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EXAMINATIONS ON PLANTS SOIL AND IN GRASSLANDS OF SOUTH-EAST HUNGARY (FLORISTICAL SUMMARY AND THE VEGETATION OF SAP KURGAN)

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Abstract: The four chosen kurgans are located in the territory of the Körös-Maros National Park (Kántor Kurgan, Bőre Kurgan, Sáp Kurgan, Bökény Kurgan). Silty grasslands of Hungary represent the westernmost occurences of East-European silty grass steppes. Generally they are the typical associations of areas with high fertility chernozem soils. At the same time, soil researches showed that the first sampling area (Kántor Kurgan) rises from a chernozem surrounding, the second one (Bökény Kurgan) from an area with meadow soil (Vertisol), and the third one (Bőre Kurgan) from a solonetz sodic area. Kurgans proved to be the most appropriate sampling areas, on the slopes of which two silt steppe associations change with a sharp boundary.

Introduction

Detailed exposure of the loess vegetation belongs to ZÓLYOMI (1936, 1958). The floristical and phytocoenological relevé of the southern regions beyond river Tisza was also carried out by him. In the field of loess grassland research, several scientists have published outstanding results in recent times (KERTÉSZ 1992, 1996a, 1996b, CENTERI and MALATINSZKY 2005, MALATINSZKY 2005). KAPOCSI et al. (1998) enriched our knowledge on the loess grassland residues of the Körös-Maros National Park with new floristic data, and valuable information were published on the dominant grass species of the territory (PENKSZA et al. 1998). PENKSZA and KAPOCSI (1998) presented the latest floristical data along river Maros, and they highlight the Bökény Kurgan and the highly valuable loess vegetation.

The so called kunhalmok (kun barrows or kurgans) also provide loess grassland residues, which are valuable sights of the southern regions beyond river Tisza. An intensive research programme has been launched on this area, which is completed with a soil research programme (TÓTH 1998, 1999, JOÓ and BARCZI 2001, BARCZI and JOÓ 2000, BARCZI et al. 2001, 2003, 2004).

Former botanical surveys carried out on the kurgans proved that the flora records of the various heaps exposed to disturbation at different extent represent extremely varying, many times transitional plant associations that can not be easiliy classified into coenologic cathegories (BARCZI 2003, JOÓ és BARCZI 2001, BARCZI és JOÓ 2003, JOÓ 2001, 2003, HERCZEG 2005, TÓTH 1998, 1999).

Material and methods

The four chosen kurgans are located in the territory of the Körös-Maros National Park, which has a prominent role in preserving the silt vegetation of Hungary (Kántor Kurgan, Bőre Kurgan, Sáp Kurgan, Bökény Kurgan). A list of species was prepared on the four Kurgans and the vegetation of Sáp Kurgan was observed, applying transect methods. From the transect records we present here the records of Sáp Kurgan, which have not been published before, however they show well the trends in the vegetation of the kurgans. Simultaneously to the transects, we took soil samples as well. In the case of the names of species we applied the nomenclature of SIMON (2000), while in the case of the names of associations we followed the coenological system of BORHIDI (2003).

Soil sampling (distinguishing soil types) of the kurgans and their neighbourhoods were carried out and disturbed and intact samples were taken from the squares. Laboratory examinations covered the following parameters: humus content, total salt content, pH H_2O and KCl, $CaCO_3$, Al-P_2O_5, Al-K_2O, pF-values, consistence and current moisture content.

Results

Table 1 contains plant species of the surveyed 4 kurgans. The small areas feature various species and contain valuable patches of vegetation.

Table 1. Plant species of the surveyed 4 kurgans
1. táblázat A négy felmért kunhalom növényfajai

Species name	*Sample areas*				*Species name*	*Sample areas*			
	1.	*2.*	*3.*	*4.*		*1.*	*2.*	*3.*	*4.*
Achillea collina	+	+	+	+	*Gypsophila muralis*	+			
Achillea pannonica	+				*Hieracium bauhinii*		+	+	+
Acinos arvensis			+	+	*Holosteum umbellatum*		+	+	+
Adonis aestivalis	+			+	*Hordeum murinum*		+		
Adonis flammea		+			*Hyoscyamus niger*	+	+		
Aegilops cylindrica	+			+	*Hypericum perforatum*	+	+	+	+
Agrimonia eupatoria	+			+	*Inula britannica*		+		
Elymus intermedium			+	+	*Kickxia elatine*			+	
Agropyron pectiniforme	+	+	+	+	*Kochia prostrata*	+		+	+
Elymus repens	+	+	+	+	*Koeleria cristata*		+		+
Agrostis stolonifera	+	+	+	+	*Lactuca saligna*		+		
Allium vineale	+				*Lactuca serriola*	+	+	+	+
Alopecurus pratensis	+	+	+	+	*Lamium amplexicaule*	+	+	+	+
Althea officinalis			+	+	*Lamium purpureum*	+	+	+	+
Alyssum alyssoides	+	+		+	*Lathyrus tuberosus*	+	+	+	+
Amaranthus albus			+		*Leonurus cardiaca*	+			
Ambrosia artemisiifolia		+		+	*Lepidium campestre*	+	+	+	
Amorpha fruticosa	+			+	*Lepidium draba*	+	+	+	+
Anagallis arvensis	+	+		+	*Lepidium perfoliatum*	+	+	+	
Anchusa officinalis			+	+	*Lepidium ruderale*	+	+		
Androsace elongata			+		*Ligustrum vulgare*	+			

Anthriscus caucalis	+		+		*Linaria genistifolia*	+			
Anthriscus torilis	+			+	*Linaria kocianovichii*			+	+
Apera spica-venti			+		*Linaria vulgaris*	+	+	+	+
Arctium lappa	+		+		*Lithospermum arvense*	+	+	+	+
Arenaria serpyllifolia	+	+	+	+	*Lolium perenne*	+	+	+	+
Arrhenatherum elatius	+	+	+	+	*Lotus corniculatus*	+	+	+	+
Artemisia maritima	+				*Malva neglecta*	+		+	
Artemisia vulgaris		+		+	*Matricaria disciodea*	+		+	+
Asperula cynanchica	+			+	*Medicago falcata*				+
Astragalus austriacus				+	*Medicago lupulina*	+	+	+	+
Atriplex tatarica			+	+	*Medicago minima*		+		
Ballota nigra	+	+	+	+	*Medicago sativa*		+	+	+
Berteroa incana	+		+	+	*Melandrium album*	+	+	+	+
Bromus inermis	+	+	+	+	*Melilotus officinalis*	+	+	+	+
Bromus japonica	+	+	+	+	*Mentha longifolia*				+
Bromus mollis	+	+	+	+	*Morus alba*	+			
Bromus squarrosus		+			*Morus nigra*	+			
Bromus sterilis	+	+	+	+	*Myosotis arvensis*	+	+		
Bromus tectorum	+	+	+	+	*Nonea pulla*				+
Calamagrostis epigeios		+			*Ononis spinosa*	+	+	+	+
Camelina microcarpa	+				*Onopordum acanthium*	+			
Capsella bursa-pastoris	+	+	+	+	*Ornithogalum orthophyllum*		+		
Carduus acanthoides	+		+	+	*Papaver hybridum*				+
Carduus hamulosus	+				*Papaver rhoeas*	+	+	+	+
Carduus nutans		+	+	+	*Phlomis tuberosa*	+			+
Carex praecox	+	+	+	+	*Phragmites australis*	+			
Carex stenophylla	+				*Picris hieracioides*	+	+	+	+
Carthamus lanatus	+				*Plantago lanceolata*	+	+	+	+
Caucalis platycarpos	+				*Plantago major*	+		+	+
Centaurea pannonica		+			*Plantago media*			+	+
Centaurea sadleriana	+				*Poa angustifolia*	+	+	+	+
Centaurea scabiosa	+			+	*Poa bulbosa*	+			
Centaurea spinulosa	+		+	+	*Podospermum canum*	+	+		
Cerastium dubium		+			*Polygonum aviculare*	+	+	+	+
Chenopodium album		+	+	+	*Polygonum convolvulus*	+		+	+
Chenopodium hybridum		+			*Potentilla argentea*	+		+	+
Chenopodium polyspermum	+		+	+	*Potentilla reptans*	+		+	+
Cichorium intybus	+	+	+	+	*Prunella vulgaris*		+		
Cirsium arvense	+	+		+	*Prunus spinosa*	+	+	+	+
Cirsium eriophorum	+		+	+	*Ranunculus polyanthemos*	+		+	+
Cirsium vulgare		+			*Robinia pseudoacacia*	+			
Conium maculatum	+	+			*Rubus caesius*	+	+		
Consolida orientalis	+	+			*Rumex crispus*	+			
Consolida regalis	+	+			*Salvia austriaca*	+	+		
Convolvulus arvensis	+	+	+	+	*Salvia nemorosa*	+	+	+	+
Coronilla varia	+	+	+	+	*Sambucus nigra*	+			
Crataegus monogyna	+		+	+	*Senecio jacobaea*				+
Crepis setosa	+	+	+	+	*Setaria lutescens*		+	+	+
Crepis tectorum		+			*Sinapis arvensis*	+	+		
Cruciata pedemontana	+	+							

Species name	*Sample areas*				*Species name*	*Sample areas*			
	1.	*2.*	*3.*	*4.*		*1.*	*2.*	*3.*	*4.*
Cynodon dactylon	+	+			*Stachys annua*		+		
Cynoglossum officinale	+		+	+	*Stachys recta*				+
Dactylis glomerata		+	+	+	*Stipa capillata*			+	+
Datura stramonium	+			+	*Taraxacum officinale*	+	+	+	+
Daucus carota	+	+	+	+	*Teucrium chamaedrys*			+	+
Descurainia sophia	+	+	+	+	*Thalictrum minus*	+			+
Echinochloa crus-galli	+			+	*Thlaspi arvense*	+			+
Elaeagnus angustifolia		+			*Thlaspi perfoliatum*		+		
Erigeron canadensis	+	+	+	+	*Thymus odoratissimus*	+	+	+	+
Erodium ciconium	+		+	+	*Torilis arvensis*			+	+
Erophila verna	+		+	+	*Tragopogon dubius*	+	+		
Eryngium campestre	+	+	+	+	*Trifolium arvense*	+			
Euphorbia cyparissias	+	+	+	+	*Trifolium campestre*	+			
Euphorbia esula	+		+	+	*Trifolium pratense*	+	+	+	+
Euphorbia falcata	+		+	+	*Trifolium repens*	+	+		
Euphorbia helioscopia	+	+	+	+	*Urtica dioica*	+		+	
Falcaria vulgaris	+	+	+	+	*Valerianella locusta*		+		
Festuca arundinacea			+		*Verbascum blattaria*	+	+		
Festuca pratensis		+			*Verbascum phlomoides*				+
Festuca javorkae	+				*Verbena officinalis*	+	+	+	
Festuca rupicola	+	+	+	+	*Veronica arvensis*		+	+	+
Festuca valesiaca	+			+	*Veronica polita*	+	+	+	+
Fragaria viridis	+		+	+	*Vicia angustifolia*	+	+		
Fumaria schleicheri	+	+	+	+	*Vicia cracca*	+		+	
Galium aparine	+	+	+	+	*Vicia lathyroides*	+			+
Galium mollugo		+		+	*Viola ambigua*	+			+
Galium verum	+	+	+	+	*Viola kitaibeliana*	+		+	+
Geranium dissectum	+	+			*Xanthium italicum*		+		
Geranium molle			+	+	*Xanthium strumarium*	+		+	
Glechoma hederacea	+	+	+	+					

1: Kántor Kurgan, 2: Bőre Kurgan, 3: Sáp Kurgan, 4: Bökény Kurgan

In the region close to the top of the kurgans the association *Agropyro-Kochietum* goes over into *Salvio-Festucetum rupicolae* association with a sharp boundary. This zonal settlement, and the presence of the typical and rare silt steppe species were found in all the three sampling areas. Due to literary data, *Festuca rupicola* is the dominant species of the *Salvio nemeorosae-Festucetum rupicolae* (ZÓLYOMI 1957), SOÓ 1964 association, and the presence of *Salvia* species is also typical. On the areas surveyed *Festuca valesiaca* and *Festuca javorkae* species also appeared in the samples along with *Festuca rupicola* species. Among *Salvia species,* only *Salvia nemorosa* appeared in the samples.

The Kántor Kurgan was formed from the soil of the ring around it. In the deeper areas around the kurgan mid-compacted, meadow soil of loamy physical properties can be found (iron movement, rust- and gleystains, under strong surplus water effect), while farther from the kurgan, on the higher and drier relieves chernozem soil can be found. The ring itself can be well reconstructed, the soil material of the kurgan possibly emerged from the humic topsoil formation. The soil material getting higher and higher

during the years served as the parent material for the soil genetic processes. The surplus water effect originating from the underground waters or from adhesion disappeared. Due to this the soil, which was basically rich in organic material "rehumified", and the biological activity accelerated (mainly earthworm- and animal tunnels can be observed). Due to the mixing and drying chernozem soils of crumby structure with uniform colour up to one meter depth formed, which does not show morphological differences on the sample areas, and which is rich in earthworm tunnels. Thus, the changing can be detected mainly in the disappearance of water effect, in drying and in the structure. The samples show loamy texture. The pH is neutral and there are no significant differences in the carbonate content. The organic material content is pretty high. In nutrient management differences are expected (in case of phosphorus and potash as well). The sample areas do not show differences regarding the pore structure and the amount of usable water.

The Bőre Kurgan is highly disturbed. It is broken in height and is cut in half by an agricultural road. One half of the area is under agricultural cultivation, but the other half is partly untouched, there are no new disturbing signs and alluvium. Solonetz and solonetz meadow soils can be found around the kurgan, which is probably formed from it. However there are no signs of iron movement and sodification. The chernozem effect is strong, the upper layer (50–70 cm) of the soil is dark with crumby structure. Under this layer the colour becomes greyer, but it is not a salt-affected layer. In the period past from the formation of the kurgan the salts may be bleached from the surveyed one-meter-layer and the soil formation processes have started, which can be examined in lime-dynamic, in the structure and in the colour. The compactness of the soil indicates loamy physical properties, which is in good correlation with the loess parent material typical for the area. The lime content is not too high: 1–3%. The organic material content shows good figures. The phosphorus and potash content indicates high nutrient content. The pF figures of the sample areas indicate similar water management.

One side of the Bökény Kurgan was heavily cut into, several paths run up to the top. In spite of that the ring can be clearly seen from semicircular aspect, and is under water at the time of the survey. Meadow chernozem is typical for the surrounding, with gleying and bogging processes. The kurgan on the cut side can be perfectly surveyed. Dark brown, grainy soil with iron marks formed on that side. The cut side is uniformly dark brown. Due to the heavily disturbed vegetation, a diagonally running transect was established by authors, following the most untouched vegetation types. The differences in the soils did not appear under these transects. The compactness figures show significant differences in each sample site, the loam and clay figures alternate. The salt content is low everywhere. The pH is neutral, the carbonate content is high and shows differences between each sample site. The humus content is also considered to be high. The nutrient content is moderately high. There are no significant differences in the usable amount of water calculated from the pF figures.

In the top region of the Sáp Kurgan (Table 2.) *Agropyron pectiniforme* has a significant role. It is present with high coverage, creating *Agropyro-Kochietum prostratae* association. This changes on the slopes of the kurgans with sharp boundary into the association typical to the base areas, the *Salvio-Festucetum rupicolae* loess grasses. Besides the dominant *Festuca rupicola*, the *Festuca valesiaca* has got a significant role, as well.

Table 2. Records of transects records on the Sáp Kurgan
2. táblázat A Sáp-halom transzszekt felvételei

			Transect 1.			
Agropyron pectiniforme	**40**	**20**	**30**	**10**	**1**	**3**
Elymus repens	0	0	0	1	2	2
Falcaria vulgaris	0	0	0	0	3	1
Festuca valesiaca	**2**	**0**	**5**	**25**	**35**	**30**
Kochia prostrata	0	3	5	3	0	0
Thesium arvense	0	0	0	0	0	1
Thymus odoratissima	0	0	2	3	5	3
			Transect 2			
Agropyron pectiniforme	**35**	**30**	**28**	**5**	**2**	**2**
Coronilla varia	0	0	0	0	0	2
Cynodon dactylon	0	0	0	0	0	3
Festuca valesiaca	3	5	5	25	30	25
Falcaria vulgaris	0	0	0	0	0	3
Kochia prostrata	**5**	**10**	**18**	**5**	**0**	**0**
Poa angustifolia	0	0	1	3	3	3
Thymus odoratissima	0	0	0	10	3	3
			Transect 3			
Achillea collina	0	0	0	2	2	2
Agropyron pectiniforme	**35**	**30**	**30**	**5**	**3**	**0**
Cynodon dactylon	0	0	5	5	8	5
Festuca rupicola	**0**	**0**	**0**	**5**	**25**	**30**
Festuca valesiaca	**0**	**0**	**5**	**20**	**5**	**5**
Hypericum perforatum	0	0	0	0	4	4
Kochia prostrata	0	0	8	5	3	0
Poa angustifolia	0	0	3	3	3	3
Salvia nemorosa	0	0	10	8	10	8
Thymus odoratissima	0	0	0	5	3	3

The Sáp Kurgan is the mostly surveyed kurgan. Its base is highly disturbed, partly due to agricultural cultivation, as well as owing to the treaded paths leading up the kurgan. The top and its surroundings, near to the monument are also treaded. Ablation and overcoverage is not observed. As a result of the disturbation, the ring can not be seen. The soils in the neighbourhood of the kurgan are highly compact, loamy, pitch-black Vertisols, lacking lime. Their structure is grainy in the A level, the B level is dry and prismatic, has coarse angular blocky structure in cases. The material of the kurgan was probably gathered from this soil. The soil of the kurgan, similarly to the previous one, has lost the gleyic characteristics deriving from water surplus. It is rather granular, chernozem type, although it is more compact near the top, because of treading. The crumby sturcture does not reach deep, it is rather typical in the root zone. With the diminishing of the amount of roots, the soil becomes a bit more compact, more grainy, thus, it has preserved more from its original caractheristics. In the same time, alcalization, water surplus effects do not occure.

Laboratory examinations showed the following results: on the basis of the compactness, the texture is clay. This verifies the assumed vertic origin of the recent soil. The total salt values do not reach the limit value of alcalization (0,15%), though, can be considered high. This indicate that the surrounding Vertisols may be under the process of alcalization and the salt content of the gathered soil was already washed out. The pH is neutral-slightly acidic, the lime contect is low. This also implies leaching. The humus content shows higher value (4%), typical to Vertisols, but significant differences can not be prognostizated between the sample areas. Great differences can be expected in the nutrient contents too. There is no relevant difference in the usable water content.

Upon the vegetation and soil surveys, significant differences occurred in the pF values and lime content, which partly appeared in the vegetation as well. The salt content was outstanding in some cases.

The nutrient content of the soil samples also showed great variety. The measured characteristics of the soils were compared with ecological demands of the plant species. The strongest connection was observed between the water and nitrogen content of the soil and the relative ecological demands of the plants. Parallel to the soil research results, botanical differences were significant mainly in the floristic composition.

Discussion

For examining the zonal vegetation structure, authors compared the soil data we had determined with the relative ecological indexes of the associations that were elaborated on an empirical basis. This examination was unsuccessful first, due to the fact that, in spite of their apparent difference, the ecological indexes of the two associations were the same in most cases. Neither we could find a significant difference in soil parameters that could have explained the change. In the region close to the top of the kurgans the association *Agropyro-Kochietum* goes over into *Salvio nemorosae-Festucetum rupicolae* association with a sharp boundary. This zonal settlement, and the presence of the typical and rare silt steppe species were found in all the three sampling areas.

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DÉL-TISZÁNTÚLI KUNHALMOK BOTANIKAI ÉS TALAJTANI VIZSGÁLATAI (FLORISZTIKAI ÖSSZEFOGLALÓ, SÁP-HALOM VEGETÁCIÓJA)

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Kulcsszavak: kunhalom, löszpusztagyep, csernozjom

A Tiszántúl déli, a Körös-Maros Nemzeti Park területén négy kunhalom (Kántor-halom, Bőre-halom, Sáp-halom, Bökény-halom) botanikai és talajtani vizsgálatát végeztük el. Célunk a talajviszonyok és a vegetációtípusok rögzítése és összehasonlítása volt. A botanikai vizsgálatok során elkészítettük a halmok teljes fajlistáját, jellemeztük a vegetációjukat és a Sáp-halom transzszekt vizsgálatot is folytattunk a vegetációjának bemutatására. A vegetáció egységekbe a talajtani viszonyok rögzítése érdekében Pürckhauer-féle mintavevővel végeztük felvételezéseket. A terület kis kiterjedése ellenére számos fajnak és vegetációtípusnak ad otthont. Alapvetően viszont mégis két vegetációcsoportba tartozó növényzettípus jelenik meg. A csúcsi területek mindegyikén az *Elymus repens* és *Agropyron pectiniforme* dominancia figyelhető meg. Ezt a *Salvio nemorosae-Festucetum rupicolae*, löszpusztagyep váltja fel, rendszerint éles határral, ami a transzszekt felvételekben is jól látszik. Ez a vegetáció típus fajgazdag, és számos ritka vagy tipikus faj is tartalmaz. A halmok anyagának 1 m mélységű vizsgálatakor mind a négy esetben morfológiailag egységes – és egymáshoz nagyon hasonló – talajképződménnyel találkoztunk. A szúróbotos vizsgálat során az eltérő növényzeti egységek alatt is ugyanolyan talajképződményt figyeltünk meg. A vizsgálat alapján a halmokon mindenhol – mivel azok az építések után mentesültek a környezet valószínűsíthető többletvízhatása alól – sötétbarna színű, gyökerekkel sűrűn átszőtt, morzsás szerkezetű, nyomokban meszet tartalmazó, több esetben mészlepedékes B-szintű csernozjom talaj alakult ki.