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SEED BANK DYNAMICS IN A SEMIARID SANDY GRASSLAND IN HUNGARY

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Abstract

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Vegetation and soil seed bank of four neighbouring patches of a semiarid sandy grassland (*Festucetum vaginatae danubialae* S o ó (1929) 1933) were studied during two vegetation periods.

1. We took coenological descriptions in the patches of the association. Soil samples were taken four times from the patches and seed bank composition was determined by the seedling emergence method. Similarity between the composition of the seed bank and the aboveground vegetation was estimated by the Sørensen index, showing high similarity in the autumn period and smaller in the spring, probably due to the depletion of the soil seed bank.

2. Density of the seed bank varied from 58 to 3155 seeds/m^2, with larger differences within single patches than between the patches. We concluded that the vigorous seed production of a few species is responsible for the extensive fluctuation of the seed bank.

3. Seeds of 88% of the examined annual species and 59% of the perennial species were occurred in the soil samples during two vegetation periods. Out of the 57 species found in the aboveground vegetation, 6 annual (*Arenaria serpyllifolia, Cerastium semidecandrum, Erigeron canadensis, Erophila verna*, *Holosteum umbellatum, Saxifraga tridactylites*) and 5 perennial (*Euphorbia seguieriana*, *Festuca vaginata, Minuartia verna, Poa bulbosa, Silene otites*) species had persistent seed bank. The association is most vulnerable at the time of early spring and at the beginning of summer, in the period when all species have the less seed reserve in the soil. This calls the attention on the importance of the transient seed bank.

Key words: semiarid grassland, seed bank, seed density, persistent and transient seed bank, drought, weather extremes

Introduction

Many studies are concerned with the comparison of the vegetation and the seed bank of arid, semiarid grasslands (Reichman, 1984; Henderson et al., 1988; Coffin, Lauenroth, 1989; Pierce,

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Cowley, 1991; Musil, 1991). Henderson et al. (1988) found considerable similarity between the aboveground vegetation and the species composition of the seed bank, while other examinations showed the lack of correlation (Coffin, Lauenroth, 1989; Perez et al., 1998; Halassy, 2001). Strong aggregation is the characteristic of the seed bank of the vegetation of open areas (Kellman, 1978; Schenkeveld, Verkaar, 1984) where the micromorphology, seed dispersion near the motherplant, wind and animals play an important role in the formation of the detected seed patterns (Pulliam, Brand, 1975; Bullock, 1976; Nelson, Chew, 1977; Reichman, 1979; Baptista, Shumway, 1998). The seed content of bare patches is negligible (Aguiar, Sala, 1997) so that significant – several order of magnitude – differences show up between the seed density of bare and vegetation-covered patches (Nelson, Chew, 1977; Patten, 1978; Reichman, 1984).

Adaptation responses by species of semiarid sandy grasslands have been investigated and explained by physiological, production-biological and niche-studies (Fekete, Melkó, 1981; Fekete, Tuba, 1982; Précsényi et al., 1977; Molnár, Nosek, 1980). Revealing of the relations between the vegetation and the soil seed bank can provide further insight into the adaptation responses at the level of reproduction.

The basis of the investigation was the soil seed bank examination of 4 patches situated near to each other *(Festucetum vaginatae danubialae* S o ó (1929) 1933.) Our aim was to identify and quantify the vegetation of the patches and the species composition of their seed bank, and the dominance-relations; to compare the changes of the seed bank density during two vegetation periods both within and among the patches; and to compare the annual and perennial species of the community while considering the type of their seed bank production.

Materials and methods

The study area is situated 25 km west of the town of Kecskemét in the Hungarian Great Plain (Kiskunság National Park, near Fülöpháza). The frequency of water shortage periods is high, the soil is nutrient poor calcareous sand with low water holding capacity. Edaphic factors are also contributing to the temperate semidesert characteristics of the sandy grassland (Zólyomi, 1958; Fekete, 1992). The sand hills are covered by grasslands, but some sand dunes are still moving. The mean annual precipitation is 350-450 mm. The vegetation cover is 50 to 60 % at highest, and the total species number is low (50 to 60). Although the cover by perennials is larger than that by the annuals, the share of annual species is also significant resulting in intensive dynamics of community through the year (Kárpáti, Kárpáti, 1954). Due to the small scale variation in the exposition and water table depth the appearance of the vegetation is rather patchy.

Soil samples were taken from two open and from two closed microhabitats of the community *Festucetum vaginatae danubialae* S o ó (1929) 1933 in August 1992, March and August 1993, and March 1994. Detailed coenological description of the area has been reported in a number of works (Hargitai, 1940; Fekete, Tuba, 1982; Bagi, 1997; Kemény et al., 2001).

The cover values (%) were determined on the basis of 8 coenological records taken in of 2x2 m quadrats within the patches. The first and the second open patches were situated on the SE side of the dune. The coverage of the first patch was about 30-40%. The highest cover value was shown by *Festuca vaginata* (see Table 1). Apart from this species *Euphorbia seguieriana* and *Silene otites* were also dominant. From the annual (mostly therophyte) species the cover value of *Arenaria serpyllifolia* was the highest in the prevernal aspect.

The vegetation of the second patch was more rare, the average cover was 20-30%. *Festuca vaginata* with tussock diameter of 20-40 cm showed the highest cover value (see Table 2). *Silene otites* was also common in

T a b l e 1. Species list with average species cover [%] in the permanent quadrats and seed number in the soil in the first patch. I/a and II/a: autumn values from the first and second year, respectively. I/b and II/b: spring values from the first and second year, respectively

No.	Life-form	Species	Cover [%]	I/a	I/b	II/a	II/b
1	H	*Alkanna tinctoria*	+				
2	Ch	*Alyssum tortuosum*	1.8	4	2	2	
3	H	*Centaurea arenaria*	0.3			2	
4	H	*Euphorbia segueriana*	8	4	1	17	1
5	H	*Festuca vaginata*	15	10	1	2	
6	H	*Koeleria glauca*	2	5	1	1	
7	MM	*Robinia pseudo-acacia*	+				
8	H	*Scabiosa ochroleuca*	0.4			3	
9	H	*Silene otites*	5	411	65	650	37
10	H	*Solidago virga-aurea*	0.2				
11	H	*Stipa borysthenica*	+				
12	H	*Syrenia cana*	+				
13	H	*Tragopogon floccosus*	0.3				
1	Th	*Arenaria serpyllifolia*	3	205	36	215	4
2	Th	*Bromus tectorum*	0.3	9			
3	Th	*Cenchrus incertus*	+		1	2	
4	Th	*Cerastium semidecandrum*	+	2			
5	Th	*Corispermum nitidum*	+		21	5	
6	Th	*Crepis rhoeadifolia*	0.5	1			
7	Th	*Erigeron canadensis*	+	50	24	185	2
8	Th	*Erophila verna*	1	145	14	1223	23
9	Th	*Holosteum umbelletum*	0.3			33	
10	Th	*Kochia laniflora*	0.8				
11	Th	*Polygonum arenarium*	0.8				
12	Th	*Salsola kali*	0.5				
13	Th	*Secale silvestre*	1	9		20	
14	Th	*Silene conica*	+				
15	Th	*Sonchus oleraceus*	+		1	1	1
16	Th	*Tragus racemosus*	–			1	
17	H	*Hieracium sp.*	–			2	

this patch. Other species were represented by a few individuals only. The number and the cover of the annual species in the prevernal aspect were both very low.

The third closed patch was situated in a depression on the sand-hill. The cover of the surface of the sand is about 60-70%, from which 10-15% were given by moss cushions and lichen thallies. *Festuca vaginata* and *Stipa borysthenica* were present with nearly identical cover values (see Table 3). *Bothriochloa ischaemum* and *Poa bulbosa* were also dominant grass-species. From the therophyte species at the prevernal aspect the *Arenaria serpyllifolia* had the highest cover value.

T a b l e 2. Species list with average species cover [%] in the permanent quadrats and seed number in the soil in the second patch. I/a and II/a: autumn values from the first and second year, respectively. I/b and II/b: spring values from the first and second year, respectively

No.	Life-form	Species	Cover [%]	I/a	I/b	II/a	II/b
1	M	*Berberis vulgaris*	+				
2	M	*Juniperus communis*	0.3				
3	MM	*Populus alba*	+				
4	H	*Euphorbia segueriana*	+			2	
5	H	*Festuca vaginata*	22	49	3	3	1
6	H	*Koeleria glauca*	+	2			
7	H	*Scabiosa ochroleuca*	0.7				
8	H	*Silene otites*	4	35	13	28	13
9	H	*Syrenia cana*	+	6			
10	H	*Tragopogon floccosus*	0.5	1			
1	Th	*Arenaria serpyllifolia*	0.1	4	6	3	1
2	Th	*Cencrus incertus*	+			1	
3	Th	*Cerastium semidecandrum*	+	1			
4	Th	*Corispermum nitidum*	+			1	
5	Th	*Crepis rhoeadifolia*	+				
6	Th-TH	*Erigeron canadensis*	+	12	18	17	3
7	Th	*Erophila verna*	0.5	2	1	538	38
8	Th	*Holosteum umbellatum*	+			4	
9	Th	*Kochia laniflora*	0.3				
10	Th	*Minuartia glomerata*	0.2	1	1	2	
11	Th	*Polygonum arenarium*	0.7				
12	Th	*Salsola kali*	0.8		2		
13	Th	*Soncus oleraceus*	+	1		1	
14	Th	*Medicago minima*	–			1	

The fourth, closed patch was situated on the top and the NE slope of the sand-hill. The vegetation was dominated by *Stipa borysthenica*, while *Festuca vaginata* was present only as scattered (see Table 4). The cover by a few annual species (*Fumana procumbens, Poa bulbosa, Carex liparicarpos*) was also considerable. Cover by cryptogamic species was 15-20%.

During the two vegetation periods of the examination there were not any significant changes in the dominance relations even when regarding the annual species.

For the seed bank examinations an area of 20x20 m was pointed out in each patch from which 20 samples were taken to 5 cm depth. The surface area of the samples was 0.76 m^2 (38.000 cm^3) per patch. Vegetative plant parts were removed from the samples by sieving. The soil samples were air-dried at room temperature and kept at a cool place for one month. The cores have been transferred to a plant growth chamber (14 hs daylength, 23/15 ^{0}C day/night temperatures) and spread in 3 cms layers on trashes. Seedlings have been identified, counted and removed after four successive germination periods in five months by mixing and spreading the soil again after each counting procedure (Thompson et al., 1997). No new individuals have been detected in the 40 days after the fourth counting procedure. Species have been identified after Csapody (1968) and using germinated seeds of species collected in the area. Species life forms and community nomenclature followed Horváth et al. (1995) and Soó (1964). The species composition of the vegetation and the soil seed bank were compared by the Sørensen similarity-index (1948). Species with persistent seed bank have been found at all sampling occasions.

T a b l e 3. Species list with average species cover [%] in the permanent quadrats and seed number in the soil in the third patch. I/a and II/a: autumn values from the first and second year, respectively. I/b and II/b: spring values from the first and second year, respectively

No.	Life-form	Species	Cover [%]	I/a	I/b	II/a	II/b
1	G	*Asparagus officinalis*	+				
2	G	*Carex liparicarpos*	0.5	1			
3	G	*Cleistogenes serotina*	1.5		2	4	
4	N	*Fumana procumbens*	4		1		
5	G	*Muscari comosum*	+				
6	M-MM	*Populus alba*	0.9				
7	H	*Bothriochloa ischaemum*	8				
8	H	*Chondrilla juncea*	+				
9	H	*Diantus serotinus*	+				
10	H	*Euphorbia segueriana*	0.7				
11	H	*Festuca vaginata*	20	1		1	
12	H	*Koeleria glauca*	6				
13	H	*Linaria genistifolia*	0.7	5		1	
14	H-Ch	*Minuartia verna*	1	4		28	
15	H	*Poa bulbosa*	6	30	1	3	3
16	H	*Sedum hillebrandtii*	+			2	1
17	H	*Silene otites*	+				
18	H	*Stipa borysthenica*	12	2			
19	H	*Stipa capillata*	2				
20	H	*Syrenia cana*	+	1		1	
21	H	*Thymus glabrescens*	+				
1	Th	*Arenaria serpyllifolia*	4	431	16	291	86
2	Th	*Bromus mollis*	+				
3	Th	*Bromus tectorum*	0.1				
4	Th	*Cerastium semidecandrum*	0.5	23	1	2	3
5	Th	*Corispermum nitidum*	0.3		1		
6	Th	*Crepis rhoeadifolia*	+				
7	Th-TH	*Erigeron canadensis*	0.2	33	8	6	2
8	Th	*Erophila verna*	0.3	187	18	159	90
9	Th	*Holosteum umbelletum*	1.2	40	5	94	61
10	Th	*Kochia laniflora*	0.5				
11	Th	*Lithospermum arvense*	0.1	4		3	
12	Th	*Medicago minima*	0.7				
13	Th	*Minuartia glomerata*	0.8	77		1	
14	Th	*Polygonum arenarium*	0.2				
15	Th	*Salsola kali*	0.1				
16	Th	*Saxifraga tridactilites*	+			1	2
17	Th	*Senecio vernalis*	0.1				
18	Th	*Silene conica*	0.8	1		7	
19	Th	*Tragus racemosus*	0.8				

T a b l e 4. Species list with average species cover [%] in the permanent quadrats and seed number in the soil in the fourth patch. I/a and II/a: autumn values from the first and second year, respectively. I/b and II/b: spring values from the first and second year, respectively

No.	Life-form	Species	Cover [%]	I/a	I/b	II/a	II/b
1	Ch	*Alyssum tortuosum*	0.3				
2	G	*Carex liparicarpos*	1.8				
3	G	*Cleistogenes serotina*	4.5	3	3	3	
4	N	*Fumana procumbens*	11	1		9	
5	G(Ch)	*Gypsophila fastigiata*	1	3			
6	M	*Juniperus communis*	+				
7	H	*Alkanna tinctoria*	1.2	2			
8	H	*Astragalus varius*	0.3				
9	H	*Bothriochloa ischaemum*	0.3			1	
10	H	*Euphorbia seguireana*	+	1			
11	H	*Festuca vaginata*	2			2	
12	H	*Helichrysum arenarium*	1.5				
13	H	*Koeleria glauca*	2				
14	H	*Linaria genistifolia*	+	3		2	
15	HCh	*Minuartia verna*	0.4	31	2	159	15
16	H	*Poa bulbosa*	8	25	1	107	2
17	H	*Scabiosa ochroleuca*	0.1				
18	H	*Sedum hillebrandtii*	+		1		
19	H	*Stipa borysthenica*	23	11		18	
20	H	*Syrenia cana*	0.5	6		4	
1	Th	*Arenaria serpyllifolia*	10	644	12	950	141
2	Th	*Bromus squarrosus*	+				
3	Th	*Cerastium semidecandrum*	4.6	44	5	79	23
4	Th	*Crepis rhoeadifolia*	0.4				
5	ThTH	*Erigeron canadensis*	0.2	21	12	41	2
6	Th	*Erophila verna*	0.2	148	8	494	38
7	Th	*Eryngium campestre*	+				
8	Th	*Holosteum umbelletum*	1.5	11		69	117
9	Th	*Kochia laniflora*	0.5				
10	Th	*Lithospermum arvense*	0.4			5	
11	ThTH	*Medicago lupulina*	+				
12	Th	*Medicago minima*	1				
13	Th	*Minuartia glomerata*	+	18			
14	Th	*Polygonum arenarium*	+				
15	Th	*Salsola kali*	+				1
16	Th	*Saxifraga tridactylites*	2	183	9	453	258
17	ThTH	*Senecio vernalis*	+				
18	Th	*Silene conica*	0.6	3			
19	Th	*Veronica arvensis*	+	7		1	
20	Th	*Cencrus incertus*	-	5			
21	Th	*Chenopodium album*	-			1	

Results

Comparing the vegetation of the patches and their seed bank on the basis of their species composition and dominance relations

Sørensen similarity between the species composition of the aboveground vegetation and that of the soil seed bank was calculated using the maximum values of species number found in each patch. Spring similarity values were smaller than the autumn ones in all cases (Fig. 1).

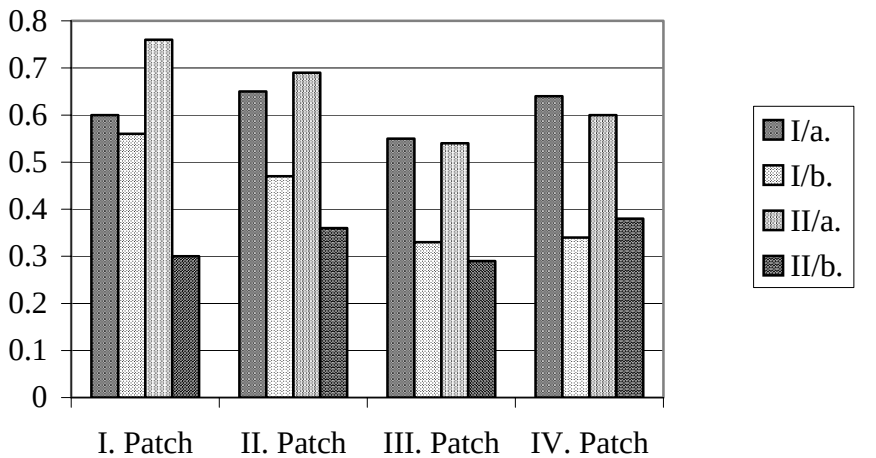

Fig. 1. Sørensen similarity values between the species composition of the aboveground vegetation and that of the soil seed bank in the investigated patches at the four sampling occasions. I/a and II/a: autumn indices from the first and second year, respectively. I/b and II/b: spring indices from the first and second year, respectively.

Seven out of the 13 perennial species appeared at least once from the four samples in patch I and 11 out of the 15 annual species were present in the seed bank. *Silene otites* was dominant among the perennial species while *Arenaria serpyllifolia* and *Erophila verna* were dominant even in the soil (Table 1). *Erigeron canadensis* was also contributing to the soil seed bank. These four species were dominant in both the spring and the autumn seasons. Though the other two dominant perennial species of the vegetation, *Euphorbia seguieriana* and *Festuca vaginata* appeared in the seed bank, their number was low. Seeds of two species were found in the soil – those of *Hieracium sp., Tragus racemosus*-, which were not present in the aboveground vegetation of the examined patches. Species with persistent seed bank were *Arenaria serpyllifolia, Erigeron canadensis, Erophila verna, Euphorbia seguieriana, Silene otites.*

Out of the 10 perennial species of patch II, 6 were present in the seed bank at least once from the four samples, while from the 13 annual species 10 were present. Dominance in the seed bank by the perennial *Silene otites* was characteristic in both spring and autumn, while *Festuca vaginata* was dominant in the seed bank only at the autumn sampling of the first year (Table 2). The seed production of the annual *Erophila verna* showed considerable differences at different sampling occasions. *Erigeron canadensis* has not appeared very often in the vegetation but at the same time it is a dominant component of the seed bank. Though the annual species *Medicago minima* was missing from the aboveground composition, its seed was found in the seed bank. Species with persistent seed bank were *Arenaria serpyllifolia, Erigeron canadensis, Erophila verna, Festuca vaginata, Silene otites.*

The seeds of 10 out of 21 perennial species and 9 from 18 annual species were present in patch III. From the dominant grass species only *Poa bulbosa* contributed to the persistent seed bank (Table 3). Further dominant grasses such as *Festuca vaginata* and *Stipa borysthenica* appeared only with a few seeds, while seeds of *Bothriochloa ischaemum* and *Koeleria glauca* were not present at all. *Arenaria serpyllifolia* and *Holosteum umbellatum* were dominant both in the aboveground vegetation and in the soil seed bank. Species with persistent seed bank were *Arenaria serpyllifolia, Cerastium semidecandrum, Erigeron canadensis, Erophila verna*, *Holosteum umbellatum, Poa bulbosa*.

The seeds of 13 out of 20 perennial species and 11 from 19 annual species were found in the seed bank in the fourth patch considering all sampling occasions (Table 4). *Cenchrus incertus* and *Chenopodium album* have not been recorded in the vegetation while they were present in the seed bank. The dominant grass species of the patch were *Stipa borysthenica*, *Poa bulbosa*, *Cleistogenes serotina* and the suffrutex *Fumana procumbens*. *Stipa borysthenica* and the *Fumana procumbens* occurred only in the autumn seed bank. *Poa bulbosa* and *Minuartia verna* were dominant in the seed bank and rather rare in the above ground records. *Erophila verna*, *Arenaria serpyllifolia, Cerastium semidecandrum* and *Saxifraga tridactylites* were the most frequent annuals in the aboveground vegetation and in the seed bank with the dominance of *Erophila verna*. Species with persistent seed bank were *Arenaria serpyllifolia, Cerastium semidecandrum, Erigeron canadensis, Erophila verna*, *Holosteum umbellatum*, *Minuartia verna*, *Poa bulbosa*.

T a b l e 5. Seed densities (seed number.m^{-2}) in the patches at the four sampling occasions. I/a and II/a: autumn values from the first and second year, respectively. I/b and II/b: spring values from the first and second year, respectively

	I/a	I/b	II/a	II/b
I. patch	1125	220	3110	89
II. patch	150	58	790	74
III. patch	1104	62	795	326
IV. patch	1535	70	3155	785

Seed densities

Seed densities varied between 58 and 3155 m^{-2} at the four sampling occasions in the two years (Table 5), with minimum values in the spring (II. patch, in spring) and maximum in the autumn (IV. patch, second year). Density

differences between the patches can reach a magnitude at the same sampling occasion, while diffences between the sampling occasions for the same patch were larger (autumn/ spring density ratios of 30 to 55).

Seed bank strategies by perennials and annuals

Species with persistent seed bank have been found at least in one of the patches at all sampling occasions. Eleven species of the 57 had persistent seed bank in at least one of the patches and 5 of these were perennials *(Euphorbia seguieriana, Festuca vaginata, Minuartia verna, Poa bulbosa, Silene otites)* (Tables 6, 7). Eighty-eight % of the annuals and 59% of the perennials were found in the soil samples. Annuals were present with similar numbers in both the spring and autumn samples, while perennials occurred mainly in the autumn samples.

Discussion

Species composition of the soil seed bank and the vegetation was most similar in the autumn period as found elsewhere (Henderson et al., 1988), while similarity was much smaller in the spring period due to the depletion of the soil seed bank. This pattern of temporal variability is formed largely by the abundance of ephemer species, and the fact that majority of these germinate and emerge in the autumn.

Only one species (*Chenopodium album*) was absent in the vegetation, while present in the seed bank. Higher seed densities of annuals than that of perennials was characteristic in the closed patches, where the dominant grasses have not been present in the seed bank, favoring the vegetative spreading (Fekete, Melkó, 1981). Both spatial (between patches) and temporal (spring–autumn) variability of the seed densities were high (Nelson, Chew, 1977; Reichman, 1984), but this fluctuation was caused by only a few species with persistent seed bank (*Arenaria serpyllifolia*, *Erophila verna, Erigeron canadensis*, *Silene otites*) as found in other grassland (Virágh, Gerencsér, 1988; Ghermandi, 1997; Baptista, Shumway, 1998). *Silene otites* has been shown to have persistent seed bank, while *Erigeron canadensis* proved to be the most succesful species in the regeneration process of a rocky grassland by virtue of its high seed production and good dispersal ability (Csontos et al., 1996/97). Variability of seed production by the perennial species was rather low, at the same time as found also by Parmenter, MacMahon (1985), except for *Minuartia verna, Poa bulbosa* and *Silene otites* with persistent seed bank. In grasslands, however, the presence and not necessarily the high density of perennials is the decisive factor (Grime, 1979). Large differences in seed densities between patches have probably been caused also by the limited distance of seed-dispersion as found by other studies (Bullock, 1976; Ellner, Schmida, 1981; Kincsek, 1985; Symonides, 1987).

T a b l e 6. Temporal variability of the soil seed bank by the perennial species. I: Not found in the soil seed bank. II: Found at one or both autumn sampling in the soil seed bank. III: Found at either the autumn or the spring samplings, with no clear preference towards either season. IV: Persistent in the soil seed bank (found at each sampling occasions)

No.	Life-form	Species	I.	II.	III.	IV.
1	G	*Asparagus officinalis*	+			
2	H	*Astragalus varius*	+			
3	M	*Berberis vulgaris*	+			
4	H	*Chondrilla juncea*	+			
5	H	*Diantus serotinus*	+			
6	H	*Eryngium campestre*	+			
7	H	*Helichrysum arenarium*	+			
8	M	*Juniperus communis*	+			
9	G	*Muscari comosum*	+			
10	MMM	*Populus alba*	+			
11	MM	*Robinia pseudoacacia*	+			
12	H	*Solidago virgaaurea*	+			
13	H	*Stipa capillata*	+			
14	Ch	*Thymus glabrescens*	+			
15	H	*Alkanna tinctoria*		+		
16	H	*Bothriochloa ischaemum*		+		
17	G	*Carex liparicarpos*		+		
18	H	*Centaurea arenaria*		+		
19	G(Ch)	*Gypsophila fastigiata*		+		
20	H	*Linaria genistifolia*		+		
21	H	*Scabiosa ochroleuca*		+		
22	H	*Stipa borysthenica*		+		
23	H	*Syrenia cana*		+		
24	H	*Tragopogon floccosus*		+		
25	Ch	*Alyssum tortuosum*			+	
26	G	*Cleistogenes serotina*			+	
27	N	*Fumana procumbens*			+	
28	H	*Koeleria glauca*			+	
29	Ch	*Sedum hillebrandtii*			+	
30	H	*Euphorbia seguieriana*				+
31	H	*Festuca vaginata*				+
32	HCh	*Minuartia verna*				+
33	H	*Poa bulbosa*				+
34	H	*Silene otites*				+

T a b l e 7. Temporal variability of the soil seed bank by the annual species. I: Not found in the soil seed bank. II: Found at one or both autumn sampling in the soil seed bank. III: Found at either the autumn or the spring samplings, with no clear preference towards either of the seasons. IV: Persistent in the soil seed bank (found at each sampling occasions). V: Found only in the spring

No.	Life-form	Species	I.	II.	III.	IV.	V.
1	Th	*Bromus mollis*	+				
2	Th	*Bromus squarrosus*	+				
3	Th	*Kochia laniflora*	+				
4	Th	*Polygonum arenarium*	+				
5	ThTH	*Senecio vernalis*	+				
6	Th	*Bromus tectorum*		+			
7	Th	*Crepis rhoeadifolia*		+			
8	Th	*Lithospermum arvense*		+			
9	Th	*Medicago minima*		+			
10	Th	*Secale silvestre*		+			
11	Th	*Silene conica*		+			
12	Th	*Tragus racemosus*		+			
13	Th	*Cenchrus incertus*			+		
14	Th	*Corispermum nitidum*			+		
15	Th	*Minuartia glomerata*			+		
16	Th	*Sonchus oleraceus*			+		
17	Th	*Arenaria serpyllifolia*				+	
18	Th	*Cerastium semidecandrum*				+	
19	ThTH	*Erigeron canadensis*				+	
20	Th	*Erophila verna*				+	
21	Th	*Holosteum umbelletum*				+	
22	Th	*Saxifraga tridactylites*				+	
23	Th	*Salsola kali*					+

Conclusion

The role of the transient seed bank, on the other hand, is the determining factor when considering the composition of the community. Significance of the persistent seed bank found for several dominant perennials may lie in providing the opportunity for regeneration in case of weather extremes, most prominently long lasting (several months without rain) droughts. Though these serious drought events are not experienced from year to year, in case of occurrence they have a profound effect on the cover of even the drought-tolerant perennial species.

Translated by the authors

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Kemény G., Nagy Z., Tuba Z.: **Dynamika zásob semien v semiarídnej piesočnatej lúke v Maďarsku.**

Počas dvoch vegetačných období sme skúmali vegetáciu a zásoby semien v pôde na štyroch susediacich plochách na semiarídnej piesočnatej lúke (*Festucetum vaginatae danubialae* S o ó (1929, 1933).

1. Cenologické druhy sme zbierali na miestach associácie. Pôdne vzorky sme pozbierali štyrikrát a zloženie zásob semien sme zisťovali metódou semenáčikovej emergencie. Podobnosť medzi zložením zásob semien a nadzemnej vegetácie sme zisťovali pomocou Sørensenovho indexu, ktorý vykázal vysokú podobnosť na jeseň a pravdepodobne vďaka vyčerpaniu zásob semien v pôde, menšiu na jar.
2. Hustota zásoby semien sa pohybovala medzi 58 až 3155 semien/m^2 s väčšími rozdielmi na jednotlivých plochách ako medzi plochami. Usudzujeme, že u niektorých druhov silná produkcia semien je zodpovedná za značnú kolísavosť zásoby semien.
3. Semená z 88% skúmaných jednoročných druhov a 59% viacročných druhov sa objavili na pôdnych vzorkách počas dvoch vegetačných období. Z 57 druhov z nadzemnej vegetácie 6 jednoročných (*Arenaria serpyllifolia*, *Cerastium semidecandrum*, *Erigeron canadensis*, *Erophila verna*, *Holosteum umbellatum*, *Saxifraga tridactyles*) a 5 viacročných (*Euphorbia seguieriana*, *Festuca vaginata*, *Minuartia verna*, *Poa bulbosa*, *Silene otites*) druhov malo stálu zásobu semien. Asociácia je najzraniteľnejšia skoro na jar a na začiatku leta, v období, keď všetky druhy majú v pôde najmenej semenných rezerv. Treba si preto uvedomiť dôležitosť nestálosti zásoby semien.