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ELEMENTARY COMPOSITION OF PLANTS ON THE INUNDATION AREAS OF THE RIVER TISZA BETWEEN TIVADAR AND TISZASZALKA

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Summari

Due to climate of Hungary meagre in rainfall overhelming quantity of meadow hay is produced on the inundation areas along the rivers. Knowledge of occurrence of valuable and toxic components in these hays is therefore very important. Until now concentration of macro- and micro elements in plant species along the rivers Zala (TÖLGYESI and KÁRPÁTI 1977), Danube (KOZMA and TÖLGYESI 1979), and the middle reach of Tisza (KOZMA and TÖLGYESI 1979) are published in detail. Examination of the upper reach of Tisza is essential because conditions on this area serve as comparison in estimation of the reaches of the river which are industrially, agriculturally and communally more burdened. In addition to problems of feeding, environment conservation and soil conservation observation on chemotaxonomy and ecology can be discussed as well. In this way, apart from the circulation of nutrients in the region, regularities commanding general interest may be reviewed: accumulating species, deviations in uptake of elements on the same biotopes, positive and negative correlations in uptake of certain pairs of elements etc. Methods proved to be suitable in the last twenty years were used, so results can be directly compared with earlier data concerning the Hungarian flora.

Materials and Methods

Samples of plants were collected between 14 and 16 June 1978: in the case of herbaceous plants the whole overground part, in the case of ligneous plants a 35—40 cm long leafy twig. From at least 25 g dry matter average samples of each species 7 g were used for chemical analysis. The 123 samples represent 68 species of flowering plants. The elements were determined by atomic-absorption and colorimetric methods after destruction with perchloric acid. In the case of boron and molibdenum incineration pretreatment was used.

Results

From the stand-point of practice the vegetation as a whole makes a good impression (Table 1). In respect of plant physiology and plant cultivation all elements are present in suitable concentrations due to abundancy of mineral nutrients and water as well on the inundation areas. Symptoms of salt-accumulation (Mg, S, Na) or accumulation of heavy metals (Zn, Cu, Mo) does not occur. The composition can be considered as ideal for feeding cattle, except sodium and manganese contents. It should be completed with sodium to 1.7 g per kg and with manganese to 80 mg per kg to be up to standard.

Evalutaing data first a comparison with the average values of 4316 samples of 804 species of 54 families of the Hungarian flora will be performed (TÖLGYESI, unpublished). Important differences can be established only in the concentration of sodium and manganese, both being lower in the species along the Tisza. The low sodium uptake has two causes. The water of the river has a low salt contents and the relatively high relief energy favour more salt leakage than salt accumulation. On the other hand, this material does not include water plants (Hydrocharitaceae, Zosteraceae atc.) and other sodium-accumulating species (e.g. Chenopodiaceae). On the river banks investigated do not occur Cyperaceae and Juncaceae in greater quantities which contain more sodium than other taxa. The manganese contents lower than the average of Hungarian flora may be attributed to the lack of manganese accumulating families Fagaceae, Betulaceae, and Abietaceae and higher water plants the species of which contain sometimes thousandtimes more manganese than the other species found here.

Comparing the data with them of the vegetation of the inundation area of the Danube (KOZMA and TÖLGYESI 1979) no important differences are found in the case of Ca, Mg, Al, and Mn. Along the upper reach of the Tisza the vegetation of the inundation area contains much more potassium, phosphorous, sulfur, iron, zinc and copper than that along the Danube.

This can be attributed to the fact that the Tisza transports weathering products originating from the upper water basin mostly covered with crystalline and vulcanic rocks (PÉCSI 1969) while the Danube runs on greater parts on marine sediments. Molibdenum contents of the vegetation along the Tisza is only a fraction of that of the vegetation along the Danube. The cause of this is not the difference in molibdenum contents of the soils but the difference in chemical reaction of them. Reaction of sediments of the Danube is always alkaline while pH of sediments of the Tisza is 6.0—6.5. Uptake of molibdenum from acidic soils is more difficult. Similar differences due to differences in the quality of rock-bed and differences in chemical reaction were observed in vegetations living on forest soils as well (TÖLGYESI and CSAPODY 1973). Differences in the quantity of dissolved and suspended nutrients can be observed also in relatively short distances in the same river. E.g. TÖLGYESI and KÁRPÁTI (1977) measured in the vegetation of the inundation area on the upper reach of the river Zala a higher zinc and a lower molibdenum concentration than on the lower reach. The cause of this is leakage and accumulation of alkalies and alkaline earths which influence in different ways of the uptake of other elements.

It is important to answer the question wether any gradation of heavy metals indicating pollution can be observed on the areas investigated till now. For this purpose the data of Compositae are summarized. It was established that composites living in the section between Tivadar and Tiszaszalka contain in average 34 ppm zinc and 9.8 ppm copper while on the section between Tokaj nad Nagykörű they contain 89 ppm zinc and 15.2 ppm copper. Although latter values can not be considered as phytotoxic nor as disquieting in feeding, the rise of the concentration of these elements is indisputable. Disclosure of the heavy metal sources and establishment of their sphere of action needs further investigations. Based on recent experiences status quo can be ascertained by high sample density analysis of some ubiquitous species.

Pressed for space results of only one collection are presented in detail (Table 2). From the many possible taxonomic comments only some are mentioned: the low Ca and B contents of monocotyledons, high Mo-concentration in Papilionaceae, zinc accumulation in Salicaceae, intensive sulfur uptake of Cruciferae *(Rorippa, Lepidium)*, etc. Even between closely related taxa definite chemical differences can be observed. E.g. *Agrositis stolonifera* differs from *Poa trivialis* by higher manganese and lower zin contents. The Cu/Mo ration in *Lotus corniculatus* is in average 2.49 while in *Trifolium pratense* it is more than the double: 5.55. Naturally, these characters are observable in other circumstances as well due to the relative constancy of ion uptake of plants (TÖLGYESI 1965).

Mineral nutrition of plants living on the same soil shows correlation depending in the first libe on internal factors. From the 78 correlation coefficients calculated from the elementary composition of 45 samples of Tiszaszalka 33 show significancy (Table 3). Correlations above a value of 0.28 are significant on P=0.05 level while above a value of 0.46 on P=0.001 level. From the interpretable connections positive correlation between alkaline earth ions (Ca—Mg), trivalent cations (Al—Fe) and important anione-forming elements (P—S) can be mentioned.

It is important to know from the stand-point of theory and practice as well, which elements show a higher and which a lower variance on the investigated areas of about one hundred square metres. To illustrate this from data of Table 1. the values of variancy coefficients are grouped according to biotops and elements in descending sequence (Table 4). It is appearent that concentration of phosphorus and potassium slightly depends on specific affiliation, the CV-values are low. In contrast to this taxonomic position of the plants much more significantly influences the concentration of zinc, iron, and molibdenum. Therefore, in the case of low sample numbers only identical or closely related species may be compared. For the present can not be interpreted the lack of expression of the variance of manganese concentration (average CV=52.9) which shows otherwise a very high variability. In general, manganese is one of the most variable micro-elements from standpoint of taxonomy and ecology as well; in the Hungarian vegetation values between 6 and 50 000 ppm (differences of four order of magnitude!) were observed.

Summarizing the most important results it can be established that the vegetation of the inundation areas along the upper reach of the river Tisza in Hungary is rich in nutrients and as fodder it is nearly perfect. Accumulation of heavy metals can be excluded in the time of sampling as contrasted to the earlier investigated lower reaches. Investigations increasing the number of sampled places are continued.

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Table 1. *Average values and standard deviations of plant species collected on the inundation area of the Upper-Tisza on 14—16 June 1978*

site		K	Ca	P	S	Mg	Na	Al	Fe	Mn	Zn	B	Cu	Mo
		g/kg						mg/kg						
Gergelyiugornya	$\bar{x}$	24.3	8.8	3.84	2.53	2.24	0.069	412	567	57.2	43.1	16.6	11.3	0.56
n=14	s ±	4.54	3.85	0.76	0.74	0.74	0.030	130.6	480.1	24.6	19.7	5.34	5.77	0.39
	CV	18.7	43.6	19.9	39.2	33.1	44.7	61.7	8.47	42.9	45.7	32.2	51.2	69.5
Tiszaszalka	$\bar{x}$	25.1	9.1	3.03	3.20	1.90	0.084	248	480	58.3	85.4	16.2	9.27	0.77
n=45	s ±	8.83	5.84	1.18	1.50	1.12	0.052	165.9	395	53.8	119.7	11.6	5.27	1.15
	CV	35.2	63.8	38.9	46.9	59.0	61.9	66.7	82.35	92.2	140.1	71.7	56.9	150.1
Tivadar I.	$\bar{x}$	23.8	9.4	3.62	3.11	2.13	0.060	170.5	300.8	35.0	36.5	11.9	10.3	0.84
n=28	s +	6.00	4.67	0.87	1.50	0.82	0.026	135.5	251	19.5	38.9	6.67	6.12	0.74
	CV	25.2	49.5	24.2	48.1	38.7	44.3	49.5	83.6	55.6	106.8	55.9	59.3	87.9
Tivadar II.	$\bar{x}$	20.5	10.1	2.62	2.98	2.36	0.066	292	380	52.6	33.8	15.3	7.86	0.127
n=23	s ±	4.58	6.00	0.78	1.44	0.99	0.028	186.7	312.7	29	31.2	7.86	2.76	0.03
	CV	22.4	59.6	29.6	48.1	42.3	42.6	63.8	82.2	44.6	92.4	51.4	35.1	101.3
Vásárosnamény	$\bar{x}$	21.5	9.8	2.82	3.02	1.94	0.065	89	153	21	52.6	11.7	7.6	0.64
n=13	s ±	5.34	4.80	1.20	1.70	0.94	0.029	39.5	42.6	6.1	71.3	6.7	3.16	0.22
	CV	24.8	48.9	35.3	56.4	48.2	44.5	44.2	27.9	29.0	135.5	57.4	41.4	34.9

Table 2. *Correlations between contents of mineral-nutrients of samples collected in Abádszalók on 28 June 1979*
(M=45; $P_{0.05}$=0.28)

	Ca	P	S	Mg	Na	Al	Fe	Mn	Zn	B	Cu	Mo
K—	*0.43*	0.11	−0.03	*0.34*	0.19	0.06	0.14	−0.05	0.14	*0.32*	*0.49*	−0.12
Ca—		*0.45*	*0.58*	*0.57*	−0.04	−0.03	*0.33*	−0.20	*0.30*	*0.78*	*0.37*	−0.09
P—			*0.57*	*0.65*	−0.15	*0.31*	*0.34*	*−0.34*	0.25	*0.57*	*0.54*	−0.15
S—				0.03	0.07	0.18	−0.08	−0.13	0.24	*0.51*	*0.46*	−0.14
Mg—					−0.02	0.22	*0.48*	−0.11	*0.36*	*0.67*	*0.58*	0.16
Na—						0.04	−0.15	*0.59*	−0.20	−0.24	0.11	0.08
Al—							*0.45*	0.06	−0.03	0.08	*0.03*	0.17
Fe—								−0.17	*0.31*	*0.34*	*0.45*	−0.03
Mn—									−0.20	*−0.29*	−0.07	−0.03
Zn—										0.23	0.03	0.11
B—											*0.47*	0.09
Cu—												−0.08

Table 3. *Correlations in mineral contents of 45 samples (mostly consisting if different species), each representing individuals of one species on the site of Tiszaszalka in June 1978*

	Ca	P	S	Mg	Na	Al	Fe	Mn	Zn	B	Cu	Mo
K—	0.42	0.74	0.42	0.58	0.62	0.12	0.49	0.07	−0.19	0.28	0.32	0.16
Ca—		0.45	0.53	0.77	0.47	−0.21	0.16	0.22	0.49	0.86	0.51	0.25
P—			0.57	0.63	0.31	0.04	0.47	0.20	−0.11	0.20	0.36	0.07
S—				0.36	0.53	0.24	0.22	0.19	0.14	0.27	0.11	0.0
Mg—					−0.64	−0.06	0.27	0.10	0.20	0.66	0.52	0.25
Na—						0.27	0.66	0.23	−0.11	0.19	0.30	0.40
Al—							0.68	0.12	−0.37	−0.19	−0.17	0.31
Fe—								0.22	−0.27	−0.01	0.03	0.36
Mn—									0.22	0.12	0.02	−0.03
Zn—										0.52	0.14	−0.19
B—											0.56	0.18
Cu—												0.13

Table 4. *Coefficients of variance ordered in decreasing sequence of CV-values from the collections of Upper-Tisza in 1978*

Site		1	2	3	4	5	6	7	8	9	10	11	12	13
Gergelyiugornya		Fe	Mo	Al	Cu	Zn	Na	Ca	Mn	Mg	B	S	P	K
n=14	CV	84.7	69.5	61.4	51.2	45.7	44.7	43.6	42.9	33.1	32.3	29.2	19.9	18.7
Tivadar I.		Zn	Mo	Fe	Al	Cu	B	Mn	Ca	S	Na	Mg	K	P
n=28	CV	106.8	87.9	83.6	79.5	59.3	55.9	55.6	49.5	48.1	44.3	38.7	25.2	24.2
Tivadar II.		Mo	Zn	Fe	Al	Ca	B	S	Mn	Na	Mg	Cu	P	K
n=23	CV	101.3	92.4	82.2	63.8	59.6	52.4	48.1	44.6	42.6	42.3	35.1	29.6	22.4
Tiszaszalka		Mo	Zn	Mn	Fe	B	Al	Ca	Na	Mg	Cu	S	P	K
n=45	CV	150.1	140.1	92.2	82.3	71.7	66.7	63.8	61.9	59.0	56.9	46.9	38.9	35.2
Vásárosnamény		Zn	B	S	Ca	Mg	Na	Al	Cu	P	Mo	Mn	Fe	K
n=13	CV	135.5	57.4	56.4	48.9	48.2	144.5	44.2	41.4	35.3	34.9	29.0	27.9	24.8

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Ártéri növényfajok elemi összetétele a Tisza Tivadar és Tiszaszalka közötti szakaszán

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Kivonat

Öt cönózisból gyűjtött 68 virágos faj 123 mintájában 13 kémiai elemet határoztak meg. Megállapítható, hogy a Tisza magyarországi felső szakaszán a növényzet tápanyagokban gazdag, de toxikus mennyiségű nehézfém mennyiséget nem tartalmaz. A cink és a réz koncentrációja jelentősen kisebb, mint Tokaj és Nagykörű között. Az adatok között számos kemotaxonomiailag is értékelhető összefüggés van. Az azonos módon vizsgált dunai növényzettel szemben jellemzően nagyobb K, P, S, Zn és Cu koncentrációk mérhetők, míg a Mo-tartalom kisebb.

Hemijski sastav biljaka plavnih područja sa deonice reke Tise izmedju Tisza Tivadar i Tiszaszalka

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Iz 5 fitocenoza putem 123 izvršene analize na 68 cvetnica, utvrdjeno je prisustvo 13 hemijskih elemenata. Konstatovano je da je vegetacija na gornjoj deonici reke Tise bogata hranljivim sastojcima, i da ne sadrži toksičnu količinu teških metala. Koncentracija Zn i Cu je znatno niža od one deonici izmedju Tokaj-a i Nagykörü. Medju podacima s^ nalazi veliki broj značajnih i u hemotaksonomskom pogledu. U odnosu sa istom metodom analiziranu vegetaciju Dunava, konstatovana je ve a koncentracija K, P, S, Zn, Cu, dok je količina Mo manja.

ЭЛЕМЕНТНЫЙ СОСТАВ ВИДОВ РАСТЕНИЙ В ЗАПЛАВЕ РЕКИ ТИСЫ МЕЖДУ ТИСА ТИВАДАР И ТИСА САЛКА

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Резюме

В 123 образках, 68 видов цветковых растений, собранных из пяти ценозов, были обнаруи жены 13 химические элементы. Можна констатировать, что на верхнем участке реки Тисы в пределах Венгрии, растительность богата на минеральные элементы, однако не содержит тяжелые металлы, в таком количестве, чтобы оно могло иметь токсическое действеи. Концентрация цинка и меди здесь значительно меньше, чем между Токаем и Надькерю. Среддaнных существует взаимосвязь, которая может быть оценена и хемотаксономически. По сравнению с дунайской растительностью, здесь значительно больше концентрация K, P, S, Zn, и Cu при чем содержание Mo меньше.