

# THE RESULTS OF PRELIMINARY INVESTIGATIONS OF AQUATIC VEGETATION IN THE REGIONAL PARK "STARI BEGEJ"

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**Abstract.** Complex data about the flora and vegetation of the Regional park "Stari Begej" are not existing in botanical literature. Fragmentary elaborations are only on vegetation of Carska bara, Vojtina mlaka and Mala bara (Gigov and Djerfi, 1960). According to these authors, aquatic macrophytes form three communities of the alliance *Potamion (Potamogetonion)* W. Koch 26 emend. Oberd. 57 of the order *Potametalia* W. Koch 26 and class *Potametea* Tx. et Prag. 42 in these marshes. The latest investigations of Carska bara, Vojtina mlaka including the riverbed of Stari Begej and the low parts of zone flooded by it indicate, that in the Regional park "Stari Begej" developed are also formations of smallest flowering plants: *Wolffia arrhiza*, *Lemna minor*, *Lemna trisulca*, *Spirodela polyrrhiza* and others. Formations of association alliance *Lemnion minoris* W. Koch et Tx. ex. Oberd. 57 of the order *Lemnetalia* W. Koch et Tx. ex Oberd 57 and class *Lemnetea* W. Koch et Tx. ex Oberd. 57 are in question.

**Keywords:** *backwater, community composition, duckweed.*

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## Introduction

The area of Regional park "Stari Begej" is located in Banat (Eastern Vojvodina), comprising a complex of marches, swamps and willow grooves at the river mouth of Begej into Tisza. According to Ham (1975), low terrains are in question (72.00-74.00 m altitude) which were regularly flooded in the past during high waters. A partial regulation, by erecting embankments and some other hydrotechnical objects, was made at the beginning of this century.

However, basic changes in the ecosystem arose after serious works in the period 1971-1974. At that time, the river Begej was partitioned at its 15th kilometer, a new embankment was erected east of the old riverbed and the flow of Begej was directed through the new riverbed (resp. canal), so that a part of Stari Begej was completely cut-off for about 10 km from Tisza and Begej.

The components of this mosaic marshy biotope are Carska bara, Vojtina mlaka, Tiganjica, Zagnjenica, Perleska bara and Stari Begej itself.

This area, (especially Carska bara and Vojtina mlaka) is mostly known by its birds, however its vegetation also deserves full attention.

The complex features of the micro- and mezorelief (shallow and deeper depressions, separated by elevations - so called "beams") and in connection with this the regime of underground and flood waters, were contributed to the presence of almost all types of vegetation: aquatic, marshy, swampy meadow and forest vegetation. Depending on actual synecological conditions, each of the mentioned types is divided into particular communities. Up till now, only the vegetation of Carska bara, Vojtina mlaka and Mala bara (Gigov and Djerfi, 1960) were fragmentarily elaborated in botanical literature for aquatic and swampy habitats, including phytocenological analyses of willow grooves. With regard to the above mentioned newly created water regime in the lower flow of Begej, and the fact that the two mentioned authors did their researches 30 years ago (prior to the newest hydro-regulation), it was expected to notice many changes of the vegetation in these three marshes.

## Material and methods

The investigations of the vegetation were carried out in the years 1989 and 1990, so the results should be considered as preliminary.

The phytocenological samples were taken with Swiss-French method (Braun-Blanquet, 1921).

The collected plant material was determined according to Flora of Serbia (1970-1986) and Jávorka (1934), while in disputable cases on the basis of Soó's (1964-1980) diagnoses. The nomenclature was taken from the above mentioned Flora of Serbia. The floral elements were quoted according to Gajic (1980). Ecological indexes were given according to Landolt (1977) and corrected according to Soó (1964-1980). Life forms for all ascertained species were interpreted according to the above author.

## Results and discussions

On this occasion, we shall describe only the macrophytic vegetation, being the first in the ecological line. According to Gigova and Djerfi (1960) in Carska bara, Vojtina mlaka and Mala bara, aquatic plants form three phytocenoses of the alliance *Potamion* (*Potamogetonion*) W. Koch 1926 emend. Oberd. 1957 (order *Potametalia* W. Koch 1926 and class *Potametea* Tx. et Prsg. 1942). However, the latest investigations of Carska bara, Vojtina mlaka, including the riverbed of Stari Begej and the low parts flooded by it when the water from fish pond is let out for cleaning purposes, show that in the Regional Park "Stari Begej", also formations of the association alliance *Lemnion minoris* W. Koch et Tx. ex Oberd 1957 of the order *Lemnetalia* W. Koch et Tx. ex Oberd 1957 and class *Lemnetea* W. Koch et Tx. ex Oberd 1957 developed. Formations of smallest flowering plants are in question, in which the following species could be found as regular elements: *Lemna minor*, *Lemna trisulca*, *Spirodela polyrrhiza* and especially *Wolffia arrhiza*. The later herbaceous species is a newcomer in our flora. This was one of the reasons why we present the results of preliminary investigations of the aquatic vegetation in the Regional Park Stari Begej, in order to draw attention to formations of a community edificator of which is *Wolffia arrhiza*.

Data given here represent first findings of this species not only in the investigated protected area, but also in this part of Banat in general. For this

reason, we wish to emphasize data about the spread of this species in Vojvodina.

a) Chorologic data for the species *Wolffia arrhiza* (L.) Wimm

In the shallow, stagnant, warm waters of the Regional park "Stari Begej", which are getting completely dry from time to time, we have found a tiny floating plant, which at first glance looked like scattered seeds. It was covering the water like a greenish carpet. We have noticed that its upper part is slightly convex and that at the back side there is a small pit. There was duck weed (*Wolffia arrhiza*) in question, a plant of tropical parts of Asia and Africa, spread also in Philippines, Jawa, Australia, Western and Southern Europe (Blečić, 1976).

First data about the arrival of this species to Vojvodina were given by Degen (1910) for Pancevo, based on plant material collected by Simonkai. In Mostonga, near Bac, it was discovered by Unger (1916) and in Deliblato sand by Kusanin (1930) - (Becarevic, 1953). The first two localities were mentioned by Jávorka (1925). Botanists who performed detailed floristic investigations in the area of today's Vojvodina, at the beginning of this century, did not mention the presence of this rare plant in swampy and aquatic flora (Kupcsok, 1915; Prodán, 1916; Kovács, 1929). The year 1951 can be considered as that when duck weed appeared in the vegetation of this part of the Pannonian plain, however, it should be concluded that the findings of this species were very rare at that time. Becarevic (1951) recorded it in a swamp at Sremski Karlovci (opposite the Railway station) and in 1953 in one canal in Novi Sad-Kac swampy area. Three years later, Slavnic confirms these two findings and gives three new localities: Petrovaradin-Karlovci marshy area, Gajica bara (filled-in canal), Obrovac and "Galad" between Kikinda and Basaid.

In his work "Contribution to the flora of Backa" Atanackovic (1958) does not mention the species *Wolffia arrhiza*. The same relates also to the works of Canak and Dokic (1969, 1970) and Parabucski (1972, 1973). The flora of Petrovaradin-Karlovci marshy area is elaborated by Obradovic and Butorac (1975) and Vukoje (1979), but they do not confirm the findings of Slavnic. This is in accordance with the opinion of Obradovic (1966, 1978) that this smallest flowering plant is in retreat in some habitats in Vojvodina.

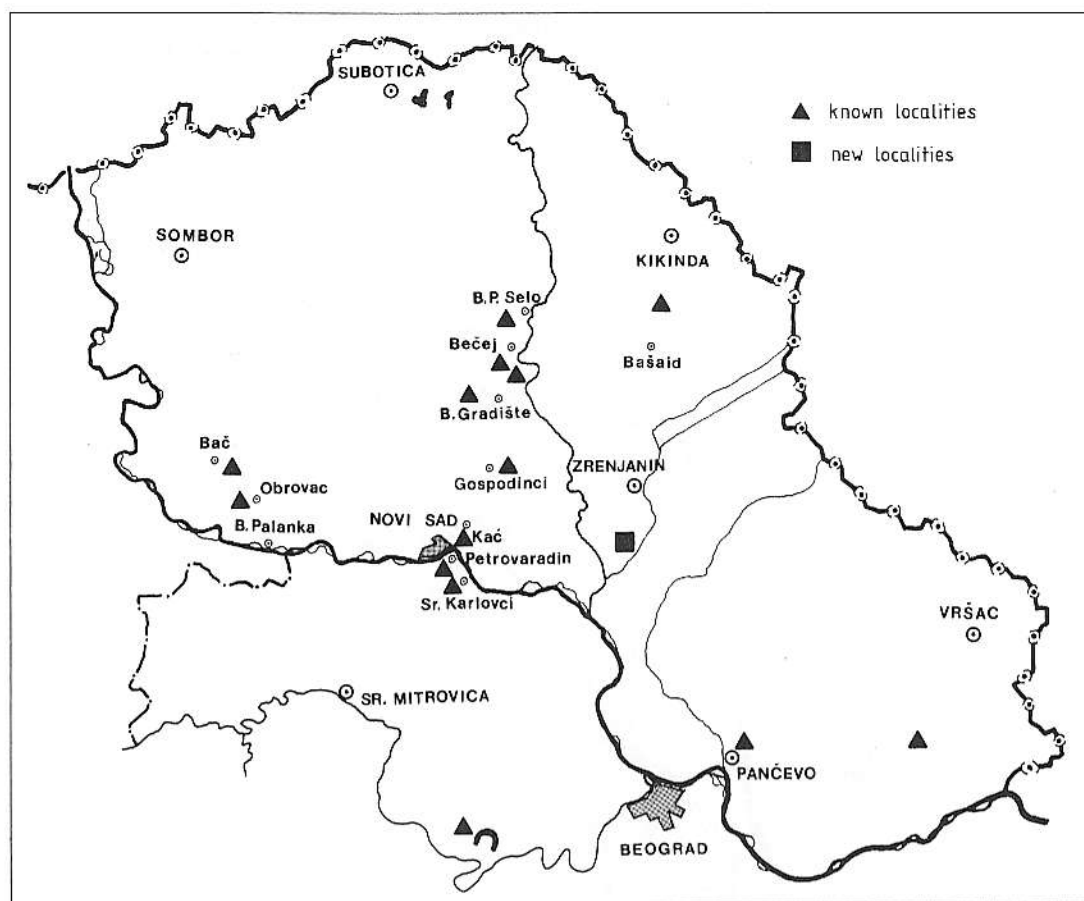


Fig. 1. Distribution of the species *Wolffia arrhiza* (L.) Wimm. in Vojvodina province

Soó (1973) mentions the species *Wolffia arrhiza* for some parts of Hungary, where it is massively spread, since it reproduces vegetatively. In Europe it has an Atlantic-Mediterranean character, while in Hungary it is a neophyte. This coincides with the understanding of Obradovic regarding some newly recorded habitats in the Vojvodina part of the plain. Our opinion is that while it retreats in the southern part of the Pannonian plain, it appears massively on newly recorded places in Vojvodina and Serbia. Canak and Dokic (1968) have ascertained it in a swamp at Mala Krsna in Serbia, Blečić (1976) records it near Belgrade, Babic and Parabucski (1971) in Jegricka at Gospodjinci.

These data are interesting, since they show that *Wolffia arrhiza* (according to some authors even a relict plant) is successful in gaining new habitats. So, Vukoje (oral report in 1980) ascertains this species in Backa, at the following localities: branch of dead Tisza-"Medenjaca" at

Stari Becej, a canal on "Medenjaca", "Ilidza" swamp at Backo Gradiste and its canal towards the canal "Becej-Bogojevo" and in the canal Backo Petrovo Selo-Becej. The spread of *Wolffia arrhiza* is possible only on such places where the slow waterflow, low water level, water eutrophication and others, are dominant factors, for the development of duck weed.

This is supported by our newest findings of this species in the area of "Stari Becej" at the following places: Vojtina mlaka in shallow depressions; several separated places in the Stari Becej floody areas (between the riverbed and old embankment, opposite Zagnjenica); between the riverbed of Stari Becej and the old embankment (opposite Palenita Greda); (see Fig. 2.).

These data indicate that duckweed is not such a rare plant of stagnant waters supplementing the areal of *Wolffia arrhiza* in Banat, Vojvodina and the Pannonian plain in general being of scattered

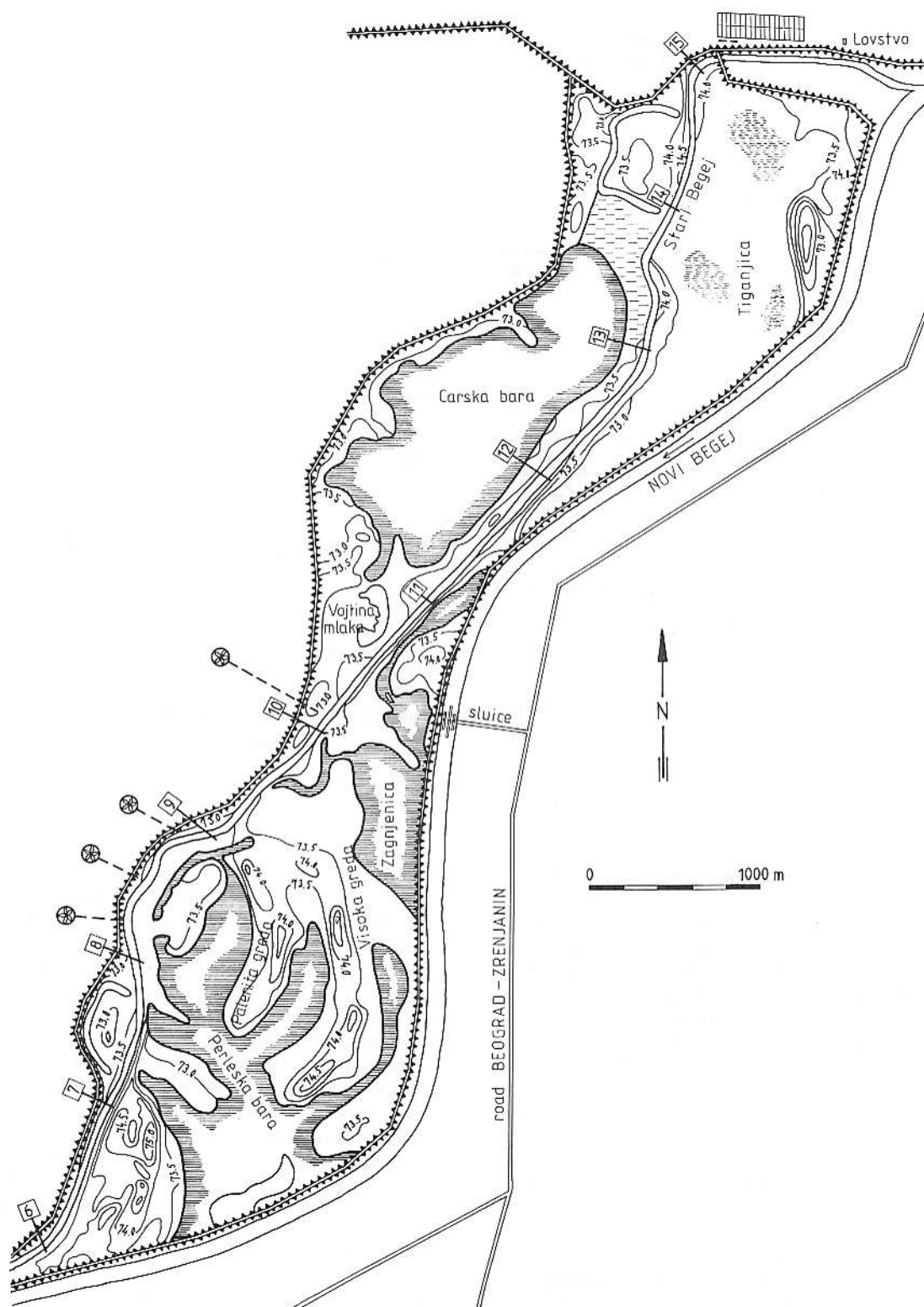


Fig. 2. Distribution of the community *Wolffietum arrhizae* in Regional Park "Stari Begej".



character. In the Flora of Serbia (1976 and 1986) except the findings in Vojvodina, near Belgrade, duckweed is mentioned by Domac (1973) for the areas of Serbia and Croatia, but no localities are mentioned. Data about the introduction of the species *Wolffia arrhiza* in the flora and vegetation of Croatia are given also by Jávorka (1925) for the vicinity of Rijeka; Hulina (1973, 1989) for the vegetation of Turopolje; Trinajstić and Trinajstić (1988) for Krapje Džol on the left bank of Sava, west of Jasenovac; Persin (1988) for marshes in Ilovac (region of Karlovac); Topic (1989) for the vegetation of Kopács meadow.

This smallest flowering plant was also ascertained in the aquatic vegetation of Slovenija (Seliskar, 1983) in stagnant tributaries near Petanjci in Pomurje (Jez and Skoberne, 1986).

The mentioned chorologic data are interesting. Becarevic (1953) for instance classifies the species *Wolffia arrhiza* as a Mediterranean plant in a wider sense, although the majority of authors here and all over the world treat it as cosmopolitan. Obradovic (1966, 1978) stresses that this taxon is of relict character in the Pannonian plain, i.e. it is a rare plant in retreat, but that it belongs to the Atlantic-Mediterranean floral elements. We are inclined to accept the opinion of Soó, that a neophyte species is in question, because from 1953 to 1980 a great number of new habitats were recorded (on Fig. 1. marked as ▲).

However, investigations in the last ten years have shown that in accordance with changed synecological circumstances of the habitat on some of these localities, *Wolffia arrhiza* is not developing any more, but that it succeeded on some new localities on the same reasons (Fig. 1., marked as ■).

#### b) Vegetation data with the dominant role of species *Wolffia arrhiza*

On the investigated area of the Regional park "Stari Begej", duckweed appears in combination with species from the family Lemnaceae: *Lemna minor*, *L. trisulca* and *Spirodela polyrrhiza*.

The number and coverage of particular herbaceous species are the consequence of newly created circumstances in the habitat. Formerly a typical marshy-swampy biotope, later it was artificially changed by channeling a part of Begej, by cutting-off part of Begej from Tisza and Begej, and by erecting a dam. Due to this changes wetting and flooding was reduced. The changed and regulated nature of flooding, low terrains have caused the appearance of formations which floristically fits mostly the ass. *Wolffietum arrhizae* Myawaki et J. Tx. 1960 during the last years by alternation of the intensity of drought and a warm

season. Since this community is separated in Mid Europe and as Slavnic (1956) states in Vojvodina, in the most shallow warm waters are developing formations which in Holland are described under the name *Wolffio-Lemnetum gibbae* Bennema 1943, this statement looks discussible at first glance. Adding to this, the fact that in their survey of aquatic macrophyte phytocenoses, formations in which *Wolffia arrhiza* has an edificatory role are mentioned under this last name by Otti (1973), Soó (1973), Parabucski et al. (1986) and others. However, Runge (1980) records them as two completely independent associations in the syntaxonomic location of plant communities in Mid Europe: *Wolffietum arrhizae* and *Lemnetum gibbae* (W. Koch, 1954) Myawaki et J. Tx. 1960. The later phytocenosis was proved also in Soviet Union (Mirkin 1986). Seliskar (1983) has a third approach to this problem, who shows formations with *Wolffia arrhiza* within the association *Lemno-Spirodeletum polyrrhizae* W. Koch 1954, and its sub-association *wolffietosum arrhizae* Segal 1965, respectively, stressing that it is perhaps more logical to classify formations with the domination of duckweed as independent associations *Wolffio-Lemnetum gibbae*, and *Wolffietum arrhizae*, respectively. This is confirmed by the viewpoint of authors who have separated the mentioned communities, and would justify our opinion based on field data and on phytocenologic separation of macrophytes of the alliance *Lemnion minoris* according to Runge and Mirkin, respectively. However, Soó (1973) gives the name *Wolffietum arrhizae* as a synonym for the ass. *Wolffio-Lemnetum gibbae* in the syntaxonomic survey of vegetation units for Hungary, that points to some new moments. Evidently, in the sense of classification, there are still some problems to be solved. The latest data for the Hungarian part of Tisza (Szalma and Bodrogekőzy, 1985) indicate that the community *Wolffietum arrhizae* was found in a backwater in the area of the village Bokros, as well.

Regardless to all above stated, to the adequacy of nomenclature, or giving some other names the community, the question belonging to an alliance is still pending. Namely, viewpoints differ in the phytocenological separation of the order *Lemnetalia* (*Lemnetea* class). The majority of authors classify phytocenoses with duckweed into the alliance *Lemnion minoris* (Hulina, 1973; Runge, 1980; Mirkin, 1986; Parabucski et al., 1986; Topic, 1989; and others). To the contrary, Slavnic (1956) describes the ass. *Wolffio-Lemnetum gibbae* within the newly separated alliance *Lemnion-Salvinion natantis* Slavnic 1956, which he gives a synonym: *Hydrocharition* (Rubel) Vierch p.p. This is not in accordance with the classification of Soó

(1973), who differentiates the communities of alliance *Lemnion* and the communities of the alliance *Hydrocharition* in the order *Lemnetalia*, adding also a new alliance *Ceratophyllion*.

In the Regional park "Stari Begej" (Fig. 2.), in Vojtina mlaka and on three other localities in the floody area between the embankment and Stari Begej, formations of the smallest flowering plants developed: *Wolffia arrhiza*, *Lemna minor*, *L. trisulca* and *Spirodela polyrrhiza*. Considering this, it can be said that communities are in question from the alliance *Lemnion minoris* W. Koch et Tx. ex. Oberd 1957.

Comparative analyses of these formations with those of communities *Wolffio-Lemnetum gibbae*, *Lemno-Spirodeletum polyrrhizae wolffetosum arrhizae* and *Wolffietum arrhizae* made in Yugoslavia, Hungary and Mid Europe within the same alliance, has shown that they are nearest to the last phytocenosis. This suggests in a way all the above stated and that some species found by Slavnic (1956) in the ass. *Wolffio-Lemnetum gibbae*, in the area of Vojvodina are now missing. Although Slavnic has recorded the mentioned phytocenosis in shallow, warm swamps in Vojvodina, getting dried-off in the most part of the year, being similar to those in the floody region of Stari Begej, after the regulation of the water regime, certain differences were nevertheless ascertained.

These differences were getting bigger due to high air temperatures in the recent years.

The formations of ass. *Wolffietum arrhizae* recorded in the vegetation of Regional park "Stari Begej", were of a poorer floristic composition (total of 4 species). As their edificator, we distinguished *Wolffia arrhiza* (duckweed), present in all formations with a maximum abundance and coverage. A sub-edificatory role belongs to *Lemna trisulca*, a species having cosmopolitan spread. It is at the same time a characteristic species of the alliance *Lemnion minoris*. Of the same importance are *Lemna minor*, and only in some formations *Spirodela polyrrhiza*. The mentioned duckweed (*L. trisulca*) in a specific way lives in a place, which by Jankovic (1974) was marked as a phenomenon of pseudo-floating. As a submersive plant, completely submerged in water below its very surface, it looks like a floating plant. By its mass and density, it is influencing the physiological processes in the deeper layers of water. Such a layerwise arrangement is the result of specific ecological features of these sciophyllous, and floating above them, heliophyllous species. *Lemna gibba* is completely absent also from these formations as well as from ass. *Wolffietum arrhizae* from Mid Europe (Runge 1980). This relates also to the aquatic vegetation of stagnant tributary around the

river Mura (Seliskar 1983). It is interesting that these relatively distant formations from Slovenija (Pomurje) are identical with the investigated formations in Banat.

Comparison with the formation of ass. *Wolffio-Lemnetum gibbae* (Slavnic 1956) indicates considerable differences. Slavnic records a total of 13 species in phytocenological table, among which there are all the four plants ascertained by us in the ass. *Wolffietum arrhizae*. However, their importance and coverage values indicate some specificities. In contrast to the analyzed, almost homogenous formations in the community *Wolffio-Lemnetum gibbae* (Obrovac, Kacki rit, Petrovaradin-Karlovi marsh, Galad between Kikinda and Basaid - according to Slavnic) dominant species is *Lemna minor*, while co-dominants are: *L. gibba* (connected only with this ass.) and *L. trisulca*. The first one was ascertained with a IVth grade constancy (1-5).

All three duckweeds are very important both floristically and physiognomically.

Characteristic species for the community is also *Wolffia arrhiza* (III<sub>3,4</sub>), however Slavnic mentions this cosmopolitan only as inclined to this phytocenosis.

The species of the alliance *Lemnion minoris* are well represented. Beside already mentioned species of the genus *Lemna*, both characteristic species of the association appear as well.

*Salvinia natans*, and taxons of special importance for the order *Lemnetalia minoris* as well (*Ceratophyllum demersum*, *Myriophyllum spicatum* and *Hydrocharis morsus-ranae*), are of differential character in relation to the formations ascertained in the investigated Regional park "Stari Begej". There are in this sense accompanying plants of high size: *Phragmites communis*, *Polygonum amphibium*, *Glyceria aquatica* and *Rumex limosus*.

Slavnic (1956) ascertains these mentioned formations of small aquatic flowering plants always near places covered with reeds or inside them. On floody terrains around Stari Begej, we rarely met duckweed near reeds. It mostly lives on places of spread shallow waters, under lonely willows, most frequently next to formations of ass. *Sparganio-Glycerietum fluitantis*.

Comparative analyses of ecological indexes (Tab. 1) according to Landolt (1977), between the analyzed phytocenosis and ass. *Wolffio-Lemnetum gibbae* Slavnic 1956, indicate some differences. They are not significant and refer to the presence of organic matters and light factor index. The formations in Stari Begej, compared with the habitat of floating flowering plants recorded by Slavnic, have less nutritive material, especially

nitrogen (N= 2.75:3.46), while the influence of light is more expressive (L= 4.20:3.76) so that these formations are rich with heliophytes. No species living in sodic habitats were recorded either in the communities of Regional park "Stari Begej". Halophytes are poorly represented in the formations by Slavnic, since he in fact describes the vegetation of shallow salt marshes. In the investigated area of Stari Begej and Carska bara, the analyzed formations were formed by tiny floating flowering plants, for which Landolt does not give indexes for the quantity of humus in the substrate and data about the dispersion of ground, what is understandable considering their ecomorph. For that reason, these rows are empty in the 1st column of table. To the contrary, also plants of high size are present (*Phragmites communis*, *Glyceria maxima* and others) in the vegetation of shallow warm marshes in Vojvodina (according to Slavnic), that is why the humus content index is 3.00. Question about plants living on waterproof, very compact soil (particles smaller than 0.0002 mm) is very proved by the dispersion value of 4.85. It is evident that this abiotic factor has no importance on the appearance and survival of floating macrophytes in the waters of Regional park "Stari Begej".

Tab. 1. Comparative survey of ecological indexes according to Landolt (1977).

Index	Ass. Wolffietum arrhizae (Stari Begej Carska bara)	Ass. Wolffio- Lemnetum gibbae (Vojvodina)
F	5	4.92
R	3	3.30
N	2.75	3.46
H	-	3.00
D	-	4.85
S	-	11 (-), 2 (+)
L	4.20	3.76
T	4.20	4.23
K	2.50	2.54

Regarding life forms, there are some differences which are in correlation with the floristic structure. All the species of the analyzed phytocenosis belong to the aquatic floating and pseudofloating plants, while also heliophytes appear in the formations of ass. *Wolffio-Lemnetum gibbae*. This has an essential reflection on the values of ecological indexes.

The similarity index according to Sørensen between the analyzed communities in the Regional park "Stari Begej" and: - *Wolffio-Lemnetum gibbae* (Vojvodina: Slavnic) = 47.05%; - *Wolffietum arrhizae* (Kopács meadow: Topic) = 61.53%; - *Wolffietum arrhizae* (Hungary:

Szalma) = 66.66%; - *Wolffietum arrhizae* (Mid Europe: Runge) = 66.66%

These percentages confirm the accuracy of the above stated assertions.

## Conclusion

The latest investigations of Carska bara, Vojtina mlaka, including the riverbed of Stari Begej and low parts flooded by it, show that also the formations of smallest flowering plants: *Wolffia arrhiza*, *Lemna minor*, *Lemna trisulca*, *Spirodella polyrrhiza* and others are developed in the Regional park "Stari Begej". Formations of association alliance *Lemnon minoris* W. Koch et Tx. ex Oberd 1957, of the order *Lemnetalia* W. Koch et Tx. ex Oberd 1957, from the class *Lemnetea* W. Koch et Tx. ex Oberd 1957 are in question.

The comparative analyses of these formations with the formations of *Wolffio-Lemnetum gibbae* Bennema 1943, *Lemno-Spirodeletum polyrrhizae* W. Koch 1954 *wolffietosum arrhizae* Segal 1965 and *Wolffietum arrhizae* Myawaki et J. Tx. 1960, ascertained in Yugoslavia and Mid Europe within the same alliance, has shown that they are closest to the last phytocenosis. However, according to phytocenological literature, the characteristic aquatic vegetation in Vojvodina are the formations of *Wolffio-Lemnetum gibbae* Bennema 1943 (Slavnic, 1956; Parabucski et al., 1986 and others).

Having in mind absence of some species, which were discovered by Slavnic in this phytocenosis of shallow warm marshes in Vojvodina, getting dry for the most part of the year, and the specific ecology of formations in the investigated area (due to reduced intensity of flooding because of regulated water regime of Stari Begej and on the other hand due to exceptionally high temperatures in the recent years), it is evident that the aquatic habitats of Regional park "Stari Begej" are covered by floating formations of the community of smallest flowering plants, which Myawaki and Tüxen described in 1960 under the name *Wolffietum arrhizae*.

## References

- Atanackovic, N. (1958): Prilog flori Backe.-Zbornik za prirodne nauke Matice srpske 14,143-150.
- Babic, N., Parabucski, S. (1971): Prikaz vegetacije Sajkasko. - in: grupa autora = Sajkaska-priroda kraja. pp. 114-139.
- Becarevic, J. (1951): O dolazenju vrste *Wolffia arrhiza* Wimmer u Sremu. - Naucni Zbornik Matice srpske, srija prirodnih nauka 1,226-227.



- Becarevic, J. (1953): O rasprostranjenju nekih mediteranskih vrsta u barskoj flori Vojvodine. - Zbornik Matice srpske, serija prirodnih nauka 4,1-4.
- Blečić, V. (1976): *Lemnaceae* S.F. Gray. In: Josifović M. (ed.). - Flora SR Srbije, Srpska Akademija nauka i umetnosti VIII, 483.
- Bodrogközy, Gy. (1962): Das Leben der Tisza XVIII. Die vegetation des Theiss-wellenraumes I. Zöologische und ökologische untersuchungen in der gegend von Tokaj. - Acta Biol. Szeged. 8,3-44.
- Domac, R. (1973): Mala flora Hrvatske i susjednih područja. - Školska knjiga p. 529.
- Canak, M., Dokic, M. (1968): Ekološka i sistematska pripadnost korova kanala i ribnjaka. - Vodoprivredni glasnik 51-54,111-132.
- Canak, M., Dokic, M. (1969): Naseljavanje osnovne kanalske mreže Hidrosistema Dunav-Tisza-Dunav vodenim makrofitama. - Letopis naučnih radova Poljoprivrednog fakulteta 13,121-132.
- Canak, M., Dokic, M. (1970): Problemi pri oceni zakorovljenosti hidrofitama. - Dokumentacija za tehnologiju i tehniku u poljoprivredni 8,1-7.
- Canak, M., Stojanović, S. (1963): Karakteristike mulja u barama kraje Velike Morave uz poseban osvrt na vegetaciju i režim poplava. - Letopis naučnih radova Poljoprivrednog fakulteta 7,1-13.
- Gigov, A., Djerfi, B. (1960): Prethodno saopštenje o biljnom pokrivaču Carske bare kod Zrenjanina i njegovoj istoriji. - Zastita prirode 18-19,64-70.
- Ham, I. (1975): Kvalitativni sastav kolonije caplji (Ardeidae) i uticaj pojedinih faktora sredine na njeno formiranje na području Donjeg Begeja u Vojvodini. - Larus 26-28,143-164.
- Hulina, N. (1973): Vegetacija u području Creta u Turopolju. - Acta botanica Croatica 32,171-180.
- Hulina, N. (1989): Prikaz i analiza flore u području Turopolja. - Acta botanica Croatica 48,141-160.
- Janković, M.M. (1972): Ekološka studija problema zaras - civanja vaskavih jezera na Novom Beogradu. - Glasnik Instituta za botaniku Botaničke baste Univerziteta u Beogradu VII,154-195.
- Janković, M.M. (1974): Vodena i mocvarna vegetacija Obedske bare. - Zbornik radova Republičkog zavoda za zaštitu prirode Srbije 1,1-81.
- Janković, M.M., Janković, J.M., Kalafatic, M., Lazarević, M.M. (1988): Ekološki aspekt Savskog jezera kod Beograda (Ada Ciganlija), s obzirom na njegovo ciscenje i sanaciju, a posebno uloga makrofita u eutrofizaciji i zarascivanju jezera. II. - Ekologija 23,65-116.
- Jávorka, S. (1925): Magyar Flóra. - Studium (Budapest).
- Jávorka, S., Csapody, V. (1934): A Magyar Flóra képekben. - Studium, (Budapest).
- Jez, A., Skoberne, P. (1986): Botanične zanimivosti mrtvic ob Muri. - Proteus 7,245-250.
- Josifović, M. (ed.) (1970-1986): Flora SR Srbije, I-X. Srpska Akademija nauka i umetnosti (Beograd).
- Kovács, F. (1929): Óbce határának virágos növényei. (Szeged).
- Kupcsok, T. (1915): Adatok Bács-Bodrog megye déli részének és Szerém megyének flórájához. - Pallas (Budapest).
- Landolt, E. (1977): Ökologische Zeigerwerte zur Schweizer Flora. Offentlichungen der Geobotanischen Institutes der ETH, Stiftung Rübel, 64 (Zürich).
- Lawalrée, A. (1980): *Wolffia* Hork. ex Wimmer. In: Tutin, T.G. (ed.) - Flora Europaea 5, p. 273, Cambridge University Press.
- Mirkin, M.B. (1986): Klasifikacija rastiteljnosti tradicionalnih klasov sistema Braun-Blanquet. Izdatelstvo Moskovskov Univerziteta (Moskva).
- Nejgebauer, V., Zivković, B., Tanasijević, Dj., Miljković, N. (1971): Pedološka karta Vojvodine. - Institut za poljoprivredna istraživanja (Novi Sad).
- Obradović, M. (1966): Biljnogeografska analiza flore Fruske gore. - Matica srpska (Novi Sad).
- Obradović, M. (1978): Retke i reliktno biljke Fruske gore sa biljnogeografskom analizom. - Matica srpska (Novi Sad).
- Parabucski, S., Stojanović, S., Butorac, B., Pekanović, V. (1986): Prodromus vegetacije Vojvodine. - Zbornik za prirodne nauke Matice srpske 71,5-40.
- Parabucski, S., Stojanović, S., Butorac, B., Vucković, M., Pekanović, V., Crncević, S., Boza, P. (1989): Vegetation of the lower Tisza river. - Tiscia, 23,13-19.
- Parabucski, S., Butorac, B. (in press): General review of vegetation in lower course of the river Tisza. - THAISZIA.
- Persin, V. (1988): Rijetke i ugrozene biljke regije Karlovac. - Zemaljski muzej Bosne i Hercegovine. Zbornik referata sa naučnog skupa "Minerali, stijene, izumrl i zivi svijet B i H" 7-8,439-443.
- Prodán, Gy. (1916): Bács-Bodrog vármegye flórája. - Pallas, (Budapest).
- Raus, Dj., Segulja, N. (1978): Prilog poznavanju mocvarne i vodene vegetacije bara u nizinskim sumama Slavonije. - Acta botanica Croatica 37,131-147.
- Runge, F. (1980): Die Pflanzen Gesellschaften Mitteleuropas. - Aschendorf (Münster).
- Seliskar, A. (1983): Prispevek k poznavanju vegetacije razredov Lemneta in Potamogetoneta v Sloveniji. - Biološki vestnik 31 (1),25-34.
- Slavnić, Z. (1956): Vodena i barska vegetacija Vojvodine. - Zbornik Matice srpske, serija prirodnih nauka 28,5-73.
- Soó, R. (1964-1985): A magyar flóra és vegetáció rendszertani-növényföldrajzi kézikönyve, I-VII. - Akadémiai kiadó (Budapest).
- Stojanović, S., Butorac, B., Vucković, M. (1987): Pregled barske i mocvarne vegetacije Vojvodine. - Glasnik Instituta za botaniku i botaničke baste Univerziteta u Beogradu (Beograd), 21,41-47.
- Szalma, E., Bodrogközy, Gy. (1985): Phytocenology of *Wolffietum arrhizae* Myaw. et J. Tx. 60 element content of its species components as well as sediment-and water samples. - Tiscia, 20,45-53.
- Topić, J. (1989): Vegetation of the Special Zoological Reserve of Kopacki rit. - Hydrobiologia 182,149-160.
- Trinajstić, I., Pavlarić, Z. (1988): Flora ornitološkog rezervata Krapje Djol u Hrvatskoj. - Biosistematika 14, No. 1,1-11.
- Vukoje, M. (1979): Vodena vegetacija Petrovaradinskog rita. - Drugi kongres Ekologa Jugoslavije (Zagreb), 1987-1998.
- Vukoje, M. (1982): Nova nalazista vrste *Wolffia arrhiza* (L.) Wimm. u flori Vojvodine. - Rezime referata VI. Kongres biologa Jugoslavije (Novi Sad).
- Vukoje, M. (1983) 1986: Makrofitska flora osnovne kanalske mreže u Vojvodini. - Zbornik radova sa naučnog skupa "Covek i biljka", Matica srpska 539-545.
- Wilmann, S. O. (1973): Ökologische Pflanzensoziologie. - Quelle and Meyer (Heidelberg).
- Zorkóczy, L. (1896): Újvidék és környékének flórája. (Újvidék).
- Zivković, B., Nejgebauer, V., Tanasijević, Dj., Miljković, N., Stojković, L., Drezgic, P. (1972): Zemljista Vojvodine. - Institut za poljoprivredna istraživanja (Novi Sad).