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PHYTOCENOLOGY OF WOLFFIETUM ARRHIZAE MIYAW. ET J. Tx. 60. ELEMENT CONTENT OF ITS SPECIES COMPONENTS AS WELL AS SEDIMENT-AND WATER SAMPLES

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Abstract

At the Hungarian lowlands, at one of the backwaters of the Alpár basin in the Tisza-valley the *Wolffietum arrhizae* plant community is again beginning to spread. At this studied site correlation was demonstrable between the changes in the element contents of the sediment-, water- and plant samples taken within the association. Apart from studing the element content of the water- and sediment samples, the element contents of the community's character species, the *Wolffia arrhiza* (water grits) as well as of the species still occurring at this site in relatively large masses — as the *Ceratophyllum demersum, Potamogeton crispus* and *Stratiotes aloides* — were studied by radiographic fluorescence spectrophotometry (RFS). During the course of analysing the element content of the plant samples it was determined that strongly positive correlation was demonstrable betweens the Fe—Mn elements ($r=0.867$), while weakly positive correlation between the Ca—K elements ($r=0.168$). Both in the case of Fe—Mn, and Ca—K, the correlation between the element content of the sediment and vegetation was weakly negative.

Analysing the obtained results with statistical methods, the element contents of the sediment-water and plant samples were well separable. The mechanism of element-uptale of the certain species and possibly their element-selectivity were well demonstrable within a cenosis during the course of the analysis.

Introduction

There is a large amount of literary data on the phytocenology of water macrophyton cenoses. However, the alimentary types, relations and alimentary dynamics of these species located within communities, the transport processes between sediment-, water- and vegetation have hardly been dealt with; the literary background is scanty in this regard. The questions arise that within a community, how and from where do the certain species take up their nutriment, how does their element transport process develop; as a consequence, what effect(s) do certain biotic and abiotic factors, have on the development or expansion (spread) of various communities? The element content analysis of the phytomass of the suspended and submerse species found in the *Wolffietum arrhizae* community, as well as of the backwater's sediment and water can be regarded as a preliminary step in respect to the processing as such of the associations of the Tisza-valley belonging to the Lemnetea and Potamogetonetea classes, and their smaller units.

Its cenological relations, place in the cenosystematic order is as follows:
Lemno-Potamea Soó 68.
Hydrochari-Lemnetea OBERD. 67.

Hydrocharietalia RÜBEL 33.
Lemnion minoris W. KOCH et TX ex OBERD. 57.
Wolffietum arrhizae MIYAW et J. TX. 60.

The main component of the *Wolffietum arrhizae* community, the *Wolffia arrhiza* (water grits) — as the smallest representative of the macrophyton — is rather widespread regarding its occurence, since in respect to the European spread of this species being of subtropical origin, it could be found at every lowland-area till the North latitude 55° and till the 18 °C isotherm line, (FINTA 1979, PRISZTER 1962, SOÓ 1980, BODROGKÖZY 1982, etc.). Besides Europe, concerning its spread it can also be found in certain areas of Africa, North America, South-West-Asia (LANDOLT 1982).

Materials and Methods

Its cenological and the elements' seasonal studies were started in the years 1983—84 in Alpár basin of the Central Tisza Valley, in the backwater situated at the border of the village Bokros. Due to the dry weather the water depth of the 200 m long, 30 m wide bed section did not exceed 60—40 cm. The water level gradually decreased from July till October. At the studied area the stand's phytomass and the backwater's sediment-and water samples were simultaneously collected in June and October, 1983 and July, September, 1984. Following sample collection the material was analysed in air-dry state. Methods used for sediment studies: the humus content was determined with bichromate (KCr_2O_7) method by photometric evaluation (SZÉKELY 1964). The study of the sediment's physical state was characterized by the restriction number of ARANY. The measurements concerning chemical reaction were performed on the basis of conductivity (BALLENEGGER 1957) and by applying pH gauge.

The element content of the semident- and water samples from the phytomass was analysed with radiographic fluorescence spectrophotometric method (RFS) (BERTALAN 1984); (EMG, RFA, NZA type 8500).

Results

Cenological characterization of the area

On the basis of the phytocenological sampling of the *Wolffietum arrhizae* it could be observed that the stand on the surface of the backwater, which could be considered as typical, closed at the beginning of June. Besides the *Wolffia arrhiza* of dominating character, the species components gaining ground were the *Lemna minor, Lemna trisulca* and *Spirodella polyrrhiza* belonging to the floating reed- grass. Directly alongshore the Wolffia a. formed clear stands with a total covering quota of 90—100%. In the initial phase of the Spring and early Summer aspect the individuals of the *Ceratophyllum demersum, Potamogeton crispus, P. pectinatus* and *Stratiotes aloides* were still observable.

The zonation of the various cenoses developing in such manner was well distinguishable. In the Autumn aspect a vast decrease in the individual number of the *Ceratophyllum, Potamogeton* and *Stratiotes* species was detectable since the spreading of the *Wolffia- Lemna* and *Spirodela* species in thick layer on the water surface created unfavourable light conditions for the submerse plants living in the lower water layer.

Environmental biological relations

On the basis of the environmental biological relations of the backwater channel it could be determined that the rather high restriction number of ARANY (93—94) referred to very fine granular, rather evenly distributed sediment. From the view-

point of aliment supply the sediment's organic matter amount was measured as high (4,13—4,54%) — being characteristic to eutrophized waters. Measured on the basis of conductivity, the salt dynamic of the bottom could be regarded as turning into solonchak. The sodium salts — searching for their origin regarding accumulation in the sediment — presumably came from the cast-ground meadow circumscribing (surrounding) the backwater's environs, becoming turning into solonetz — on the basis of their vegetation. Seasonal changes were detectable in respect to the pH values of the sediment and the water sample (Table 1).

Table 1

	Humus	Total salts	Restriction no. of Arany	pH
	%			
Sediment sample:				
I. (VII. 14.)	4,13	0,14	93	6,22
II. (IX. 6.)	4,21	0,14	94	6,32
III. (X. 16.)	4,54	0,16	93	7,11
Water sample:				
I. (VII. 14.)				7,62
II. (X. 16.)				8,25

The analysis of the element content of the sediment — water and plant samples was carried out with radiographic fluorescence spectrophotometric method (RFS) from simultaneously collected sediment-water and plant samples. The peaks of the analysed elements Si, P, S, Cl, K, Ca, Ti, Mn, Fe, Sr — deriving from the method — appeared in order of succession with the increase in stimulus. The place of appearance and height of the various peaks were characteristic of the element and its quantitative

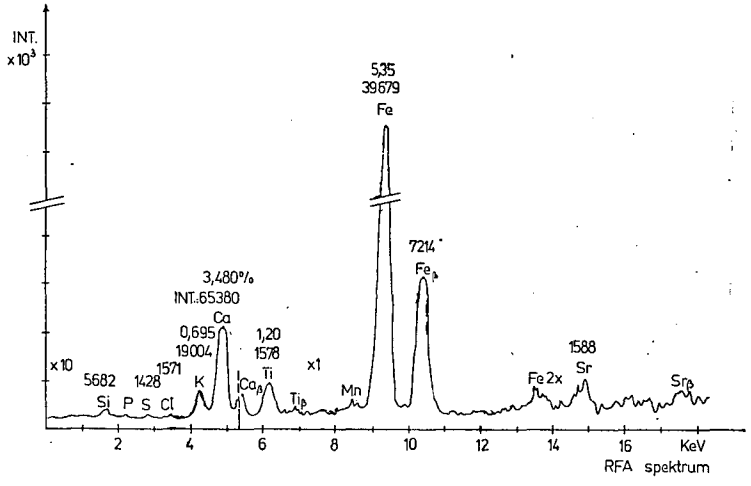


Fig. 1. RFS analysis of the sediment sample of *Wolffietum arrhizae* community. The percental value of the various elements could be determined from the calibration straight line drawn on the basis of the measured integral (INT.) value

Table 2. *Rlysis RFS analysis of the sediment-, water- and plant samples of the Wolffietum arrhizae communitv*

		K	Ca	Mn	Fe %
Potamogeton crispus	(1)	2,1205	3,310	1,500	0,742
Wolffia arrhiza	(2)	2,105	3,385	2,050	1,015
Sediment sample	(3)	0,695	3,480	1,020	5,350
Stratiotes aloides	(4)	3,540	3,380	1,340	0,357
Ceratophyllum demersum	(5)	2,280	3,420	1,830	0,695
Water sample I. (VII. 14.)	(6)	0,755	8,025	0,830	0,085
Water sample II. (X. 16.)	(7)	0,721	8,035	1,020	0,005

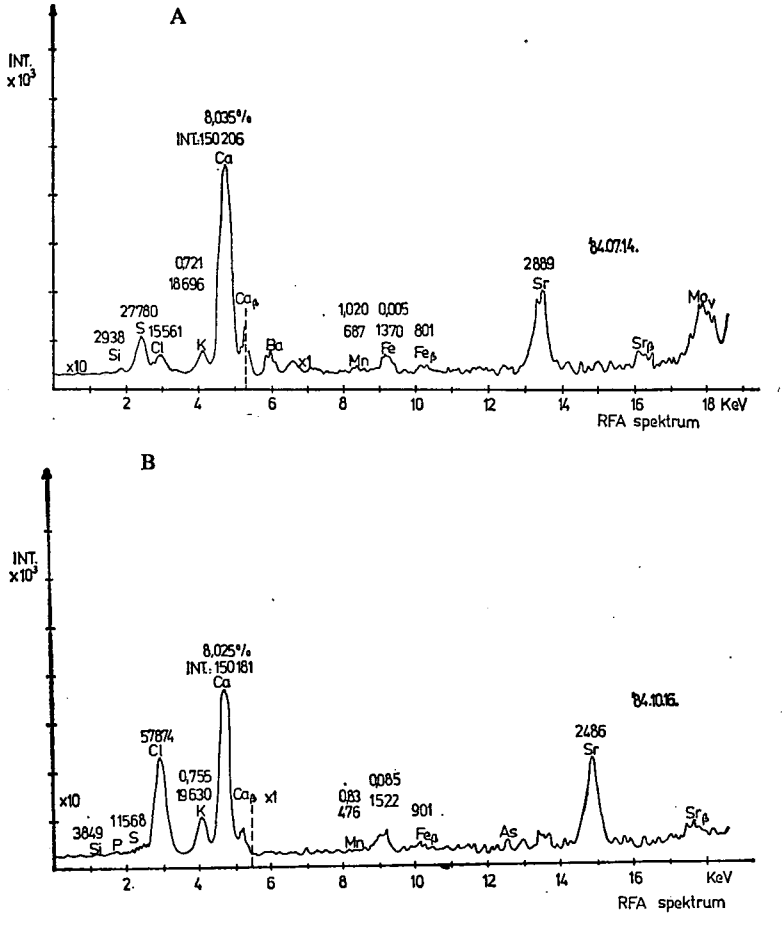
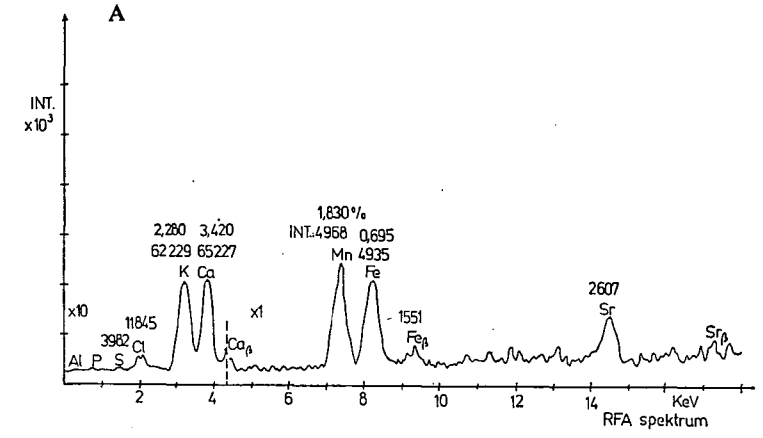
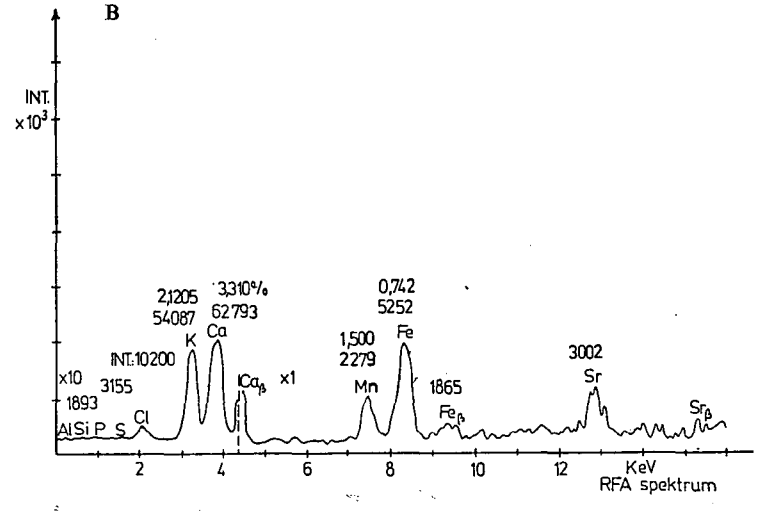
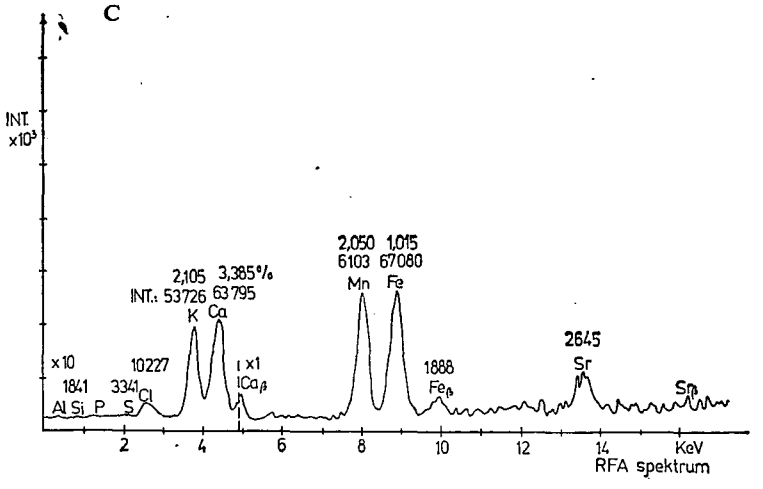


Fig. 2/A. RFS analysis of the water sample I. taken from *Wolffietum arrhizae* community. 2/B. RFS analysis of the water sample II. of *Wolffietm arrhizae*


A
INT.
x10³
2,280 3,420
62229 65227
K Ca
1,830%
INT.4968 0,695
Mn 4935
Fe
2607
Sr
x10
11845
3982
Cl
x1
Caβ
1551
Feβ
Srβ
Al P S
2 4 6 8 10 12 14 KeV
RFA spektrum


B
INT.
x10³
2,1205 3,310%
54087 62793
K Ca
0,742
5252
Fe
1,500
2279
Mn
3002
Sr
INT.10200
x10
3155
1893
Cl
Caβ
x1
1865
Feβ
Srβ
Al Si P S
2 4 6 8 10 12 KeV
RFA spektrum


C
INT.
x10³
2,050 1,015
6103 67080
Mn Fe
2,105 3,385%
INT.: 53726 63795
K Ca
2645
Sr
x10
1841
10227
3341
Cl
x1
Caβ
1888
Feβ
Srβ
Al Si P S
2 4 6 8 10 12 14 KeV
RFA spektrum

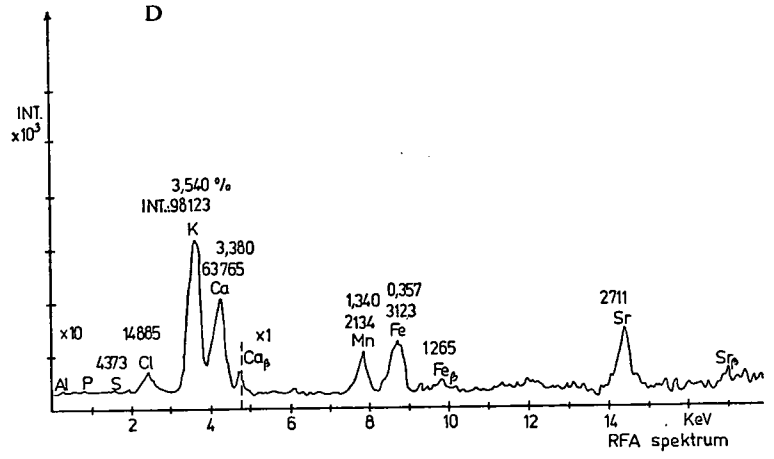


Fig. 3. RFS analysis of the plants *Ceratophyllum demersum* (A), *Wolffia arrhiza* (B), *Potamogeton crispus* (C) and *Stratiotes aloides* (D)

data. The study results of the element content of the sediment's water and vegetation were the followings. Rather high (5,35%) Fe, and relatively low Mn (1,020%) amount was measured from the sediment. The appearance of such trend of iron is natural both in the soil and in the sediment. Besides this the appearance of titanium was only characteristic of and demonstrable in the sediment, its role in the case of plant element transport was not significant. Strontium was measured in minimal amount in the sediment (Fig. 1).

The seasonal changes of the element content of water samples taken on several occasions could be followed. Besides outstandingly high Ca-content, high S-content characterized the element content of the water at the beginning. Later on, from the occuring elements the sudden increase of chlorine could be detected. Minimal increase could be observed in the case of K and Fe, while decrease in value could be found for S, Ca and Mn, Sr. Attention was called to As, which appeared in the later water sample, not being found earlier neither in the sediment, nor in the water (Fig. 2/A, B.)

The summarizing results of the RFS analysis of the elements are comprised in Table 2, in respect to K, Ca, Mn and Fe.

As the first step of the path leading to the observation of the relations and development of the vegetation's element content. The element content analysis of the *Wolffietum arrhizae* community's species was performed in the case of the *Potamogeton crispus, Ceratophyllum demersum, Wolffia arrhiza* and the *Stratiotes aloides.*

According to our results slightly positive correlation ($r=0,168$) was observable between the plants in the case of K—Ca, while strongly positive correlation ($r=0,867$) could be found for Fe—Mn.

Studying the element content of two plants, the *Ceratophyllum demersum* and the *Wolffia arrhiza,* strong similarity could be observed regarding their values considering the ratio of K, Ca, Mn, Fe and Sr. From the plants, the *Wolffia* accumulated higher amount of Mn and Fe. In the case of *Potamogeton crispus* lower Ca, Mn and Fe concentration was measured, as compared to the previous species, while the maximum of the Sr content measured in the plants was found here. The joint participation of Ca and Sr in high percentage has been experienced by authors

earlier, too, in other, also *Potamogeton* species. During the course of the analysis of element contents of the *Stratiotes aloides* the great accumulation of potassium was striking (3,54%), while the Fe and Mn values were the lowest here from all the studied plants.

On the basis of the measurements it could be determined that the plants accumulated potassium, magnum and strontium from the environment, while they repressed the uptake of iron, calcium and chlorine. The correlation between the element contents of the sediment and vegetation was weakly negative (r=0,194) both in the case of Fe—Mn and Ca—K (Fig. 3/A, B, C, D).

Tight connection could be found between the development of the sediment's water- and plant element content, the development of which connection is natural (FELFÖLDY 1979, HUTCHINSON 1975). The evaluation of the relationships between these were performed with classification (FEKETE 1981).

As the result of cluster-analysis, on the basis of the dendogram it could be determined that three separate groups could be distinguished (1 5 2) (3) (6 7). On the basis of their separable element contents the vegetation (1 5 2 4), the water (6 7) and the sediment (3). The similarity value was the highest for the water samples taken at two different periods (0.983). From the viewpoint of similarity value correlation was found between three plants; *Potamogeton crispus* (1), *Ceratophyllum demersum* (5) (0.959) and *Wolffia arrhiza* (2) (0,949). The *Stratiotes aloides* (4) differed from these with a lower similarity value (0.855), well supporting the assumption that the element transport of the plants shown on the dendogram (1 5 2) took place from the water in the case of K, Ca, Fe, and Mn uptake, their similarity values stood the clor sest to each other. Regarding its similarity valus, the *Stratiotes aloides* (4) was smalle-

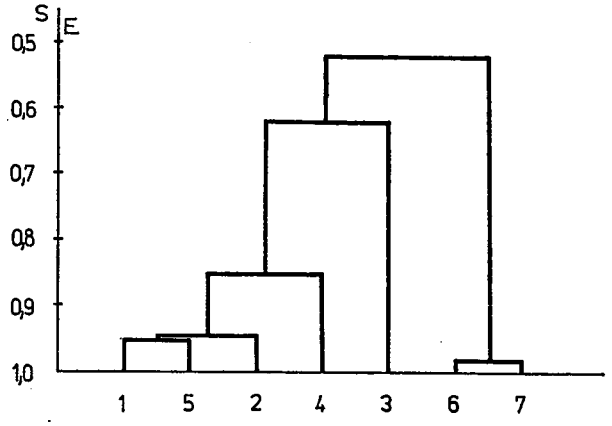


Fig. 4. Dendogram of the sediment, water and plant samples of the *Wolffietum arrhizae* on the basis of the relationship between element content

1. — *Potamogeton crispus*
2. — *Wolffia arrhiza*
3. — Sediment
4. — *Stratiotes aloides*
5. — *Ceratophyllum demersum*
6. — Water sample I.
7. — Water sample II.

than the previous three plants, indicating that element transport could take place both from the water and from the sediment, with the help of the root-system.

It could be determined that on the basis of the dendogram the mechanism of element uptake, and perhaps the element selectivity of the different plant species can well be separated within a cenosis (Fig. 4).

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A Wolffietum arrhizae Miyaw et J. Tx. 60. fitocönológiája, fajkomponenseinek, valamint üledék- és vízmintáinak elemtartalma

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Kivonat

A Wolffietum arrhizae társulás cönológiai és elemek szezonális vizsgálatait 1983—84. évben végeztük Bokros község határán elterülő holtágban. Az üledék- és vízminták elemtartalmának vizsgálatán túl a társulás karakterfajának *Wolffia arrhiza* (vizidara), és ezen a termőhelyen előforduló fajok, mint a *Ceratophyllum demersum, Potamogeton crispus* és *Stratiotes aloides* elemtartalmának vizsgálatát végeztük el energia diszperzív röntgenfluoreszcencia spektrofotometriás (RFS) eljárással. A növényminták elemtartalmának analízise során megállapítható volt, hogy a Fe—Mn elemek között erősen pozitív korreláció, (r=0,867), míg gyengén pozitív korreláció volt kimutatható Ca—K elemek között, (r=0,168). A növények a környezetből a kálciumot, mangánt és stronciumot akkumulálják, míg a vas, kálium és klór felvételét visszaszorítják. Statisztikai módszerrel elemezve az eredményeket, az üledék-, víz és növényminta elemtartalma egymástól jól elkülöníthető. Egy cönózison belül az egyes fajok elemfelvételi mechanizmusa, esetleg elemszelektivitása az analízis során kimutatható volt.

Фитоценология содержание элементов видовых компонентов, подонков, а также водных образцов Wolffietum arrhizae Miyaw. et J. Tx. 60.

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Резюме

Изучение растительных сообществ и сезонных элементов *Wolffietum arrhizae* были проведены в 1983—84 годах в старице реки Тисы вблизи села Бокрош. Кроме изучения подонка и видового состава водных растений было проведено также изучение состава ассоциации *Wolffia arrhiza*, а также другие произрастающие здесь растения: *Ceratophyllum demersum*, *Potomageton crispus*,. *Stratiotes aloides* Исследования проводили при помощи дисперсионной энергии, рентгенофлюоресценции и спектрофотометрического метода (RFS). При анализе растительных элементов установлено, что между элементами Fe—Mи существует значительная корреляция (P=0,867), более сниженная позитивная корреляция возникает между Ca—K элементами (P=0.168). Растения аккумулируют из окружающей среды калий, манган и стронций, причем аккумуляция железа, кальция камищелья калих.

Анализируя статистическим методом полученные результаты приходим к выводам, что содержание элементов подонка, воды и растений от себя далеко отделяются. Внутри растител содержание элементов подонка, воды и растений от себя далеко отделяются. Внутри растительных сообществ при анализе хорошо освещается механизм приема элементов отдельных видов, пожалуй также селекционности элементов.

Fitocenologija i sadržaj elemenata u biljkama, uzorcima vode i sedimentima zajednice Wolffietum arrhizae Miyaw. et J. Tx. 60.

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Abstrákt

Ispitivanja cenotičkih odnosa i prisustva elemenata u zajednici *Wolffietum arrhizae*, vršena su u sezonskom aspektu u toku 1983—84. godine, u mrtvaji na području sela Bokros. Pored utvrdjivanja prisustva elemenata u uzorcima sedimenata i vode ispitivane zajednice, analiza je izvršena i na karakterističnoj vrsti ove zajednice *Wolffia arrhiza*, kao i na ovom biotopu prisutnim vrstama: *Ceratophyllum demersum, Potamogeton crispus i Stratiotes aloides*, rentgenfluorescentno-špektrofotometrijskom metodom, na bazi disperzije energije. Na osnovu analize uzoraka sadržine elemenata u biljkama, utvrdjeno je, da je izmedju elemenata Fe—Mn pozitivna korelacija jaka (r=0,867). I izmedju elemenata Ca—K se javlja još slaba pozitivna korelacija (r=0,168). Biljke iz sreidin akumuliraju Ca, Mn i St, dok primanje Fe, K, i Cl potiskuju. Sadržaji elemenata, uzorkovanh iz sedimenata, vode i biljaka, jasno se odvajaju pri statističkoj analizi. Pri analizi utvrdjen je mehanizam selektivnog primanja elemenata od strane pojedinih vrsta date biocenoze.