

## **ANATOMICAL FEATURES OF THE ROOT, STEM AND LEAF BLADE OF *POTAMOGETON PECTINATUS* L. AND *VALLISNERIA SPIRALIS* L.**

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**Abstract:** *Potamogeton pectinatus* L. (Fam. *Potamogetonaceae*) and *Vallisneria spiralis* L. (Fam. *Hydrocharitaceae*) are two submerged, rooted hydrophytes, growing entirely under the water surface. Both are attached by means of their root system to the bottom of waters [2, 6, 8].

Due to the aquatic environment conditions, these plants show several peculiar morphological and anatomical adaptations in response. At the present, the anatomical features of the hydrophytes are poorly documented in Romania [3, 5, 9, 10]. The present paper deals with some histological and anatomical aspects of the main vegetative organs, namely root, stem and leaf blade of the two investigated plants.

### **Material and methods**

Cross sections of the vegetative organs obtained by manual techniques were stained with alum-carmin and iodine green, than embedded in glycerin gelatin. Histological observations and the light micrographs were performed by means of BIOROM-T bright field microscope, equipped with TOPICA 601-A video camera, using scanning technique.

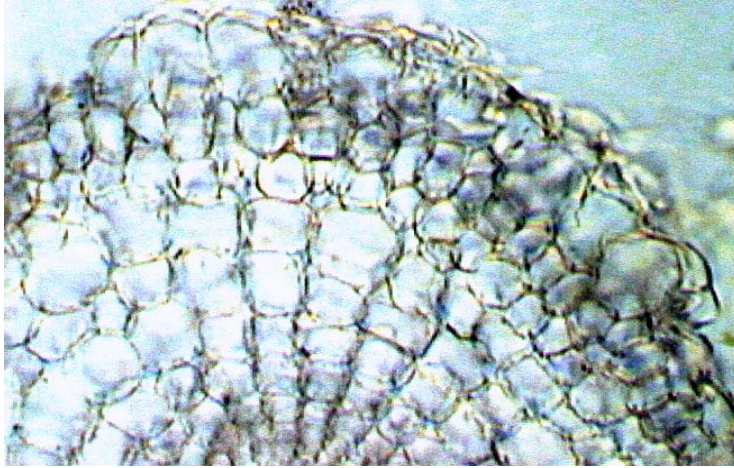
### **Results and discussions**

Cross sections of the root of *Potamogeton pectinatus* reveal the epidermis, the cortex and the stele. The epidermis, the outermost layer of vegetative organs is composed of isodiametric, thin-walled cells. Cuticle and root hairs are absent.

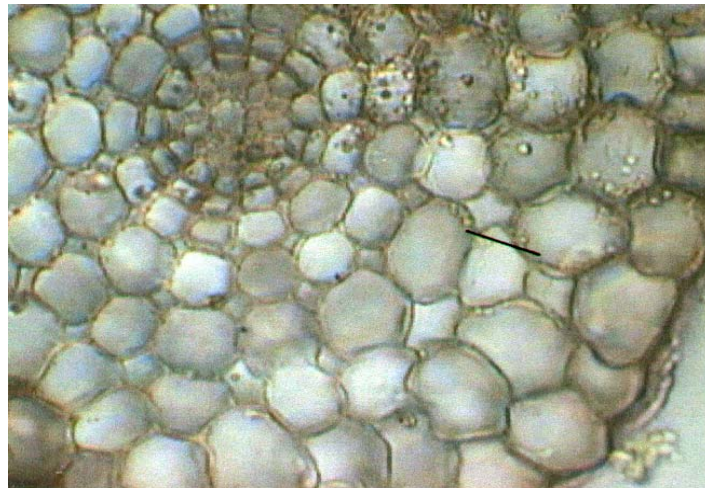
The cortex is well developed and differentiated into two zones. Just bellow the epidermis a single layer of thick-walled cells is present, presumably equivalent with the exodermis. The inner cortex consists of compactly arranged parenchimatous cells (5-6 layers) (Fig. 1A).

The stele is surrounded by a single-layered endodermis and pericycle. The poorly developed vascular bundles consist of few xylem and phloem elements. The metaxylem vessels are located towards the center, the protoxylem ones face towards the periphery. Phloem fills the spaces between the xylem groups (Fig. 1B).

The same structure exhibits the cross section of *Vallisneria spiralis* root, but the cortex has not distinctly differentiated regions and the vascular bundles are reduced in number. The xylem elements are extremely reduced (Fig. 2).



**Fig. 1:** Cross section of the root of *Potamogeton pectinatus* L.: A- portion with epidermis and cortex.; B- the stele. X 227: C- cortex; E- epidermis; Ed- endodermis; Mx- metaxylem; P- pericycle; Ph- phloem; Px- protoxylem; S- stele. Orig.



**Fig. 2:** Cross section of the root of *Vallisneria spiralis* L. X 173: C- cortex; E- epidermis; Ed- endodermis; P- pericycle; Ph- phloem; X- xylem. Orig.

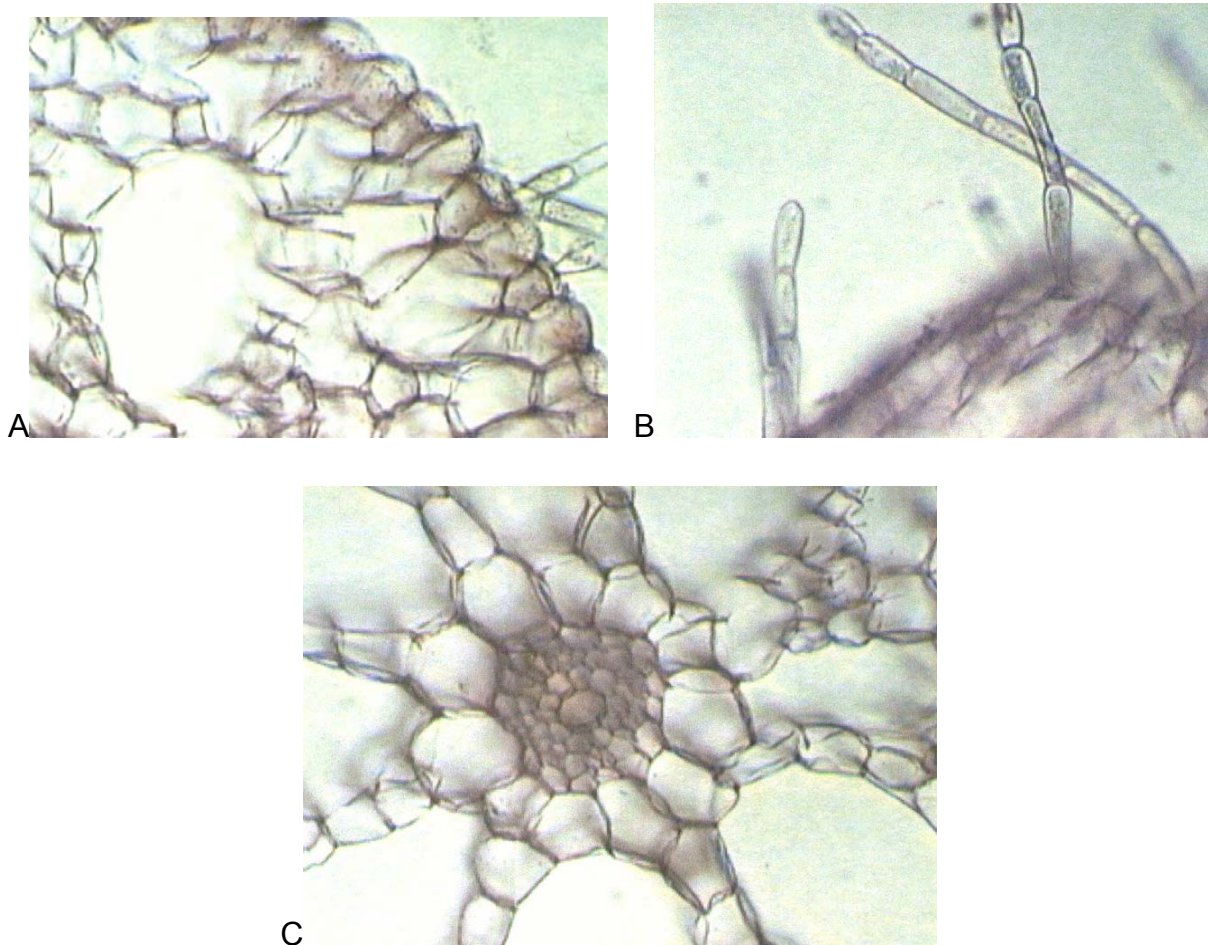
Cross section of the stem of *Potamogeton pectinatus* reveals interesting anatomical features. The epidermis consists of a single layer of, more or less, polygonal cells. Characteristically, the cuticle is absent, but among the epidermal cells, simple many-celled hairs are present (Fig. 3A, B).

The cortex is differentiated into two distinct regions. The outer region is composed of 3-4 layers of compactly arranged parenchymatous cells, followed by symmetrically arranged large air spaces, mostly located around the stele. These air spaces are divided by partitions, called by some authors [4] trabeculae, made up of a single layer of thin-walled parenchyma cells (Fig. 3C).

The centrally located vascular system of the stele is poorly developed and consists of a single xylem element, surrounded by phloem. The endodermis and the

pericycle are absent and a sole parenchymatous sheath of large cells surrounds the vascular tissue instead.

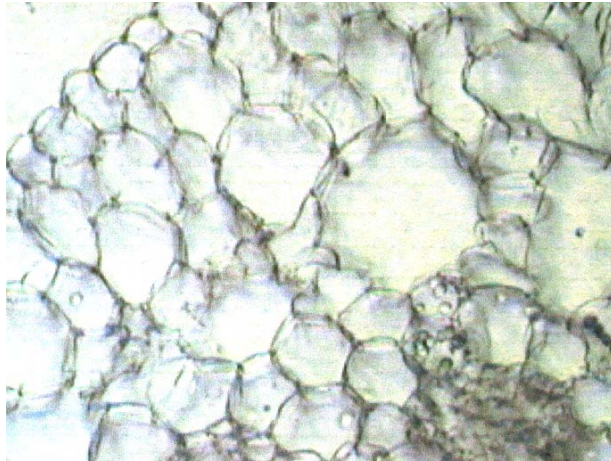
The stem of *Vallisneria spiralis* show almost the same anatomical details but the epidermal cells are different in shape, lack a cuticular covering. The air spaces of the cortex are smaller and, in the ground tissue, starch grains are present (Fig. 4A, B).



**Fig. 3:** Cross section of the stem of *Potamogeton pectinatus* L.: A- portion with epidermis and cortex. X 240. B- epidermis with hairs. X 320: C- the stele. X 240: AC- air chamber; BS- bundle sheath; C- cortex; E- epidermis; H- hairs; Ph- phloem; T- trabeculae; X- xylem. Orig.

The vascular system represented by a number of vascular bundles are irregularly scattered in the ground tissue. The vascular tissue is poorly developed the xylem being represented by 2-3 large xylem elements. The phloem showed normal development, like a compactly arranged parenchyma. In the center of the structure is a single large intercellular air chamber filled with gases (Fig. 4B).





**Fig. 4: Cross sections of the stem of *Vallisneria spiralis* L.: A- portion with epidermis and cortex. B- two vascular bundles. X 192: AS- air space; BP- basic parenchyma; BS- bundle sheath; C- cortex; E- epidermis; VB- vascular bundle. Orig.**

Cross section of *Potamogeton pectinatus* leaf blade reveals a simple organization with poorly developed vascular elements and the lack of mesophyll. The upper epidermis consists of a single layer of cells larger than the lower epidermal cells. Cuticle is absent. The epidermal cells contain chloroplasts. Mechanical elements are absent (Fig. 5A). Some authors [4] consider that its epidermis exhibits stomata, but others deny the presence of them [1,5,7,10].

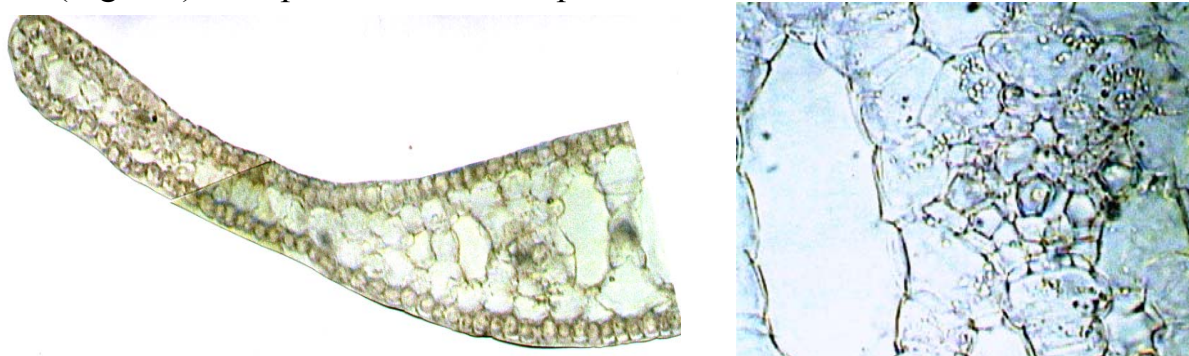
The vascular system of the unit vein is extremely reduced and undifferentiated into xylem and phloem. It has a single, small vascular tract, containing few thin-walled elements (Fig. 5B).



**Fig. 5: Cross sections of the blade of *Potamogeton pectinatus* L. A- portion with both epidermis (upper and lower) and the vein. X 240. B- the vascular bundles. X 300.: AS- air space; LE- lower epidermis; UE- upper epidermis; VB- vascular bundles. Orig.**

Transversal section of *Vallisneria spiralis* leaf blade exhibits a differentiation into upper and lower epidermis, forming the outer boundary of the blade. A very thin layer may sometimes be present covering the epidermal cells. The two epidermal layers consist of a single layer of, more or less, large thin-

walled cells, interrupted by larger (midrib zone) and smaller (peripheral zones) air spaces (Fig. 6A). The presence of chloroplasts characterizes these cells.



**Fig. 6:** Cross sections of the blade of *Vallisneria spiralis* L. A. Portion with both epidermis (upper and lower) and mesophyll. X 101. B. The rib-mid vein. X 200: AC- air chamber; BS- bundle sheath; LE- lower epidermis; M- mesophyll; Ph- phloem; SVB- small vascular bundles; UE- upper epidermis; X- xylem. Orig.

In the midrib zone, a prominent closed collateral vascular bundle is present, surrounded by a distinct bundle of parenchyma sheath. It is composed of phloem and xylem. Phloem is present towards the lower epidermis. However, the xylem is reduced to a few elements lining the upper epidermis. Towards the peripheral regions of the blade, few small and poorly developed bundles occur (Fig. 6B).

### Conclusions

Results indicate that the root of both species exhibits a single layer of thin-walled epidermal cells. Cuticle is absent and root hairs are present only in *Potamogeton pectinatus*. Cortex is well developed and has no air spaces. Mechanical tissues are generally absent, but a layer of thick-walled cells may be present, sometimes, in *Potamogeton pectinatus* root cortex just below the epidermis. The centrally located stele, surrounded by endodermis, consists of pericycle and vascular tissues. The vascular system consists of few xylem and phloem elements.

Cross sections of *Potamogeton pectinatus* and *Vallisneria spiralis* stems reveal some special characters in accordance with their submerged life habit. The epidermis is composed of thin-walled cells, cuticle is absent but chloroplasts occur. The cortex has large, well-developed air chambers, in a more or less, regular arrangement, filled with atmospheric gases. Mechanical tissues are completely absent. The poorly represented vascular tissue consists of few xylem elements. In *Potamogeton pectinatus* the stele is centrally located, while in *Vallisneria spiralis* a number of vascular bundles, scattered in the basic parenchyma, are present. A single intercellular air chamber is an interesting feature of *Valissneria spiralis* stem.

The leaf blade of both species shows the characteristic features of hydrophytes. Both single layered upper and lower epidermis are present, each of them composed of thin-walled cells. Cuticle is usually absent, but a faint layer may occur in *Vallisneria spiralis* blade. The epidermal cells contain chloroplasts.

The mesophyll is absent in the leaf blade of *Potamogeton pectinatus*, but it is well-developed in *Vallisneria spiralis*, containing chloroplasts and large air chambers.

The vascular tissue of the veins was reduced; especially the xylem elements are scarce, surrounded by thin-walled large parenchyma cells. It should be noticed, the single vascular bundle of *Potamogeton pectinatus* blade, comparatively with several vascular bundles exhibited by *Vallisneria spiralis*.

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### CARACTERE HISTO-ANATOMICE SPECIFICE ALE RĂDĂCINII, TULPINII ȘI LIMBULUI FOLIAR LA *POTAMOGETON PECTINATUS* L. ȘI *VALLISNERIA SPIRALIS* L.

#### (Rezumat)

Lucrarea de față își propune să prezinte caracterele histo-anatomice ale organelor vegetative ale întregului corm la două specii dintre plantele acvatice submerse, des întâlnite în bălțile și lacurile din țara noastră și folosite frecvent la amenajarea acvariilor: *Potamogeton pectinatus* L. și *Vallisneria spiralis* L., caractere determinate de adaptarea lor la viața acvatică. În acest scop s-au efectuat secțiuni transversale prin rădăcina, tulpina și frunza acestor două plante.

Rădăcina, ambelor specii, prezintă, la exterior, o epidermă (rizodermă), unistratificată, sub care se găsește scoarța nediferențiată, formată din mai multe straturi de celule așezate compact. Totuși, la rădăcina de *Potamogeton pectinatus* se observă, că celulele cortexului, situate imediat sub epidermă, au pereții ușor îngroșați (cu valoare de exodermă în caz de

exfoliere a epidermei) (Fig. 1, 2). Stelul, situat central, este format din periciclu și țesut conducător. Se remarcă numărul redus de vase conducătoare de xilem și de floem. Stelul este protejat, la exterior de o endodermă unistratificată (Fig. 1). Tulpina la ambele specii prezintă la exterior epiderma unistratificată (lipsită de cuticulă) scoarță și stel. La specia *Potamogeton pectinatus*, la nivelul epidermei, se observă peri pluricelulari simpli (Fig. 3A, B). La ambele specii, cea mai mare parte a cortexului este reprezentat printr-un aerenchim, adevărate camere aerifere. Diferențieri se remarcă la nivelul cilindrului central. Astfel, la *Potamogeton pectinatus* stelul este situat central pe când la *Vallisneria spiralis* el este reprezentat prin mai multe fascicule vasculare înglobate în parenchimul scoarței. În ambele cazuri fasciculele vasculare sunt protejate de teți fasciculare de natură parenchimatică. Se constată numărul redus al elementelor de xilem și de floem în fasciculele vasculare ale ambelor specii (Fig. 3C; 4A, B). Frunza ambelor specii prezintă caracteristici anatomice imprimite de modul acvatic de viață. Se remarcă deosebiri esențiale la nivelul limbului foliar al celor două specii. Astfel, la *Potamogeton pectinatus* limbul este reprezentat printr-o epidermă superioară cu celule mult mai mari ca cele ale epidermei inferioare iar central se observă prezența unui fascicul vascular, extrem de sărac în elemente vasculare, care reprezintă unica nervură a frunzei. De o parte și de alta a nervurii (protejată de o teacă de natură parenchimatică), se găsesc două spații mici intercelulare. Mezofilul și cuticula lipsesc. La *Vallisneria spiralis*, ambele epiderme sunt unistratificate. Mezofilul este format din mai multe straturi de celule (spre nervura principală), numărul lor scăzând, treptat, către extremitățile limbului. În mezofil sunt prezente mai multe nervuri și camere aerifere. Nervura principală (mai mare) este situată central iar câte două nervuri secundare (mai mici) spre extremitățile limbului. Se remarcă faptul că, fasciculul vascular al nervurii principale este de tip colateral deschis.