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TAXONOMIC AND ECOLOGICAL COMMENTS RELATING MACRO- AND MICRO-ELEMENT CONCENTRATIONS IN PLANT SPECIES OF INUNDATION AREA

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Summary

13 elements in 45 samples of 41 plant species grown on the middle reach of Tisza at Abádszalók were analysed. It were observed some taxonomic correlations and some accumulating species were recognized. It was established that the vegetation contains no toxic concentrations of the investigated elements although the zinc contents is a multiple of the average of the Hungarian flora. Consequently the hay from the inundation areas is very suitable to complete field grown fodder plants with low zinc contents.

During the chemical analysis performed by authors and coworkers always succeded to obtain some general rules. Such evaluations were published about the vegetations along the rivers Zala (TÖLGYESI and KÁRPÁTI 1977), Danube (KOZMA and TÖLGYESI 1979), and Tisza (KOZMA and TÖLGYESI 1979). Here report will be given about an inundation area of the Tisza (at Abádszalók) the vegetation of which was already surveyed on the XI[th] Conference about Tisza-Research (KOZMA and TÖLGYESI 1980). 45 samples including 41 species were investigated with methods described in earlier publications. In the first line ion-selectivity of plants living in the same biotop will be described in connection with concrete examples. For the practice mineral contents of the hydrophilous and hygrophilous vegetation along this reach of the Tisza will be explained and compared to other meadows of inundation area in Hungary. These data can be utilized in plant cultivation, feeding and environment conservation.

Taxonomic correlations

Data of chemical composition in Table 1. relate in the case of herbaceous plants to the whole overground part while in the case of lignous plants to a 35 cm long leafy twig.

It can be established that family Gramineae is characterized by low Ca, Mg, Cu and B contents. Latter character can generally be observed on dry habitats as well (TÖLGYESI and KOZMA 1974). The same characters separate the so called acidic grasses (Cyperaceae, Juncaceae, Typhaceae) from the dicotyledons. Their high manganese contents separates them at all events. Average concentration of all the species is 88.3 mg per kg while *Carex vesicaria* contains 725 ppm magnanese. Great differences in manganese uptake between the species is characterized by a variance coefficient of 167 per cent. Manganese is very suitable for taxonomic separation; on the investigated area which was less than one hundred square metres its concentration varied between 13 and 725 ppm. If also hair-weeds and other aquatic plants had been investigated, the highest manganese contents would attain 40 000 ppm. While variance coefficient of the macro-elements potassium and magnesium is relatively low (28 per cent), that of sodium which on the basis of its general occurrence may be considered as a meso-element is high (78 per cent). It is interesting that some species with high manganese concentration contain high sodium concentration as well. This correlation is significant; according to data of Table 2. it can be characterized by a correlation coefficient of 0.59. For these species during evolution a good sodium and manganese supply was assured by salt accumulation and reductive environment in the wet soil.

Variance of sulfur concentration (average 3.55 g per kg) is 53 per cent. In general, species rich in sulfur are rich in calcium, phosphorous, boron, and copper as well which is shown by significant correlation coefficients. *Xanthium italicum* and *Sium latifolium* proved to be sulfur-accumulants in earlier investigations too, while *Rorippa austriaca* as a member of the family Cruciferae has a higher sulfur contents than the average value — as it was expected.

Between extreme values of iron and aluminium the differences are thirteenfold and variance is also high: 59 per cent and 71 per cent respectively. Taxonomix separation is not expressed, only lower iron contents of the monocotyledons might be mentioned.

Molibdenum contents in Fabaceae is 1.10 ppm in average, definitly higher than that of the whole collections: 0.64 ppm in average. The difference is more expressed when compared with the average value 0.35 observed in the 21 samples of dicotyledons (Fabaceae excepted).

Higher copper concentrations were consistently observed in the species of Compositae and Labiatae. It must be mentioned the high (20.6 ppm) copper contents of *Alisma plantago-aquatica*, a value rarely observed among monocotyledons. This is the consequence of the biochemical habitus and not a result of a contamination. The average copper contents (9.9 ± 4.1 ppm) corresponds to the average value observed in Hungary.

One of us earlier reported the prominent zinc accumulation in the Salicaceae: the same was observed here in *Populus* and *Salix*. Species of the genera *Lycopus* and *Lythrum* occurring on the inundation area were registered as new zinc accumulating plants. Revising earlier collections these species proved to be leading in this respect inside other associations. Uptake of zinc can be connected with the uptake of three other elements (Ca, Mg, Fe) only while copper kalcium, boron, and phosphorous uptake showed parallel changes with eight-eight other elements.

Ecological notes

Zinc contents observed on the inundation area of Abádszalók is significantly higher than the average value (36.9 ppm) of the 54 families of the Hungarian flora (TÖLGYESI, in preparation): in the 45 samples in average 75.8 ppm zinc was found. Is this characteristic on the Middle-Tisza? To answer the question the Compositae species were examined. In the recent collection the Compositae show an average value of 83 ppm; earlier in the same family in Tokaj 73 ppm, in Tiszasüly 108 ppm, in Tiszafüred 65 ppm, and in Nagykörű 94 ppm average values were observed. It can not be stated that there exists an "anomaly"; if it exists, it concerns a longer reach. On the Upper-Tisza in Hungary TÖLGYESI found in 14—16 June 1978 in Tivadar 36 ppm, in Gergelyiugornya 43 ppm, in Vásárosnamény 53 ppm, and in Tiszaszalka 85 ppm average zinc contents. This is lower than the values observed on the middle reach of the river. It should be sampled a greater area within a short time to discover possible industrial contamination. Such a surveying should be extended, however, to the affluents as well. Due to shortage in capacitity in collecting and analysing it would be necessary to restrict to some indicator plants. E.g. between copper contents in 21 samples of *Alisma plantago-aquatica* and copper contents of soil extracted according to Weterhoff a significant correlation was found (n=21, r=0.44). It could be attempted to use the zinc-accumulating capacity of the *Lycopus* and *Lythrum* species as well.

It can be established that on the area investigated plant nutrients occur in abundance. Mineral nutrients concentration in herbaceous plants is equal to that whiches may be considered as ideal. Abundant water supply and availability of nutrients is only one cause of this phenomenon; among others low calcium contents make possible uptake of manganese, zinc (and partly boron as well) with a higher efficiency. On the other hand the low organic matter accumulation (as contrasted to meadow soils) collects only moderate or sufficient quantity of molibdenum. Thus no excess of molibdenum or too small Cu per Mo ration injurious for phytophagous mammals occur.

From the stand-point of podder-chain very favourable composition is accompanied by high dry-matter production. All species are represented by big, virulent individuals. This is a rare and lucky coincidence of qualitative and quantitative indexes. While on alkaline soils high mineral contents of the vegetation is combined with low production, the field grown fodder plants shows a low (only in this ecosystem observable) contents of meso- and micro-elements. Favourable development of wild mammals in the forests of inundation area supports authors' observations. According to authors' supposition mineral constituents taken up by the grasses of the inundation area is only a fragment of the quantity which reaches the biotop by overground and underground water currents. Gathering hay of these biotops one part of the nutrients leaked from agricultural soils might be recuperated. The hay from the inundation areas is indispensable in feeding cattle. Corn silage contains only half while the vegetation of Abádszalók the double of the standard zinc concentration (40 ppm). Steady use (elimination) of the vegetation produce not only fodder rich in nutrients but at the same time "detoxify" the biotop. Thus heavy metals (useful in small quantities) can not accumulate excessively and can not disturb the balance of the ecosystem.

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Taxonómiai és ökológiai észrevételek ártéri növényfajok makro- és mikroelem koncentrációjával kapcsolatban

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Kivonat

A Tisza középső szakaszán, Abádszalók mellett az ártéren gyűjtött 41 növényfaj 45 mintáját elemezték 13 elemre. Megállapitottak néhány taxonomiai összefüggést. Felhívják a figyelmet néhány akkumuláló fajra. Megállapították, hogy a növényzet a vizsgált elemekből nem tartalmaz toxikus mennyiségeket, bár a cinktartalom többszöröse a magyar flóra átlagának. Ezen tulajdonsága alapján a hullámtéri széna igen alkalmas a kis cinktartalmú szántóföldi takarmánynövények kiegészítésére.

Taksonomska i ekološka zapažanja koncentracije makro- i mikroelemenata na biljkama plavnih stani ta

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Abstrakt

Analiza na prisustvo 13 hemijskih elemenata izvršena je sa 45 uzoraka 41 biljne vrste sa plavnog područja srednjeg toka reke Tise, pored naselja Abádszalók. Utvrdjena je izvesna taksonomska uslovljenost. Ukazano je na nekoliko akumulativnih vrsta. Autori su nadalje utvrdili da od analiziranih elemenata vegetacija ne sadrži toksičnu količinu, mada sadržaj Zn je višestruko iznad proseka u flori Madjarske. Na osnovu ovakvih svojstava seno sa plavnih područja se javlja kao značajna primesa krmnom bilju sa obradivih površina sa malom količinim Zn.

ТАКСОНИМИЧЕСКИЕ И ЭКОЛОГИЧЕСКИЕ ЗАМЕЧАНИЯ ОТНОСИТЕЛЬНО КОНЦЕНТРАЦИИ МАКРО- И МИКРОЭЛЕМЕНТОВ В РАСТЕНИЯХ РАЗВИВАЮЩИЕСЯ НА РАЗЛИЧНЫХ ТЕРРИТОРИЯХ РЕКИ

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Резюме

На различных территориях среднего течения р. Тисы вблизи Обадсалок было собрано 41 вид растений в 45 эксикатах, в которых разузнали и анализировали по содержании 13 элементов. Между которыми обнаружили таксономические взаимосвязи, и подчеркнули некоторые аккумилативные виды.

Было определено, что растения из анализированных элементов не содержат токсические вещества, несмотря на то, что содержание цинка в них гораздо больше среднего содержания цинка венгерской флоры. На основании этого свойства растений, сено заливных лугов может послужить хорошим дополнением к кормовым растениям пахотных земель с малым содержанием цинка.

Table 1. *Composition of plant species collected on the inundation area of Abádszalók on 28 June 1979*

	K	Ca	P	S	Mg	Na	Al	Fe	Mn	Zn	B	Cu	Mo
	g/kg						mg/kg						
Glyceria maxima	18.3	2.8	2.06	1.76	1.72	0.52	45	76	110	31.6	5.3	8.1	0.85
Lolium perenne	15.0	3.2	2.87	3.27	1.32	0.88	60	92	32	33.2	4.9	4.6	2.44
Poa palustris	16.3	2.0	1.92	2.29	1.16	0.40	45	63	20	64.0	4.2	5.4	0.45
Poa palustris	14.8	2.0	1.67	1.34	1.44	0.72	48	58	15	16.8	5.5	5.2	0.68
Puccinellia limosa	16.3	1.6	2.77	2.93	1.08	0.40	42	82	42	38.8	3.8	8.9	0.32
Typhoides arundinacea	14.0	2.8	1.33	2.07	1.20	0.36	35	63	29	44.0	5.1	4.2	0.39
Bolboschoenus maritimus	20.8	6.8	1.39	1.76	1.80	1.96	96	100	150	94.0	11.8	13.1	0.55
Carex vesicaria	19.3	3.4	1.65	2.00	1.48	0.48	163	185	725	56.0	8.0	8.6	0.34
Eleocharis palustris	18.3	5.2	1.30	3.05	0.64	0.52	42	68	74	98.0	10.0	5.7	0.47
Schoenoplectus palustris	14.8	5.4	1.40	4.15	1.56	2.92	68	83	600	18.8	10.0	3.5	0.36
Juncus articulatus	18.5	5.4	2.04	4.92	1.68	1.60	317	269	115	92.0	11.8	13.1	1.72
Typha angustifolia	22.7	14.2	1.73	2.02	2.00	2.92	24	35	390	22.0	14.4	5.4	1.29
Typha latifolia	18.8	11.4	2.32	1.87	1.88	0.88	34	54	160	27.6	26.6	6.1	1.11
Alisma plantago-aquatica	21.3	12.8	2.46	3.58	2.44	2.40	90	117	360	66.0	16.6	20.6	0.34
Amorpha fruticosa	12.5	11.0	2.14	2.12	2.00	0.44	63	176	63	38.0	36.7	14.7	1.36
Galega officinalis	18.8	9.8	2.53	3.17	2.16	0.56	76	130	31	60.4	24.1	10.7	1.57
Glycyrrhiza echinata	17.3	13.0	2.80	2.85	1.84	0.56	102	307	42	41.6	24.3	10.9	0.48
Lotus corniculatus	22.8	11.2	2.16	2.37	1.72	1.04	95	130	13	52.0	13.7	9.5	0.43
Melilotus officinalis	16.8	13.4	2.28	3.81	2.44	0.44	59	111	16	39.2	45.0	9.1	0.58
Trifolium campestre	21.5	10.8	2.96	3.49	1.86	0.44	103	149	17	77.2	18.4	9.8	0.49
Trifolium hybridum	24.3	14.2	2.67	2.85	2.44	0.48	104	134	24	74.0	33.2	10.3	1.34
Vicia cracca	16.3	14.4	2.08	2.59	2.08	0.40	90	208	32	117.2	32.7	7.7	3.30
Inula britannica	29.0	13.4	2.82	4.15	2.20	0.52	33	135	29	88.0	41.2	12.5	0.19
Matricaria maritima	23.8	9.2	4.42	3.37	2.20	0.48	210	227	22	68.8	28.1	9.8	0.62
Seneico jacobea	22.3	12.8	5.91	4.80	2.60	0.66	145	189	22	107.2	34.2	13.9	0.58
Xanthium italicum	24.3	27.8	4.89	8.49	3.00	0.56	98	235	34	68.8	85.4	18.5	0.29
Lycopus europaeus	33.3	12.6	3.47	5.86	2.64	0.64	99	193	89	176.0	41.0	17.0	0.49
Lycopus exaltatus	24.0	13.4	2.98	2.85	2.24	0.48	60	388	49	116.0	30.0	16.0	0.66
Stachys palustris	16.8	14.0	2.65	2.39	2.64	0.40	108	359	45	74.0	25.1	10.5	0.49
Oenanthe aquatica	27.3	18.4	4.28	7.85	2.80	1.40	73	324	79	88.0	28.9	14.7	0.42
Sium latifolium	40.0	13.6	3.91	6.49	2.28	1.24	50	73	56	44.8	23.4	13.1	0.40
Lythrum salicaria	16.5	15.8	2.62	0.19	2.64	0.52	121	254	63	172.8	24.1	9.8	0.34
Lythrum virgatum	14.8	12.8	3.26	2.97	2.40	0.40	69	149	31	184.0	22.8	9.5	0.18
Lysimachia vulgaris	16.5	12.4	1.77	2.76	2.36	0.44	65	237	28	31.2	18.1	4.2	0.23
Lysimachia vulgaris	15.8	5.8	1.96	2.15	1.76	0.40	91	141	65	28.0	19.4	7.4	0.27
Rorippa austriaca	15.8	16.0	2.46	5.66	1.64	0.48	196	263	20	88.0	39.9	4.0	0.32
Centaurium pulchellum	21.5	4.9	5.41	4.50	3.87	0.86	281	297	25	105.8		16.5	
Gratiola officinalis	25.8	12.8	2.65	7.12	2.64	1.16	65	465	29	122.4	24.7	13.5	0.43
Rumex crispus	21.8	9.0	2.35	1.90	2.48	0.96	41	76	48	28.4	20.0	6.5	0.44
Plantago major	27.5	28.4	4.22	8.64	2.64	0.48	76	128	20	80.0	30.4	9.8	0.43
Rubus caesius	17.3	10.6	2.62	3.17	2.80	0.44	31	217	36	43.6	32.7	8.6	0.21
Fraxinus pennsilvanica	10.8	8.0	3.64	2.75	2.24	0.48	26	127	18	28.0	23.4	8.0	0.10
Populus canadensis	15.3	9.4	2.92	4.03	2.48	0.48	37	90	23	200.0	30.4	9.7	0.08
Salix alba et fragilis	16.5	17.4	2.26	4.39	2.44	0.40	60	123	67	193.6	33.6	8.6	0.09

Table 2. *Tiszaszalka, 16. June 1978. From inundations and earthwork heavily cut-up surface; samples collected on places with differences*

minimally 6 m

	K	Ca	P	S	Mg	Na	Al	Fe	Mn	Zn	B	Cu	Mo
		g/kg								mg/kg			
Calamagrostis pseudophragmites	18.3	1.4	2.12	1.70	0.64	0.056	98	106	82	26.4	9.4	6.8	0.11
Typhoides arundinacea	21.0	2.2	2.35	2.44	1.00	0.028	10	81	14	23.2	5.0	3.6	0.08
Agrostis stolonifera	24.6	2.6	2.73	2.88	1.60	0.080	374	438	78	28.8	2.2	6.1	0.45
Agrostis stolonifera	27.9	3.6	3.59	4.05	2.24	0.088	344	910	120	38.0	6.5	8.6	0.27
Agrostis stolonifera	23.7	3.2	2.80	2.37	1.56	0.086	324	301	73	25.6	3.4	4.9	0.48
Agrostis stolonifera	19.5	3.0	2.19	2.15	1.60	0.088	578	840	141	16.8	3.8	5.5	0.42
Poa trivialis	18.3	3.2	2.97	2.51	1.24	0.108	510	1190	71	62.0	1.1	9.8	0.22
Poa trivialis	21.0	3.2	2.84	2.12	1.20	0.068	438	518	41	67.2	1.8	7.2	0.21
Poa trivialis	14.4	2.0	1.97	1.61	0.76	0.060	123	158	56	64.4	2.1	5.7	0.18
Phleum pratense	24.6	2.8	2.72	1.8	1.06	0.080	438	546	82	28.4	2.9	5.8	0.70
Phleum pratense	25.2	2.0	2.59	1.51	0.92	0.072	408	470	42	32.0	2.0	5.0	0.29
Agropyron repens	27.3	4.0	3.20	2.98	1.32	0.076	408	568	34	24.8	0.9	7.6	0.44
Lolium perenne	22.2	4.4	2.91	3.07	1.56	0.088	459	910	51	32.0	3.8	6.2	0.51
Festuca pratensis	13.5	3.6	1.79	1.68	0.76	0.036	319	350	32	28.0	3.1	3.1	0.48
Bromus inermis	25.5	3.2	2.93	2.93	1.28	0.040	117	155	25	27.2	3.2	7.4	0.21
Phragmites communis	21.0	4.0	2.36	4.44	0.76	0.128	111	172	43	57.2	0.9	7.6	0.40
Festuca pratensis	21.6	2.6	2.24	2.09	1.04	0.036	31	77	36	17.6	2.0	4.4	0.99
Lotus corniculatus	29.4	9.8	3.08	3.24	2.16	0.120	361	966	49	42.5	19.6	8.5	6.10
Lotus corniculatus	25.8	9.2	2.86	2.10	2.32	0.136	366	448	35	48.0	26.1	9.9	2.42
Lotus corniculatus	31.2	13.8	3.38	3.36	2.44	0.152	331	959	68	66.0	16.9	10.4	3.02
Trifolium campestre	16.2	10.6	1.84	2.85	1.64	0.080	586	1225	50	46.0	17.8	7.6	2.29
Trifolium repens	45.0	25.4	7.07	7.03	4.52	0.316	205	1330	170	96.0	29.1	17.1	1.72
Amorpha fruticosa	17.4	8.4	3.57	3.14	2.08	0.072	91	183	20	52.0	16.2	20.1	1.64
Trifolium pratense	30.3	18.6	3.19	3.34	3.72	0.084	246	264	40	66.0	30.2	17.6	2.52
Trifolium pratense	26.7	17.4	2.28	2.12	3.26	0.148	518	609	54	41.2	30.9	13.7	3.13
Vicia sp.	20.4	11.4	2.67	2.39	2.60	0.040	77	155	38	72.0	22.7	6.5	0.92
Rorippa prostrata	25.8	11.0	1.70	6.80	0.64	0.036	93	109	15	36.0	22.7	3.2	0.32
Lepidium ruderale	19.2	9.4	2.42	6.10	1.36	0.092	197	288	19	56.8	16.4	3.7	0.47
Matricaria inodora	23.4	7.8	1.98	2.29	1.80	0.060	145	165	26	35.2	20.1	5.1	0.34
Stenactis annua	28.2	8.8	3.95	3.17	1.40	0.064	438	1120	63	36.0	23.4	8.7	0.27
Artemisia vulgaris	39.0	13.8	3.48	2.49	2.60	0.096	238	372	70	96.8	43.2	29.7	0.[illegible]6
Tanacetum vulgare	34.5	11.2	3.86	2.02	1.62	0.072	408	505	45	44.0	19.4	8.2	0.16
Echynocystis lobata	52.5	16.0	4.84	6.64	3.44	0.184	207	1330	50	60.8	18.0	12.6	0.34
Echynocystis lobata	40.2	13.6	5.44	4.34	3.60	0.164	279	1330	57	48.0	18.1	7.9	1.19
Echynocystis lobata	37.5	15.0	7.07	7.00	3.76	0.148	185	318	42	44.0	14.8	10.3	0.17
Aristolochia clematitis	33.6	11.4	4.13	3.83	2.92	0.048	85	139	46	46.0	22.5	16.0	0.20
Rubus caesius	18.6	9.4	3.20	2.80	3.52	0.064	317	434	40	42.8	22.3	3.6	0.22
Melandrium album	41.7	9.2	2.84	1.29	3.64	0.044	261	473	56	52.8	21.8	7.6	0.16
Salix purpurea	16.2	17.4	2.75	2.93	2.04	0.028	66	152	76	356.0	25.6	9.3	0.05
Salix fragilis	16.8	17.0	2.03	4.78	1.96	0.052	90	190	345	356.0	31.7	7.7	0.05
Salix alba	17.4	15.2	2.18	4.10	2.56	0.064	103	195	31	372.0	33.8	10.3	0.08
Populus alba	23.1	13.6	3.68	4.19	3.00	0.092	99	247	40	316.0	25.4	12.6	0.04
Populus deltoides	20.1	17.0	2.12	2.87	2.64	0.052	41	113	22	608.0	35.8	10.2	0.09
Fraxinus sp.	12.6	11.8	2.08	2.29	1.96	0.048	38	104	13	68.8	20.9	15.9	0.03
Fraxinus angustifolia ssp. *hungarica*	15.9	7.2	2.46	2.24	2.52	0.036	24	88	24	40.0	19.3	18.1	0.13