

CONTRIBUTIONS TO THE ANATOMY OF *HEDERA HELIX* L. (ARALIACEAE)

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Abstract: The paper is part of a study comprising the histo-anatomical features of the vegetative organs in some woody climbers. The stem and leaves (except the petiole) of *Hedera helix* possess specific features in accordance with its climbing nature of *Hedera helix*. The stem exhibits a secondary structure, thickenings due to the activity of a conventional cambial ring. Cork cambium is also present, initially superficial, forming a cylinder (circular ring in cross section) around the stem. The cortex is extremely reduced, consisting of 3-4 layers of parenchymatous cells. The stele occupies the largest part of the stem. The mechanical tissue is poorly developed and consists of septate fiber bundles in the stem., but it is well developed in the petiole, being represented by collenchymatous cell layers. The stele consists of three collateral vascular bundles. Bundle sheaths are absent in the blade and petiole. The hardness of blade is given by collenchyma cells located in between the middle vein and the two epidermises. A number of calcium oxalate druses are present in both the stem cortex and in the blade (especially around the mid rib vascular bundle). Stellar hairs for the protection of plant are present on the stem surface, petiole and blade. Secretory cavities are present in both stem and blade, but the petioles lack them.

Introduction

English ivy or simply ivy (*Hedera helix* L.) is an evergreen climbing vine of the Araliaceae family. Vines attach to the bark of trees, brickwork, and other surfaces by means of numerous, small root like structures, which exude a glue-like substance. Older stems of ivy may reach a foot in diameter. Leaves are dark green, waxy, somewhat leathery, and are arranged alternately along the stem. English ivy has many recognized leaf forms, the most common being a 3-lobed leaf with a heart-shaped base. Umbrella-like clusters of small, greenish-white flowers appear in fall if sufficient sunlight is available. The fruits appear in spring, are black and fleshy at maturity and enclose stone-hard seeds [6, 11]. English ivy is an aggressive invader that threatens all vegetation levels of forested and open areas, growing along the ground but climbs as well into the forest canopy [8]. The berries and leaves are toxic. Their saponin content may produce severe stomach pains, diarrhea, labored breathing, and eventually coma if the poisonous parts are consumed in greater quantity. The berries are used as emetic and cathartic [10]. The botanical literature deals mainly with the morphological aspects of the plant and with some anatomical characteristics of the blade, but observations on the stem and petiole of this species are almost lacking.

Material and Methods

Sections of the mature stem and leaf (including the petiole) were performed by using manual techniques. The sections were stained with alum-carmin and iodine green. The samples were embedded in glycerin gelatin. Histological observations and micrographs were performed with a BIOROM –T bright field microscope, equipped with a TOPICA 6001A video camera. The micrographs were obtained from the computer assisted video camera.

Results and Discussions

Cross sections of the stem of *Hedera helix* L. exhibit that the outermost layer of cells – the epidermis – consists of simple compactly arranged barrel cells, covered by a thick cuticle.

Stellate hairs usually are present (Fig. 2c). The periderm consists of cork, just below the epidermis, phellogen (a single layer of thin-walled cells, radially flattened in shape and compactly arranged) and phelloderm. The slightly suberized cork cells are compactly packed, without intercellular spaces. The phelloderm consists of large parenchyma cells, mostly facing the vascular bundles. Some intercellular spaces are found between them. Just below the cortex, a compact vascular tissue occurs. Secondary thickening develops from conventional cambial cylinder (ring) as in other dicotyls [2, 3, 4, 5, 7]. Cork cambium is present, at the beginning superficially located, forming a circular cylinder (ring) around the stem. The cambium produces secondary xylem towards the inner side and secondary phloem towards its outer side. The secondary phloem comprises sieve elements, companion cells and phloem parenchyma (mostly peripherally). Remarkable is the presence of septate fibers, around the stem, with mechanical role (Fig. 1a, 2).

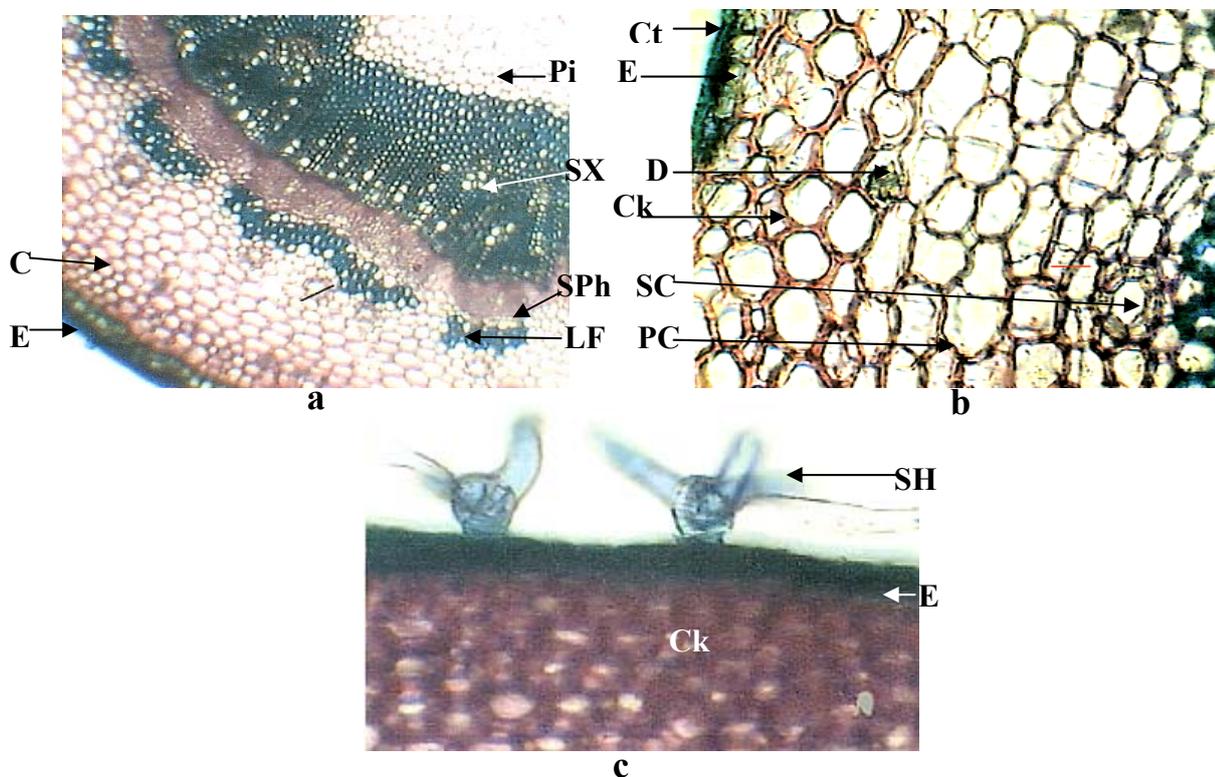


Fig. 1: Cross section of the stem. a - General view (X 115). b - Portion with epidermis and cortex. c - Stellate hairs (X 200). C - cortex; Ck - cork, Ct - cuticle, D - druses, E - epidermis; LF - libriform fibers, Pi - pith, SC - secretory cavity; SH - stellate hairs; SPb - secondary phloem; SX - secondary xylem. Original.

Internal phloem is absent. The secondary xylem found in the stem of *Hedera helix* consist of radial layers of xylem vessels, placed in libriform mass (fibers). Remarkable is the large diameter of the xylem vessels. Secondary xylem is crossed by wide rays. Primary xylem elements located toward the center of the stem are also present (Fig. 2). The pith is made up of spongy collenchyma, large number loosely arranged parenchyma cells, with large intercellular spaces filled up with cellulose. Medullar bundles are absent. Secretory cavities containing resin are present (Fig. 1a, b, 2).

Transversal sections of the petiole reveal epidermis, cortex and stele (Fig. 3a). The epidermis consists of a single layer of strongly cutinized cells, covered externally by a thick mixture of cutis and wax. Its continuity is interrupted by the presence of stomata and stellate hairs. The cortex is differentiated into two zones. The outer zone is tabular collenchyma (4

layers), the inner one consists of parenchymatous cells, filling up almost the entire central portion of the petiole (Fig. 3b). Secretory cavities are absent. The stele is composed of three closed collateral vascular bundles. The centrally located one is larger and consists of radially arranged xylem vessels, facing the abaxial surface, whereas the phloem is located adaxially position. Close to the abaxial surface of the petiole, there are two small, poorly developed vascular bundles. Complex hairs, mostly stellate (branched) are usually present (Fig. 1c) as previously Ackerfield (2001) reported.

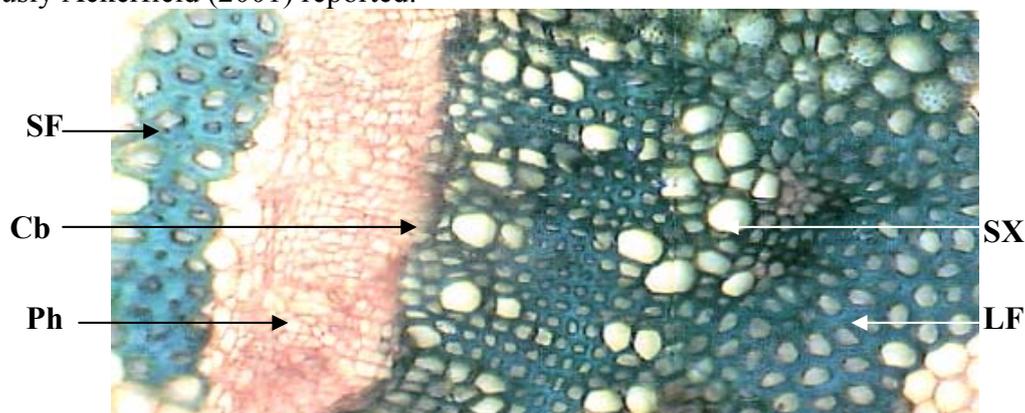


Fig. 2: Detail of stele. X 200: Cb - cambium, LF - libriform fibres, Ph - phloem; SF - septate fibers, SX - secondary xylem. Original.

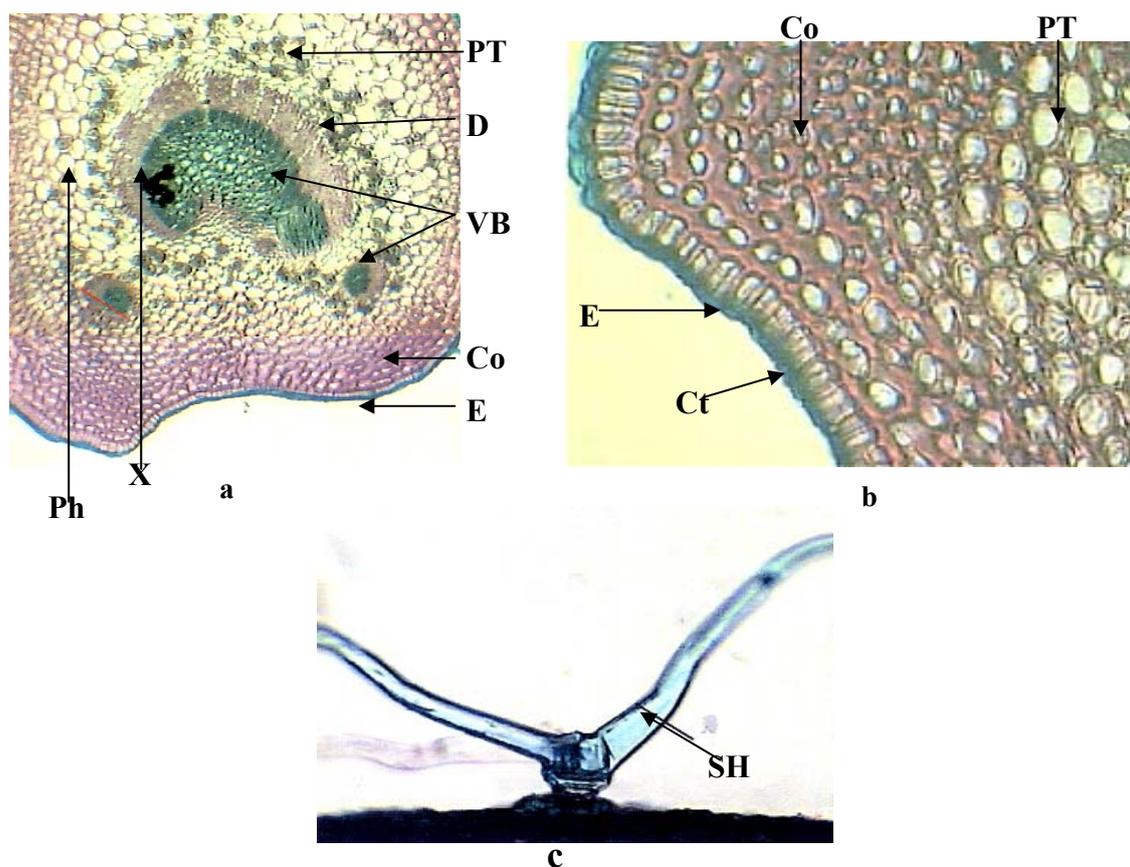


Fig. 3: Cross sections of the petiole. a – General view (X 80). b – Detail showing the epidermis and cortex (X 362). c - Stellate hair (X 240). Ct – cuticle; Co – collenchyma; D – druses; E – epidermis; Ph – phloem; PT – parenchyma; SH - stellate hair; VB - vascular bundle; X - xylem. Original.

Cross sections of the bifacial blade revealed the heterogeneous mesophyll, differentiated into palisade and spongy tissues. The mesophyll underlies both upper and lower epidermis. The

upper epidermis consists of simple, regularly arranged cells. The upper and inner walls of the epidermal cells are markedly cutinized. The cuticle is covered by wax. Viougeas *et al.* (1995) previously reported that the amount of wax increases from 12.3% in the young up to 18.6% in the old leaves. The thickness of the cuticle as measured by both light and electron microscopy increases 12-fold during leaf growth to reach 4.25 μm in mature ones. However, the percentages of cutis and non-lipid constituents do not vary significantly with leaf age. Waxes are increases as well. An adaxial hypodermis is present. The two layered palisade tissue consists of numerous chloroplasts. The one-layered lower epidermis consists of smaller cells, covered by thin cuticle. Its continuity is broken by the presence of stomata and stellate hairs (Fig. 4b). Spongy parenchyma connects the veins to the palisade tissue (Fig. 4a). The midrib consists of a single closed collateral bundle with radially arranged xylem facing the upper epidermis, whereas the phloem elements face the lower one. Bundle sheaths are absent. From vascular bundle of the midrib the minor veins are detached, separated by pith rays (Fig. 4b). Beneath the midrib's vein and the lower epidermis numerous druses are present. Minor blade veins without phloem transfer cells, protected outside by parenchymatous sheaths, are embedded in the mesophyll. Secretory cavities distributed mostly around the midrib are evident (Fig. 4a, b, c).

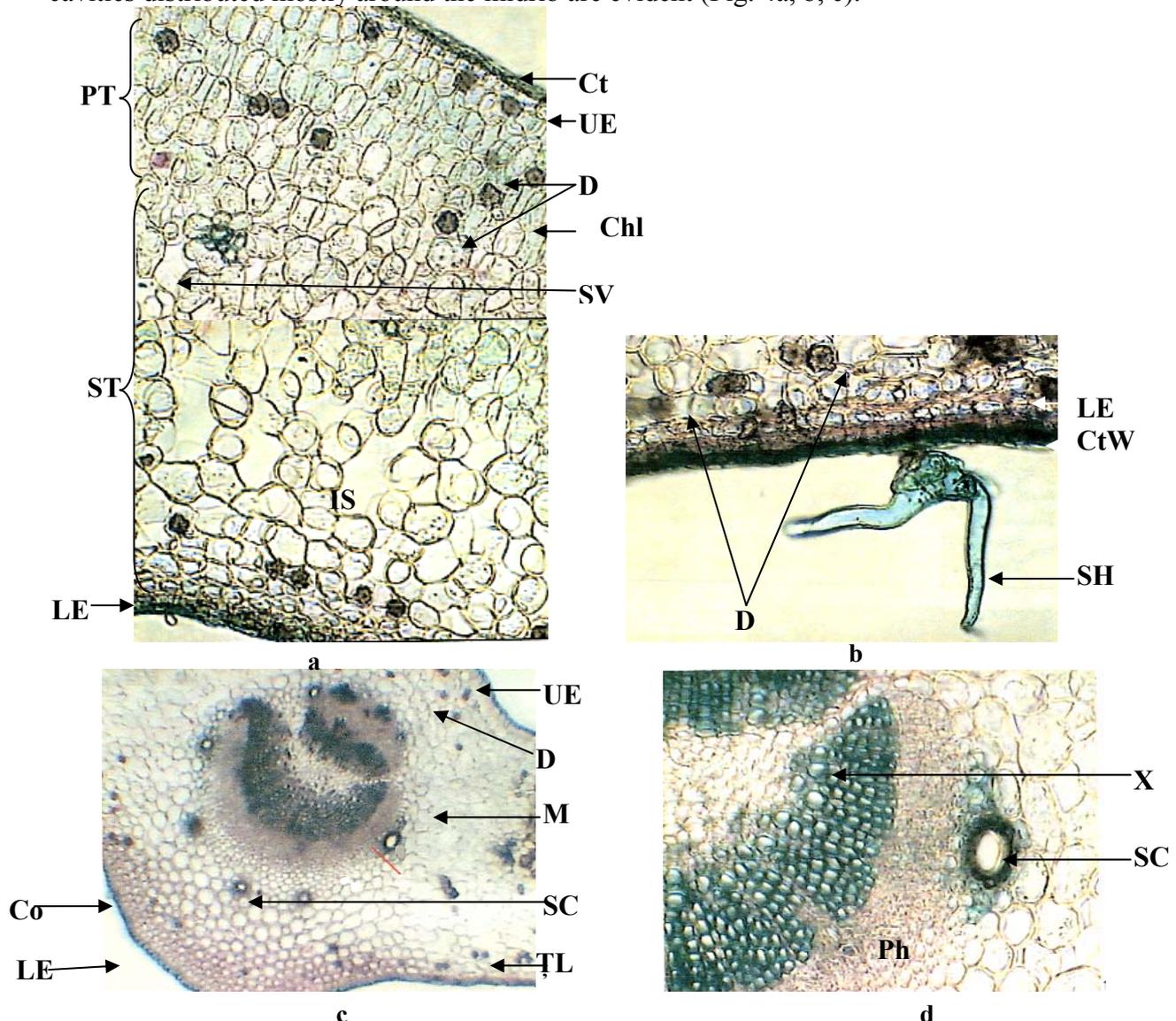


Fig. 4: Cross sections of the leaf blade. a - Portion of the blade. b - Stellate hairs (X 180). c - Midrib (X 80). d - Details with vascular bundle and secretory cavities of the midrib (X 180). Co - collenchyma; Chl - chloroplasts; CtW - cuticle with wax; D - druses; LE - lower epidermis; M - mesophyll; MR - midrib; Ph - phloem; SV - secondary vein; ST - spongy tissue; X - xylem. Original.

Conclusions

The present findings indicate that the stem and leaf (excepting the petiole) of *Hedera helix* possess specific features in accordance with the climbing nature of the plant. The stem has secondary structure (secondary thickening) developing by means of a conventional cambial ring. Cork cambium is present, initially located superficially, forming a cylinder (circular ring) around the stem. The cortex is extremely reduced, consisting of 3-4 layers of parenchyma cells. The stele fills up almost the entire stem. The mechanical tissue is poorly developed. It consists of packets of septate fibers in the stem. In the petiole it is represented by several collenchymatous cell layers. The stele consists of three collateral vascular bundles. Bundle sheaths are absent around the vascular bundles of the blade and petiole. The blade hardness is given by a number of collenchyma cells, placed between the midrib and lower epidermis. Druses of calcium oxalate are present in the stem cortex and in the blade (especially around the midrib vascular bundle). Stellate hairs serving the protection of plant are present in the stem, petiole and blade. Secretory cavities are present in both stem and blade. Such secretory elements are absent in the petiole. The surface of petiole and leaf blade exhibits thick cuticle layers. These are due to deposition of intracuticular wax lamellae.

REFERENCES

1. Ackerfield, J., 2001, Trichome morphology in *Hedera* (Araliaceae), *Edinburgh J. Bot.*, **58**: 259-267.
2. Andrei, M., 1978, *Anatomia plantelor*, Ed. Did. și Ped., București.
3. Batanouny, K., M., 1992, *Anatomy of Plants*, Univ. Press, Cairo.
4. Bavaru, A., Bercu, R., 2002, *Morfologia și anatomia plantelor*, Ed. Ex Ponto, Constanța.
5. Essau, K., 1988, *Plant Anatomy*, (4 ed.), John Wiley and Sons Inc., New-York.
6. Săvulescu, T., (Ed.), 1958, *Flora R.P.R.*, Vol. VI, Ed. Acad. Române, București: 323-324.
7. Șerbănescu-Jitariu, G., 1980, *Morfologia și anatomia plantelor*, Ed. Did. și Ped., București.
8. Thomas, L. K. 1998. Topographic alterations, forest structure, and invasion by English ivy (*Hedera helix* L.) in the Rock Creek floodplain, Washington D.C., *Natural Areas Journal*, **18**: 164-168.
9. Viougeas-M. A., Rohr, R.; Chamel, A., 1995, Structural changes and permeability of ivy (*Hedera helix* L.) leaf cuticles in relation to leaf development and after selective chemical treatments. *New Phytol.*; **130**, (3): 337-348.
10. Wichtl, M., 1994, Herbal Drugs and Phytopharmaceutical. To for *Handbook Practice on to Scientific basis*, Stuttgart, Medpharm Scientific Publ.: 3, 251.
11. Watson, L., Dallwitz, M. J, 1991, The families of angiosperms: automated descriptions, with interactive identification and information retrieval, *Aust. Syst. Bot.*, **4**: 681-95.

CONTRIBUȚII LA CUNOAȘTEREA ANATOMIEI SPECIEI *HEDERA HELIX* L. (ARALIACEAE)

(Rezumat)

Lucrarea de față face parte dintr-un studiu privind anatomia organelor vegetative ale unor specii volubile și agățătoare din flora noastră spontană. Iedera (*Hedera helix* L.) este o plantă perenă, agățătoare din familia Araliaceae. Ea se urcă pe scoarța copacilor, pe ziduri și pe alte suprafețe, cu ajutorul rădăcinilor sale scurte și dese care secretă o substanță lipicioasă. Frunzele, alterne pe tulpină, au forme variate, deseori trilobate, fiind acoperite de ceară. Florile mici alb-verzui sunt grupate în inflorescențe umbeliforme. Fructele, toxice, necomestibile sunt cărnoase și apar primăvara [6, 11]. Iedera este o specie invazivă ce amenință toate nivelele de vegetație atât din păduri cât și din locuri deschise [8]. Saponinele, conținute de plantă, pot produce dureri stomacale, diaree, dureri respiratorii iar ingerată în cantități mari pot duce la comă [10].

Secțiunile transversale efectuate prin tulpină înfățișează o structură relativ secundară, prezentă la multe dicotile [2, 3, 4, 5, 7], îngroșarea sa fiind rezultatul activității unui cambiu convențional. Stelul ocupă cea mai mare parte din tulpină. Se remarcă prezența fibrelor sclerenchimatice septate, cu rol mecanic. Sistemul conducător, format din elemente de xilem și de floem, formează țesuturi compacte, xilemul fiind plasat într-un parenchim sclerenchimatic. În mijloc se găsește parenchimul medular cu rol de depozitare. Se remarcă elemente histologice

secretoare, reprezentate prin canale secretoare rezinifere, plasate cortical. Continuitatea epidermei stelului este întreruptă de prezența perilor ramificați (Fig. 1a, b, c; 2).

Secțiunile transversale prin pețiol înfățișează, la exterior, epiderma unistratificată cu peri ramificați [1], sub care se găsește scoarța. Scoarța este diferențiată în două zone. Zona externă este reprezentată printr-un colenchim tabular iar cea internă, de asemenea pluristratificată, este de natură parenchimatică. Stelul apare format din trei fascicule vasculare, două mai mici, situate abaxial și unul mai mare central. Fasciculele vasculare sunt de tip colateral, cu liberul situat spre epidermă. Se remarcă lipsa canalelor secretoare din structura pețiolului (Fig. 3a, b, c).

Limbul, pe secțiune transversală, prezintă succesiunea obișnuită de țesuturi: epiderma superioară, epiderma inferioară și mezofilul heterogen. Ambele epiderme sunt acoperite de cuticulă amestecată cu ceară vegetală [9]. Canale rezinifere sunt prezente, în special în jurul nervurii mediane. Nervura mediană este reprezentată printr-un fascicul colateral din care se desprind nervurile secundare. Continuitatea epidermei inferioare este întreruptă, un numai de prezența stomatelor și a perilor ramificați, prezenți pe tulpină și pe pețiol (Fig. 4, a-d).

Druzele de oxalat de calciu sunt prezente atât în tulpină, cât și în frunză (limb și pețiol) (Fig. 1b, 3a, 4a, c.).

Prin caracterele sale anatomice, specifice (cuticula epidermală groasă, cerificată, slaba dezvoltare a țesutului mecanic, reducerea cortexului în tulpină și pețiol etc.) specia este perfect adaptată condiției sale de plantă agățătoare.