

### III. LARGE PONDWEED BEDS – POTAMETALIA

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#### *General description*

*Potametalia* association order consists of the broadleaved rooted pondweeds of still- and slowly floating water bodies with depth of several meters. Several species occurring in this order are purely aquatic plants while other species can be present in terrestrial forms (amphibian plants). Large pondweed beds (*Potamion lucentis*) are the pioneer communities in the eutrophication processes (Borhidi 2003).

#### III.1 *Potametum lucentis* (Hueck 1931)

Syn.: *Myriophyllo-Potametum potametosum acuminati* Slavnic 1956, *Lemneto-Utricularietum* cons. *P. lucens* Timár 1954, *Myriophyllo-Potametum potametosum lucentis* Soó 1957 (Soó 1964).

The community was described by Hueck in 1931. Earlier it was treated as the subassociation of *Myriophyllo-Potametum* (Borhidi and Sánta 1999).

#### *Habitat conditions*

Pondweed bed community is present in 4-7 m deep, moderately eutrophic and mesotrophic, still or slowly moving waters (Borhidi 2003).

#### *Characterization of stands along River Tisza and its tributaries*

Along river Tisza, 15 relevés were recorded on percentage scale in 4 stands and 10 relevés on AD scale in 4 stands between 1965 and 2000 (cf. Appendix page 158). It can be discussed from the records that all the relevés are dominated by *Potamogeton lucens*. *Ceratophyllum demersum* is also constant, and it dominates the submerged layer. If the surface layer develops it is dominated by *Salvinia natans* and *Hydrocharis morsus-ranae*, and these species may be accompanied by *Lemna minor* and *Spirodela polyrrhiza*.

The studied stands differ from the literature data (Borhidi 2003) since other plants as those with large submerged leaves are also characteristic. In certain relevés the occurrence of swamp and reed bed species like *Sparganium erectum*, *Bolboschoenus maritimus*, *Phragmites communis* causes further difference.

From among the protected species, *Salvinia natans* was present in the stands at Zsaró-rivulet, Tisza-oxbow of Hordód, Körös-oxbow of Dan-zug. *Trapa natans*

occurred in the stands at Lake Tisza, Körös-oxbow of Dan-zug, Körtvélyes-oxbow, Algyő at Nagyfa.

It is typical for the submerged layer in most relevés that *Ceratophyllum demersum* reached a significant cover value beside the dominant *Potamogeton lucens*. In one of the relevés at Tisza-oxbow of Hordód, *Myriophyllum spicatum* had also a higher cover value. All of the above mentioned species were present in the Körtvélyes stand (Bodrogekőzy 1982) accompanied by *Potamogeton perfoliatus*. The relevés of Körös-oxbow were exceptional because only *Potamogeton lucens* formed the submerged layer. In the relevés taken by Timár at Algyő Nagyfa, *Potamogeton gramineus* was codominant with *Potamogeton lucens*. In the stands at Tiszafüred, Algyő and Körös-oxbow, species of broad-leaved pondweed carpets, swamps and reed beds may also occur with considerable dominance like *Trapa natans*, *Sparganium erectum*, *Polygonum amphibium*, *Bolboschoenus maritimus*, *Nuphar lutea*, *Phragmites australis*, *Sagittaria sagittifolia*.

### Multivariate statistical analysis

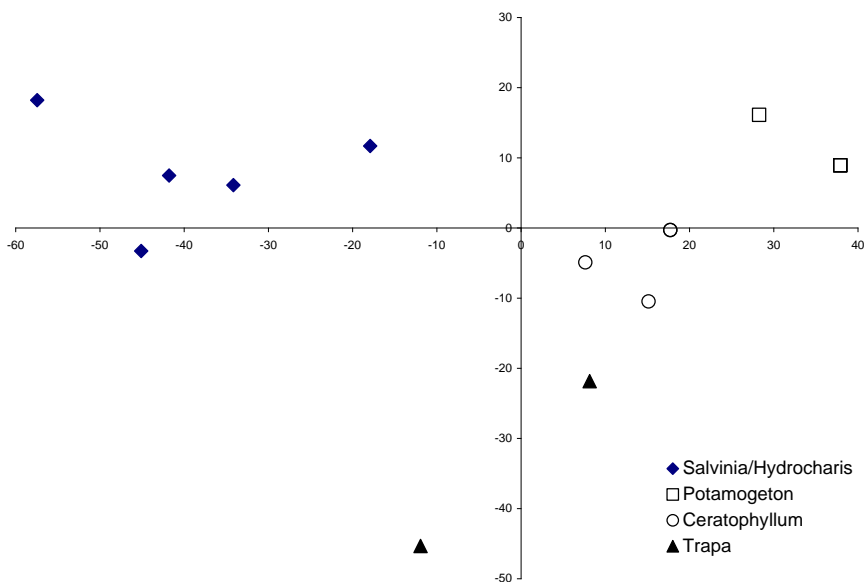


Fig. 1. PCA ordination of the relevés (n=15) of *Potamogeton lucens* community recorded on percentage scale (centered PCA). Relevés marked with diamond are dominated by *Salvinia* and *Hydrocharis*, those marked with open square are dominated by *Potamogeton*. Open circle signs the dominance of *Ceratophyllum*, and triangle signs the dominance of *Trapa*.

Principal component analysis (PCA) was performed on percentage scale data. Due to the low number of species, more than 95 % of the total variance is accounted for by only three components. The scatterplot of the relevés (Fig. 1.) that derived from centred Principal component analysis presents the aggregation according to the species composition and dominance. *Potamogeton lucens*, *Salvinia natans*, *Ceratophyllum demersum* and *Hydrocharis morsus-ranae* are the determining species, and are connected to component 1; *Trapa natans* is of secondary importance as it is present only in two relevés. The cover values of *Potamogeton lucens* are high in the right hand objects, and those of *Salvinia natans*, *Ceratophyllum demersum* and *Hydrocharis morsus-ranae* are higher at the left hand relevés. The relevés characterized by the considerable cover values of *Salvinia* and *Hydrocharis* were sampled in the same stand of Zsaró-rivulet. The reason of separation of relevés marked with triangle was the dominance of *Trapa natans* in the surface layer. The aggregation of the relevés is less connected to the geographic area.

Due to the low number of AD-samples the multivariate analysis was not performed.

### **III.2 *Myriophyllo-Potametum* Soó (1934)**

Syn.: *Potametum myriophylletosum* Soó 1934, *Potametum perfoliati potametosum lucentis* Koch 1926, *Potametum mixtum* Soó, 1930, 1933 (Soó, 1964).

The community was described by Soó in 1934 (Soó 1934)

#### ***Habitat conditions***

This community occurs normally in the muddy bank zone of shallow large lakes and oxbow lakes. It can be characterized with great photosynthetic activity and biomass production (Borhidi 2003).

#### ***Characterization of stands along River Tisza and its tributaries***

We found very few data from this community recorded along the river Tisza. Two relevés were recorded on percentage scale and 1 relevé on AD scale in 1951 and in 2003 (cf. Appendix page 160). The relevés recorded on percentage scale differ from the published community description (Borhidi 2003), since *Myriophyllum spicatum* did not occur in the quadrates but instead *M. verticillatum* dominated the stand which is usually an accompanying species. The list of the accompanying species is similar to the literature data: *Potamogeton perfoliatus* generally subdominant, further accompanying species are: *Hydrocharis morsus-ranae*, *Lemna minor*, *Lemna trisulca*, *Salvinia natans*, *Spirodela polyrhiza*,

*Potamogeton natans*, *Trapa natans*. The last two species were present only in one of the relevés. On the basis of the species composition and considering also the results of Kárpáty V. (Borhidi 2003), the 2 percentage scale relevés can be considered as the facies of *Myriophyllo-Potametum*.

The archive relevé recorded on AD scale includes only two species: *Myriophyllum spicatum* is dominant and *Trapa natans* is subordinate accompanying species. We used only one relevé from those of Timár made in *Myriophyllo-Potametum* (Timár 1954) because *Myriophyllum* species occurred only in this sample. In the other relevés of Timár, *Potamogeton perfoliatus* is the dominant species forming communities, and other pondweed species like *P. pectinatus* or *P. natans* are not present in the relevés of Timár.

The species number of the relevés was very low, and only two protected species were found. *Salvinia natans* was present only in the stand at Tisza-oxbow of Hordód, and *Trapa natans* occurred in both stands.

### **III.3 *Nymphaeetum albo-luteae* (Nowinski 1928)**

Syn.: *Myriophyllo-Potametum* W. Koch 1926, Slavnic 1956; *Nuphareto-Castalietum* Soó, 1928, 1933, 1934, 1936, 1938, 1940-41, 1945; Soó-Zólyomi 1951; Timár 1954 (Soó, 1964).

The community was described by Nowinski in 1928 (Nowinski, 1928).

#### ***Habitat conditions***

Floating broad-leaved carpets are characteristic of large, permanent waterbodies, lakes, and oxbows and sometimes channels and slowly flowing rivers with moderately deep water. The community survives for a long time if the ecological conditions are optimal (Borhidi 2003).

#### ***Characterization of stands along River Tisza and its tributaries***

Along the river Tisza, 50 relevés were recorded on percentage scale and 11 relevés on AD scale between 1947 and 2005. The relevés belonged to 12, and 7 stands, respectively (see Appendix page 161). The separate occurrence of the two dominant species, *Nymphaea alba* and *Nuphar lutea*, supports that the community can be treated as two separate associations but mixed stands can also be observed. Submerged species can accompany the floating species complex thus the community consists of 2 layers in this case. In the *Nuphar* beds (*Myriophyllo verticillati-Nupharetum luteae* W. Koch 1926), *Lemna* species (*L. minor*, *L. trisulca*) and *Hydrocharis morsus-ranae* can accompany the dominant species in the surface layer while in the submerged layer *Ceratophyllum demersum* is present.

Waterlily beds (*Ceratophyllo-Nymphaetum albae* (Kárpáti 1963, Borhidi 2001) differ from the previous community because they are less tolerant to eutrophization (Borhidi 2003). *Lemna* species (*L. minor*, *L. trisulca*), *Spirodela polyrrhiza* and *Hydrocharis morsus-ranae* can occur in the free-floating layer while the community is characterized with *Ceratophyllum demersum*, *Myriophyllum spicatum*, *Utricularia vulgaris* and *U. australis* in the submerged layer.

Some swamp and reed bed species occur in the relevés like *Butomus umbellatus*, *Sagittaria sagittifolia*, *Sparganium erectum*, *Agrostis stolonifera*, *Glyceria maxima*, *Typha angustifolia*, and this occurrence is different from the literature data (Borhidi 2003).

From among the protected species, *Hottonia palustris* was found in the Viss-oxbow and Lake Sulymos (Tóserdő). *Nymphaea alba* was recorded in all of the stands except for those at Zsaró-rivulet and Viss-oxbow. *Salvinia natans* was present at Török- and Zsaró-rivulet, Viss-oxbow, Lake Nagy at Bodrogzug, Lake Tisza, Lake Sulymos, Tisza-oxbow of Alpár and Tisza-oxbow of Nagysziget.

The difference among the stands appears in the strata of the community and in the rate of the dominant and accompanying species. *Nymphaea alba* is dominant in the surface layer in 65 % of relevés, and 25 % of the relevés is dominated by *Nuphar lutea*. In the remaining relevés, other species are dominant or codominant (*Hydrocharis morsus-ranae*, *Stratiotes aloides* and *Glyceria maxima*). In 58 % of the samples a submerged startum is present which consists of free-floating and rooted hydrophyte species.

In most of the relevés recorded on AD scale *Nymphaea alba* is dominant in the surface layer and it is subordinate in some cases. In one of the relevés *Nuphar lutea* is dominant, and two relevés are dominated by *Sagittaria sagittifolia*.

### ***Multivariate statistical analysis***

Both percentage and AD-scale data were evaluated with Principal component analysis. In the PCA of percentage data, 4 components were important, they accounted for 91.4 % of the total variance. The ordination scatterplot (Fig. 2) shows four distinct groups of objects that are separated according to the dominant species composition. The distinctive species are *Nymphaea alba*, *Nuphar lutea* and *Ceratophyllum demersum*. The effects of *Nymphaea* and *Nuphar* are opposite, and they determine the distribution of the objects along the first axis. *Ceratophyllum* is mainly responsible for the distribution along the second axis.

During the ordination of AD scale samples, the original cover values were converted. Instead of + sign 0,1 was used, and in the case of interval values (e.g. 2-3) their means (2,5) were used. In the PCA-ordination of AD-scale data, the first 5 components proved to be important, and accounted for 91.2 % of the total variance of data. The distribution of the points in the scatterplot (Fig. 3) is determined mostly

by the AD values of *Nymphaea alba* growing from the left to the right along the first axis.

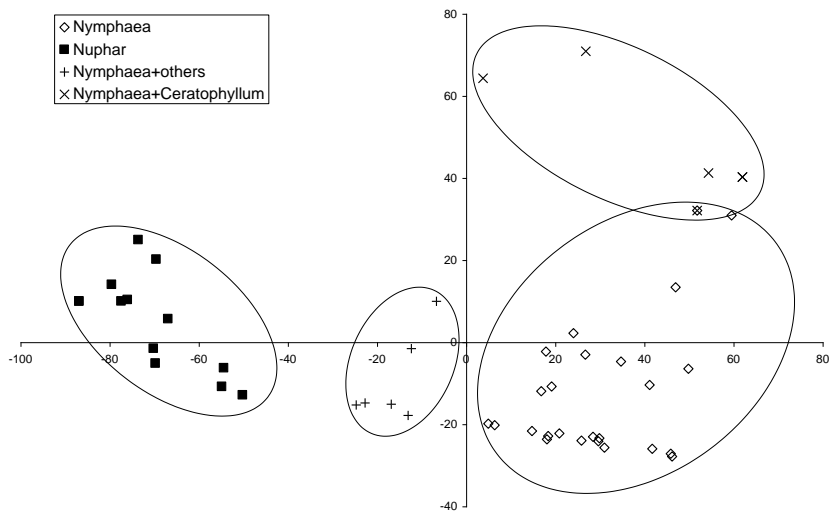


Fig. 2. PCA ordination of the relevés (n=50) of *Nymphaeetum albo-luteae* community recorded on percentage scale (centered PCA). The relevés are separated according to the dominant species composition.

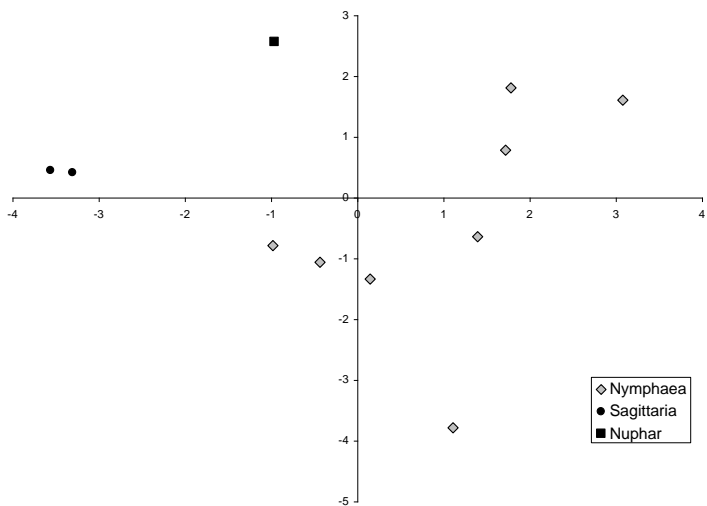


Fig. 3. PCA ordination of the relevés (n=11) of *Nymphaeetum albo-luteae* community recorded on AD scale (centered PCA). The relevés are distinguished again by the dominant species.

The relevés on the left are characterized by smaller AD values of *Nymphaea alba* and are dominated by *Sagittaria sagittifolia* or *Nuphar lutea*. Two relevés are co-dominated by *Salvinia natans* or *Ceratophyllum demersum* but these points do not separate definitely from those dominated only by *Nymphaea*.

The distribution of the relevés in the ordination hyperspace is not connected to the river sections or certain places. The sub-associations or facies may be affected by the local water chemistry.

### **III.4 *Trapaetum natantis* (V. Kárpáti 1963)**

Syn.: *Nuphareto-Castalietum* cons. *Trapa* Timár 1954, *Trapa* soc. Soó, 1933, 1934, *Trapo-Nymphoidetum* Ubrizsy 1961 (Soó 1964).

The community was described by V. Kárpáti (1963). Earlier this community was considered as the water chestnut consociation of *Nuphareto-Castalietum* (Timár 1954) or the same community as fringed waterlily carpets (Ubrizsy 1961 in Soó 1964).

#### ***Habitat conditions***

Water chestnut carpets are the vegetation of slowly moving and still eutrophic waters. This community favours the parts of water bodies which can easily warm up and are moderately alkalic. The stands develop till the depth of 2 m (Borhidi 2003).

#### ***Characterization of stands along River Tisza and its tributaries***

The structure of this community can be evaluated on the basis of 96 relevés from the Tisza valley. Fifty five relevés were recorded on percentage scale (19 stands) and 41 relevés on AD scale (16 stands). The records were done between 1947 and 2005 (Appendix page 164). The stands are mainly species-poor dominated by *Trapa natans*, and also *Lemna* species and *Hydrocharis morsus-ranae* are characteristic. Contrary to the literature data (Borhidi 2003), the community has got two layers in about half of the relevés. The surface layer consists of the above species accompanied often by *Spirodela polyrrhiza* and *Salvinia natans*. Several broad-leaved species occur in the free-floating layer like *Nuphar lutea*, *Nymphaea alba*, *Nymphoides peltata*, *Potamogeton nodosus* or *P. natans*. *Ceratophyllum demersum* forms the submerged layer in most cases, and sometimes it can be accompanied by *Utricularia vulgaris*, *U. australis*, *Myriophyllum spicatum*, *M. verticillatum*, *Najas marina*, *N. minor* and *Potamogeton* species (*P. crispus*, *P. lucens*, *P. pectinatus*, *P. perfoliatus*).

From among the protected species, *Trapa natans* occurred in each stands. *Marsilea quadrifolia* was found only in the Kengyel-oxbow. *Salvinia natans*

occurred in the stands of Zsaró-rivulet, Lake Tisza (Tiszavalk, Poroszló, Egerstream, Csapó, Kozmafok-Sarud, Adádszalók, Kisköre) and Tisza oxbow lakes (Lake Gó, Szóró, Feketeváros, Labodár, Osztora, Mártély and Körtvélyes). *Nymphaea alba* occurred in the stands at Tiszavalk and Poroszló, and *Nymphoides peltata* was found in the stands near Tiszavalk, Kozmafok-Sarud and Kisköre.

The surface layer of the majority of relevés recorded on percentage scale was dominated by *Trapa natans*. Only 3 relevés were characterized by larger cover values of *Stratiotes aloides* and *Hydrocharis morsus-ranae*. In Kengyel-oxbow and Zsaró-rivulet, certain swamp and reed bed species appeared as accompanying species like *Glyceria maxima*, *Sagittaria sagittifolia* or *Butomus umbellatus* cover values of which were low (less than 8 %). Most of the relevés had also submerged layer which was formed mainly by *Ceratophyllum demersum* or sometimes by *Lemna trisulca*. In 3 stands (Kengyel, Zsaró-rivulet, Tisza-oxbow of Szóró), there was no submerged layer which was probably the result of the shallow water. The total species number was only 24 and only 5 species performed higher cover values. The frequency of 7 species was considerable. The average number of species per relevé was about 4, and only one species was present in several relevés.

The dominance of the species were much more varied in the relevés made on AD scale. *Trapa natans* was dominant again in every relevés except for two ones, but occurred in each relevé. The other species were less frequent and rarely dominant. *Polygonum amphibium* formed a consociation in certain samples of the stands near Poroszló and Körtvélyes. *Nymphoides peltata* was co- or subdominant in some samples of the Sarud stand. *Hydrocharis morsus-ranae* was subdominant in one of the relevés of Tiszavalk. *Nymphoides peltata* did not occur frequently but should be codominant with *Trapa natans*. In the relevés recorded at Lake Tisza, *Salvinia natans* and *Spirodela polyrrhiza* were frequent species with low cover value as accompanying species. The submerged layer was also diverse: *Ceratophyllum demersum*, *Urticularia australis* and *Lemna trisulca* were frequent but with low cover values. *Myriophyllum* species were also the members of the submerged layer. *Myriophyllum spicatum* was present only in few relevés but with considerable AD-value in the southern part of Tisza valley (Szolnok-Southern border) while *M. verticillatum* occurred in one stand at Lake Tisza as an accompanying species. The following species occurred only in the stands of Lake Tisza: *Najas marina* and *N. minor*, *Potamogeton pectinatus* and *P. perfoliatus*, while *Potamogeton crispus* and *P. lucens* were recorded from the waters of the Southern part of Tisza (Szolnok-Southern border).

### **Multivariate statistical analysis**

Principal component analysis of percentage data resulted that 3 components are considerable on the basis of eigenvalues, they account for 94.38 % of the total variance of data. The ordination plot (Fig. 4) shows a very characteristic



distribution of points representing the relevés. Cover values of *Ceratophyllum demersum* and *Trapa natans* are of primary importance in this respect. The cover value of *C. demersum* is growing from the left to the right along the first axis while that of *T. natans* is growing from the bottom to the top along the second axis thus these two species can be coupled with the first and second components, respectively. The relevés are apparently separated along the first axis by the dominance classes of *C. demersum*, and scattered along the second axis by the dominance values of *T. natans*. Other species play no definite role in this respect.

PCA analysis of AD-scale data resulted 8 components considerable which account for 94.31 % of the total variance. This means that more species are responsible for the point distribution than in the previous analysis. In this analysis, *Trapa natans* plays the most important role and can be coupled with the first component. Its abundance is the highest on the right side of the graph, and one relevé is separated on the left as being practically an open water stand. The distribution of the points along the second axis is influenced by several species with considerable abundance thus groups characterized with the occurrence of *Polygonum amphibium*, *Nymphoides peltata* and *Ceratophyllum demersum* are distinguished. The overlap among the groups is rather large at the right side that is due to the high abundance of *Trapa natans* (Fig. 5).

No relationship was found between the species composition and geographic position of the stands.

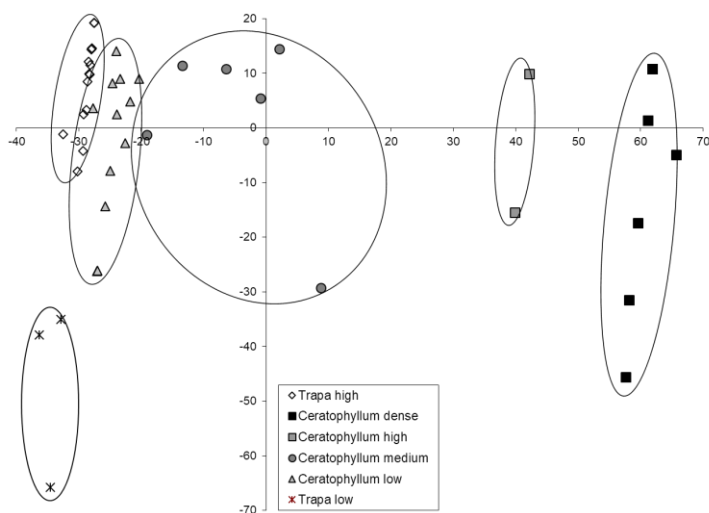


Fig. 4. PCA ordination of the samples (n=55) of *Trapa natans* community recorded on percentage scale (centered PCA.) *Trapa natans* is present and in most cases dominant in the relevés; *Ceratophyllum demersum* is not present in the plots marked with „*Trapa high*” and „*Trapa low*”.

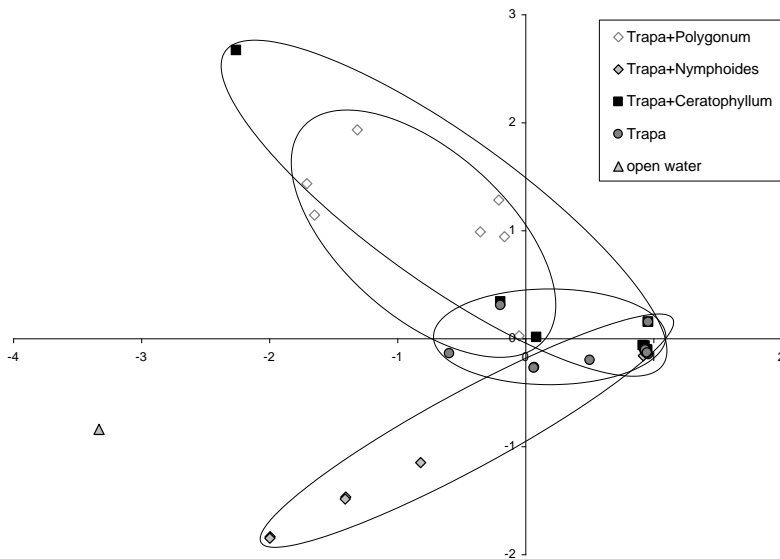


Fig. 5. PCA ordination of the samples (n=41) of *Trapa natantis* community recorded on AD scale (centered PCA.) The relevés are distinguished according to the second most important species. The groups of relevés of similar character have considerable overlaps.

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