# HISTO-ANATOMICAL ASPECTS REFERING TO THE VEGETATIVE ORGANS OF TWO SPECIES OF *Inula* L. FROM ROMANIA FLORA

**AFEMEI Marinela, BOZ Irina, TOMA Constantin**

**Abstract.** The authors analyse the structure of vegetative organs of two *Inula* L. species from Romania flora, evidencing the constant and particular histo-anatomical features of this species. Peculiar attention has been given to the number of vascular bundles, the thickness of periphloemic strands, presence or absence of root hairs, protective hairs and the absence or presence of aerenchyma in cortical parenchyma.

**Keywords:** *Inula,* anatomy, vegetative organs, protective hairs, aerenchyma.

**Rezumat. Aspecte histo-anatomice referitoare la organele vegetative a două specii de *Inula* L. din flora României.** În cadrul acestei lucrări, autorii analizează structura organelor vegetative la două specii de *Inula* L. din flora României, evidenţiind caracterele comune şi particularităţile histo-anatomice ale acestor două specii. O atenţie deosebită a fost acordată numărului de fascicule conducătoare, grosimea straturilor perifloemice, prezenţa sau absenţa perilor rădăcinii, perilor tectori şi prezenţa sau absenţa aerenchimurilor la nivelul parenchimului cortical.

**Cuvinte cheie:** *Inula*, anatomie, organe vegetative, peri tectori, aerenchim.

## INTRODUCTION

*Inula* L. *(*LINNAEUS, 1747) is a large genus of about 120 species in the world, spread in temperate areas from Europe and Asia (NYÁRÁDY, 1964). In Europe this genus comprises about 19 species (TUTIN et al., 1976). In Romanian flora 10 species can be found, but one of these has not been anymore confirmed in the former (NYÁRÁDY, 1964) or recent botanical works (OPREA, 2005; CIOCÂRLAN, 2009). In nature we can found also hybrids derived by crossing different species of *Inula*, but these are not mentioned any longer in recent botanical works (CIOCÂRLAN, 2009).

From the genus *Inula*, mainly *I. helenium* was studied, an herb known since ancient times. BRUNETON, 1999 called substances in the plant and their role in combating various diseases. Thus, he notes that certain substances found in the rhizome of the plant - and izoalantolactone are cytotoxic in vitro, with antifungal and antibacterial properties. At concentrations of 10 mg/ml, it prevents the growth of fungi pathogenic for humans: *Microsporum cookie*, *Trichophyton mentagrophytes*. Among *Inula* species growing in our country, *Inula helenium* L. is considered a medicinal herb (AHMAD et al., 2006; BARNES et al., 2007; SCHISCHKIN, 1999; TEHON, 1951; YBERT & DE MEUX, 2001). But many species of *Inula* were known and used in Romanian popular medicine (BORZA, 1925, 1936; BUTURĂ, 1935, 1936; PANŢU, 1902).

*I. ensifolia* L. is a perennial plant, having a forked horizontal rhizome. The stem is high (10-40 cm), glaber, usually presenting a single anthodium in the top, rarely more. The leaves are linear, sessile with paralleled vein. The plant bloom from July to August and the fruit is an achene (NYÁRÁDY, 1964). In our country this specie is common in Maramureş, Muntenia, Moldova, Dobrogea, being rarely met in the Danube Delta.

*I. hirta* L. is also a perennial plant, having a horizontal rhizome. Aerial stem is 10-15 cm tall, hairy, covered with leaves up to blossom (anthodium). Leaves are oblong-ovate, narrow-lanceolate or narrow-elliptic, sessile; the margins finely denticulated rarely full. The flowers are grouped in large anthodia, usually solitary. The plant flowers from June to September. The fruit is an achene, usually glabrate. *I. hirta* vegetate through meadows, vineyards, forest edge, rib thickets, forest steppe zone is common to oak floor (NYÁRÁDY, 1964).

Research regarding the anatomical structure of *Inula* sp. is relatively few METCALFE & CHALK 1950 (1972) and often referring to *I. helenium* (TERPILO, 1961; LEMAIRE, 1882; MANSFIELD, 1916). In this context, our work continues the research starting in 2010 (TOMA et al., 2010) and tries to bring new data regarding the anatomy of *Inula* species from Romanian flora.

## MATERIAL AND METHODS

The plant material for this study is represented by *I. ensifolia* and *I. hirta.* This species were collected during the flowering period from Valea lui David, Iaşi district. For the histo-anatomical research, the vegetal material has been fixed and preserved in 70% ethylic alcohol. The sections were cut with a microtome and a botanical razor. The vegetative organs were cross sectioned, on different levels, from the top to the basis. First of all, the sections were submitted to a discoloration process, using sodium hypochlorite (20-25'), then coloured (with iodine green and with ruthenium) and mounted in gel. The drawings were performed by means of a Romanian (Projektionszeichenspiegel) microscope and the micrographs were performed by means of a Novex (Holland) microscope, using a Canon A95 camera.

## RESULTS AND DISCUSSIONS

**Root** (Figs. 1; 2)

For both investigated species the roots are adventitious, originating from rhizomes and having an endogenous origin. The rhizodermis presents isodiametric or easy high cells, with external wall visible curved and thicker than others. From place to place we can observe long absorbent hairs, having a dilated base and the external wall very thin.

The cortical parenchyma is very thick with unilayered exodermis and endodermis. The endodermis is casparian type and his cells present often a brown coloured content, called helenin.

At *I. ensifolia* the central cylinder is relatively thin and starts with a unilayer pericycle, his cells alternate with the endodermis cells. On this pericycle there develop six phloem vessels consisting in sieved tubes and companion cells. Normally, these vessels should have to alternate with the same number of xylem vessels. In reality, all the central part of central cylinder is homogenous, form by cells with thick walls, unlignified, so it is hard to observe the phloem vessels.

At *I. hirta* the central cylinder is thicker and presents a secondary structure, resulting from the activity of cambium. The ring of phloem is sinuous, with different thickness, consisting in sieved tubes, companion cells and less parenchyma cells. The secondary xylem presents a pentagonal shape with five rounded angles coming in contact with pericycle.

**Rhizome** (Figs. 3-6)

The rhizome presents a secondary structure resulting from the activity of the cambium. The cross section is irregular circular and the epidermis presents small cells with the external wall thicker than the others and covered by a thin cuticle. The phellogen forms by dedifferentiation in hypodermic position, very few (2-3) layers of suber pointed to exterior and the same number of phelloderm layers pointed to interior. Therefore, under the epidermis there appears a thin periderm that in time will determinate the peeling of the epidermis. The cortex is relatively thin, parenchymatous assimilator, of meatic type and it is not end in a special type of endodermis.

The central cylinder is very thick, almost entirely of secondary origin, being formed by an external phloem thin layer, (with sieved tubes, companion cells and many parenchyma cells) and a few internal xylem layers (often two-there) with different thickness. Both rings of secondary xylem and secondary phloem are crossed by narrow parenchymatic rays on the level of xylem and wider parenchymatic rays on the level of phloem.

The pith is parenchymatic-cellulosic, relatively thin, most of the cells from the central part being disorganized or in process of disorganization, resulting aeriferous cavities, with fitful configuration.

On some sections of *I. hirta* we can observe the formation of adventives roots with endogenous origin, formed due to the pericycle.

**Stem** (Figs. 7-14)

In cross section of the **superior level** of the stem, both analysed species present an irregular contour, with rounded angles. The epidermis present isodiametric cells, with external walls thicker than the rest and covered by a thin ribbed cuticle. From place to place, there are present the stomata and long multicellular, uniseriate protective hairs. In *I. hirta*, the stomata appear above the external part of the epidermis.

On both analysed species the cortex is relatively thin, differentiated in two subzones: an external one, with small cells and an internal one, with big cells of different thickness, because of the penetration of vascular bundles. The cortex is not ending with a special endodermis.

In *I. ensifolia*, the central cylinder is very thick, formed by many (25-27) collateral vascular bundles and a thick parenchymatic-cellulosed pith of meatic type. The vascular bundles present different size, the largest one rising powerful in cortex, so the contour of the vascular bundles is visible sinuous. In the bigger vascular bundles, there already appear the elements of a secondary xylem (vessels and libriform fibres). All the bundles present a very thick layer of sclerenchymatic fibres at the periphery of the phloem.

In *I. hirta*, the central cylinder is also very thick with very thick pith and many (22-24) vascular bundlers of different sizes. The phloem of these vascular bundles is formed by sieved tubes, companion cells and a few parenchyma cells. The xylem presents the elements of primary origin disposed in radial array, separated by cells of cellulosic parenchyma, and the elements of secondary origin disposed circularly and separated by few libriform fibres.

The pith of both analysed species is parenchymatic lignified, of meatic type, with the wall slightly thickened.

In cross section of the **median level** of the stem, in comparison with the superior level, the contour became almost circular, the ribs being much attenuated. The structure of the central cylinder remains similar with the one of the anterior level; the cortex presents a few vascular bundles, covered completely by sclerenchymatic fibres.

In cross section of the **inferior level** of the stem the central cylinder became thicker, with many vascular bundles (30-32). The epidermic cells present external thick walls covered by a cuticle much thicker; the hypodermic layer is visible colenchymatic. In the thickness of the cortex we remark a few vascular bundles with primary structure surrounded completely by sclerenchymatic fibres.

**Leaf** (Figs. 15-18)

At both analysed species, in front side view, the epidermis consists of irregularly-shaped cells, with weak waved walls. Along the veins (presenting different width, often parallel) the cells are rectangular-oblong with straight lateral walls. Both epidermis present stomata of anomocytic type, so the limb is amphistomatic.

In cross section, the midrib is strongly rising at the inferior part of the limb. Epidermis present isodiametric cells, with externals and internal walls thickening at the right of the main and secondary ribs. Among the protective hairs we remark short secretory hairs, multicellular, with 2-3 layers of glandular cells.

The mesophyll is homogeneous, formed by palisade tissue at the upper side and lacunar tissue at the lower one, so, the blade has a bifacial-heterofacial (dorsiventral) structure. At *I. hirta,* here and there, the cells situated under the superior epidermis present a regulate disposition, being slightly higher, so remembering of the palisade cells.

The vascular bundles present different dimensions. The vascular bundle from the midvein is thicker and the lateral bundles are smaller, with sclerenchymatic fibres on both poles or only on phloem pole. The smallest (thinnest) vascular bundles have only phloem and are surrounded by a parenchyma – sheath.

## CONCLUSIONS

The structure of these two *Inula* sp. that we studied is relatively similar, the difference consisting in the number of vascular bundles, the thickness of periphloem sclerenchymatic strands, presence or absence of root hairs, the position of stomata and the number of palisade layers in the structure of lamina. Our results regarding the histo-anatomical researches confirm the existent data from the literature, very few and with a general character and, on the other hand, bring new information.

## ACKNOWLEDGEMENTS

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## REFERENCES

AHMAD J., AQIL F., OWAIS M. 2006. *Modern Phytomedicine. Turning Medicinal plants into drugs.* Wiley-VCH Verlag GmbH & Co. Co.KGaA, Weinheim: 2-25.

BARNES J., ANDERSON L. A., PHILLIPSON J. D. 2007. *Herbal medicines (third ed.).* Pharmaceutical Press, London. Chicago: 85-101.

BORZA A. 1925. *Flora grădinilor ţărăneşti române. II. Plantele de podoabă, de leac, de farmece şi credinţe*. Buletinul Grădinii Botanice şi al Muzeului Botanic de la Universitatea din Cluj. **5**(3-4): 49-74.

BORZA A. 1936. *Noutăţi etnobotanice româneşti: o farmacie băbească*. Buletinul Grădinii Botanice Cluj. **16**(1-4): 17- 27.

BRUNETON J. 1999. *Pharmacognosy. Phytochemistry. Medicinal plants*. 2nd ed. Paris and New York: Intercept Ltd, Londers: 265-380.

BUTURĂ V. 1935. *Plante cunoscute şi întrebuinţate de românii din Ardeal. Note etnobotanice*. Buletinul Grădinii Botanice Cluj. **15**: 219-227.

BUTURĂ V. 1936. *Plante cunoscute şi întrebuinţate de românii din Transilvania*. Buletinul Grădinii Botanice Cluj. **16**(1-4): 71-77.

CIOCÂRLAN V. 2009. *Flora ilustrată a României. Pterydophyta et Spermatophyta (ed. a 2-a)*. Edit. Ceres. Bucureşti.

LEMAIRE A. 1882. *De la détermination histologique des feuilles médicinales*. Theodor Oswald Weigel, Leipzig: 47-155.

MANSFIELD W. 1916. *Histology of medicinal plants (first ed.)*. New York. John Wiley & Sons. Inc. London: Chapman & Hall, Limited: 219-298.

METCALFE C. R. & CHALK L. 1950 (1972). *Anatomy of the Dicotyledons.* Clarendon Press, Oxford. **2**: 782-804.

NYÁRÁDY E. I. 1964. *Fam. Compositae.* In: Flora R. P. R. Edit. Academiei Române. Bucureşti. **9**: 264-291.

OPREA A. 2005. *Lista critică a plantelor vasculare din România*. Edit. Universităţii „Al. I. Cuza" Iaşi. 668 pp.

PANŢU Z. C. 1902. *Vocabular botanic, cuprinzând numirile ştiinţifice şi populare române ale plantelor*. Bull. Herb. Institutul de Botanică Bucureşti. **1**(2): 105-138.

SCHISCHKIN B. K. 1999. *Fam. Compositae.* In: Flora of the USSR, Smithsonian Institution Libraries. Washington D.C. **25**: 404-446.

TEHON L. R. 1951. *The drug plants of Illinois (circular 44)*. Natural History Survey Division. Urbana. 67 pp.

TERPILO N. I. 1961. *Anatomiceskij atlas lekarstvenyh rastenij*. Gosud. Mediţinskoe izdatel'stvo U.S.S.R., Kiev: 72-86.

TUTIN T. G., HEYWOOD V. H., BURGES N. A., MOORE D. M., VALENTINE D. H., WALTERS S. M., WEBB D. A. 1976. *Flora Europaea*, *Plantaginaceae to Compositae (and Rubiaceae*). Cambridge University Press. **4**: 133.

TOMA C., GRIGORE M.-N., AFEMEI MARINELA, STĂNESCU IRINA-ELENA. 2010. *Histo-anatomical considerations on some romanian Inula L. species, with pharmacological action.* Analele Ştiinţifice ale Universităţii „Al. I. Cuza", Iaşi, Secţiunea a II- a. Biologie: 5-13.

YBERT E. & DE MEUX A. L. 2001. *Larousse Encyclopédie des Plantes Médicinales. Identification, preparations, soins*. Larousse, Paris: 52-153.

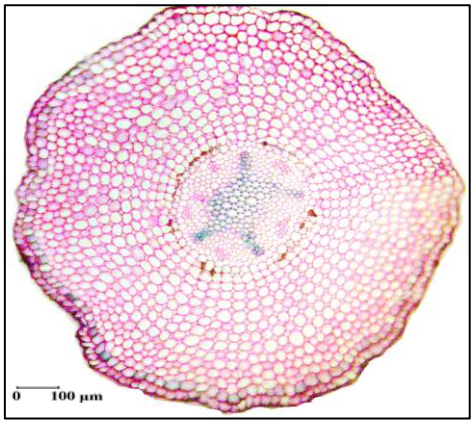



Fig. 1

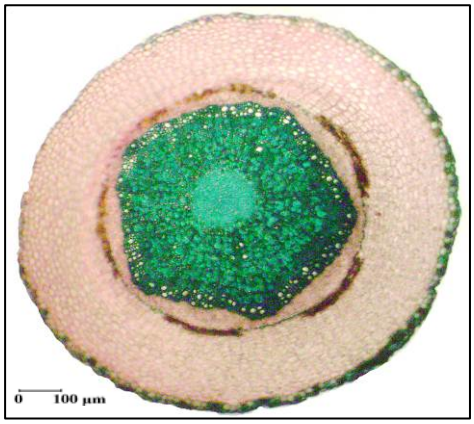
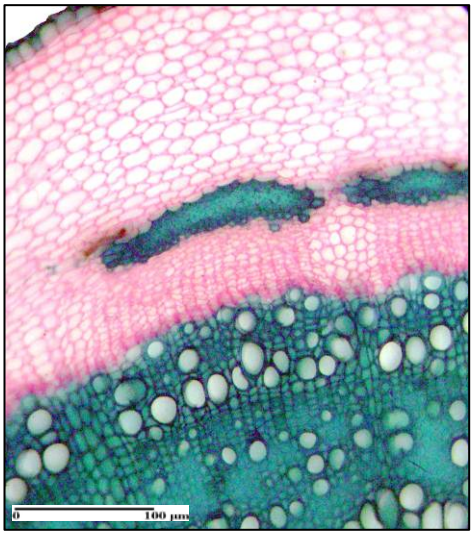



Fig. 2

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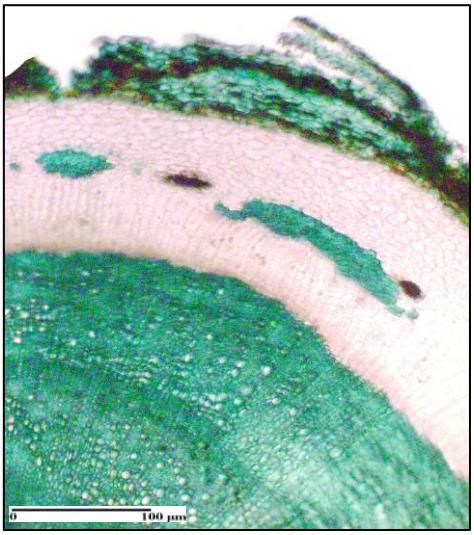


Fig. 4

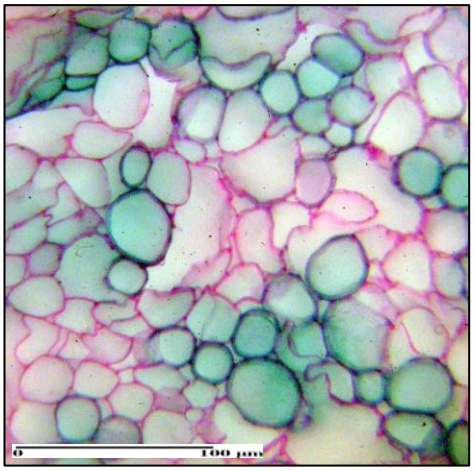


Fig. 5


Fig. 6

Figure 1. Cross section through the root of *I. ensifolia*. / Figura 1. Secțiune transversală prın rădăcină la *I. ensifolia* (original).
Figure 2. Cross section through the root of *I. hirta*. / Figura 2. Secțiune transversală prin rădăcină la *I. hirta* (original).
Figure 3. Cross section through rhizome of *I. ensifolia*. / Figura 3. Secțiune transversală prin rizom la *I. ensifolia* (original).
Figure 4. Cross section through rhizome of *I. hirta*. / Figura 4. Secțiune transversală prin rizom la *I. hirta* (original).
Figure 5. Aeriferous cavities from the rhizome pith of *I. ensifolia*. / Figura 5. Cavități aerifere din măduva rizomului de *I. ensifolia* (original).
Figure 6. Aeriferous cavity from the rhizome pith of *I.hirta*. / Figura 6. Cavitate aeriferă din măduva rizomului de *I. hirta* (original).

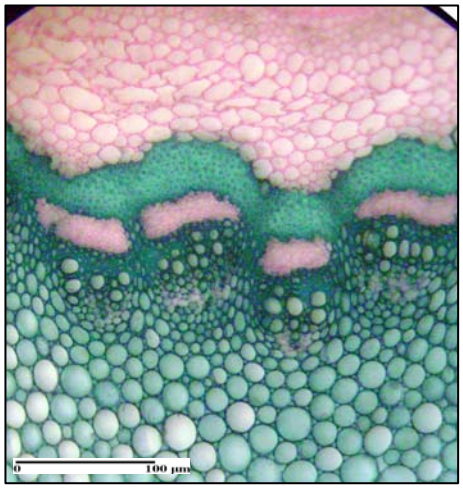


Fig. 7

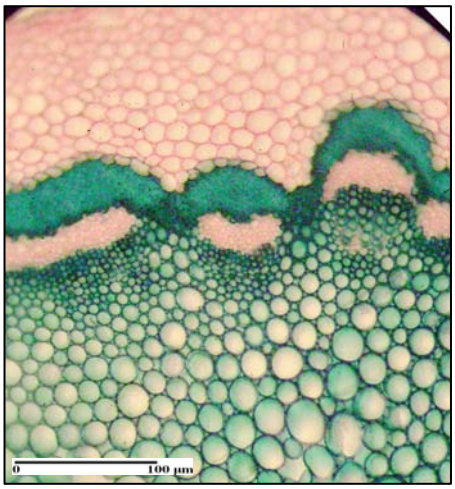


Fig. 8

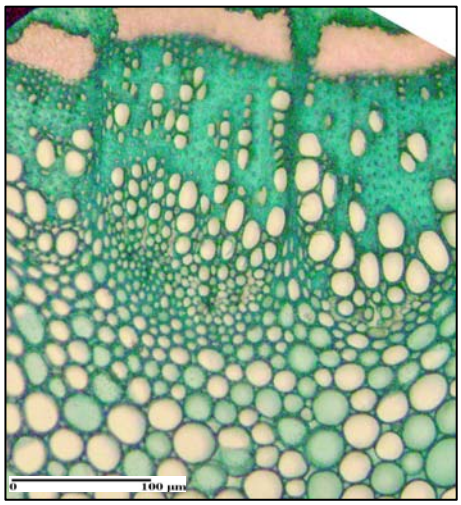


Fig. 9


Fig. 10

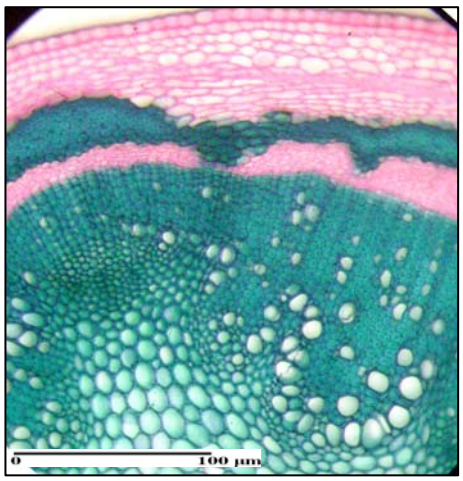


Fig. 11

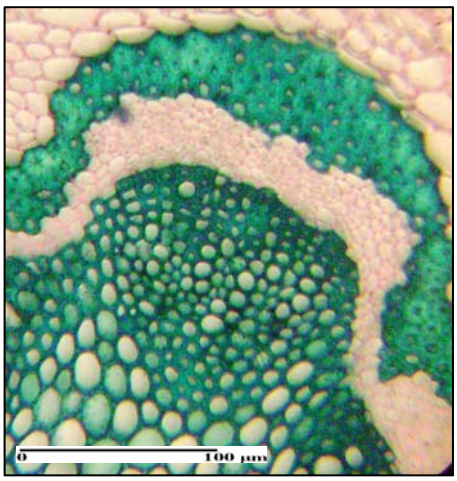


Fig. 12

Figure 7. Cross section through the stem (superior level) of *I. ensifolia*.
Figura 7. Secţiune transversală prin tulpină (treime superioară) la *I. ensifolia* (original).
Figure 8. Cross section through the stem (superior level) of *I. hirta*.
Figura 8. Secţiune transversală prin tulpină (treime superioară) la *I. hirta* (original).
Figure 9. Cross section through the stem (middle level) of *I. ensifolia.*
Figura 9. Secţiune transversală prin tulpină (treime mediană) la *I. ensifolia* (original).
Figure 10. Cross section through the stem (middle level) of *I. hirta.*
Figura 10. Secţiune transversală prin tulpină (treime mediană) la *I. hirta* (original).
Figure 11. Cross section through the stem (inferior level) of *I. ensifolia.*
Figura 11. Secţiune transversală prin tulpină (treime inferioară) la *I. ensifolia* (original).
Figure 12. Vascular bundler - stem (inferior level) of *I. hirta.*
Figura 12. Fascicul conducător - tulpină (treime inferioară) la *I. hirta* (original).

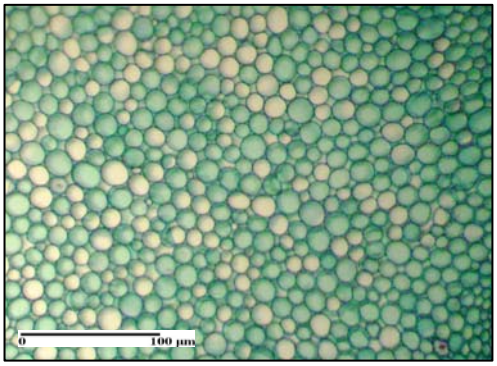


Fig. 13

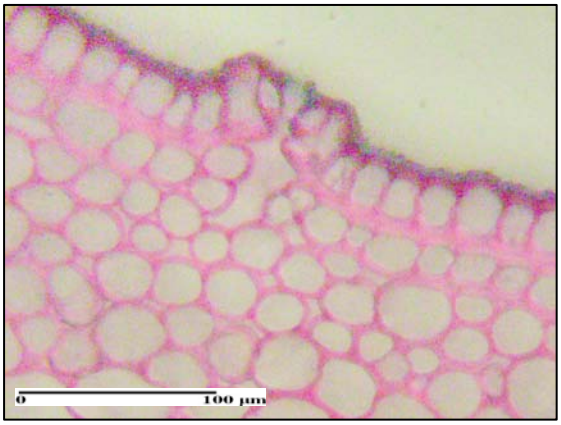


Fig. 14

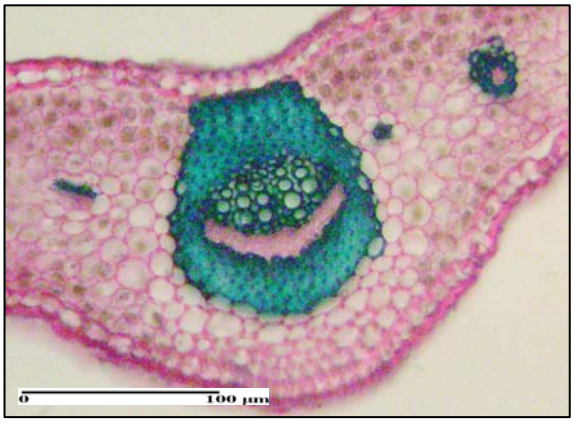


Fig. 15


Fig. 16


Fig. 17

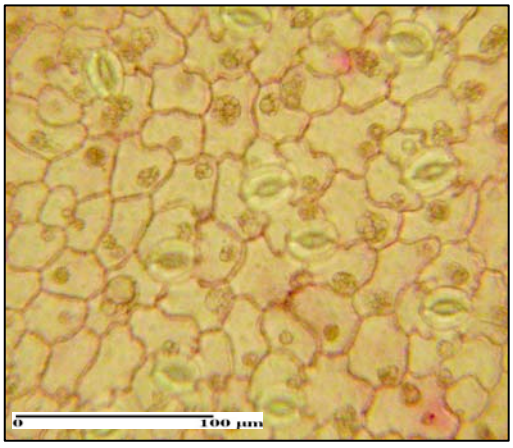


Fig. 18

Figure 13. Pith - inferior level of the stem of *I. ensifolia*. / Figura 13. Măduvă din treimea inferioară a tulpini de *I. ensifolia* (original).
Figure 14. Stomata from the stem of *I. hirta.* / Figura 14. Stomată de la nivelul tulpinii la *I. hirta* (original).
Figure 15. Cross section through the leaf of *I. ensifolia.* / Figura 15. Secțiune transversală prin limbul foliar la *I. ensifolia* (original).
Figure 16. Stomata from the leaf of *I. ensifolia.* / Figura 16. Stomată de la nivelul limbului foliar la *I. ensifolia* (original).
Figure 17. Cross section through the leaf of *I.hirta.* / Figura 17. Secțiune transversală prin limbul foliar la *I.hirta* (original).
Figure 18. Front side of the epidermis of *I. ensifolia.* / Figura 18. Epiderma văzută de față la *I. ensifolia* (original).

**Afemei Marinela, Boz Irina, Toma Constantin**
Faculty of Biology, "Alexandru Ioan Cuza" University of Iași
E-mail: afemeimarinela@gmail.com; irina.boz@uaic.ro

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