ANATOMICAL FEATURES OF THE VEGETATIVE ORGANS OF SALVINIA NATANS (L.) ALL. (SALVINIACEAE)

CARACTERELE ANATOMICE ALE ORGANELELOR VEGETATIVE LA SALVINIA NATANS (L.) ALL. (SALVINIACEAE)

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Abstract: The article comprises the investigation on the structure vegetative organs of an aquatic fern, namely Salvinia natans (L.). The specific fern characters is represented, mostly, by the stem structural organization, especially those of the vascular system. The hydrophytic features such as the presence of aerenchyma well developed in the stem and submerged leaf and less in the emerged leaf are described and discussed. Remarkable is the heterogenous mesophyll with numerous chloroplasts and the blade epidermal papillae and hairs.

Key words: anatomy, stem, submerged dissected leaf, emerged leaf, Salvinia natans

INTRODUCTION

Salvina natans (L.) All., sometimes called floating water moss or simply salvinia, is actually a floating aquatic fern. The stem is floating, filamentous and branched. The floating leaves are longer than broad, 9-13-5-7 mm, entire at apex, arranged in regular rows and lying flat on the water surface. The leaves are small, round and covered with small hairs or papillae. Papillae serve as water proofing. The plant consists of two floating leaves and a third submerged dissected leaf that serves as a root. The spore cases are at the base of this submerged leaf. Air cavities in the leaves help the tiny plant to stay afloat (Waterhouse and Mitchell, 1998, Săvulescu, 1952.). An annual fern, in the wild this plant will grow very large often covering entire lake surfaces. The species has been entered in the Red Data Book of Ukraine (1996) and protected in the Danube delta (Ukraine and Romania). Reproduction by spores and vegetatively. Information, however, on the anatomy of Salvina natans (L.) All. (vegetative organs), especially of the emerged and submerged leaves, is actually lacking.

MATERIAL AND METHODS

Cross sections of stems and leaves (emerged and submerged) were obtained using a rotary microtome. The sections were stained with alum-carmine and iodine green and were embedded in Canada balsam. Observations were made with a BIOROM-T bright field microscope, equipped with a TOPICA-6001A video camera. The microphotographs were obtained from the video camera through a computer.

RESULTS AND DISCUSSIONS

Cross-section of the stem reveals a primary structure consisting of epidermis, cortex and stele. The one-layered, slightly elongated, epidermis cells are thin-walled, covered by a
thin cuticle and bear simple hairs. The cortex occupies the major portion of the petiole. It is composed of an aerenchyma with large 7 air chambers separated by unicellular, unbranched partitions (Grinţescu, 1985 Sporne, 1975), named trabeculae (Batanouny, 1992). (Fig. 1A, B). The endodermis is composed of large thick-walled cells. Kroemer (1903) suggested that this wall thickening was the result of cutinized blade superpositions, infirmed by other authors (Ogura, 1938, Bierhorst, 1971, Bercu, 2004a) (Fig. 1C). The stele is represented by one-layered pericycle and the vascular system embedded just in the centre of the aerenchymatic tissue. The vascular system is poorly developed and consists of few centrally located xylem elements (meta- and phloem vessels), surrounded by phloem. The protoxylem vessels interpenetrate the phloem elements, constituted of sieve cells, lack companion cells and phloem parenchyma forming a reduced protostele as Ogura (1938/72) reported with leptocentric trend (by our opinion) (Fig. 1B).

The metamorphosed leaf. The third submerged dissected leaf serves as a root. Cross section of the dissected leaf exhibits a single layer of epidermal cells, which are internally connected to the cortex, the latter is composed of a ground tissue with large 6 air chambers (aerenchyma), separated by trabeculae. The epidermal cells are thin-walled and slightly irregularly radial-elongated, uncovered by cuticle and bear a number of secondary roots and absorbent hairs. The centrally located stele is surrounded by 9 parenchyma cells. Beneath the parenchyma cells is the pericycle and the vascular system (Fig. 2A, B). The xylem string is located between the phloem bundles (two phloem bundles). That attributes to the root a diarch structure. The diarch stele is composed of two xylem vessels fuse towards the centre. The 2 protoxylem vessels are exarch, facing the pericycle (Fig. 2C). The floating leaves, in transversal sections, reveal a homogenous mesophyll. As other floating ferns (Azolla filiculoides L.), the upper epidermis bears papillae and many-celled hairs (Andrews and Ellis, 1913; Bercu, 2004b), and consists of a single layer of cells, covered by a thin cuticle. Remarkable are the grouped epidermal hairs which appear isolate towards the margins of the

![Figure 1](image1.png)

**Fig. 1.** Cross sections of the stem. Portion with epidermis and cortex (a). A hair (b). The stele (c): AC- air chamber, E- epidermis, Ed- endodermis, H- hair, Ph- phloem, Pc- pericycle, St- stele, T- trabeculae, XV- xylem vessel (orig.).

![Figure 2](image2.png)

The metamorphosed leaf. The third submerged dissected leaf serves as a root. Cross section of the dissected leaf exhibits a single layer of epidermal cells, which are internally connected to the cortex, the latter is composed of a ground tissue with large 6 air chambers (aerenchyma), separated by trabeculae. The epidermal cells are thin-walled and slightly irregularly radial-elongated, uncovered by cuticle and bear a number of secondary roots and absorbent hairs. The centrally located stele is surrounded by 9 parenchyma cells. Beneath the parenchyma cells is the pericycle and the vascular system (Fig. 2A, B). The xylem string is located between the phloem bundles (two phloem bundles). That attributes to the root a diarch structure. The diarch stele is composed of two xylem vessels fuse towards the centre. The 2 protoxylem vessels are exarch, facing the pericycle (Fig. 2C). The floating leaves, in transversal sections, reveal a homogenous mesophyll. As other floating ferns (Azolla filiculoides L.), the upper epidermis bears papillae and many-celled hairs (Andrews and Ellis, 1913; Bercu, 2004b), and consists of a single layer of cells, covered by a thin cuticle. Remarkable are the grouped epidermal hairs which appear isolate towards the margins of the
blade (Fig. 3A, B). Beneath the upper and lower epidermises is the mesophyll containing numerous chloroplasts, differentiated into palisade and spongy tissue the latter with large air spaces. The lower epidermis possesses smaller tipped hairs (Fig. 3C). Poorly developed vascular elements are irregularly embedded the mesophyll, screened by the presence of chloroplasts (Fig. 3A).

![Fig. 2. Cross section of the dissected leaf. Portion with epidermis and cortex (a) A hair (b). The stele (c): AC- air chamber, E- epidermis, Ed- endodermis, Ph- phloem, Pc- pericycle, St- stele T- trabeculae, X- xylem (orig.).](image)

The lower epidermal cells, in paradermal section, discloses undulated cells with chloroplasts. Stomata are a screened, by the abundance of chloroplasts (Fig. 3D).
Fig. 3. Cross section of the emerged leaf. Portions of the mesophyll with many-celled hairs (a, b). A lower epidermal hair (c). Paradermal section (d): Cl- chloroplasts, EC- epidermal cell, H- hair, IS- intercellular space, LE- lower epidermis, PT- palisade tissue, S- stoma, SP- spongy tissue, T- trabeculae, TH- tipped hair, UE- upper epidermis (orig.).

CONCLUSIONS
Anatomically, Salvinia natans (L.) All. exhibits characteristics of ferns with hydrophytic features in accordance to its aquatic habit. The stem has a primary structure with a conductive stele and a cortical aerenchyma. The dissected, submerged leaf cortex is also aerenchymatic and is covered by an epidermis. The protostele consists of few xylem and phloem elements. The emerged leaf has a chlorenchymatic heterogenous mesophyll placed beneath the upper and lower epiderms. Large air cavities are present in the spongy tissue. The upper epidermis bear many-celled hairs and the lower one, stomata, screened, such as the vascular bundles, by the presence of chloroplasts.

REFERENCES


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