



CHARACTERISTIC FEATURES OF *Acorus gramineus* Sol. ex Aiton.

Rodica BERCU

Department of Botany, Faculty of Natural and Agricultural Sciences Str. Mamaia, 124, 900527 Constantza, Romania. E-mail: rodicabercu@yahoo.com

SYNOPSIS

Key words:

adventitious root,
aquatic,
blade,
histoanatomy,
petiole,
rhizome,
Acorus gramineus

The article comprises investigation of the adventitious root, rhizome and leaf anatomy of an aquatic perennial herb *Acorus gramineus* Sol. ex Aiton. The plant is native to Japan in eastern Asia, where it usually occurs in wetlands and shallow water. The anatomical characteristics of the adventitious roots exhibit a primary structure. The isobilateral blade possesses a homogenous mesophyll with a V-shaped expansion. The rhizome discloses the cortex with small intercellular spaces. In the rhizome ground tissue amphivasal and collateral bundles are present. The blade is homogenous with numerous air chambers. The vascular bundles are protected by sclerenchymatous cells to the bundles poles. Phloem is oriented to the blade surface.

The anatomy of the vegetal organs of *Acorus gramineus* species discloses certain features of anatomical and ecological interest.

INTRODUCTION

Acorus gramineus Sol. ex Aiton known as grassy-leaved sweet flag or shi ahang pu belongs to Acoraceae family. This genus was once placed within the family Araceae (aroids), but more recent classifications place it in its own family Acoraceae, of which it is the sole genus of the oldest surviving line of monocots (Simon & Schuster's Guide 1992; Wunderlin et al., 1988). The sweet flag is an aquatic or wetland perennial with semi-evergreen foliage. It can grow fully or partially submerged though it can also succeed in drier habitats (Muhleberg, 1982). It has narrow 30 cm high glossy leaves and looks like thick, lush grass. They are flat, about 1.3 cm wide and tend to flop over. *Acorus gramineus* have horizontal rhizomes. The insignificant flowers, shaped like little horns, are produced in midsummer on erect

hollow stems. Usually only plants grown in water produce flowers (Watson & Dallwitz, 1992). This cultivar succeeds as a submerged aquatic plant (Bown, 2003; Hiscock, 2003) that is why in Romania it is known mostly as an aquarium plant. Our objectives were to show the anatomy of the vegetal organs, exhibiting some features of anatomical and ecological interest concerning *Acorus gramineus*. In the literature there are no more recent studies (Metcalf et al., 1960) of the vegetal organs anatomy (adventitious root, stem (rhizome) and leaf of this species) almost lack, there are no information concerning root and leaf anatomy except for some sporadic information (1900-1960).

MATERIAL AND METHODS

The plants were collected from the Faculty's laboratory aquarium. Small pieces of the adventitious root, rhizome, leaf and spathe were fixed in FAA (formalin:glacial acetic acid:alcohol 5:5:90). Cross sections of the vegetative organs were performed with the classical technique used in vegetal histology (Bercu & Jianu, 2003). The samples were stained with alum-carmin and iodine green. Histological observations and micrographs were performed with an OPTIKA bright field microscope with built-in zoom camera.

RESULTS AND DISCUSSION

Cross section of the adventitious root reveals that the outermost layer of barrel-shaped cells – rhizodermis - is composed of common cells. Hairs are absent. The cortex is well developed and rough, differentiated into two distinct zones. The outer cortex – exodermis – consists of one compactly arranged layer of cells. Lignified thickenings of the outer cells wall are present (Fig. 1).

The inner cortex is well developed and consists of a number of layers of parenchymatous cells compactly arranged enclosing intercellular spaces and occupying the most portion of the root. Characteristically, as Kroemer (1903) and Metcalf et al. (1960) reported the one-layered endodermis bears Casparian strips, alternating, at places, with pericycle cells. Passing cells are present opposite the xylem poles (Fig. 1).

The stele is enclosed by a single-layered pericycle. The stele vascular bundles are represented by xylem and phloem vessels with radial arrangement. The protoxylem vessels show exarch condition facing the pericycle and metaxylem vessels are placed towards the centre (Fig. 2).

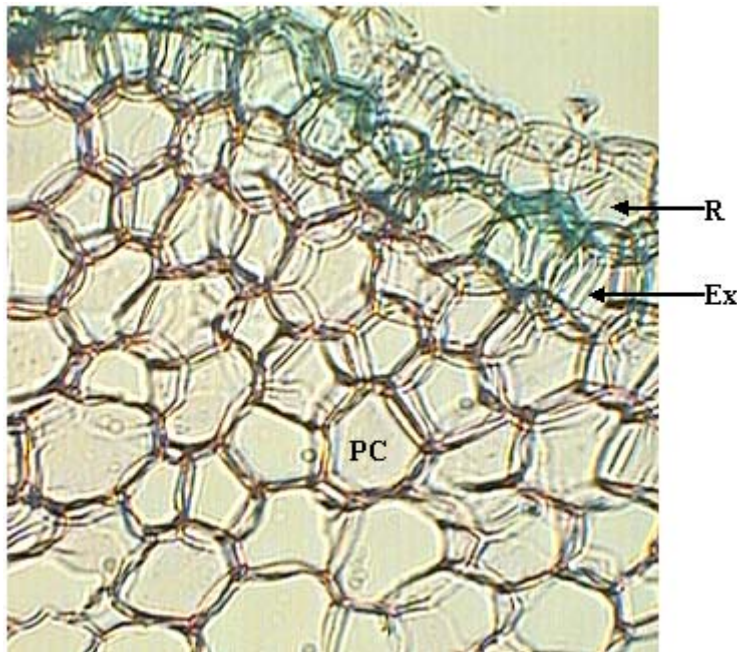


Fig. 1. Cross sections of the adventitious root. Portion with rhizodermis and cortex: Ex- exodermis, PC- parenchymatous cortex, R- rhizodermis.

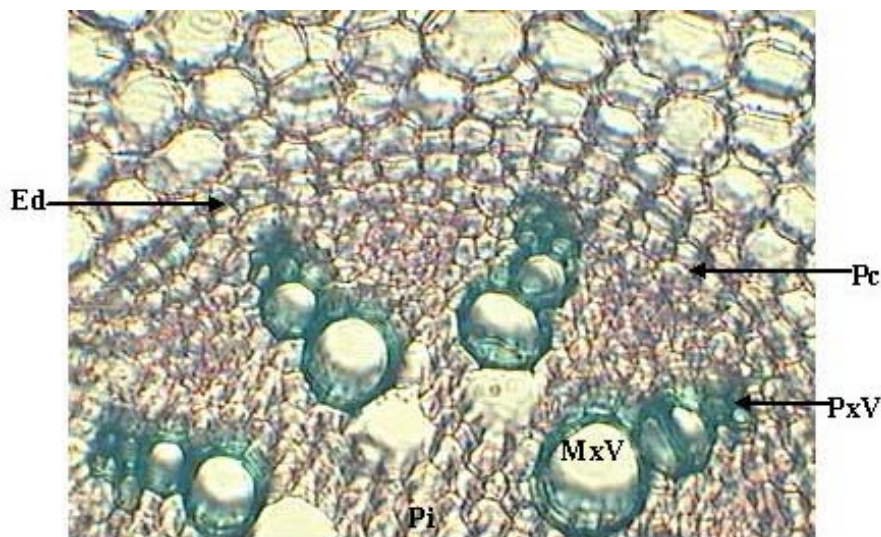


Fig. 2. Cross sections of the adventitious root. Portion of the stele: Ed- endodermis, MxV- metaxylem vessel, Pc- pericycle, Ph- phloem, PxV- protoxylem vessel, Pi- pith.

Phloem (sieve cells and companion cells) is well developed and is present among the xylem groups. In between the xylem and phloem vessels pith rays are present. The central portion of the stele is occupied by pith with compactly arranged parenchymatous cells.

The rhizome possesses a one-layered epidermis. Below the epidermis the cortex is mostly composed of present small air cavities.

The uniformly thickened endodermis, not mentioned by other authors (Metcalf et al. 1960; Kroemer 1903) consists of one layer of common cells. Starch granules are present in the rhizome ground tissue especially in the centre. In the ground tissue a number of vascular bundles belonging to the stele occur. Remarkable are the centrally located amphivasal bundles. The rest of vascular bundles are close collaterally facing the peripheral region of rhizome. Here and there groups of sclerenchymatous cells are present (Fig. 3).

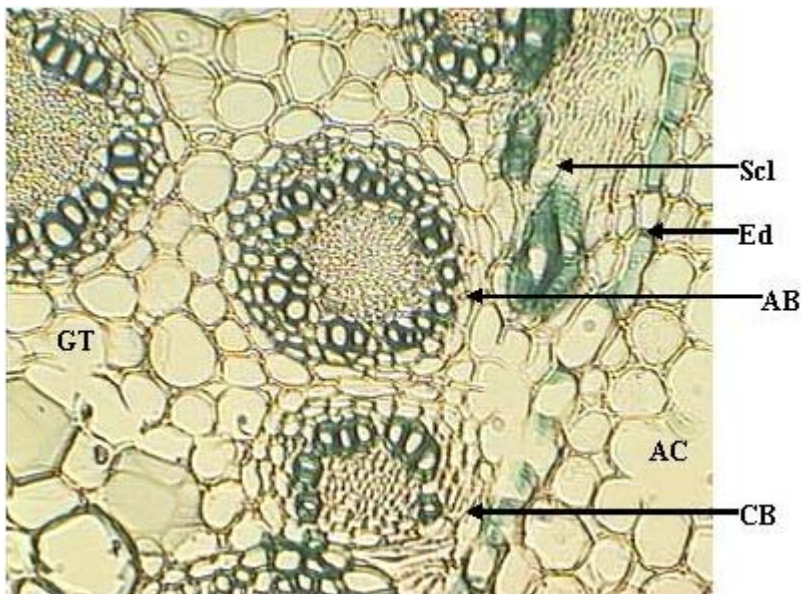


Fig. 3. Portion of the rhizome stele (cross section): AB- amfivasal bundle, AC- air chamber, CB- collateral bundle, Ed- endodermis, GT- ground tissue, Scl- sclerenchymatous cells.

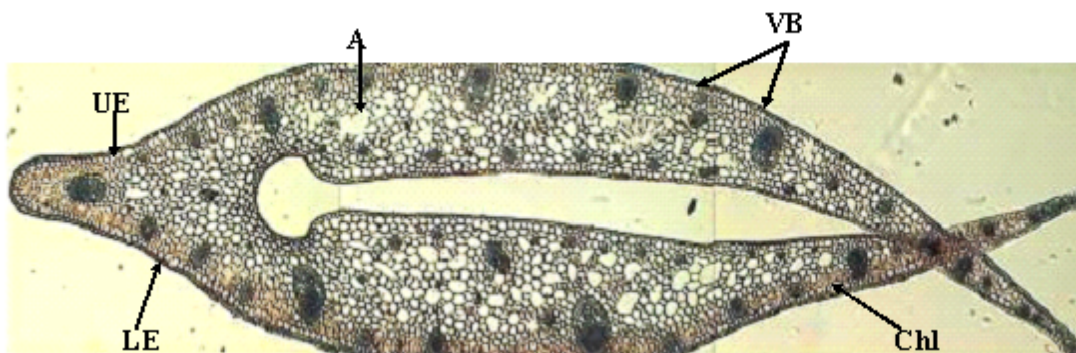


Fig. 4. Cross section of the blade: A- aerenchyma, Chl- chlorenchyma, LE- lower epidermis, UE- upper epidermis, VB- vascular bundles.

Cross section of the blade exhibits isobilateral structure with a deltoid-convex (or V-shaped) expansion (Fig. 4).

The upper epidermis as well as the lower one forms a single layer of uniformly small thin-walled cells, covered by cuticle. The mesophyll, like in other aquatic species (Batanouy, 1992), is differentiated into a chlorenchyma tissue (3-4 layers of cells) and a spongy tissue represented by an aerenchima. All parenchymatous cells abound in chloroplasts especially those placed bellow the epidermis. Remarkable are the numerous air chambers of the mesophyll separated from each other by uniseriate partitions. The air chambers are developed rhexigenously (Bavaru & Bercu 2002; Bercu 2007) (Fig. 5A, B).

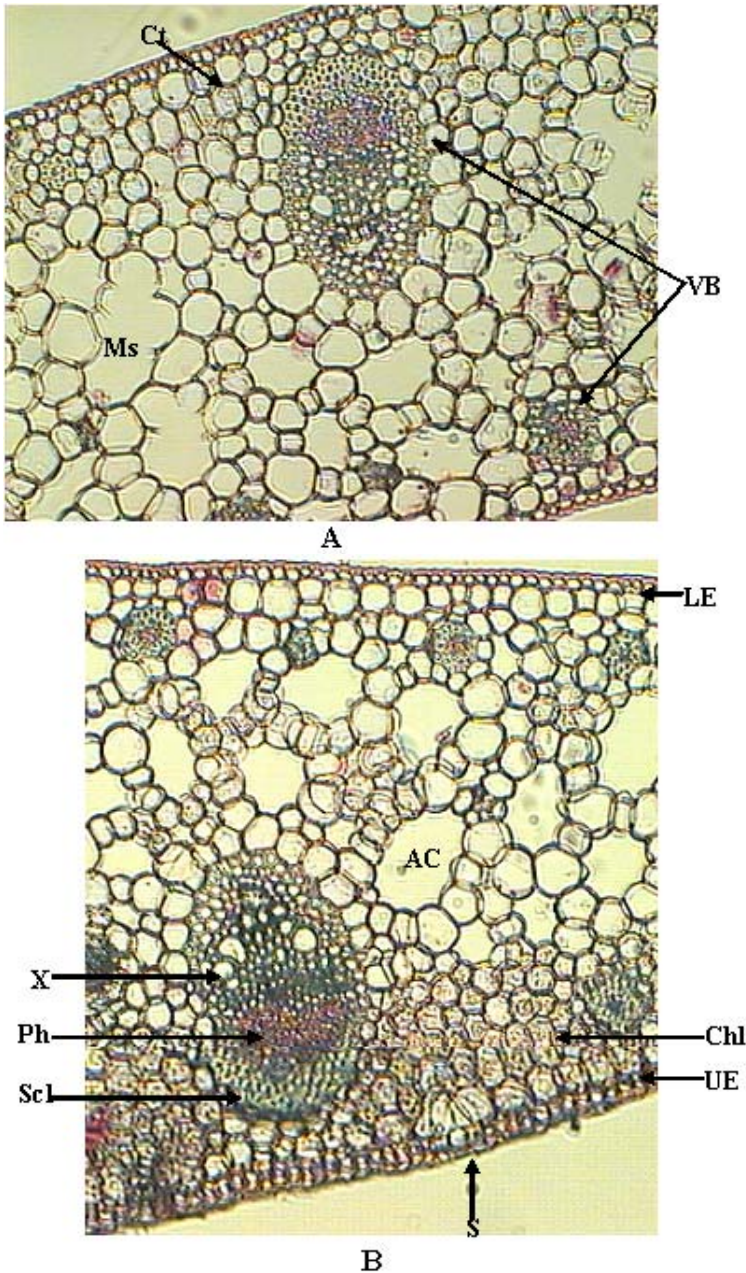


Fig. 5.
Cross sections of
the blade. Abaxial
(A) and adaxial (B)
portions:
AC- air chamber,
Chl- chlorenchyma,
Ct- cuticle,
LE- lower epidermis,
Ms- mesophyll,
Ph- phloem,
Scl- sclerenchyma,
S- stoma,
UE- upper epidermis,
VB- vascular bundle,
X- xylem (orig.).

The vascular system is represented by numerous small and large vascular collateral bundles. They are placed mostly to the periphery bellow the upper and lower epidermis. The xylem and phloem vascular bundles are normally developed whereas the smaller ones consist of only few sieve cells and companion cells. Each vascular bundle is protected by sclerenchyma fibres placed on both poles of the bundle. Remarkable is the inversed position of the vascular bundles reported to the lateral "winged" blade. Nevertheless phloem is oriented to the blade surface. The upper and lower epidermis continuity is interrupted by stomata with small substomatal cavities (Fig. 5A, B).

CONCLUSIONS

Results revealed that the root of *Acorus gramineus* possesses a typical primary structure characteristic to dicots' roots. However, the cortex is well-developed. The rhizome discloses that the epidermis is an aerenchyma. In the ground tissue several amphivasal and collateral vascular bundles are present and abundant starch granules.

Remarkable is the isobilateral blade with large and small veins placed to the surface of the blade. The mesophyll possesses numerous air chambers and a well-developed chlorenchyma tissue. The mechanical tissue is almost absent, except for some sclerenchyma elements placed in the rhizome and to the blade poles of the large vein vascular bundles. The histo-anatomical features of the plant organs are in accordance with its hydrophytic nature.

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Summary

CHARACTERISTIC FEATURES OF *Acorus gramineus* Sol. ex Aiton.

Acorus gramineus Sol. ex Aiton, known as grassy-leaved sweet flag or shi ahang pu, belongs to Acoraceae family. The sweet flag, native to Japan (Est of Asia) is an aquatic or wetland perennial with semi-evergreen foliage about 30 cm high.

Cross section of the adventitious root reveals the outermost layer of barrel-shaped cells – rhizodermis. The cortex is well developed and roughly differentiated into 2 distinct zones, the outer cortex – exodermis – and a parenchyma region (inner cortex). The stele is enclosed by a single-layered pericycle. The stele vascular bundles are represented by xylem and phloem vessels with radial, alternate arrangement (Figs. 1, 2). The rhizome possesses a one-layered epidermis. Below the epidermis the cortex is represented by an aerenchyma with small air chambers. The stele is enclosed by a one-layered endodermis. In the ground tissue a number of amphivasal (toward the centre) and collateral (to the periphery) vascular bundles belonging to the stele are present (Fig. 3).

Cross section of the blade exhibits isobilateral structure with a deltoid-convex (or V-shaped) expansion (Fig. 4). The mesophyll, such as other aquatic species, is differentiated into a chlorenchyma tissue (3-4 layers of cells) and a spongy tissue represented by an aerenchyma. Numerous air chambers of the mesophyll separated from each other by uniseriate partitions occur. The upper epidermis, such as the lower one, forms a single layer of uniformly small thin-walled cells covered by cuticle.

The vascular system is represented by numerous small and large vascular collateral bundles. They are placed mostly to the periphery below the upper and lower epidermis. The xylem and phloem vascular bundles are normally developed whereas the smaller ones consist of only few sieve cells and companion cells. Each vascular bundle is protected by sclerenchyma fibres placed on both poles of the bundle. The

phloem tissue is oriented to the blade surface. The upper and lower epidermis continuity is interrupted by stomata with small substomatal cavities (Fig. 5A, B).

Received: 16 February 2009.