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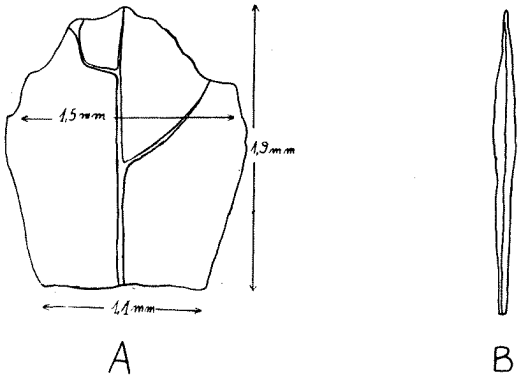
PRILOG POZNAVANJU ANATOMSKE GRAĐE SEKUNDARNO-SUBMERZNIH LISTOVA KOD VODENE BILJKE ORAŠAK

(*TRAPA LONGICARPA* M. J a n k.)

U toku individualnog razvića oraška (*Trapa longicarpa* M. J a n k.) od stabljika se prvo razvija glavna stabljika, zatim sporedne stabljike i tek u određenim uslovima spoljašnje sredine može da dođe do razvića bočnih stabljika na glavnom stablu. O individualnom razviću oraška (*Trapa L.*) kao i pojavi bočnih stabljika detaljno je pisao M. M. J a n k o v i ć (1956). Bočna stabljika se razvija u pazuhu flotantnih listova koji su naknadno potopljeni u vodu. U prvim fazama razvića glavna stabljika raste vertikalno naviše, sve do momenta izbijanja flotantne rozete na površinu vode. Pošto stablo i dalje raste ono postepeno tone u vodu i na taj način dolazi do naknadnog potapanja flotantnih listova. U pazuhu ovih, naknadno potopljenih listova, u određenim uslovima spoljašnje sredine, razvijaju se bočne stabljike.



Sl. 1. (A) Sekundarno-submerzni list (znatno uvećan), (B) primarno submerzni linearni list (2 x). Original.

Fig. 1. (A) Secondary-submerse leaf (considerably enlarged), (B) primary-submerse linear leaf (2 x). Original.

Na bočnim stabljikama razvijaju se submerzni i flotantni listovi. Submerzni listovi bočne stabljike morfološki se znatno razlikuju od submerznih listova glavne stabljike, kako po veličini i obliku, tako i po nazubljenosti, pojavi dlaka i drugom (sl. 1). Pošto se submerzni listovi na bočnoj stabljici razlikuju od submerznih listova na glavnoj stabljici, i pošto se bočna stabljika razvija na nodusu koji je naknadno potopljen u vodu M. M. J a n k o v i ć (1956) ih je nazvao sekundarno-submerznim listovima.

Ovaj rad je prilog poznavanju anatomske građe sekun-

darno-submerznih listova. Koliko mi je poznato o anatomskoj građi ovih listova do sada nije objavljen ni jedan rad.

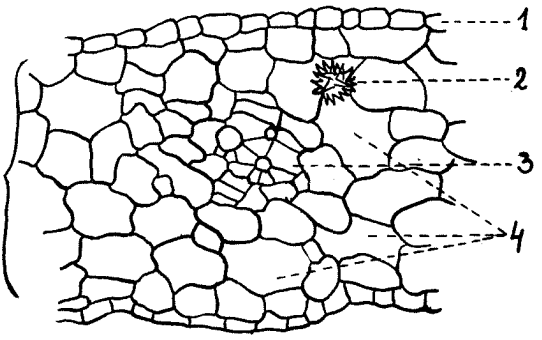
Prijatna mi je dužnost da se na ovom mestu zahvalim profesoru Dr Miloradu Jankoviću, od koga je i potekla ideja za ovaj rad, na korisnim savetima i sugestijama.

Sekundarno-submerzni listovi su uzeti sa bočnih stabljika *Trapa longicarpa* juna meseca 1963. godine. Materijal je fiksiran u alkoholu i formalinu a kasnije je obrađivan parafinskom metodom. Preseci debljine 10 mikrona bojeni su Delafield-ovim hematoksilinom i kombinacijom boja svetlo zeleno i safranin.

Sekundarno-submerzni listovi se nalaze na bočnoj stabljici na I, II, III, IV i V nodusu (ako noduse brojimo počev od mesta izbijanja bočne stabljike iz glavne). List na petom nodusu i u morfološkom i u anatomskom pogledu predstavlja prelaz od sekundarno-submerznih ka flotantnim listovima.

Sekundarno-submerzni listovi imaju jednoslojni epidermis na kome se nalazi veoma slabo razvijena kutikula. Ćelije epidermisa lica lista su krupnije od ćelija epidermisa naličja. Počev od lista na drugom nodusu na epidermisu naličja lista, oko glavnog nerva, nalaze se višećelijske dlake.

Između epidermisa lica i naličja lista nalazi se mezofil koji nije diferenciran na sunđerasto i palisadno tkivo. Mezofil je sagrađen iz manje-više okruglastih ćelija između kojih se nalaze krupni intercelulari. Intercelulari su najširi u srednjem delu liske. U pojedinim ćelijama mezofila nalaze se kristalne druze kalcijum oksalata. Ćelije u kojima se nalaze kristali obično su raspoređene kroz sredinu lista i oko sprovodnog snopića. Kristalne druze vremenom rastu i probijaju membranu ćelije u kojoj se nalaze i tako dospevaju u intercelulare. (Sl. 2).



Sl. 2. Poprečni presek kroz sekundarno-submerzni list. 1 — epidermis, 2 — kristal, 3 — sprovodni snopić, 4 — intercelulari, 5 — mezofil. (400 x). Original.

Fig. 2. Cross section through secondary-submerse leaf. 1 — epidermis, 2 — crystal, 3 — vascular bundle, 4 — intercellulars, 5 — mesophyll 11. (400 x). Original.

U mezofilu se nalaze i sprovodni snopići. U listu sa prvog nodusa nalazi se samo jedan, cetralno postavljen, sprovodni snopić. U listovima koji se razvijaju na višim nodusima ovaj centralno postavljen sprovodni snopić se grana.

Sprovodni snopić je sagrađen pretežno od elemenata koji sprovode organske materije, dok sudova ima veoma malo i njihove membrane nisu lignifikovane. Oko sprovodnog snopića nalazi se parenhimska sara.

I ako se sekundarno-submerzni listovi morfološki veoma razlikuju od primarno submerznih, ipak njihova anatomska građa pokazuje skoro istu sliku.

Kao što sam rekla list koji se razvija na petom nodusu bočne stabljike i anatomski i morfološki predstavlja prelaz od sekundarno-submerznih ka flotantnim listovima. Flotantni listovi imaju građu koja je karakteristična za listove svetlosti (višeslojno palisadno tkivo, razvijena kutikula, stome u epidermisu lica lista, dlakavost i dr.). Interesantno je da se flotantni listovi razvijaju jedno vreme pod vodom i da se sve gore navedene karakteristike nalaze još kod sasvim mladih listova što ukazuje na izvesnu pripremu listova za život u vazdušnoj sredini.

I ako su sekundarno-submerzni listovi zelene boje o njihovom fotosintetičkom doprinosu biljci, kao važnom faktoru u datim uslovima, ne može se govoriti, jer se oni razvijaju u vreme kada na biljci postoji masa krupnih flotantnih listova.

Prilikom razvića bočne grane skoro istovremeno se razvijaju i sekundarno-submerzni i flotantni listovi. Sekundarno-submerzni listovi veoma brzo gube zelenu boju i opadaju.

Razviće bočne stabljike u izvesnom smislu predstavlja skraćeno razviće glavne stabljike. Sekundarno-submerzni listovi po anatomskoj građi pripadaju grupi submerznih listova, ali po svom spoljašnjem izgledu podsećaju na mlade flotantne listove (M. Janković, 1956). Na njima se čak javljaju dlake što nije karakteristika submerznih listova. Ove činjenice me navode na misao da bi možda sekundarno-submerzne listove trebalo smatrati izmenjenim flotantnim listovima, čiji je oblik verovatno uslovljen mestom razvića bočne stabljike na glavnom stablu, a i drugim faktorima koji posredno ili neposredno utiču na razviće ovih listova (svetlost, temperatura i dr.). Ako pođemo od konstatacije da razviće bočne stabljike predstavlja skraćeno razviće glavne, onda bismo sekundarno-submerzne listove mogli da smatramo kao izmenjene primarno submerzne, jer su oni veoma slični po anatomskoj građi. Morfološke razlike koje se javljaju između ove dve vrste submerznih listova, i koje ih jasno razdvajaju, mogu da budu prouzrokovane nizom unutrašnjih i spoljašnjih faktora. Na pitanje koji su to faktori i kakvo je njihovo dejstvo nadamo se da će dati odgovor eksperimenti koje ćemo uskoro postaviti.

ZAKLJUČCI

1. Sekundarno-submerzni listovi se razvijaju na bočnoj stabljici od prvog do petog nodusa.
2. Počev od lista sa drugog nodusa na naličju sekundarno-submerznih listova razvijaju se višećelijske dlake.
3. Mezofil nije diferenciran na palisadno i sunđerasto tkivo.
4. Sekundarno-submerzni list koji se razvija na petom nodusu bočne stabljike i u morfološkom i u anatomskom pogledu predstavlja prelaz od submerznih ka flotantnim listovima.

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Summary

JELENA BLAŽENČIĆ

ON THE ANATOMICAL STRUCTURE OF SECONDARY-SUBMERSE LEAVES IN AQUATIC PLANT-WATER NUT

(*TRAPA LONGICARPA* M. Janković)

In the course of the individual development of water nut (*Trapa longicarpa* M. Janković) of all stems the main stem develops first, then secondary ones and only under appropriate conditions of the environment on the main stem may develop lateral stems. M. Janković (1956) wrote in detail about the individual development of water nut (*Trapa L.*) as well as about the appearance of lateral stems. Lateral stem develops from bud in axil of floating leaves which are later immersed into the water. In the first stages of the development the main stem grows vertically up, until the floating rosette sprouts on the water surface. Since the stem condinues to grow it gradually sinks into the water and it results in additional immersing of the floating leaves. From bud in axil of these, additionally immersed leaves develop lateral stems under the appropriate conditions of the environement.

The submerse and floating leaves develop on the lateral stem. The submerse leaves of the lateral stem morphologically differ considerably from those of the main stem, both in size and shape, as well as in jaggedness, the appearance of hair and others (fig. 1). Since the submerse leaves on the lateral stemdiffer from those on the main stem, and since the lateral stem develops on the nodus which is subsequently immersed into the water M. M. Janković (1956), named them as secondary-submerse leaves.

This paper is on the anatomical structure of secondary submerse leaves. As much as I know up to now no paper has been published on the anatomical structure of these leaves.

Secondary-submerse leaves were taken from the lateral stems of *Trapa longicarpa* in June, 1963. The material was fixed in alcohol and formalin and later treated with paraffin method. The sections, 10 microns thick, were stained with Delafield's haematoxylin with the combination of colours-light green and safranin. Secondary-submerse leaves are on the lateral stem from the first up to the fifth nodus (if we count the nodi from the place where the lateral stem sprouts from the main one). The leaf on the fifth nodus, both in morphological and anatomical aspect, represents the transition from the secondary-submerse towards the floating leaves.

Secondary-submerse leaves have single layered epidermis and very poorly developed cuticle. The cells of the epidermis of the leaf surface are larger than those of the back of the epidermis. Starting from the leaf on the second nodus on the epidermis of the back of the leaf, round the main nerve, there are multicellular hairs.

Between the epidermis of the surface and the back of the leaf there is the mesophyll which is not differentiated into palisade and spongy parenchyma tissue. The mesophyll is composed of more or less roundish cells between which there are larger intracellulars. The intracellulars are widest in the middle part of the leaf. In certain mesophyll cells there are crystal druse of calcium oxalate. The cells in which there are crystals are usually arranged through the middle of the leaf and around the vascular bundle. Crystal druses gradually grow and penetrate the membrane of the cell in which they are situated and thus they reach intracellular.

Vascular bundles are in the mesophyll. In the leaf from the first nodus there is only one, centrally placed, vascular bundle. In the leaves of higher nodi this centrally placed vascular bundle ramifies.

On the cross-section of secondary-submerse leaf (fig. 2) one can see the structure of one vascular bundle. In the vascular bundle the number of eleemnts which conduct inorganic substances and water is rather reduced, while the number of elements which conduct organic substances is greater. In the vascular bundle we see several tracheas and larger number of cells of condicting parenchyma, sieve tubes and companion cells. Bundle sheath is around the vascular bundle.

Although seconrary-submerse leaves morphologically differ very much from primary-submerse ones, their anatomical structure show nearly the same picture.

As I had said the leaf which develops on the fifth nodus of the lateral stem both anatomically and morphologically represents the transition from secondary-submersed leaves towards the floating ones. The floating leaves have the structure which is characteristic for leaves of light. The floating leaves develop in the water in which they stay a short time. By intercalary growth of the stem the floating leaves sprout onto the water surface.

Although the secondary-submerse leaves are green one cannot speak about their photosynthetic contribution to the plant, as an important factor in the given conditions, because they develop when the great number of large floating leaves exist on the plant.

During the lateral stem development nearly simultaneously develop both secondary-submerse and floating leaves. Secondary-submerse leaves very quickly lose green colour and fall.

The lateral stem development represents in a way the shortened development of the main stem. Secondary-submerse leaves by their anatomical structure belong to the group of submerse leaves, but by their outer look they very much remind of young floating leaves. Hairs and even stomata appear on them, what is not characteristic of submerse leaves. These facts make me think that perhaps secondary-submerse leaves should be looked at as changed floating leaves, whose shape is probably caused by the place of the lateral stem development on the main stem, and also by other factors which directly or indirectly effect the development of these leaves. If we start from the assumption that the lateral stem development represents the shortened development of the main one, then we could consider secondary-submerse leaves as changed primary-submerse, beacuse they, by thei anatomical structure, are nearly the same. Morphological differences, which appear between these two groupst of leaves, and which clearly differentiate them, may be due to the series of factors whose effects we shall study in the future experiments.

CONCLUSIONS

1. Secondary-submerse leaves develop from the first up to the fifth nodus on the lateral stem.

2. Multicellular hairs develop on the back side of secondary-submerse leaves starting from the leaf on the second nodus.

3. Mesophyll is not differentiated into palisade and spongy parenchyma tissue.

4. Secondary-submerse leaf which develops on the fifth nodus of the lateral stem represents both morphologically and anatomically the transition towards floating leaves.