HISTO-ANATOMICAL AND PECULIARITIES OF THE AERIAL VEGETATIVE ORGANS IN *PULMONARIA OFFICINALIS* L. AND *PULMONARIA RUBRA* SCHOTT.

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The purpose of this work was to characterize the stem and leaf anatomy from two medicinal species from Pulmonaria genus. The stem has an elliptic shape, with ribs, in transaction and primary structure in both analysed species. The epidermis is uniseriate and has numerous trichomes, both non-glandular and secretors, especially in Pulmonaria rubra. The glandular ones are capitate; they have short or long multicellular stalk and unicellular head. The non-glandular trichomes are unicellular with very thick walls and coated with granular cuticle. The xylem vessels have radial distribution in Pulmonaria officinalis and an irregular one in P. rubra. The xylem parenchyma is transformed in collenchyma in P. officinalis stem, especially in the medullar area. The leaf epidermis, in surface view, has epidermal cells with sinuous contour, more evident on the abaxial surface. In cross section, the single-layered epidermis is covered with a thin cuticle. Anomocytic stomata occur on the lamina, predominantly on the abaxial side, and they are slightly raised above the other epidermal cells. The palisade parenchyma is unilayered, followed by one or two layers of collecting ramified cells, with different shapes in the two analyzed species.

Key words*:anatomy, hairs, leaf, stem, Pulmonaria*

The family *Boraginaceae* occurs worldwide, especially in the tropics and subtropics. It comprises about 100 genera and 2000 species. Most representatives of this family are herbaceous, but lianas, shrubs and trees also occur.

The genus *Pulmonaria* (lungworts) is flowering plants in the family *Boraginaceae*, native to Europe and western Asia. In this paper morpho-anatomical investigations regarding vegetative organs of *Pulmonaria officinalis* and *P. rubra* was carried out. *Pulmonaria rubra* is endemic for the Carpathians and Balkans Mountains.

Lungwort are medicinal plants and has high mucilage content; this makes it useful in the treatment of chest conditions, being of particular benefit in cases of chronic bronchitis; the leaves and flowering shoots are astringent, diaphoretic, diuretic, emollient and expectorant.

There is no detailed study on anatomical and histo-anatomical properties of the analyzed species. Metcalfe and Chalk (1979) [5] and Watson and Dallwitz (1991) [7] investigated structural characteristic of the family *Boraginaceae*.

Another *Boraginaceae* species was investigated from anatomical point of view: *Anchusa* [1], *Onosma* [2, 3], *Anchusa, Borago, Pulmonaria, Symphytum* etc [6].

MATERIAL AND METHOD

The vegetal material was collected fromMarzesti forest (Iasi country) – *Pulmonaria officinalis* L. and Zugreni (Suceava country) – *Pulmonaria rubra* Schott.

The vegetative organs (roots, stems and leaves) were fixed and conserved in ethanol 70%. The sections made with free hand using a razor blade and colored with ruthenium red and methylen-blue. The photos were made after the obtained permanent slides using an Olympus BX51 microscope with an Olympus E-330 digital photo camera.

RESULTS AND DISCUSSIONS

In cross section the roots of this species present a unilayered epidermis, the cortical parenchyma is formed by isodiametric cells, the endodermis shows Caspary strips, and the pericycle is unilayered. The root structure is pentarch in both analyzed species (*fig. 3a*). The secondary structure is produced only by cambium. The vascular cambium, originating between the xylem and the phloem, forms new cells, first inside of the cambium cylinder (initial secondary xylem) (*fig. 3b*).

The stem has primary structure in both analyzed species. In cross section, the top of the stem appears circular with 2-3 ribs in *Pulmonaria officinalis* and with only one rib in *P. rubra* (*fig. 1a, b, 3c, d*). The epidermis is unilayered, with tectors and glandular hairs. The hairs (especially the tector one, are more abundant in *P. rubra*). In *P. officinalis*, the epidermis and the first subepidermic cells layer could be detached by the cortex. The primary conducting tissues have a concentric rings shape; 6-7 vascular bundles in *P. rubra* and 8-9 in *P. officinalis* could be observed. Between bundles, the conducting tissue is represented only by the phloem (fig. 1e, g). The cortex and the pith consist of parenchyma cells, with thin, cellulosic walls. The structure remains primary at the median and the basal level of the stem (*fig. 1 c, d, e, f, fig. 3e, f*). In *P. officinalis*, at the stem basis, the vascular bundles have a collencymatic tissue at the phloemic pole (*fig. 1c*). In the same time, the xylem parenchyma cells localised between the protoxylem vessels have cellulosic but thick cells (of collenchymatic type). The procambium is still active; a lot of metaxylem vessels in different stages of morphogenesis could be observed (*fig. 1g*). A similar situation is visible in the stem of *P. rubra.*

The leaf has bilateral structure. The stomata, by anomocytic type, are present on both epidermises (*fig. 2c, d*). The upper and lower epidermises consist of a single layer of cells. Unicellular and multicellular glandular and tector hairs (with cystoliths at their basis) are dense on both surfaces. The midrib is prominent at the lower epidermis and has a single vascular bundle with primary structure (*fig. 2a, 4a*). The palisade parenchyma is unistratified and consists of short cells in *P. officinalis* and longer cells in *P. rubra.* In both species, under the palisade parenchyma, one or even two layers of ramified, collecting cells could be observed (*fig. 2b, 4b*). Their role is to transport the photosynthesis products from palisade parenchyma to the vascular bundles (phloem tissue).

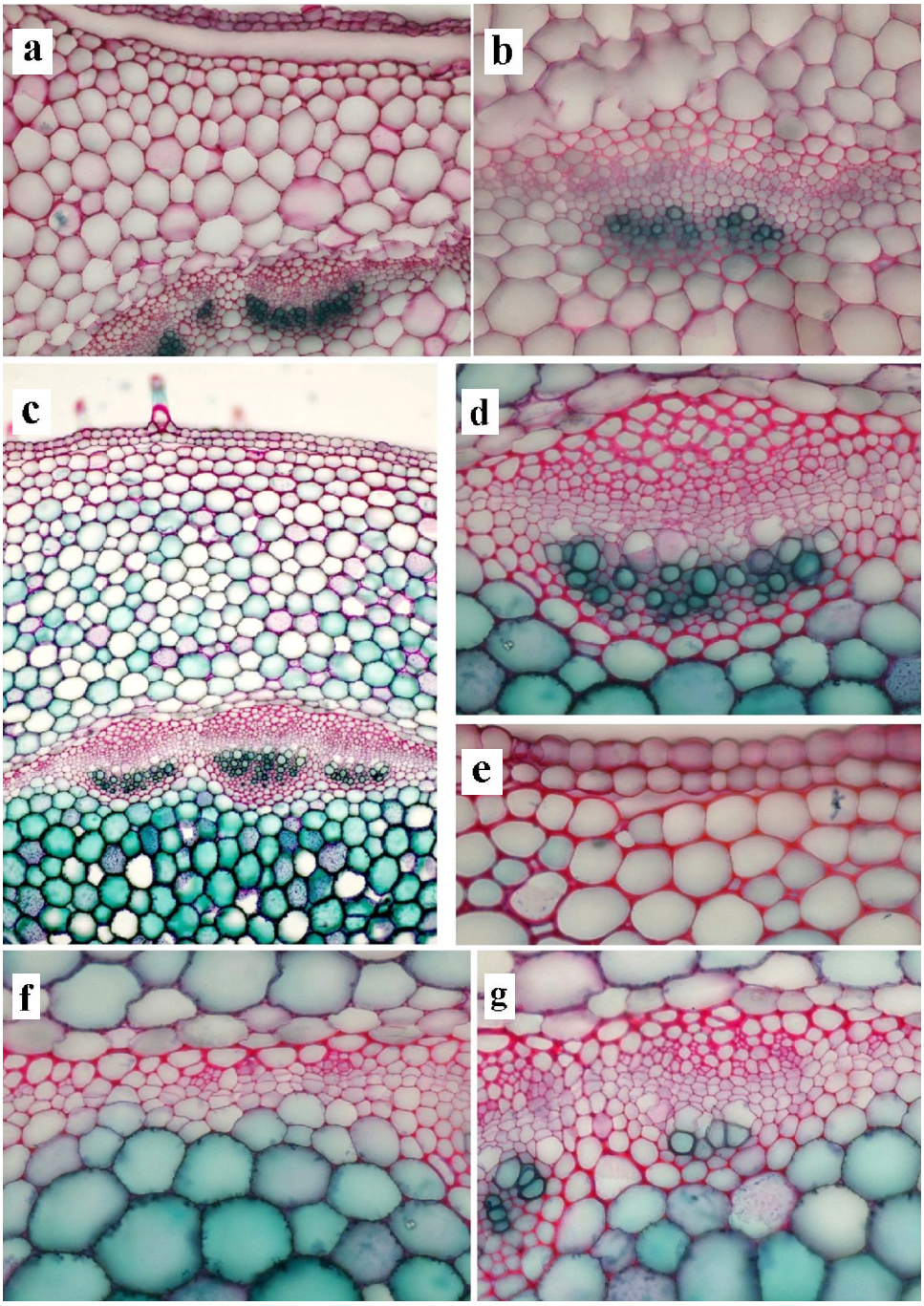

Figure 1 **Cross sections through the stem of *Pulmonaria officinalis*: a – top of the stem, b – detail from a vascular bundle, c basis of the stem, d - detail from a vascular bundle, e – detail from the epidermis and cortex, f – detail with conducting tissue consist from phloem only, g – detail from a small vascular bundle (original)**

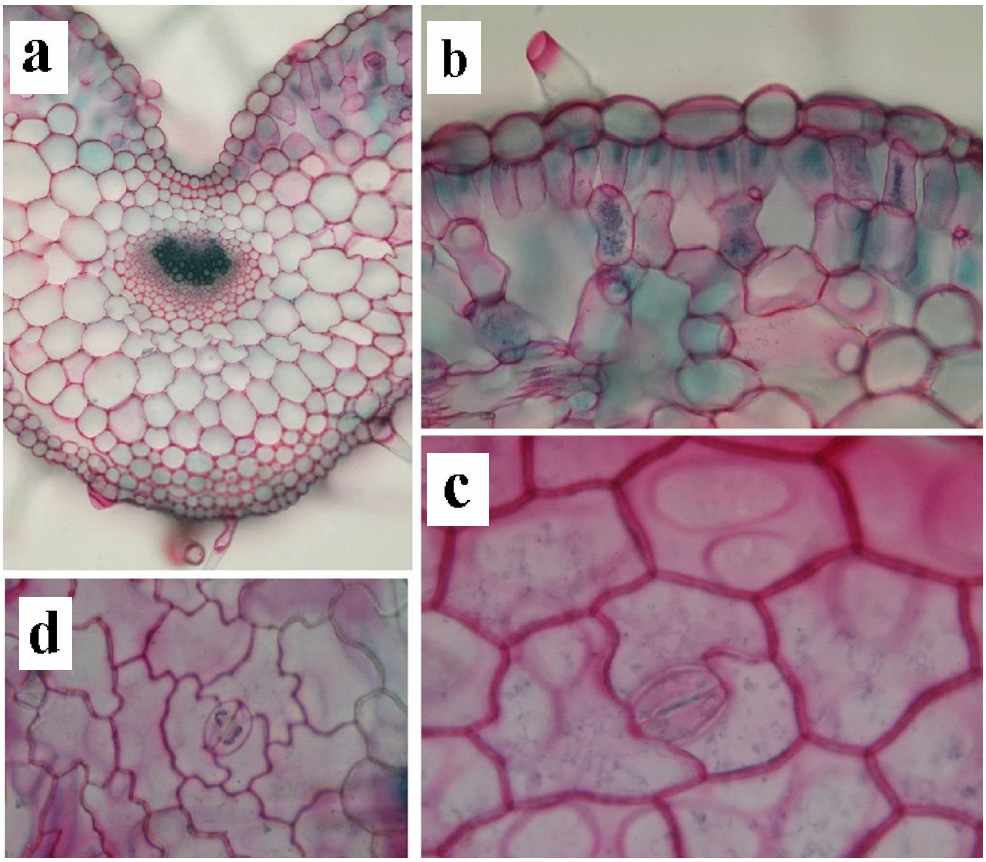

Figure 2 a, b **Cross section through the lamina of *Pulmonaria officinalis*: a – midrib, b – mesophyll; c, d – epidermis in front view: c – upper epidermis, d – lower epidermis (original)**

Lansing and Franceschi (1999) [4] demonstrate the role of the collecting cells in some legumes leaves. The spongy parenchyma is multilayered, with cells irregularly-shaped; it is thicker in *P. rubra* leaves.

The tector hairs are characteristic of the *Boraginaceae* family. They are conical, unicellular, with thick and warty wall and calcified apical portion. Surrounding this trichome base were special subsidiary cells protruding above the level of the other epidermic cells (*fig. 4e*). Two types of tector hairs were found: first is short, with the development of a body similar to a bulbous cystolith in the basal portion and the second is long, with inconspicuous cystolith bodies. Glandular trichomes (*fig. 4c, d*) consisted of an epidermic basal cell, a uniseriate stalk (long or short) and a unicellular secretory head.

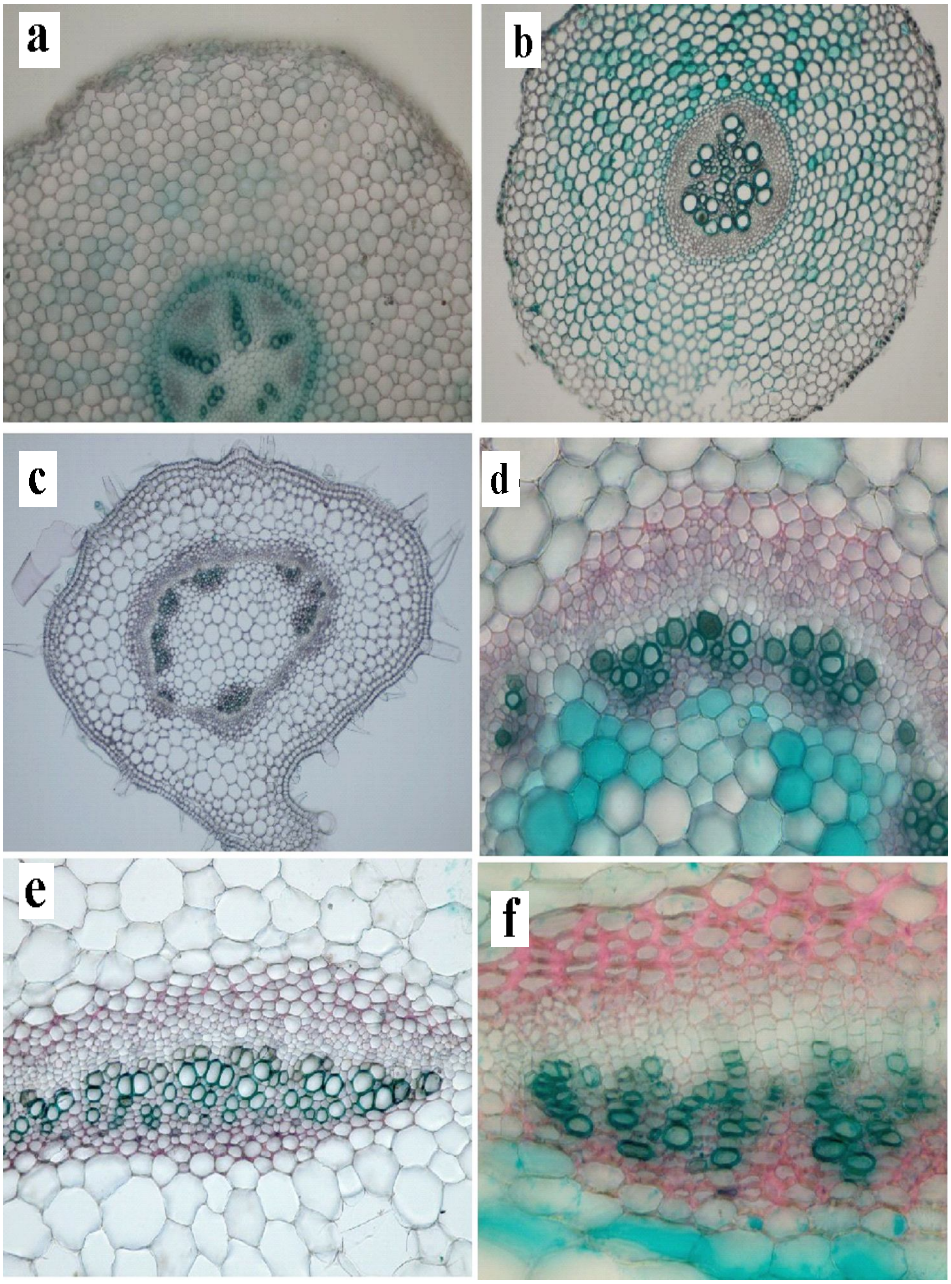

Figure 3 **Cross sections through the root and stem of *Pulmonaria rubra*: a – root with primary structure, b - root with secondary structure, c – top of the stem, d – detail with a vascular bundle, e – middle of the stem, f – stem basis (original)**

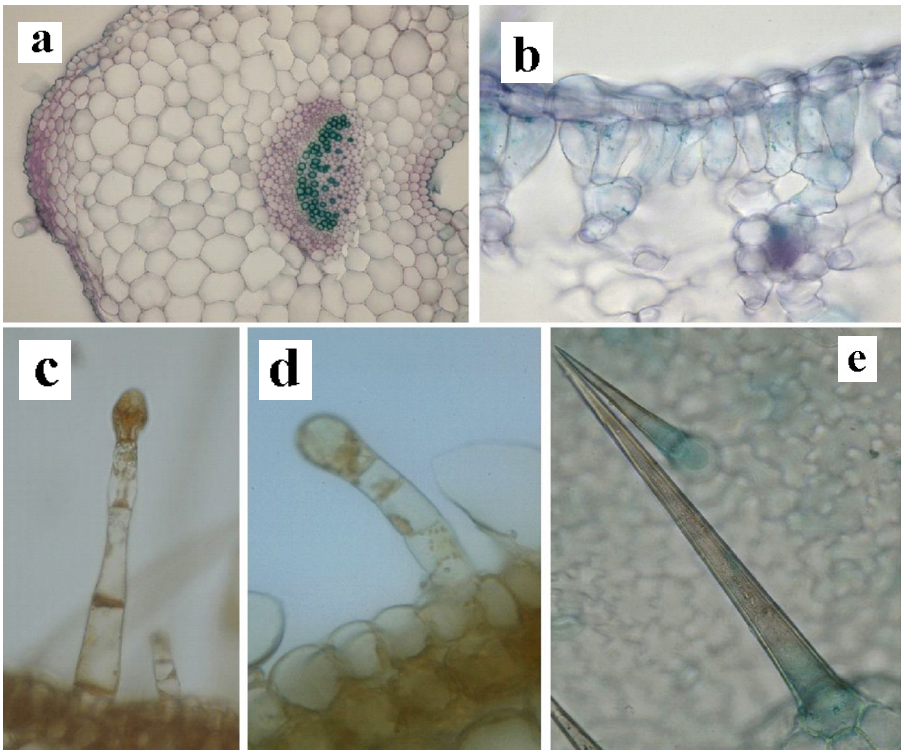

Figure 4 a, b **Cross sections through the lamina of *Pulmonaria rubra*: a – mid rib, b – mesophyll; c, d – glandular hairs, e – tector hair (original)**

CONCLUSIONS

This is the first record of the anatomical structure for *Pulmonaria rubra,* endemic Carpathian species. They are numerousness structural similarities between *P. rubra* and *P. officinalis*; that could be an argument for their taxonomical approach. Primary vascular tissue is disposed in a cylinder, without separate bundles, with centrifugal development. Lamina is dorsiventral, Cystoliths are present at the bases of some tector hairs.

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