul foliar este hipostomatic, cu structură bifacială-heterofacială și dorsiventralitate normală.

**Cuvinte cheie:** *Trollius europaeus* L., morfologie, anatomia organelor vegetative.

### INTRODUCTION

Few aspects are known about *Trollius europaeus* L.; studies regarding morphology, anatomy, interactions with its pollinators, vegetal associations where this species is present were made. *T. europaeus* or 'the Globe-flower' is a perennial plant from Ranunculaceae family. The stem bears leaves deeply divided into 3-5 toothed lobes and a yellow, globe-shaped flower; the tepals have nectaries at their base and a large number of stamens, which is typically for the family. Each flower produces a large number of follicles. It grows in damp ground in shady areas, woodland and scrub; it flowers between June and August. It is slightly poisonous and is purgative and rubefacient when used fresh (CIOCARLAN, 2000; OPREA, 2005; TIȚĂ, 2008; ZANOSCHI et al., 1981).

In a comparison between *Primula veris* and *T. europaeus* regarding seed germination behaviors, it was settled that seeds buried in soil and exhumed at irregular intervals showed that primary seed dormancy was overcome by cold-stratification. *T. europaeus* seeds germinated equally well in darkness and in light, so they could germinate even when they are deep in the soil; after 16 months burial, only 8% of the seed remained viable (MILBERG, 1994). Then there was another study (HITCHMOUGH et al., 2000) which investigated the efficacy of pre-sowing treatments in dormancy in wild collected and cultivated genotypes of *T. europaeus* and a cultivated hybrid.

Pollination by seed parasites was discovered and studied in *T. europaeus* (PELLMYR, 1989); the author explained the ratio costs/benefits in the mutualism based on seed parasites as pollinators.

*T. europaeus* was mentioned in studies regarding vegetal associations in the Bistrita Mountains (MARDARI, 2008). METCALFE & CHALK (1972) explained numerous anatomic aspects regarding Ranunculaceae species, while FILIPESCU (1969) showed some anatomic features of *T. europaeus* and *Isopyrum thalictroides*.

### MATERIAL AND METHODS

The analyzed material is represented by samples of *Trollium europaeus* L. harvested the Bistrita Mountains. The material was first preserved in ethylic alcohol 70%. The sections were cut manually, using microtome and elder pith as support. The histological sections were washed in sodium hypochlorite, then in acetic acid (in order to eliminate the cellular content) and distillate water. The sections were coloured with iodine green (1 minute), washed in 90% ethylic alcohol and distilled water then coloured with ruthenium red (1 minute) and again washed in distilled water. In order to obtain the permanent slides, the histological sections were mounted in glycerol-gelatine drops; then they were analyzed in Optika light microscope. The light micrographs were performed by using a Canon A540 camera.

### RESULTS AND DISCUSSIONS

The roots are quite thin and show a primary structure in cross section (Fig. 1), with known anatomic regions: rhizodermis, cortical parenchyma, and central cylinder. Rhizodermis bears big cells (Fig. 2), with very thick and suberified external walls. The cortex is divided into exodermis, cortical parenchyma, and endodermis. The exodermis consists of cells with the walls a little bit thicker than the walls of the cells belonging to the cortical parenchyma. This latter is quite thick (10-12 layers); its component cells are big and bear cellulosed walls. The cortex ends in a primary type endodermis made by flattened cells, which present casparian thickenings in their lateral walls. The central cylinder (Fig. 3) starts with a pericycle which consists of small isodiametric cells. In the fundamental parenchyma of the central

cylinder 4 xylem bundles (formed of vessels of various dimensions with very thickened and lignified walls) and 4 phloem bundles are present.

The plant has a tall stem, of almost 60 cm. The cross section through its middle region shows a circular profile (Fig. 4). Epidermis consists of isodiametric cells (Fig. 5), having the external wall covered by a thin cuticle. Here and there, small stomata are present. The cortex shows a thin parenchymatic region which consists of 7-8 layers of cells with thin, cellulosed walls. The first 2 layers closed to the epidermis are collenchymatised, presenting tangential collenchyma. There are, also, a few channels in the cortex (Fig. 5), of various dimensions, surrounded by flattened cells. The central cylinder bears numerous vascular bundles (almost 35-40), of various dimensions (Fig. 6). The xylem has numerous vessels of various dimensions (Figs. 7 and 8), with quite thin, but lignified walls; the smaller vessels have less thickened walls and are surrounded by cellulosed parenchyma. The phloem consists of small elements, clustered like a circular mass in cross section. The entire xylemic mass is concave on the side towards the phloem, so the latter is often partly surrounded by xylem (METCALFE & CHALK, 1972). At the opposite part of the xylem, the sclerenchymatic fibers of the pericycle group adjoin the phloem, like a strong sheath made by fibers with thickened and strongly lignified walls. Usually, the sclerenchymatic sheath is bigger than the phloemic mass. All vascular bundles are embedded in a parenchymatic region (17-20 layers), which consists of cells with lignified walls; the cells closed to the bundles are small and become bigger as they are away from the bundles. The pith is parenchymatous, disorganized in a central hollow.

The petiole of the leaf has a circular profile in cross section (Fig. 9). The epidermis consists of high cells, having the external wall covered by thin cuticle and small stomata (Fig. 10). The cortex is thick, lacunary type, with lacunae of various dimensions. The first 2-3 layers near the epidermis present angular collenchyma. The collaterally-closed vascular bundles are numerous (21-34), of various dimensions (Figs. 11-13), disposed on a ring. The xylemic vessels have thick walls, strongly lignified; the smaller vessels are embedded in a cellulosed parenchyma. The outer pole of the xylemic part shows a thick parenchymatic region, with angular collenchyma. The phloemic elements are grouped as a circular mass, in cross section, as we mentioned above when talking about the bundles of the stem. At the phloemic pole, a few sclerenchymatic elements are present, having thickened and lignified walls, no matter the dimension of the vascular bundle.

In front side view, the epidermis shows polygonal cells with sinuous walls (in the upper epidermis - Fig. 14) or strongly waved walls (in the lower epidermis - Fig. 15). Stomata are present only in the lower epidermis, so the limb is hypostomatic.

The leaves are deeply divided into 3-5 toothed lobes. The cross section through the foliar limb shows a linear profile (Fig. 16). Both epidermises consist of polygonal cells, having the external walls covered by thin cuticle. The cells belonging to the upper epidermis are big, similar to the bulliform cells. Stomata are present in the lower epidermis. The mesophyll is differentiated into palisade tissue toward the upper epidermis, formed by high cells and lacunary tissue toward the lower one, so the foliar limb has a bifacial-heterofacial structure, with normal dorsiventrality. The palisade tissue consists of two layers of high cells; their dimension is decreasing towards the lacunary tissue, which has very big lacunae (Fig. 22). There are numerous vascular bundles, of various dimensions (Figs. 17, 18); the one present in the middle vein is the biggest one. Their structure is similar to that of the bundles, which belong to the petiole and to the stem; each bundle has well developed xylem and phloem; only a few of them show 2-3 sclerenchymatic fibers at the phloemic pole; only the bigger bundles show angular collenchyma at both xylemic and phloemic poles (Figs. 19, 20), as if the bundles were anchored between both epidermis. All the vascular bundles are surrounded by a parenchymatic sheath (Fig. 21) composed by 1-2 layers of cells.

## CONCLUSIONS

The cross section through the root shows a primary structure. The central cylinder bears 4 xylem bundles (formed of vessels of various dimensions with very thickened and lignified walls) and 4 phloem bundles.

The vascular bundles belonging to the stem, petiole and leaf of the analyzed exemplars of *Trollius europaeus* show similar anatomic characteristics. The foliar limb is hypostomatic, with bifacial-heterofacial structure and normal dorsiventrality.

## ACKNOWLEDGEMENTS

The research was supported by financial resources of PNCDI II Programme no. 52-174/2008: "The refinement of the spontaneous flora biodiversity of Romania, in order to increase the varieties of ornamental plants (BIODIVDECOR)".



Fig. 1

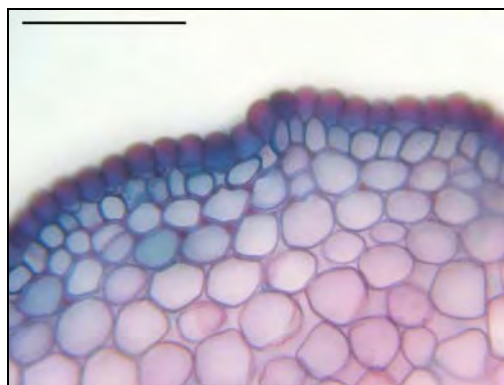


Fig. 2



Fig. 3



Fig. 4

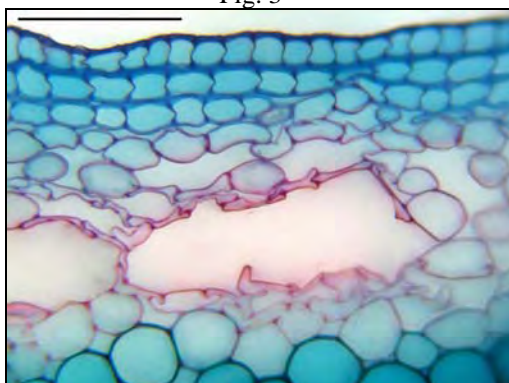


Fig. 5

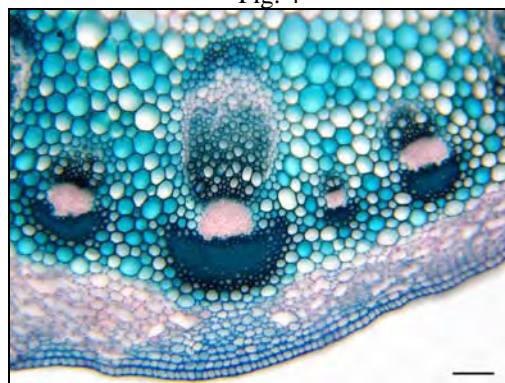


Fig. 6

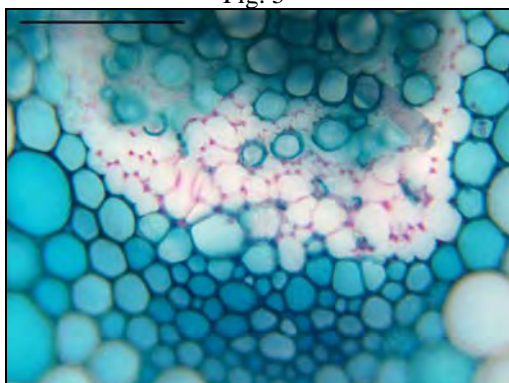


Fig. 7

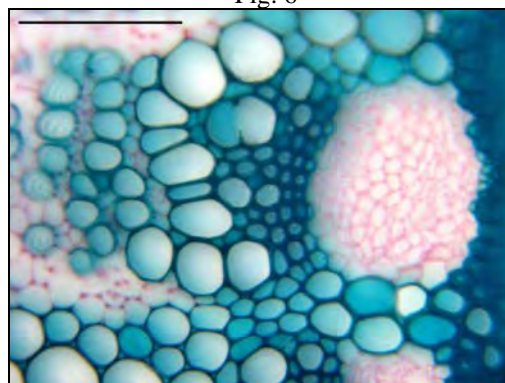


Fig. 8

Figure. 1. Cross section through the root. / Figura 1. Secțiune transversală prin rădăcină (original).

Figure 2. Rhizodermis and cortical parenchyma. / Figura 2. Rizoderma și parenchimul cortical (original).

Figure 3. Central cylinder of the root. / Figura 3. Cilindrul central al rădăcinii (original).

Figure 4. Cross section through the stem (middle level). / Figura 4. Secțiune transversală prin tulpină (regiunea mediană) (original).

Figure 5. Secretory channels in the cortex of the stem. / Figura 5. Canale secretoare în scoarța tulpinii (original).

Figure 6. Vascular bundles of various dimensions. / Figura 6. Fascicule conducătoare de dimensiuni diferite (original).

Figures. 7 and 8. Aspects of a single vascular bundle. / Figurile 7 și 8. Aspecte ale unui singur fascicul conducător (original).





Fig. 9

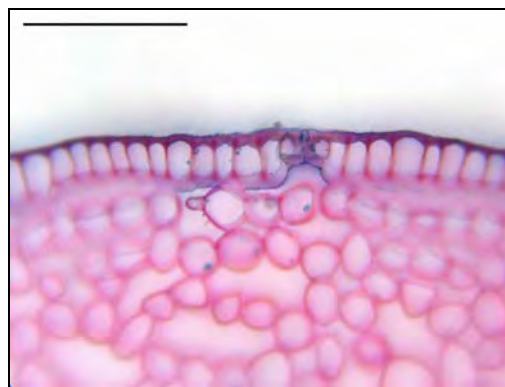


Fig. 10

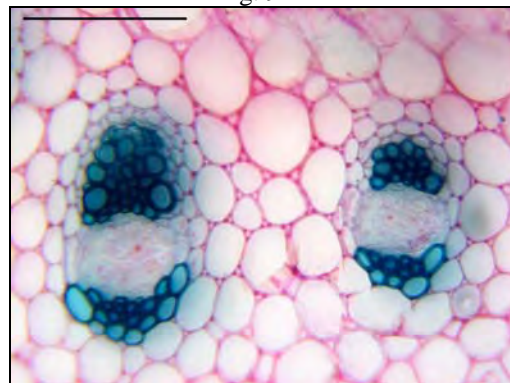


Fig. 11

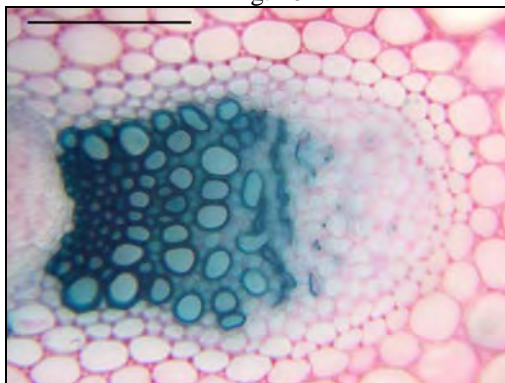


Fig. 12



Fig. 13

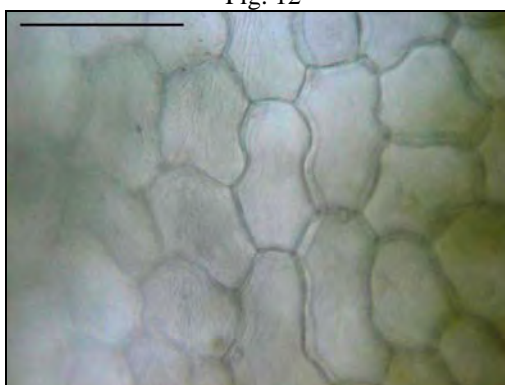


Fig. 14

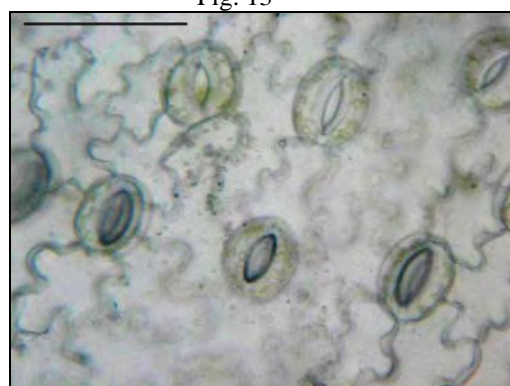


Fig. 15

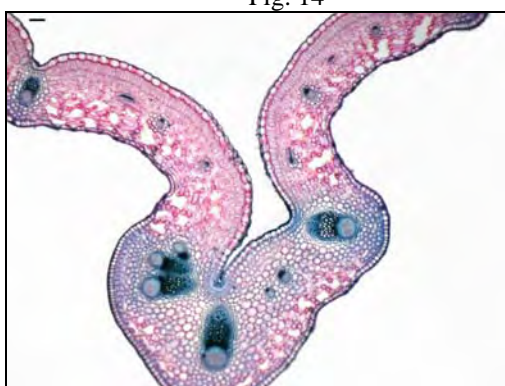


Fig. 16

Figure 9. Cross section through the petiole of the leaf. / Figura 9. Secțiune transversală prin pețiolul frunzei (original).  
 Figure 10. Epidermis and fundamental parenchyma of the petiole. / Figura 10. Epiderma și parenchimul fundamental al pețiolului (original). / Figures 11-13. Vascular bundles. / Figurile 11-13. Fascicule conducătoare (original).  
 Figure 14. Upper epidermis in front side view. / Figura 14. Epidermia superioară a limbului foliar văzută de față (original).  
 Figure 15. Lower epidermis in front side view. / Figura 15. Epiderma inferioară a limbului foliar văzută de față (original).  
 Figure 16. Cross section through the foliar limb. / Figura 16. Secțiune transversală prin limbul foliar (original).



Fig. 17

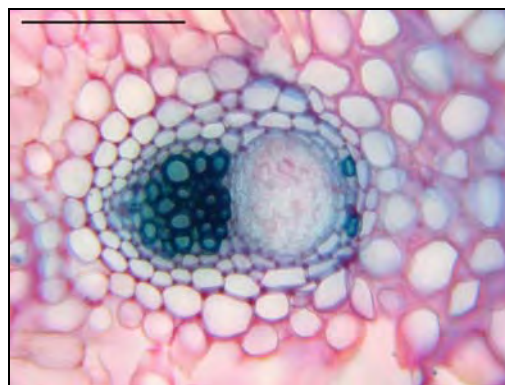


Fig. 18

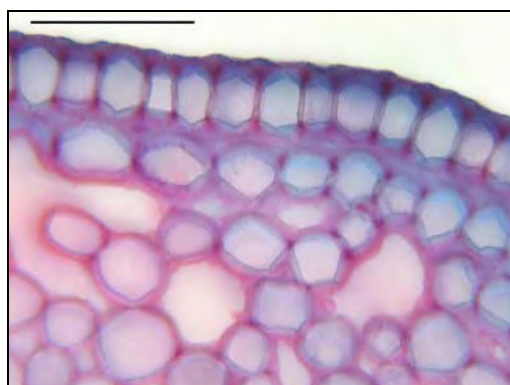


Fig. 19



Fig. 20

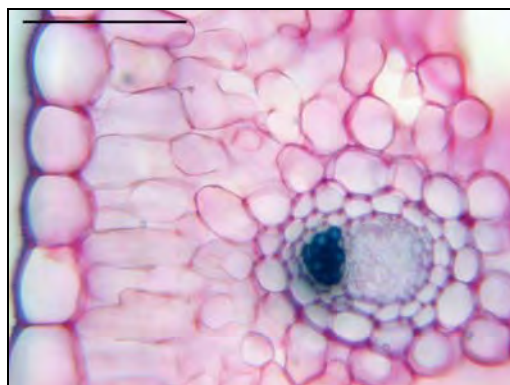


Fig. 21



Fig. 22

Figure 17. Cross sections through the foliar limb. / Figura 17. Secțiune transversală prin limbul foliar (original).

Figure 18. Vascular bundle. / Figura 18. Fascicul conducător (original).

Figure 19. Lower epidermis of the foliar limb. / Figura 19. Epiderma inferioară a limbului foliar (original).

Figure 20. Cross section through the second vein. / Figura 20. Secțiune transversală printr-o nervură secundară (original).

Figure 21. Cross section through the foliar limb: upper epidermis and palisade tissue. / Figura 21. Secțiune transversală prin limbul foliar: epiderma superioară și țesutul palisadic (original).

Figure 22. Cross section through the foliar limb: lower epidermis and lacunary tissue. / Figura 22. Secțiune transversală prin limbul foliar: epiderma inferioară și țesutul lacunos (original).

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Received: May 03, 2010

Accepted: July 25, 2010