CONTRIBUTIONS TO KNOWING THE ANATOMY OF THE VEGETATIVE ORGANS OF *HEDERA* L. (*ARALIACEAE*)

CONTRIBUȚII LA CUNOAȘTEREA ANATOMIEI ORGANELOR VEGETATIVE LA *HEDERA* L. (*ARALIACEAE*)

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Abstract. *The researches conducted on the anatomy of the vegetative organs of Hedera helix, H. helix* var. *tres coupe and H. canariensis have revealed the existence of a number of characteristic peculiarities, among which mention should be made of those of the stem epidermis, of the subepidermic cortical collenchyma, and of the assimilatory tissue of the leaf. These peculiarities represent the expression of the adaptations to the different life environment of the species analysed.*

Rezumat. *Cercetările efectuate asupra anatomiei organelor vegetative la Hedera helix, H. helix var. tres coupe şi H. canariensis au relevat existența unor particularități caracteristice, dintre care le menționăm pe cele ale epidermei tulpinii, colenchimului cortical subepidermic şi ale țesutului asimilator al frunzei. Aceste particularități constituie expresia adaptării la mediul de viață diferit al speciilor analizate.*

The *Araliaceae* family, including some 700 species belonging to 55 genera, consists mostly of trees and shrubs. *Hedera* is a genus made up of 15 species of climbing, or ground-creeping evergreen woody plants in the family *Araliaceae*, native to the Atlantic Islands, western, central and southern Europe, northwestern Africa and across central-southern Asia east to Japan. *Hedera helix* L., the ivy (*Araliaceae*, *Araliales*, *Asteridae*, *Rosopsida*, *Angiospermae*, *Spermatophyta*) (Ehrendorfer, 1999) is the best-known temperate species. The species included in the genus *Hedera* are important as ornamental, medicinal, ecological plants, while, in some cases, *Hedera helix* can become an invasise species.

MATERIAL AND METHODS

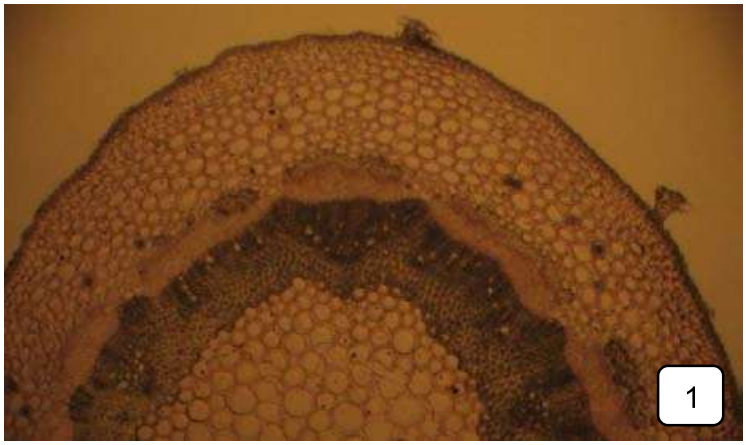
The vegetable material used consisted of vegetative organs sampled from the spontaneous species *Hedera helix* and from *H. helix*. var. *tres coupe* and *H. canariensis*, all plants cultivated for ornamental purposes. *Hedera canariensis* is native to the Canary Islands, Portugal, the Azores, and North Africa. The material was analysed in cross-sections made across the young stems and leaves. The sections were treated with Javel water and coloured with Geneva reagent, analysed under the optical microscope, and microphotographed with a Canon digital camera.

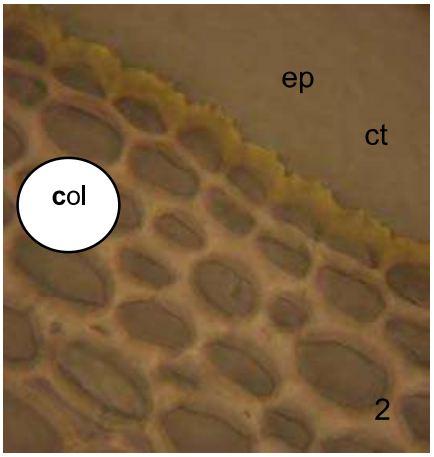
RESULTS AND DISCUSSIONS

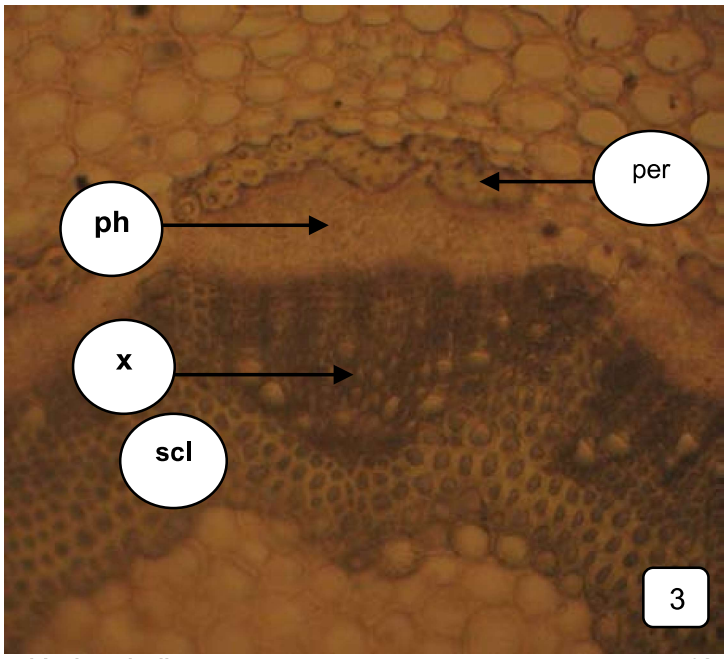
The anatomy of the stem. On the outside, the young stem is delimited by a one-layer epidermis, made up of small cells. The cuticle covering the epidermis is

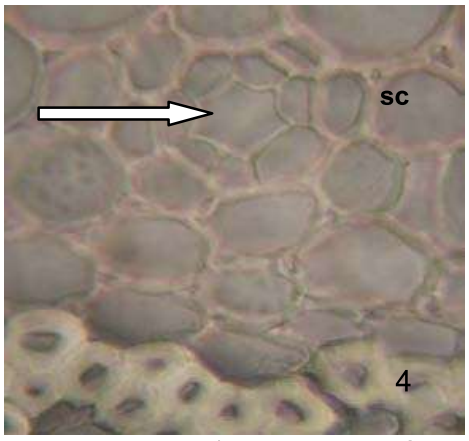
thick in *H. helix* (fig. 2), and thinner in the ornamental species (fig. 6, 8), a peculiarity determined by the different environment of the species under analysis. In all the species, the cuticle displays transverse crests. The epidermis exhibits multi-cell tectorial hairs (fig.1). The multi-layered cortex is differentiated into the external and the internal cortex. The outer cortex is collenchymatous, and made up of 3 to 5 strata of cells, in *H. helix* having more evident thickening of the cell walls (fig. 2). In *H. helix*. var. *tres coupe*, the collenchima is reduced, being made up of 2 to 3 strata of cells (fig. 5, 6). In *H. helix*, the collenchyma becomes sclerous, a process that can also be noticed in the stem and petiole of other dicotyledonous (Duchaigne, 1955). The inner cortex, made up of bigger cells than those in the outer cortex (fig. 1, 5, 7), has thickened cell walls in *H. helix*, and thin walls in H. *helix*. var. *tres coupe* and *H. canariensis*. Within that area, druses can be noticed, more frequently in *H. helix* and H. *helix*. var. *tres coupe*. In all species near the central cylinder of the inner cortex can be found secretory ducts with a polygonal lumen, delimited by secretory cells (fig. 4); secretory ducts are formed in a schizogeneous manner (Carr & Carr, 1970; Fahn, 1979) and are characteristic of the *Araliaceae* (Metcalfe & Chalk, 1950; Carlquist,1988, Kolalite and all., 2003). These structures are traditionally regarded as a character of great diagnostic importance for this family (Takhtajan 1987). The central cylinder is delimited by a fragmented sclerenchymatous pericycle (fig. 3, 4, 5), which does not occur in *H. canariensis* (fig. 7). The vascular bundles belong to the open collateral type, and have various sizes. The intrafascicular cambium is roundly linked to the interfascicular one, and differentiated in the parenchyma of the primary medullar radii, thus constituting a continuous cambial ring, which will generate secondary vascular tissues. In the internal and lateral regions, the vascular bundles are accompanied by a sclerenchymatous tissue (fig. 1, 3, 5, 7). The cell walls of the sclerenchyma are more thickened in *H. helix* and H. *helix*. var. *tres coupe*, and thinner in *H. canariensis*. Certain vascular bundle of *H. canariensis* lack the xylem (Fig. 7). The pith of the stem is made up of isodiametric cells, which have slightly thicker walls in *H. helix*. In the medulla, secretory canals can be noticed in H. *helix*. var. *tres coupe* and in *H. canariensis* (fig. 9, 10) and, sometimes, druses.

The petiole. It is of a polystellic type, each vascular bundle being surrounded by its own endodermis (fig. 12). The one-layered epidermis, which lies outside, has a structure similar to that of the stem. Under the epidermis there is a three-to five-layered collenchyma, the walls of which are heavily thickened. Very much as in the case of the stem, the collenchyma is better developed in *H. helix* and *H. canariensis*. Under the collenchyma there lies a parenchyma that contains oxaliferous cells (fig. 12). The vascular bundles lie in the shape of a circle (fig. 11). On the outside of the vascular bundles, in the parenchyma, there are the secretory ducts (fig. 13), as in the phloem (fig. 13, 14).





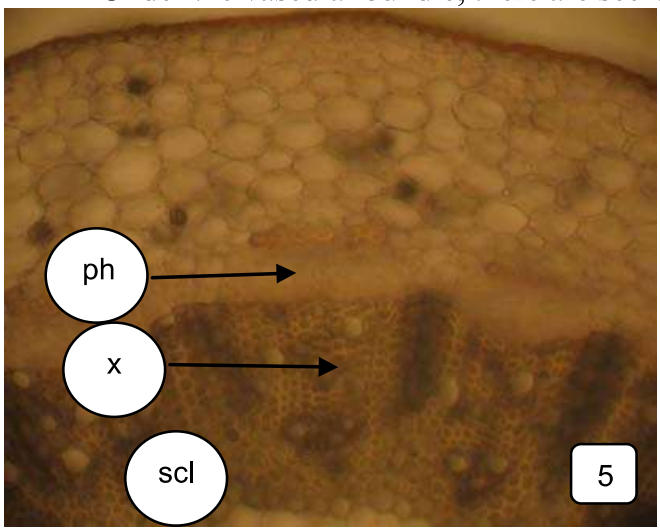


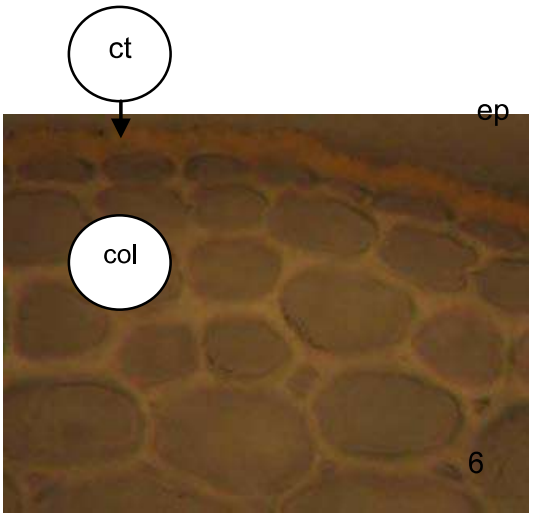


Hedera helix – cross section through the stem. **Fig. 1.** (Oc. 10x, ob.10, orig.). **Fig. 2.** Detail from epidermis and outer cortex: col-collenchym, ct-cuticle, ep-epidermis (oc. 10x, ob 40, orig.). **Fig. 3.** Detail from stel: ph-phloem, per-pericycle, scl-sclerenchym x-xylem, (oc. 10x, ob. 20, orig.). **Fig. 4.** Secretory duct from cortex (arrow): sc-secretory cels (oc. 10x, ob.40).

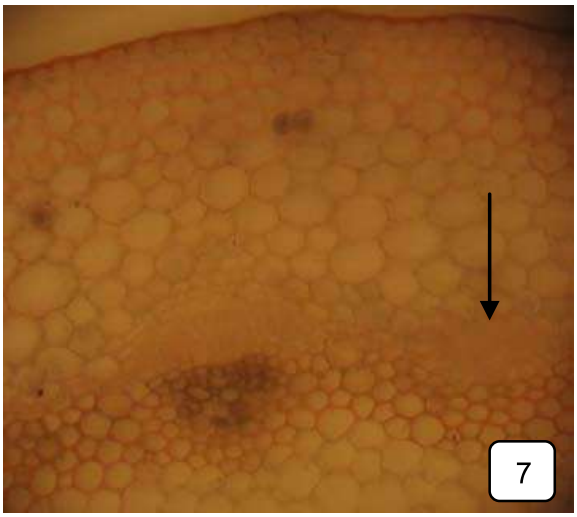
The lamina. Facing the median nervure, on both the adaxial and abaxial sides, all the species display a protuberance. In that region, under the epidermis, there lies a collenchymatous tissue. On the outside, the leaf exhibits a one-layer epidermis, covered by the cuticle, with stomata on the lower one. The mesophyll is differentiated into a palisadic, and a lacunous parenchyma. The cells of the palisadic parenchyma are longer in *H. helix*, and more of less isodiametric in H. *helix*. var. *tres coupe* and in *H. canariensis* (fig. 17, 18). The mesophyll contains numerous oxaliferous cells. The median nervure is made up of a larger collateral fascicle, arc-shaped, which has a xylem oriented towards the adaxial face and the phloem going towards the abaxial face, and, above it, a smaller collateral fascicle, with a reverse orientation of the vascular tissues. Both fascicles exhibit sclerenchyma on the outside region of the phloem (fig. 15), stunted in *H. canariensis*.

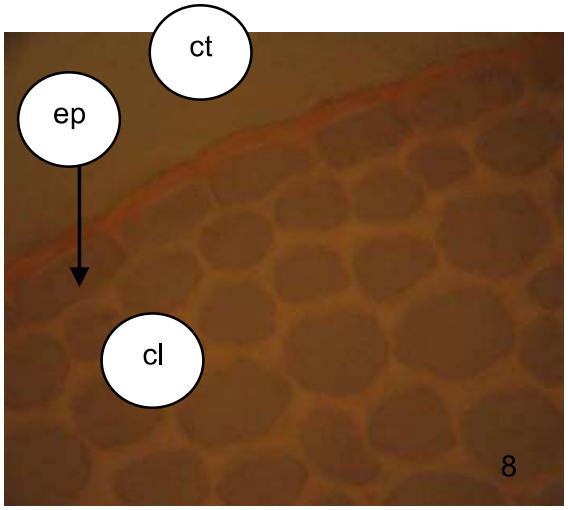
Under the vascular bundle, there are secretory ducts.



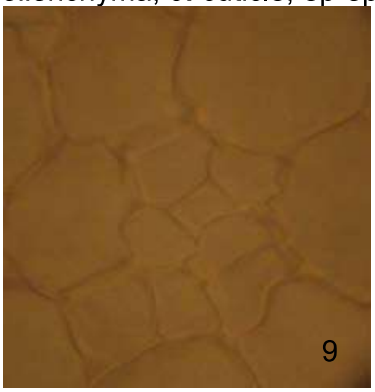


Hedera helix var. *tres coupe* - cross section through the stem. **Fig. 5.** (oc.10x, ob. 20, orig.). **Fig. 6.** Detail from epidermis and outer cortex: col-collenchyma, ct-cuticle, ep-epidermis (oc. 10x, ob 40, orig.).





Hedera canariensis - cross section through the stem. **Fig. 7.** Vascular bundle lack the xylem (arrow) (Oc.10x, ob. 10,orig). **Fig. 8.** Detail from epidermis and outer cortex: cl-collenchyma, ct-cuticle, ep-epidermis (oc. 10x, ob 40, orig.).



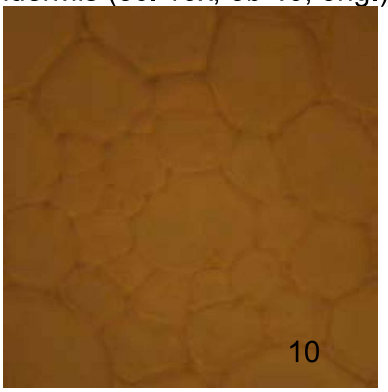
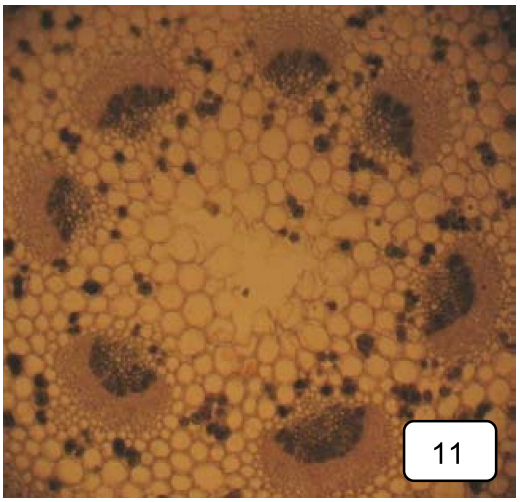
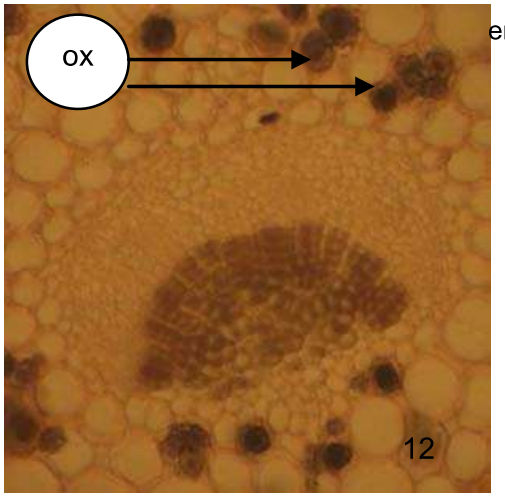
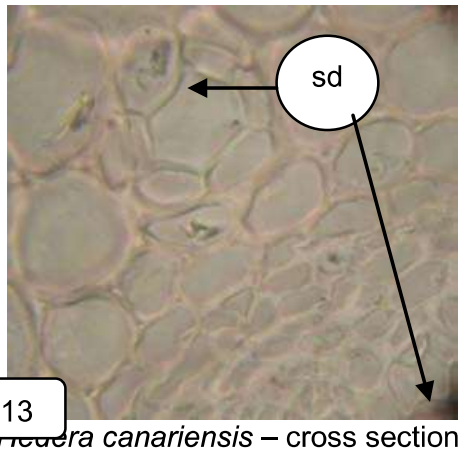


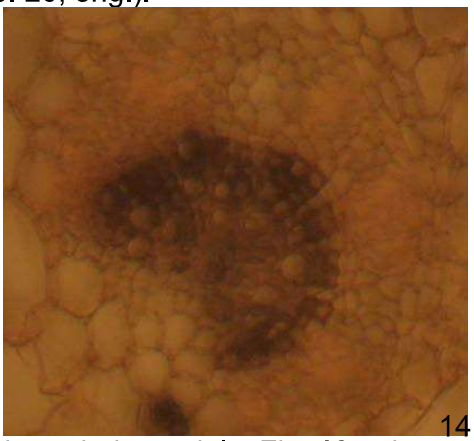
Fig. 9, 10. *Hedera canariensis* - cross section through the stem. Detail from pith: secretory ducts (arrow) (oc. 10x, ob. 40, orig.).



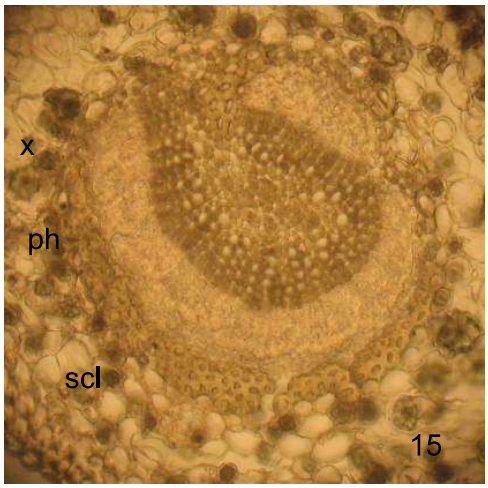


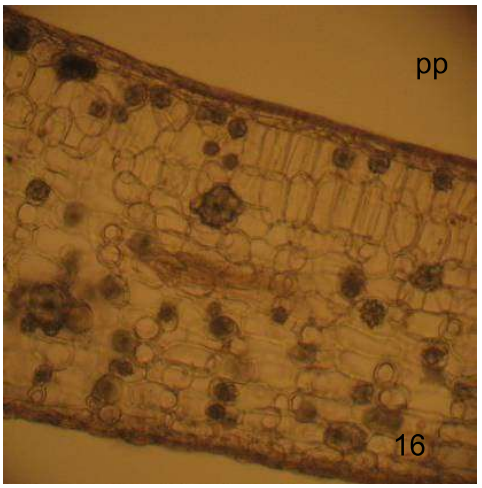
Hedera helix – cross section through the petiole. **Fig. 11.** The vascular bundles (oc. 10x, ob. 10, orig.). **Fig. 12.** Details of vascular bundle: end-endodermis, ox- oxaliferous cells, (oc. 10x, ob. 20, orig.).





Hedera canariensis – cross section through the petiole. Fig. **13.** sd-secretory duct (oc. 10x, ob. 40, orig.), **Fig. 14.** Secretory duct in phloem (arrow)(oc. 10x, ob. 20, orig.).





Hedera helix – cross section through the leaf. **Fig. 15.** Median vein: ph-phloem, x-xylem, scl-sclerenchyma (oc. 10x, ob. 10, orig.), **Fig. 16.** Lamina: pp-palisadic parenchyma (oc. 10x, ob. 10, orig.).

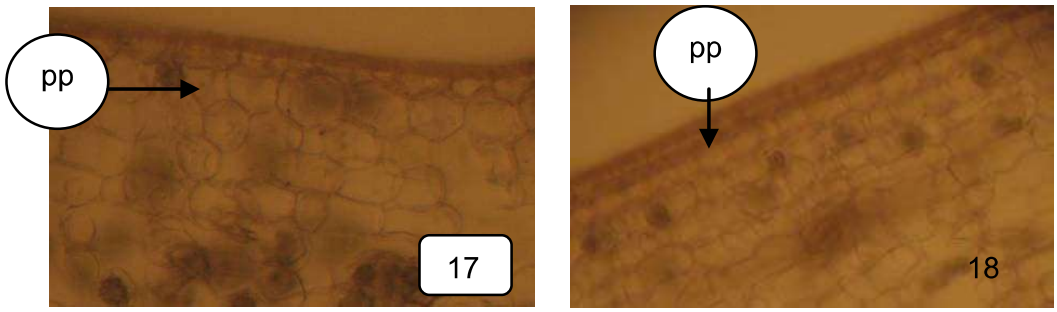


Fig. **17.** *Hedera helix* var. *tres coupe* – cross section through the lamina: pp-palisadic parenchyma (oc. 10x, ob. 20, orig.). Fig. **18.** *Hedera canariensis* – cross section through the lamina: pp-palisadic parenchyma (oc. 10x, ob. 20, orig.).

CONCLUSIONS

The general structure design of the two species and of the variety *tres coupe*, which has been analysed, is similar, and the structural differences are the expression of their adjustment to different environments. Thus, *H. helix*, a spontaneous species as well as a species cultivated outside as an ornamental plant, displays a thicker cuticle and a more developed subepidermal collenchyma, in both the stem, and the petiole and lamina. The sclerenchyma lying on the internal and lateral sides of the vascular bundles in the stem is more developed in *H. helix*, as well as in its variety, representing a species-defining characteristic. The structure of the assimilatory parenchyma also represents the result of the adjustment to a different environment; the palisadic parenchyma is made up of prosenchymatic cells only in the species that vegetates in the outer environment, while the vegetable material cultivated indoors has a palisadic parenchyma made up of shorter cells in *H. helix* var. *tres coupe*, and nearly isodiametric cells in *H. canariensis*.

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