I. DUCKWEED COVERS – LEMNETALIA MINORIS

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General description

Species-poor communities forming cover mainly on still- or slowly flowing or sometimes temporary water bodies. Any of the character species can reach considerable cover value. The dynamics of the community is determined by the anatomical characters of the plants forming the association (Borhidi 2003).

I.1. *Salvinio-Spirodeletum* (Slavnic 1956)

Syn: *Lemneto-Utricularietum* cons. *Salvinia natans* Timár 1954 (Soó, 1964); *Lemno-Spirodeletum salvinietosum* Koch 1954 (Soó, 1964); *Lemno-Salvinietum natantis* Ubrizsy 1961 (Soó, 1964)

Habitat conditions

The community was described by Slavnic in 1956 (Slavnic 1956). It is a free-floating vegetation on the surface of still- and slowly flowing water bodies forming thick covers in most cases. The structure of this community is more complex than that of other duckweed communities because the floating plants have also a tiny rhizosphere. Sometimes other species form a second, submerged layer (Borhidi 2003). In respect to the vegetation architecture, the most determining abiotic environmental factors are the water supply, water movement and wind speed. The stands of the community may be degraded by floods several times a year but they can regenerate within a short period (Bodrogközy 1982). The appearance and condition of this community strongly depends on the fluctuation of water level e.g. in lake Bence (Nagy 1996). The increase of the concentration of alkali cations, which can be attributed either to the mineralized water in the dry years or to the decomposition of the vegetation at the end of the summer, is favourable for the community. Dominant anion of the water bodies is hydrogen-carbonate. Total quantity of Na and K ions exceeds that of Ca and Mg ions and this increases the alkalinity of the water (Bölöni *et al.* 2003). This community is sensitive to water pollution (Fekete *et al.* 1997).

Characterization of stands along River Tisza and its tributaries

Salvinio-Spirodeletum is evaluated on the basis of 28 relevés that were taken between 1982 and 2005. Further details are listed in the Appendix at page 153. This

community consists of two strata: the species with tiny rhisosphere form the upper stratum and the submerged species form the second one. The surface layer is dominated mainly by *Salvinia natans* and in the submerged layer *Ceratophyllum demersum* is frequently the dominant species. Other species that are constant in this community such as *Spirodela polyrrhiza, Lemna minor, L. trisulca* and *Urticularia vulgaris* may become locally dominant. In the relevés recorded along the River Tisza, we found certain differences compared to the literature community descriptions (Borhidi 2003). The dominant species of other communities can be present in these duckweed stands because of their mosaic-like structure. For example *Trapa natans, Hydrocharis morsus-ranae, Glyceria maxima* and *Stratiotes aloides* can occur in these stands and they may be even accompanying species.

From among the protected species *Salvinia natans* occurred in each stand. *Trapa natans* was present in the following stands: Lake Tisza (Kisköre), Berettyó (Karcag-Püspökladány), oxbow lake of Tisza (Tisza-oxbow of Szóró, Besenyszög), oxbow lake of Körös (Körös-oxbow of Dan-zug, Gyomaendrőd), oxbow lake of Tisza (Körtvélyes-oxbow, Mártély).

Salvinia natans was dominant in most of the relevés and was monodominant in the half of them. In the relevés of the oxbows of Bodrogköz, *Lemna triscula* and *Sparganium erectum* were codominant or subdominant. A similar phenomenon can be observed with *Trapa natans* in the relevés from Körös-oxbow and in one case this species was even dominant in the surface layer. The other characteristic species, *Spirodela polyrrhiza* occurred more than 2/3 of the relevés (it was present for example in each sample in Körös-oxbow) and it was dominant in the surface layer in two relevés. In 3/4 of the relevés a submerged layer was formed in most cases by *Ceratophyllum demersum*, and in one sample by *Urticularia vulgaris*. Total vegetation cover of the relevés was much less in Körös-oxbow than in the other relevés.

Multivariate statistical analysis

We carried out a centred principal components analysis (PCA) ordination on the relevés. Considering the eigenvalues, 5 components are important which account for 96 % of the total variance of data. The relevés can be divided into 3 groups but several samples are separated on the scattergram (Fig. 1). It appears that *Salvinia natans* and *Ceratophyllum demersum* are responsible for the formation of the groups. Former species is in close connection with axis 1 while *Ceratophyllum demersum* with axis 2. The cover value of *Salvinia natans* increases from the left to the right along axis 1 and that of *Ceratophyllum demersum* increases from the bottom to the top along axis 2. *Salvinia natans* is dominant in the relevés that compose group A. In several cases *Trapa natans* becomes subdominant. Another common feature of the relevés in group A is that in most cases the submerged layer

did not develop, except for 2 relevés in which the cover of *Ceratophyllum demersum* is between 0.1 % and 10 %, (Fig. 1.). In the quadrates of group B, *Ceratophyllum demersum* forms a submerged layer and its cover value is between 40 and 70 %. *Salvinia natans* is also dominant. In the surface layer of relevés of group C the cover of *Salvinia natans* is lower (10-20 %). The relevés can be characterized with the dominance of *Trapa natans* and *Ceratophyllum demersum* in the submerged layer. The quadrates of group D are slightly separated from those of group A due to the codominance of *Lemna trisulca*. Also *Sparganium erectum* and *Utricularia vulgaris* may be codominant. In quadrates 6 and 20, the coverage of *Salvinia natans* is low (1-3 %), and the surface layer is dominated by *Spirodela polyrrhiza*. The separation of these units is caused by the presence and high coverage of *Ceratophyllum demersum* in quadrate 6 while being absent from quadrate 20.

Relevés recorded on AD scale consist of 15 species, many of them are reed bed and large sedge community elements. These two quadrates were not included in the multivariate analyses.

The aggregations of ordination plot (Figure 1.) do not coincide with Tisza river sections. Although the most important accompanying species of the community were recorded with different rate in each relevé, but this phenomenon did not cause any separation among the units/sections. *Ceratophyllum demersum* was absent only from two relevés of oxbow lakes of Tisza (Tokaj-Szolnok and Szolnok-Southern border). *Lemna minor* was present in every section except for Szolnok-Southern border. *Lemna trisulca* was recorded from two sites: oxbow lake of Bodrog and Lake Tisza. *Trapa natans* is not a character species here, but occassionally it reaches a considerable cover value. The number and proportion of accompanying species may be determined by plenty of biotic and abiotic factors, like species composition and propagule pool of neighbouring stands, abundance of water birds, the degree of eutrophisation, the depth and transparency of waterbody, drifting of water, degree of habitat disturbance.

The examination of euhydrophyte communities has some difficulties the most important of which is connected with the free-floating species. These species can easily be driven among and above the rooted vegetation therefore their presence-absence and abundance–dominance values can be evaluated only taking into account these facts.

The presence of additional species may be the consequence of the mosaic-like habitat structure and of the community complexes that are characteristic features of euhydrophyte communities.

The low transparency of shallow waters, several strata of the vegetation and the seasonal changes in the aspects made the study more difficult. In mosaic-like and overlapping vegetation, correct placing of the quadrate samples and determination of the borderline of the communities were not easy (Szirmai *et al.* 2006).

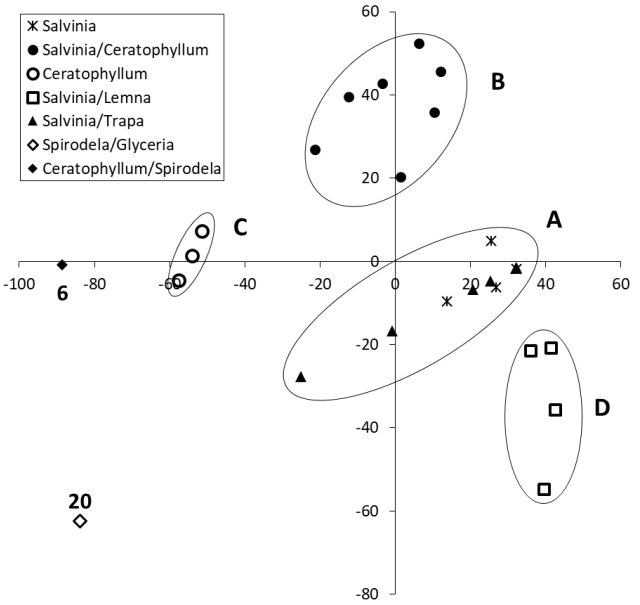

Fig. 1. PCA ordination of the relevés of *Salvinio-Spirodeletum* community (n=26) recorded on percentage scale (centered PCA; for the explanation of legends see text.)

I.2 *Wolffietum arrhizae* (Miyav. and J. Tx. 1960)

Syn.: *Wolffio-Lemnetum gibbae* (Benn. 1943) *wolffietosum arrhizae* (Soó, 1964).

The community was described by Miawaki and Tüxen in 1960 (Miyaw. & Tx., 1960). Earlier it was determined as the subassociation of *Wolffio-Lemnetum gibbae* (Soó, 1964).

Habitat conditions

According to Borhidi, the stands with *Lemna gibba* are characteristic for Middle and Western Europe. This community is azonal floating hydrophyte vegetation with short life span (Borhidi 2003). It is the indicator of eutrophic, HCO_3 rich, alkalic waters. *Wolffia arrhiza* is frequent and forms communities (Bölöni *et al.* 2003, Lakatos 1978). It forms great stands which can be swept by floods according to Bodrogközy, but they can regenerate within a short period (Bodrogközy 1982).

Characterization of the species and the stands along River Tisza and its tributaries

Rootless Water Meal, *Wolffia arrhiza*, is one of our smallest flowering plants. It is a subtropic-mediterranean species. The Hungarian distribution of the species can be connected to the migration of birds. It was first reported from the Soroksár Danube line by Boros, later Almádi reported the species at oxbow lake of Körös at Békésszentandrás (Almádi 1961). In the 1960's the species was observed in many places: S. Tóth observed it in oxbow lake of Tisza near Oszlár and in the surroundings of Tiszalúc, L. Tóth in Lake Velence, Vörösss reported it from Dráva plain at Szapronca, Tihanyi reported it in the Southern part of Somogy at Középrigóc from the water of Nagy-Bók. In the 70's the plant was reported from more localities. Fintha found it in the dead river-bed of Túr stream in the surroundings of Túrricse then in the oxbow lake between Túrriccse and Kölcse, and *Wolffia* performed the highest cover in Malom lake at Csaholc. Tölgyesi wrote about it in the Nagy Sulymos Lake and Kis Sulymos Lake between Lakitelek and Alpár, Legány found it at Tiszadob (at oxbow lake of Szelep), D. Pethe reported it from the watercourse of Dédai forest in the surroundings of Beregedaróc, and from Badalói-szeg oxbow at Tarpa. Fintha found it in the oxbow-lake of Szamos in the surroundings of Fülpösdaróc (Fintha 1979). Lakatos observed the plant near Taktakenéz in an oxbor-lake of Tisza and mentioned an occurrence at Cserehát (Lakatos 1978). *Wolffia* was reported from the Szamos dead channel at Csengersima in 1983 by Fintha, Egey found it in the oxbow-lake of Viss in Bodrogköz (Egey 1987). Recently the species and its association were reported from Kisköre reservoir by Szalma (Szalma 2003).

Characteristic feature of *Wollfia* is that it disappears and later appears again. Lakatos explained this dynamics with the seeds which crop in one year and may germinate in the next favourable year. These dormant seeds ensure the survival of the population during unfavourable conditions and the recolonization (Lakatos 1978).

Wolffia may disappear from many places due to the changing ecological conditions as a consequence of the changing weather. Then the distribution of the species can be observed again in some places (Fintha 1984). The seasonal changes of *Wolffia* together with other hydrophyte species, mainly with *Lemna trisulca* (Almádi 1961) can be well observed. The free-floating species (*Lemna* spp., *Wolffia arrhiza, Spirodela polyrrhiza*) often appear or replace each other only at the end or in the middle of the vegetation period. At the beginning of the vegetation period *Lemna minor* is dominant. *Spirodela polyrrhiza* reaches its maximum in the middle of summer. *Lemna trisulca* becomes dominant by the end of summer, and *Salvinia natans* and *Wolffia arrhiza* by the end of autumn (Szirmai *et al.* 2006). On the basis of the experiences at Taktakenéz, the community consists of several hydrophyte

species, the most characteristic species are: *Hydrocharis morsus-ranae, Spirodela polyrrhiza, Wolffia arrhiza, Lemna trisulca* (Lakatos 1961).

On the basis of the relevés along Tisza (9 relevés recorded on percent scale in one stand and 7 relevés recorded on AD scale in 4 stands between 1977-2005; cf. Appendix page 155) the following features can be summarized about the species composition of the community: it is a single layered, rarely double layered community. The floating species (mainly duckweed species) formed the upper layer and the submerged species formed the lower one (*Ceratophyllum demersum, Myriophyllum spicatum*). *Wolffia arrhiza* and *Lemna trisulca* were often codominant in moderately eutrophic waters. *Lemna minor* and *Spirodela polyrrhiza* were additional species.

Wolffia arrhiza was not monodominant differently from the recent literature (Borhidi 2003).

The relevés of Túr-oxbow were species-poor consisting of 3 species, this can be due to the small size of the sample quadrate. In the stands at Malom lake *Salvinia natans, Spirodela polyrrhiza* and *Wolffia arrhiza* were found. In the stands at Túr-oxbow, *Lemna minor* replaced *Salvinia*.

In certain relevés (in the samples of Török-rivulet) a submerged layer was observed which was formed by *Ceratophyllum demersum*. In the submerged layer of Körtvélyes stand, *Myriophyllum spicatum* was present as a constant species, in one of the relevés it was codominant with *Ceratophyllum demersum* while *Potamogeton lucens* was dominant in another relevé. In 60 % of the samples from Török-rivulet, *Wolffia arrhiza* and *Lemna trisulca* were codominant. *Lemna minor* and *Spirodela polyrrhiza* were subdominant in the relevés from Körtvélyes backwater in addition to *Wolffia arrhiza*. In one of the relevés, *Polygonatum amphibium* var. *aquaticum* formed consociation.

No multivariate analysis was performed since the number of the relevés was limited.

Channels are specific from coenological point of view. The bed of the channels is narrow and not too deep (about 1 to 2 m in depth), therefore plants have smaller habitats. Stands have less space, they are more crowded, the individuals of certain species cover each other so in many cases community complexes are formed on and under the water surface (Szirmai *et al.* 2006). The species composition of the stands of channels is different in many cases from the literature description of the community.

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