

STUDIES ON THE MORPHO-ANATOMICAL PARTICULARITIES OF *LYSIMACHIA NUMMULARIA* L.

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ABSTRACT

The objective of the study was the histo-anatomical analysis of the root, stem and leaf belonging to the species *Lysimachia nummularia* L. from the *Primulaceae* family.

The plant is native to Europe, but has been introduced to North America, where it is considered an invasive species in some areas. It aggressively spreads in favourable conditions, such as low wet ground or near ponds. It is moderately difficult to remove by hand pulling. Any tiny piece left behind will regrow. The research results led to the following assessments: root with primary structure and beginning of secondary structure, the presence of calcium oxalate druze in the bark, endoderm and primary type conducting bundles. The results of the study also demonstrated the existence of the stem with four prominent ribs, a meatic-type bark with small secretory channels and a central cylinder with a secondary structure. Another element studied from a histo-anatomical point of view; leaf with dorsiventral bifacial structure, with heterogeneous asymmetrical structure, collateral free-woody bundle, without periectors. From the morpho-anatomical data described, it can be concluded that the species *Lysimachia nummularia* L. belongs to the family *Primulaceae* and is related to other species of the genus *Lysimachia*.

Keywords: *Lysimachia*, *Primulaceae*, microscopy, vegetative organs.

INTRODUCTION

Lysimachia nummularia L. (*Primulaceae*) (Figure 1), is a herbaceous, perennial, chamefite plant, widespread in our country, in wetlands, in meadows and on the waterfront, through bushes and meadows, ditches and micro-depressions in mountain, hill and plain regions. Globally it is found in Europe, the Caucasus, introduced in Japan and North America.

According to the classification system proposed by Cronquist [2], Takhtajan [3] and Zimmerman [4], accepted by Ehrendorfer [5, 6] and adopted and supplemented by I. Pop et al., *Lysimachia nummularia* L. [7], has the following systematic classification [8]: *Magnoliophyta*, Class *Magnoliatae*, Subclass

Dilleniidae, Order *Primulales*, Family *Primulaceae*, Genus *Lysimachia*, Species *nummularia* L.

Known since antiquity, the plant was discovered by Lysimachus (in Pliny the Elder), and its name is also found in Dioscorides as *Lysimacheios*, indicating a species of the genus *Lysimachia*, probably given in honor of the Thracian king, Lysimachus. The green parts of the plant contain hemolytic saponosides, tannins, flavonosides, phenolic acids, polyuronides, which is why it has medicinal uses both internally and externally [9].

Popularly known as yolk or straight, *Lysimachia nummularia* L, has a sudden, glabrous stem, round opposite leaves and solitary, yellow axillary flowers [10].

In the present study, we aimed to identify and describe the anatomical structure of vegetative organs in order to identify the peculiarities of *Lysimachia nummularia* L, necessary to differentiate the peculiarities of the plant species from other species of the genus *Lysimachia*.

MATERIAL AND METHOD

The fresh plant was harvested on July 19, 2020, from the edge of Lake Tău-Brazi in the Roșia Montană area of Alba County (Figure 2), where the yolk forms large associations (Figure 1). In order to research from a histo-anatomical point of view, the material represented by the vegetative organs (root, stem and leaves) was subjected to several stages of work. Fixation and preservation of the fresh material was performed in 70% ethyl alcohol. The sectioning was done manually, with the help of the hand microtome and the botanical razor, using as support the elderflower marrow.

The obtained sections were subjected to the bleaching process (with sodium hypochlorite) for 20-35 minutes, after which they were washed with acetic water and distilled water [11], [12]. The sections were then stained with iodine green and ruthenium red (staining used in plant histo-anatomical studies) as follows: The sections were first stained with iodine green (1 minute), washed with 90% ethyl alcohol, and then stained with ruthenium red (1 minute) and finally washed with distilled water [13], [14].

The colored sections were mounted in drops of glycerol gelatin, between the slide and the slide, thus making permanent preparations. After the preparations thus obtained, color photographs were taken with the OPTIKA photon microscope, with Canon A540 digital camera. Scale for photographs = 100 μm.



Fig. 1. *Plant association with straight*



Fig. 2. *Lysimachia nummularia L.*

RESULTS AND DISCUSSIONS

Cross section through the root

The following characters are distinguished:

- the contour of the section is circular, slightly wavy (Figure 3);
- the structure is primary with the beginning of secondary structure, due to the presence of a multilayered suber formed of cells with thin walls (Figure 4);

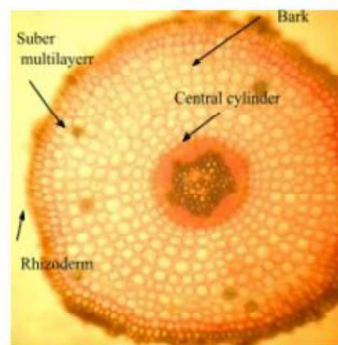


Fig. 3. *Cross section through the root of Lysimachia nummularia L. (6x)*

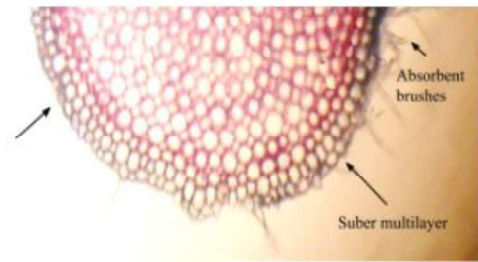


Fig. 4. *Cross section through the root of Lysimachia nummularia L. (10x) -detail*

On the outside there is a rhizoderm, formed by a single layer of cells with external walls slightly thicker than the others, covered by a cuticle that forms a characteristic relief; some cells turned into single-cell absorbent hairs. The primary bark is very thick, comprising 8-10 layers of round oval cells, with thin cellulosic walls and intercellular spaces; it is differentiated into exoderm, cortical parenchyma

and endoderm; the cells are larger in the middle of the bark and smaller outwards and inwards (Figure 4).

The exoderm, well highlighted, is unistratified, with large cells, slightly elongated radially, with moderately thickened and suberified walls.

The cortical parenchyma is compact and moderately cholenchymatized to the exoderm, but for the most part it has cells of circular contour, with thin walls, leaving small intercellular spaces between them, forming a true meatic parenchyma; cells with calcium oxalate dredges are observed in some places:

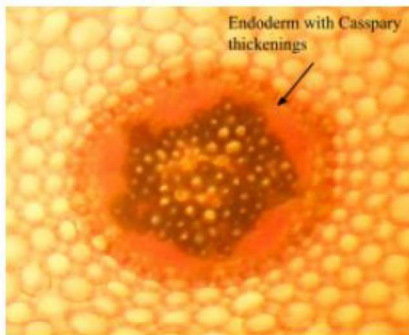


Fig. 5. Cross section through the root of *Lysimachia nummularia* L. Endoderm with Cassparry thickenings (100x)

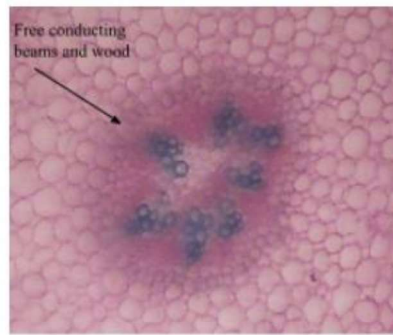


Fig. 6. Cross-section through the root of *Lysimachia nummularia* L. Free-conducting beams and wood (100x)

The last layer of the bark is a primary type endoderm, with the cells elongated tangentially and arranged in an orderly manner, alternating with those of the pericycle; shows obvious lenticular thickenings (Cassparry thickenings) (Figure 5);

The central cylinder, located deep, starts with a unilayered pericycle, on which 5-7 wooden beams rest, alternating with as many free beams included in the fundamental parenchyma of the central cylinder (Figure 6); the liber consists of Liberian vessels (sieved tubes), attachment cells and Liberian parenchyma; the wooden fascicles are formed by wooden vessels of meta and protoxylem and very few wooden parenchyma cells; the metaxillem vessels go to the center of the root, occupying part of the spinal cord; the marrow, interrupted by a group of metaxillem vessels, consists of medullary parenchyma of the meatic type.

Stem cross section

The cross section through the stem has the following characters:

The contour of the cross section is elliptical-oval, with four visibly prominent ribs at the ends (Figure 7); on the outside there is a single-layered epidermis, formed by isodiametric cells, with domed external walls; they have a round-square shape, are uniformly thickened all around and covered by a thin ribbed cuticle; from place to place there are stomata formed by cells slightly smaller than the cells of the epidermis (Figure 8);

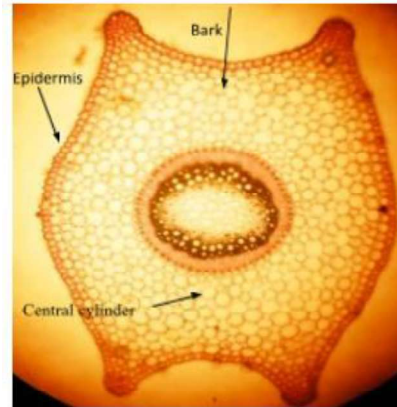


Fig. 7. Cross section through the stem of the species *Lysimachia nummularia* L. (100x)

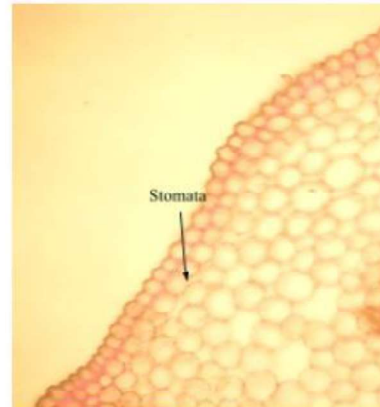


Fig. 8. Cross section through the stem of the species *Lysimachia nummularia* L. Detail from the epidermis (100x)

The bark is parenchymal-cellulose of meatic type, with rounded cells, bigger and bigger inwards; from place to place it has wide air spaces between cells and small secretory canals; the hypodermic layer, slightly cholenchymatized consists of cells smaller than the rest of the bark; near the ribs the thickening process is more pronounced than in the rest of the hypodermis;

The innermost layer of the bark is a primary type endoderm, with its thickening of the Casspari visible and made up of cells of different sizes; the central cylinder consists of conductive tissues of secondary origin, arranged in an annular and represented by an outer ring of free secondary and an inner ring of secondary wood, which arose from the activity of the bill of exchange; it does not start with a special type of danger; the free ring is slightly thinner than the wooden one; the wooden ring has discontinuities, in which thicker areas, consisting of several vessels, alternate with thinner portions, consisting of fewer vessels and of smaller caliber.

The secondary free ring consists of sieved tubes, attachment cells and Liberian parenchyma cells.

The wooden ring consists of protoxilem vessels, towards the outside and metaxilem vessels, towards the centre of the cord; the vessels are arranged in series, in order and are surrounded by cellulosic woody parenchyma; the medullary rays are narrow, relatively unobvious.

The marrow is thick, parenchymal-cellulosic, meatic type, consisting of two types of cells: very large, in the centre of the spinal cord and very small at its periphery, some cells at the periphery of the spinal cord are oxaliferous (Figure 8).

Leaf cross section

The leaf cross section has the following characters:

- in cross section, the median rib is prominently visible at the abaxial face of the tongue, and at the adaxial face there is a slightly deepened groove (Figure 9);
- at the level of the nerve there is a single hypodermic layer of colenchyma, a fundamental parenchyma formed by large isodiametric cells with thin parts and large intercellular spaces, and in the centre, a large, free-wood beam with primary structure, next to which appears a beam of very small dimensions (Figure 10);
- the conducting beam is surrounded by a unilayered parenchyma sheath, formed by uniformly arranged cells; it consists of a free cord, towards the lower epidermis and a wooden cord, towards the upper epidermis; under the free cord is a sclerenchyma sheath;

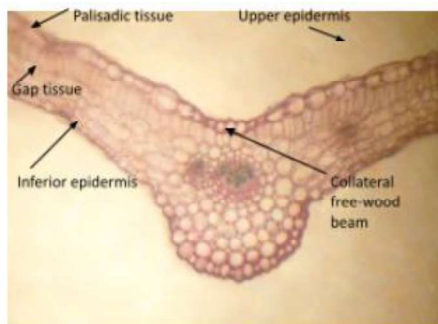


Fig. 9. Cross section through the leaf of the species *Lysimachia nummularia* L. (100x)

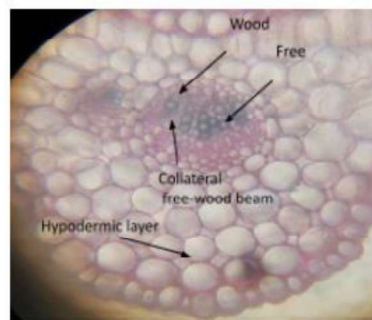


Fig. 10. Cross section through the leaf of the species *Lysimachia nummularia* L. Detail of the median rib (100x)

- the release cord has sieved tubes, attachment cells and Liberian parenchyma;
- the wooden cord consists of radial rows of proto- and metaxillem vessels, separated by cellulosic woody parenchyma (Figure 8);
- the upper epidermis consists of a single layer of very large, vesicular cells, of different sizes, with the outer wall thicker than the others and covered by a very thin cuticle; from place to place there are stomata, less than in the lower epidermis; tector brushes are missing (Figure 10);
- the lower epidermis, formed by a single layer of cells, has larger cells at the level of the median nerve, but of different sizes, and at the level of the tongue, much smaller cells; all are interrupted by stomata.

- the mesophile has 5-6 layers of cells and consists of a unistratified palisade on the upper face (the cells being 3-4 times higher than wide) and a lacunar multilayered parenchyma on the lower face;
- the limb has a dorsoventral bifacial structure.

CONCLUSION

The analysis of the cross sections through the vegetative organs of the species *Lysimachia nummularia* L. showed that the analyzed species has a structure characteristic of the group to which it belongs, respectively of the *Primroses*. Thus, the root has a primary structure with a little developed central cylinder, the 6-7 wooden bundles, alternating with the free ones.

The endoderm has lenticular thickenings (Cassparry punctuation); the primary endoderm shows obvious Cassparry scores.

The bark is of the meatic type with large intercellular spaces and cells with calcium oxalate dredges.

The stem has the contour of the elliptical-oval cross section, at the ends with four visibly prominent ribs. The leaf has epidermis covered by an obvious cuticle, asymmetric heterogeneous mesophilic, is devoid of periectors and has a dorsiventral bifacial structure with unistratified palisade tissue.

The conducting beam is of the collateral type, consisting of a free cord, towards the lower epidermis and a wooden cord, towards the upper epidermis; under the free cord there is a sclerenchymal sheath.

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