

## ANATOMICAL STRUCTURE OF SOME *EUPHORBIA* SPECIES FROM THE ROMANIAN FLORA

### STRUCTURA ANATOMICĂ A UNOR SPECII DE *EUPHORBIA* L. DIN FLORA ROMANIEI

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#### Abstract

This article compares the anatomy of (subterranean and aerial) vegetative organs of 4 *Euphorbia* species from the Romanian flora, focusing on identifying the histo-anatomical characters recognised as delimiting the different taxa. The investigated taxa present constant anatomical characters (laticifers in all vegetative organs; libriform gelatinous fibers; periphloemic cordons of sclerenchymatous fibers; stomata of anizocytic and anomocytic-type in foliar limb) as well as variable ones (type of epidermis cells in stem and lamina; organization of stem cortex and pith; distribution, morphology and frequency of laticifers; structure of foliar limb).

#### Rezumat

În prezentul articol este analizată, comparativ, structura aparatului vegetativ la 4 taxoni de *Euphorbia*, ce cresc în România, evidențându-se trăsăturile histo-anatomice cu rol în diagnoza speciilor, ce ar putea servi la determinarea lor atunci când plantele nu sunt înflorite sau fructificate. Taxonii investigați prezintă caractere anatomice constante (laticifere în toate organele vegetative; fibre libriforme gelatinoase și cordoane de fibre sclerenchimatice perifloemice în tulpină; stomate de tip anomocitic și anizocitic în limbul foliar) și variabile (tipul de celule epidermice în tulpină și lamină; organizarea lemnului secundar și a măduvei tulpinii; distribuția, morfologia și frecvența laticiferelor; structura limbului foliar).

**Key words:** *Euphorbia*, vegetative organs, anatomy, laticifers

**Cuvinte cheie:** *Euphorbia*, organe vegetative, anatomie, laticifere

### INTRODUCTION

Following-up on our histo-anatomical researches on the vegetative organs of some *Euphorbia* taxa (ROTARI, 2004; ROTARI & TOMA, 2004; GALEȘ & TOMA, 2005, GALEȘ & TOMA, 2006), this paper analyzes comparatively the structure of the root, rhizome, aerial stem and leaf of 4 *Euphorbia* species from the Romanian flora.

The existing literature on the anatomy of *Euphorbia* species is quite rich, if considering the researches on the origin, development and structure of non-articulated laticifers as well as on the cyathia structure and it might be considered poor, if one takes into account the papers exclusively devoted to the anatomy of the vegetative organs of the species from this genus.

The most ample paper which analyzes the structure of the stem and leaf of species from the *Euphorbiaceae* family is that of Gaucher (1902). Succinct references on the structure of the vegetative organs of some *Euphorbia* species are founded in some general treatises which analyze the angiosperms anatomy published by SOLEREDER (1899), BONNIER G. & LECLERC DU SABLON (1905), METCALFE & CHALK (1950), ESAU (1965) and NAPP-ZINN (1973, 1974).

The Romanian literature of the field includes no study exclusively on the structure of the *Euphorbia* species; there are only a few data on the structure of some vegetative organs (IVĂNESCU & TOMA, 2003, TUDOSE, 2001) or general mentions in some lectures and manuals of Anatomy and Morphology of Plants (GRINȚESCU, 1985; ȘERBĂNESCU-JITARIU & TOMA, 1980; TOMA & GOSTIN, 2000).

### MATERIAL AND METHODS

The material utilized in the study belongs to 4 *Euphorbia* taxa (*E. bazargica* PROD., *E. nicaeensis* ALL., *E. peplus* L., *E. carniolica* JACQ), collected from different parts of Romania (Moldova, Dobrogea, Transilvania).

The material fixed and preserved in ethylic alcohol, has been subsequently processed (cross-sectioned, coloured with iodine green and ruthenium red and inserted into glicero-gelatina), according to the currently applied methods in vegetal anatomy investigations. The permanent slides obtained have been analyzed with a Novex (Holland) microscope and have been photographed on the same microscope with a Sanyo digital camera.

### RESULTS AND DISCUSSIONS

#### THE STRUCTURE OF THE SUBTERRANEAN VEGETATIVE ORGANS

The investigated taxa are perennial, with the exception of *E. peplus*, which is annual. The analyzed vegetative organs (root, rhizome) evidences a secondary structure resulted from the activity of both lateral meristems, i. e. the cambium and the phellogen.

In the root of *E. peplus*, the phellogen is differentiated from the endodermis, forming a few atypical cork layers the external ones being exfoliated and some layers of phellodermis with widened tangentially and not collenchymatous cells (fig. 1).

In the rhizome of perennial taxa, the phellogen arises in the inner cortex, the both generated tissues having a typical organization (fig. 2). The cork is very thick (10-14 layers) in *E. bazargica*, or thin (3-4 layers) in *E. nicaeensis*.

In the both analyzed vegetative organs, the xylem is the most extended tissue, the vessels of different diameter being solitary or grouped (fig. 3). The libriform fibers walls often appear as an outer non-shrinking wall surrounding an inner gelatinous wall portion in permanent slides (CARLQUIST, 1970). In the taxa investigated in our study, the libriform fibers have a very thick, weakly lignified secondary wall (in the root), being partially or totally gelified (in the rhizome) (fig. 4). The secondary xylem parenchyma is cellulosic; in the rhizome it forms tangential discontinuous bands which penetrate in patches the libriform mass; in the root this is predominant towards the external part of the central xylem body. Both conducting tissues are traversed by medullar parenchymatous-cellulosic multiseriate rays (in the rhizome) which are partially lignified (in the root), being most wide in the secondary phloem.

In the root of *E. peplus*, the secondary phloem is differentiated into two areas; the internal one is conducting, the external one being exclusively formed by phloem parenchyma cells (fig. 5). In the rhizome, most of the phloem elements are collenchymatous, through these laticifers of different size are present (fig. 6).

The pith of the rhizome is parenchymatous – cellulosic, partially disorganized. In the rhizome of *E. nicaeensis*, the primary vessels are grouped in radiary columns which deeply penetrate the thickness of the pith (fig. 7).

#### THE STRUCTURE OF THE AERIAL STEM

In all the investigated taxa, the passing from the primary structure to the secondary structure, may be observed along the aerial stem.

The epidermis has cells of cubic or tabular shape (*E. peplus*), with thick periclinal walls; the external wall is covered by a cuticle of variable thickness. In *E. nicaeensis* and *E. bazargica*, most of the epidermal cells evidence a papila-shaped prominence in the middle of the external wall, some of them forming very short prickle-shaped hairs (fig. 8). The stomata are located on the same level with the epidermis cells (*E. carniolica*, *E. peplus*), or under the external level of the epidermis, a shallow suprastomatal chamber being formed in *E. nicaeensis* and *E. bazargica*.

In *E. carniolica* and *E. peplus*, the parenchymatous cellulosic primary cortex is homogenous, of meatic type. In the other two analyzed taxa, in the cortex, three different areas may be distinguished; an external one of tangential collenchyma type, a middle one with numerous aeriferous cavities, separated by uniseriate lama in *E. nicaeensis* and an internal one, relatively compact, in which numerous big laticifers are founded (fig. 9).

The stem endodermis is usually not well defined in *Euphorbia* genus, as mentioned by METCALFE & CHALK (1950); in all taxa investigated in this study an endodermis of specially type is not observed.

In the epidermis and the cortex of *E. peplus*, simple crystals of calcium oxalate, solitary or grouped in quadratic system are founded (fig. 10). SOLEREDER (1899) mention the presence of crystals shaped like a whetstone in the cortex of the axis of *E. splendens* Bojer and GAUCHER (1902) point out that the species from *Euphorbia* genus have never crystals of calcium oxalate. Our investigations agree with those of SOLEREDER.

In the aerial stem's zone with primary structure, the stele comprises a variable number (20-50) of vascular bundles of collateral open type, disposed on a circle. At the periphery of the phloem, cordons of incipient sclerenchymatous fibers of polygonal contour in transverse section, with more or less thick and not yet lignified walls are present (fig. 11). The pith is parenchymatous-cellulosic, having aeriferous cavities of variable size, resulted from the disorganization of some cells (*E. carniolica*, *E. peplus*) or represents an aerenchyma of lamellar type (*E. nicaeensis*, *E. bazargica*).

The secondary structure of the aerial stem results in the most part from the activity of the cambium; only in *E. carniolica* and *E. bazargica*, the phellogen arises in patchy in the outer cortex (fig. 12).

The conducting secondary tissues are of annular type, with the exception of *E. bazargica*, in which these conserve the fascicular feature of those from primary structure, the medullary rays of variable width, from the secondary xylem, being parenchymatous cellulosic or lignified. In the thickness of the secondary xylem, the libriform formed by fibers with very thick, moderately lignified and partially gelified secondary wall, are predominated (fig. 13).

In the aerial stem's zone with secondary structure, the sclerenchymatous fibers are completely formed, having a very thick and weakly lignified secondary wall, the most part of it being gelified (fig. 14). These fibers represent a constant characteristic of the *Euphorbiaceae* family (GAUCHER, 1902).

#### THE STRUCTURE OF THE FOLIAR LIMB

The mesophyll has a variable structure, in correlation with the plants' growth conditions, varying in the specimens of the same species, in the leaves of the same plant and in the same leaf, along the limb (GAUCHER, 1902).

According to the foliar limb structure, the analyzed taxa may be divided into two groups: 1- taxa with bifacial izofacial (centric-heterogenous) leaves (*E. bazargica*, *E. nicaeensis*); 2- taxa with heterofacial bifacial leaves (*E. carniolica*, *E. peplus*), the characteristics of the mesophyll being relatively constant in each group.

In all the investigated taxa, except *E. bazargica* (fig. 15), the median nervure are prominent on the abaxial face of the limb and comprises, in the fundamental collenchymatous parenchyma, a single vascular bundle of variable size, in which the vessels are disposed, in generally, in radiary columns separated by a few parenchyma cellulosic cells.

The surface of the foliar limb presents polygonal cells with straight (*E. bazargica*, *E. nicaeensis*) (fig. 16) or sinuous lateral walls (*E. carniolica*, *E. peplus*) (fig. 17); in transverse section epidermis cells are tangential elongated or

approximately isodiametrical, the external wall being more thick than the others and covered by a thin cuticle. In *E. bazargica* și *E. nicaeensis*, the epidermis cells are of papilla shaped, some of them forming very short prickle-shaped hairs, as GAUCHER (1902) observes in other *Euphorbia* species.

The stomata are of anizocytic and anomocytic-type, being localized in both of the epidermis, with the exception of *E. carniolica*, in which the foliar limb is hipostomatic. In the existing literature it is mentioned that the stomata, in European species of *Euphorbia*, are predominantly rannunculaceous (METCALFE & CHALK, 1950), without guard cells of special type and localized generally at the level of the epidermis: at the cuticle level or at the half of the epidermis cell height (GAUCHER, 1902). In the taxa investigated in this study, the stomata cells are small and located under the external level of the epidermis, being formed a shallow suprastomatal chamber.

#### THE MORPHOLOGY AND DISTRIBUTION OF THE LATICIFERS

The species of the *Euphorbia* genus present non-articulated, branching and non-anastomosing laticifers (ESAU, 1965) with cellulosic, usually thin walls (RUDALL, 1987).

In all (subterranean and aerial) vegetative organs of the taxa taken into study, laticifers, localized in certain tissues (cortical parenchyma, phloem, assimilatory foliar tissues) may be observed. The wall of the laticifers is always cellulosic, uniformly thickened or has in patchy centripetal thickenings (*E. nicaeensis*) (fig. 18).

### CONCLUSIONS

The investigated taxa present the following constant characters: non-articulated laticifers with cellulosic thick walls in all the vegetative organs; periphloemic cordons of sclerenchymatous fibers in the structure of the stem; stomata of anizocytic and anomocytic-type in the foliar limb; libriform gelatinous fibers.

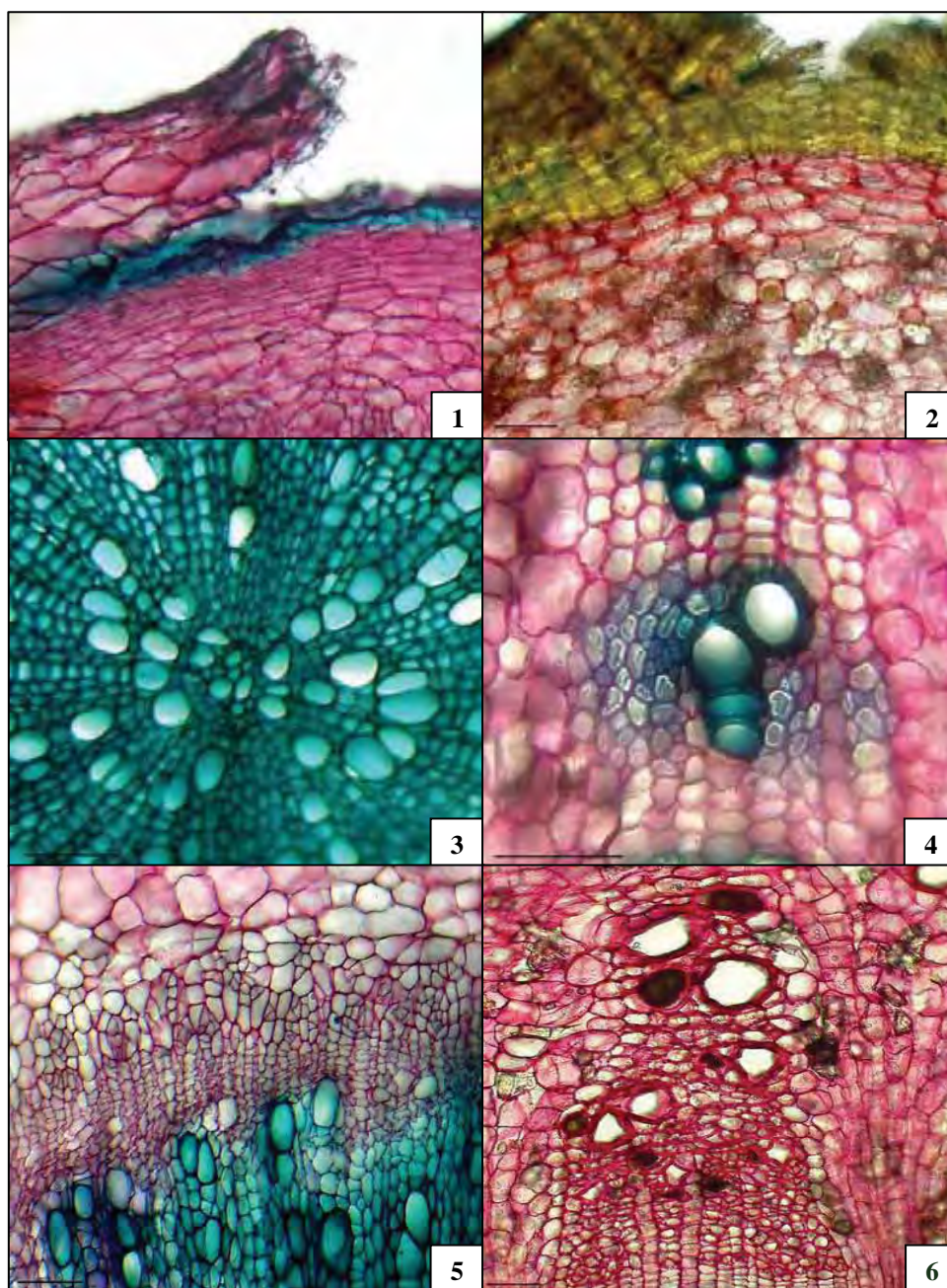
The structure of the vegetative organs of the taxa taken into study differs in several characters: the stem cortex organization; the pattern of epidermis cells, the (annular or fascicular) organization type of the secondary vascular tissues of the stem.

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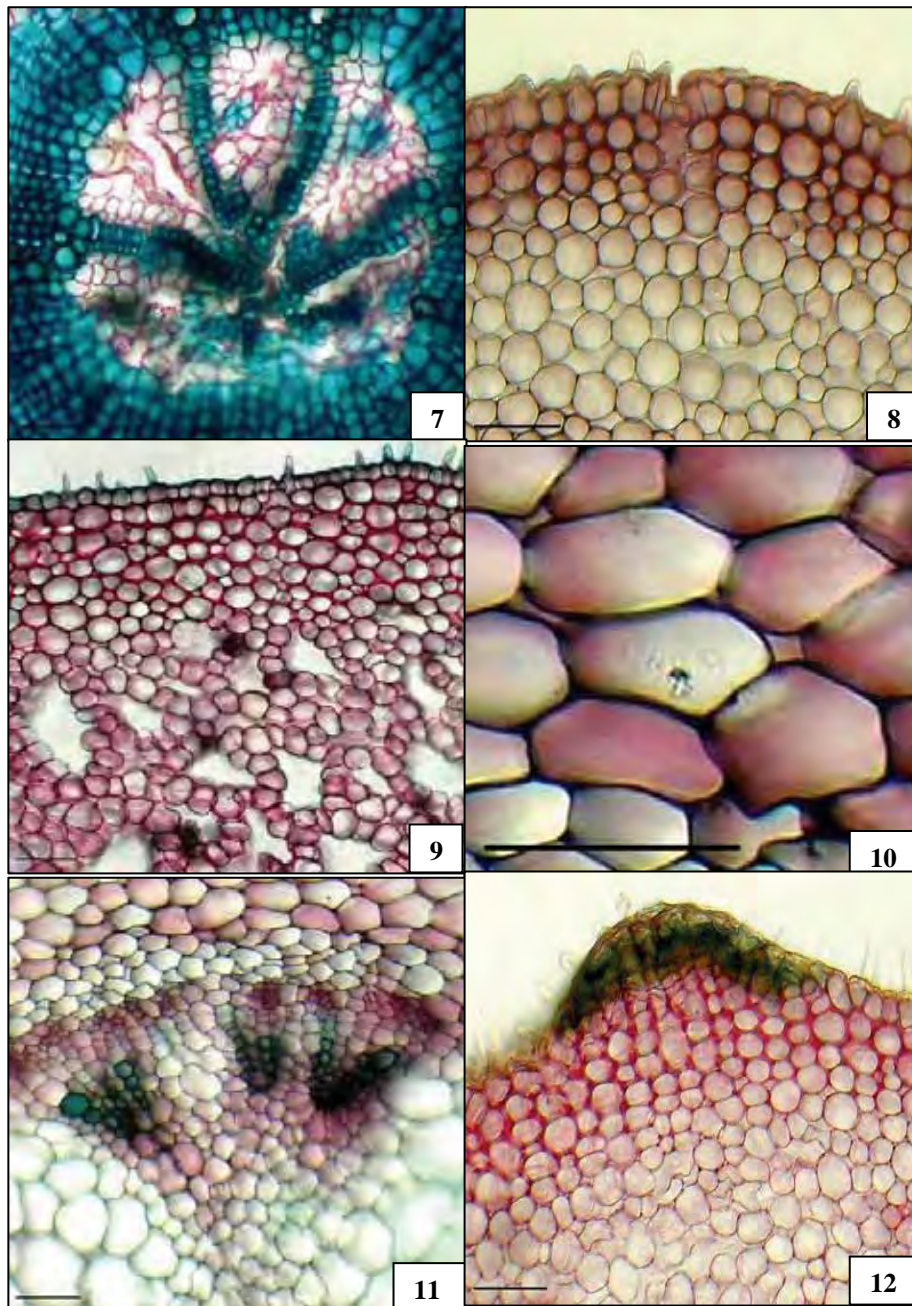
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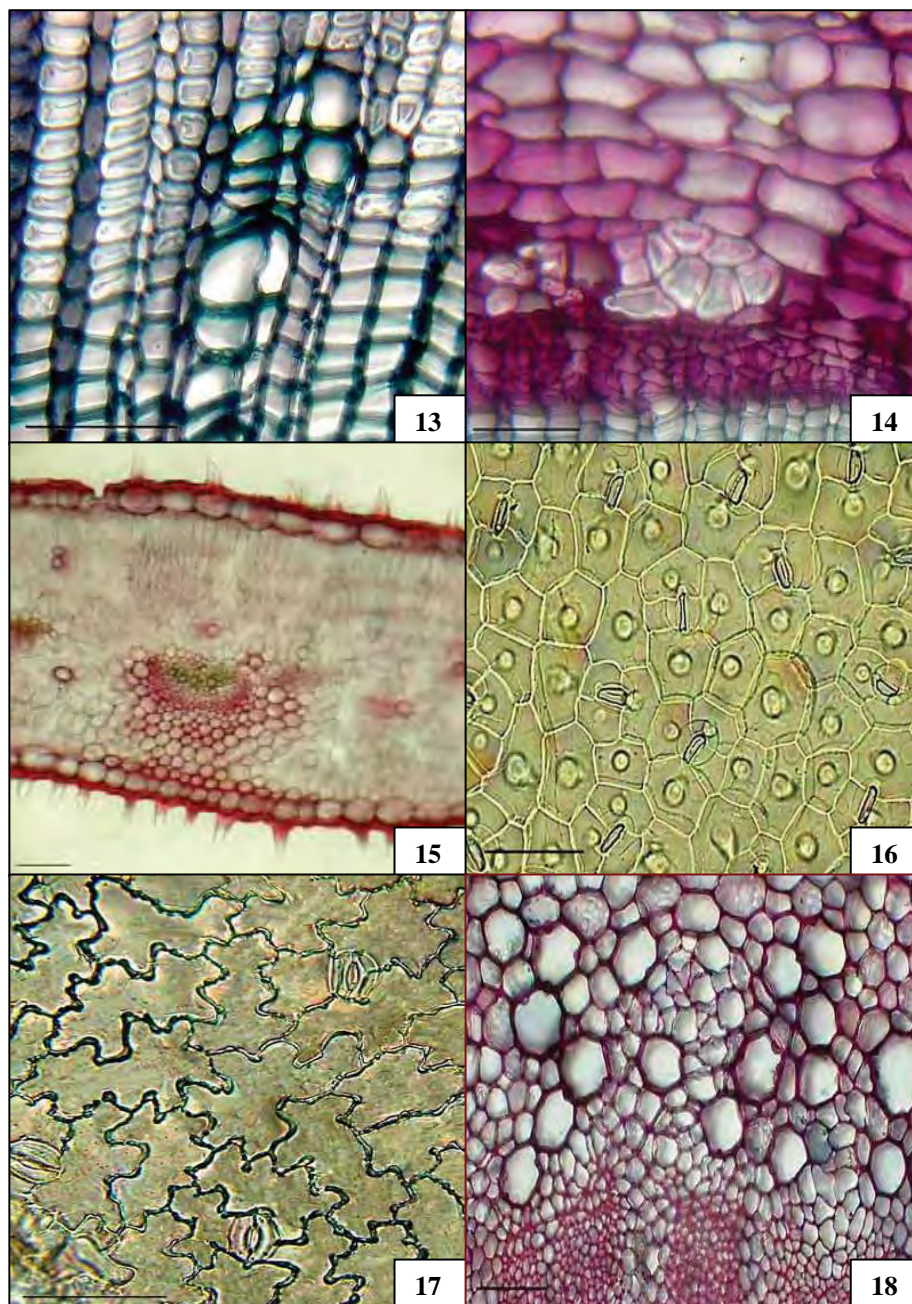
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**Fig. 1-6.** 1, 3, 5. Secțiune transversală prin rădăcina de *E. peplus* / Transverse section of root of *E. peplus*. 2. Secțiune transversală prin rizomul de *E. bazargica* / Transverse section of rhizome of *E. bazargica*. 4, 6. Secțiune transversală prin rizomul de *E. nicaeensis* / Transverse section of rhizome of *E. nicaeensis*. Scara=50 $\mu$ m / Scale bars=50 $\mu$ m.



**Fig. 7-12.** 7. Secțiune transversală prin rizomul de *E. nicaeensis* / Transverse section of rhizome of *E. nicaeensis*. 8. Secțiune transversală prin treimea superioară a tulpinii aeriene de *E. bazargica* / Transverse section of aerial stem of *E. bazargica* (upper level). 9, 11. Secțiune transversală prin treimea superioară a tulpinii aeriene de *E. nicaeensis* / Transverse section of aerial stem of *E. nicaeensis* (upper level). 10. Secțiune transversală prin treimea superioară a tulpinii aeriene de *E. peplus* / Transverse section of aerial stem of *E. peplus* (upper level). 12. Secțiune transversală prin treimea inferioară a tulpinii aeriene de *E. bazargica* / Transverse section of aerial stem of *E. bazargica* (lower level). Scara=50 $\mu$ m / Scale bars=50 $\mu$ m.



**Fig. 13-18.** 13, 14. Secțiune transversală prin treimea inferioară a tulpinii aeriene de *E. carniolica* / Transverse section of aerial stem of *E. carniolica* (lower level). 15. Secțiune transversală prin limbul foliar de *E. bazargica* / Transverse section of foliar limb of *E. bazargica*. 16. Secțiune superficială prin limbul foliar de *E. bazargica* (la fața adaxială) / Surface section of foliar limb of *E. bazargica* (at adaxial side). 17. Secțiune superficială prin limbul foliar de *E. carniolica* (la fața abaxială) / Surface section of foliar limb of *E. carniolica* (at abaxial side). 18. Secțiune transversală prin treimea superioară a tulpinii aeriene de *E. nicaeensis* / Transverse section of aerial stem of *E. nicaeensis* (upper level). Scara=50 $\mu$ m / Scale bars=50 $\mu$ m.