

## **The positive effect of extreme weather: the new localities of selected endangered plant species found during extremely moist year 2010**

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### **Abstract**

The saline soils area covered by specific halophytic vegetation was radically decreased during last few decades. The temporary pools in arable fields may provide the environmental conditions favourable for some rare plant species. The year 2010 was defined as extremely moist; and rainy weather favoured the frequency and range of inundated field depressions occurrence in Podunajská nížina Lowland. During field mapping and vegetation inventory, the occurrence of one endangered species (EN) *Cirsium brachycephalum*, five critically endangered (CR) species (*Heleochoa alopecuroides*, *H. schoenoides*, *Lindernia tribracteatum*, *Schoenoplectus supinus* and *Lythrum tribracteatum*) and one potentially extinct species (EX?) *Chenopodium chenopodioides* were recorded. The conservation value of the temporary pools in agricultural field is discussed in terms of long-term survival of the species in cultural landscape.

**Key words:** field depressions, halophyte, endangered plants, Podunajská nížina Lowland

### **Introduction**

Saline soils belong to hydromorphic soils which are strongly influenced by intensive water evaporation and the salt dynamics of ground water is the most important factor in their formation (BOROS, 2003). In Slovakia saline soils covered by halophytic plant communities are distributed in warm and dry

lowland regions; the largest area of saline soils area were concentrated in Podunajská nížina Lowland, lesser in Východoslovenská nížina Lowland (KRIST, 1940; KRIPPELOVÁ, 1965). The areas of saline soils have all been markedly reduced during last few decades in Slovakia due to human activities. For instance, OSVAČILOVÁ & SVOBODOVÁ (1961) mentioned approximately 8300 ha of soil with saline vegetation in Podunajská nížina Lowland but contemporary, only about 500 ha have been re-discovered there (SÁDOVSKÝ et al., 2004). As a consequence, the typical halophytic plant species belongs to the most threatened plant species in Slovakia now. Plant communities of periodically flooded saline habitats represent unique initial stages plant succession. Typical dominants of these habitats are annual saline grasses, as *H. alopecuroides*, *H. schoenoides* or *S. supinus* (HOLUB, GRULICH, 1999b, c; HOLUB, 1999b). The formation of these plant communities is closely associated with annual water level decrease and we can usually find it in the second half of the vegetation period (SÁDOVSKÝ et al., 2004). Vernaly flooded depressions on arable fields can provide secondary habitats and thus serve as the refugium for these specific plant communities in cultural landscape (ELIÁŠ jun. et al., 2008; LUKÁCS et al., 2013; ZLACKÁ et al., 2006). Extremely rainy weather in 2010 has given rise to the inundated field depression on much larger area as during normally moist or dryer years. Therefore, we initiated the field survey devoted to the mapping of inundated field depressions in Podunajská nížina Lowland, and inventory of their flora.

### **Materials and methods**

Field survey was carried out in 2010 since May to October in the territory of Podunajská nížina Lowland (southwestern Slovakia). The method of field mapping and inventory was used - when the inundated field depression was found, the locality was examined for rare plant species occurrence. At the locality the number of individuals and the approximate area (using GPS device) was estimated. Phytosociological relevés were also sampled using modified Braun-Blanquet cover – abundance scale (BARKMAN et al., 1964). The conservation status of the species was stated according Feráková et al.

(FERÁKOVÁ et al., 2001). Geographical coordinates were derived through GPS device Garmin GPSMAP 60CS.

Palmer Drought Severity Index (PDSI) is usually used for the evaluation of drought (PALMER, 1965); here we used the calculation results to demonstrate the opposite extremity – to define moist periods (Table 1.) The index is standardized for various regions and time periods and used for the evaluation of drought in various areas with various climates (DUNKEL, 2009). The program was afforded by Slovak Hydrometeorological Institute. The input data consists of average monthly precipitation totals, average monthly air temperatures, and average temperatures during the evaluated period, latitude and available water capacity. We used the data from Hurbanovo climatological station. The climate data was provided by Slovak Hydrometeorological Institute. Available water capacity was provided by the Soil Science and Conservation Research Institute in Bratislava.

**Table 1.** PDSI classification scale for the definition of moist and dry periods

PDSI value	Characteristics of the evaluated month
≥ 4.00	extremely moist
3.00 to 3.99	very moist
2.00 to 2.99	moderately moist
1.00 to 1.99	slightly moist
0.50 to 0.99	weakly moist
0.49 to -0.49	neutral
-0.50 to -0.99	weakly dry
-1.00 to -1.99	slightly dry
-2.00 to -2.99	moderately dry
-3.00 to -3.99	severely dry
≤ -4,00	extremely dry

## Results

Although we have examined a relatively large area of the Podunajská nížina Lowland and numerous field depressions were examined, the most interesting findings were recorded mostly on salinized soils around Komárno, Hurbanovo and Štúrovo (south-western Slovakia). Seven endangered plant species were recorded: one endangered (EN) species *Cirsium brachycephalum* Jur.; five

critically endangered (CR) species – *Heleochloa alopecuroides* (Piller et Mitterp.) Host ex Roemer, *Heleochloa schoenoides* (L.)Host ex Roemer, *Lindernia procumbens* (Krocker) Philcox, *Lythrum tribracteatum* (L.) Holub, *Schoenoplectus supinus* (L.) Palla.; the species *Chenopodium chenopodioides* (L.) Aellen is considered as probably extinct (EX?) in Slovakia.

Two new localities of ***Cirsium brachycephalum*** were recorded. In addition to the locality near Hurbanovo (tab. 2), another locality situated south-eastern from Trávnica village (district Komárno) was found. There, approximately a hundred individuals were growing at south-eastern part of narrow field depression long about 500m. ***Heleochloa alopecuroides*** was found at one locality (tab.2); few individuals were also growing solitary in adjacent corn field. The discovery of field depression at this locality was interesting because three rare species were found growing at one place. More, it was the only locality with ***Lindernia procumbens*** occurrence, the species very rare in the Podunajská nížina lowland. Another species rarely occurring at our survey area was ***Lythrum tribracteatum***, hence, the records of two new localities were valuable, even though only one individual was found at the locality Zlatná na Ostrove (tab.2). In 2010, we recovered the occurrence of ***Heleochloa schoenoides*** at several recently or longer known localities. Two new localities were found (tab.2), the record at the locality Zlatná na Ostrove was of high value as we found big population reaching several thousand individuals there. The species ***Chenopodium chenopodioides*** was found at one locality (tab. 2). There, the fields all around were completely flooded in spring and in beginning autumn denudated banks were covered with sparse vegetation of segetal or marsh species. ***Schoenoplectus supinus*** was recorded at five localities. The most valuable was the finding of the field depression at the locality Zemianska Olča (south), where we recorded thousand individuals of *S. supinus* growing on rather large area (tab. 2)

The PDSI values given in the Table 3 indicate that every month was defined as moist in 2010 at the surveyed area. The most interesting is the period from May to the end of year – according PDSI these months were defined as extremely moist. This extremely moist year followed after three dry years (Tab. 3)

**Table 2:** The occurrence of selected endangered plant species recorded in field depressions at the localities of Podunajská nížina lowland in 2010. The short description of the localities, approximate area and number of individuals, the measure of abundance/cover according modified Braun-Blanquet cover-abundance scale is given.

Name of the locality	date	Locality description	Approx. area	species	Approx. number of individuals	Braun-Blanquet (abundance/cover level) <sup>1</sup>
Hurbanovo	5.10.2010	field depression at the edge of corn field	600 m <sup>2</sup>	<i>Cirsium brachycephalum</i>	20	+
Iža, part hon Konopište	16.9.2010	field depression at the edge of corn field	400m <sup>2</sup>	<i>Heleochloa alopecuroides</i>	several tens	+
				<i>Schoenoplectus supinus</i>	several tens	2a
				<i>Lindernia procumbens</i>	10	+
Zlatná na Ostrove, part Majer Pavol	16.9.2010	field depressions at the edge of wheat field	1000m <sup>2</sup>	<i>Heleochloa schoenoides</i>	several thousand	4
		salinized field depression in the wheat field	not estimated	<i>Lythrum tribracteatum</i>	1	r
Okánikovo	24.8.2010	field depression at the edge of corn field	500m <sup>2</sup>	<i>Schoenoplectus supinus</i>	not estimated	+
				<i>Lythrum tribracteatum</i>	several hundred	2a
Zemianska Olča, north of village	24.8.2010	field depression in the corn field	100m <sup>2</sup>	<i>Heleochloa schoenoides</i>	into 50 individuals	1
				<i>Chenopodium chenopodioides</i>	several tens	1
Horná Zlatná	21.6.2010	field depression in the corn field	100m <sup>2</sup>	<i>Schoenoplectus supinus</i>	several tens	+
Zemianska Olča, south of village	16.9.2010	field depression in the corn field	1200 m <sup>2</sup>	<i>Schoenoplectus supinus</i>	several thousand	3 to 4

1Modified Braun – Blanquet cover-abundance scale

r solitary, 1-3 individuals

+ few individuals

1 < 4% (cover)

2a 5-10%

2b 11-25%

3 25-50%

4 50-75%

5 75-100%

**Table 3:** Monthly values of PDSI in the period 1990 - 2010. The data from climatological station in Hurbanovo (Podunajská nížina Lowland) were used for calculation

year	I.	II.	III.	IV.	V.	VI.	VII.	VIII.	IX.	X.	XI.	XII.
1990	-2.65	-3.02	-3.93	-3.16	-4.02	-4.08	-4.41	-5.12	-4.74	-3.79	-3.42	-3.12
1991	-3.52	-3.39	-3.57	-3.33	-2.65	-2.74	-2.26	-2.65	-3.12	-2.98	1.27	1.19
1992	-0.19	-0.5	-0.09	-0.25	-0.9	0.21	1.2	-1.22	-1.45	0.78	0.56	1.22
1993	1.27	-0.11	0.13	-0.45	-1.24	-1.49	-1.82	-2.29	-2.24	1.42	1.99	2.73
1994	3.09	2.72	2.19	2.51	3.07	2.63	1.7	1.89	1.91	2.95	2.41	1.72
1995	1.47	1.33	2.01	2.74	2.64	3.38	2.75	2.83	3.29	2.28	2.38	2.75
1996	3.36	3.5	3.13	3.76	4.67	4.1	4.13	3.65	4.1	-0.08	-0.67	-1.01
1997	-1.27	-1.84	-2.18	-1.68	-1.51	-2.13	-1	-1.63	-1.94	-2.08	-0.92	-1.27
1998	-1.16	-1.89	-2.34	-2.03	-2.41	0.37	0.69	0.24	1.91	2.67	2.7	2.35
1999	1.92	2.47	2.13	1.88	1.5	2.65	4.28	4.23	3.05	2.89	3.1	3.39
2000	3.2	2.71	3.48	0.02	-0.68	-1.96	-1.42	-2.15	-2.5	-2.92	-2.71	-2.56
2001	-2.4	-2.46	-1.61	-1.75	-2.19	-2.62	-1.6	-2.18	-0.97	-1.42	-1.62	-2.01
2002	-2.46	-2.87	-3.12	-2.64	-2.71	-3.34	-3.19	0.56	0.7	1.35	1.04	1.14
2003	1.38	-0.19	-0.83	-1.25	-1.62	-2.39	-2.87	-3.33	-3.87	-3	-3.46	-4
2004	-3.83	-0.03	0.27	-0.18	-0.38	0.93	0.36	1.34	-0.3	-0.38	-0.51	-0.74
2005	-0.93	0.4	0.03	0.44	0.17	0.05	0.1	0.78	-0.07	-0.54	-0.75	1.67
2006	2.59	2.92	3.1	2.69	3.49	3.24	2.54	2.92	-0.47	-0.91	-1.38	-2.33
2007	-2.54	-2.63	-2.42	-3.24	-3.29	-3.62	-4.43	-3.58	-2.68	-2.03	-1.83	-2.06
2008	-2.13	-2.69	-2.15	-1.93	-2.47	-2.2	-1.27	-1.63	-1.28	-1.79	-2.29	-2.14
2009	0.04	0.9	1.17	-0.91	-1.22	-1.14	-1.44	-1.51	-1.77	0.06	-0.07	0.47
2010	0.79	1.13	0.92	2.07	4.29	5.37	6.38	7.18	7.77	7.27	7.62	7.73

## Discussion

The rareness of the species discussed in this article has several reasons – most of them has the northern border of their distribution range in Slovakia; they are growing on specific stands - the sites flooded in spring and deeply drying on summer, especially they represents the species of mudflat bottoms; they are halophytes or sub-halophytes; they are mostly minute, low-growing plants with low concurrence ability (FERÁKOVÁ, GRULICH, 1999; HOLUB, 1999a,b; HOLUB, GRULICH, 1999a,b,c; PROCHÁZKA et al., 1999). We could consider the radical decrease of specific habitats area caused by landscape use change and more frequent occurrence of dry years as two important key factors negatively influencing distribution and occurrence these species in Slovakia

now. For this reason temporary pools on arable fields may have considerable importance in survival of these species in cultural landscape. The appearance of waterlogged arable fields is sporadic and irregular; it often happens that the fields are not covered by water for decades, but in some years floods appear because of high precipitation (LUKÁCS et al., 2013). And, this situation happened in the year 2010 in Slovakia. Similar conditions were also occurring in the year 2006 when the first eight months were defined as moderately to very moist; especially May and June were defined as the moistest in the year (tab. 3). In this year Sádovský (SÁDOVSKÝ 2006 ined) recently recorded 10 localities of *Cirsium brachycephalum* at Podunajská nížina Lowland and also *Heleochloa alopecuroides* was recovered at several localities in 2006 in Podunajská nížina Lowland (SÁDOVSKÝ 2006 ined., SÁDOVSKÝ, ELIÁŠ jun. 2006 ined). In 2005 five new localities of *Schoenoplectus supinus* were found in Východoslovenská nížina Lowland (ZLACKÁ et al., 2006), thousands of individuals were recorded at some of the localities. According PDSI calculated using data from Milhostov climatological station (south-eastern Slovakia) every month was defined as moist, and namely May and June were defined as moderately moist (ZUZULOVÁ, 2014). Similar to our records, *S. supinus* occupied field depressions, edges of field path or terrain depressions in pasture (ZLACKÁ et al., 2006), so the habitats considered as secondary for the species. The extreme conditions also influenced the population size of *H. schoenoides* in Mostové Nature Reserve (Podunajská nížina Lowland) in 2004, nine months were defined as dry (tab. 3), and population covered 5-10% of area, however in 2006 the population covered up to 50% at the same locality (ELIÁŠ jun. et al., 2008). Vegetation of ephemeral wetlands is growing in specific, highly dynamic habitats. The speed of plant development, short life cycles and long-term survival in dormant propagules is typical for these plants (DEIL, 2005). Large sections of the populations and/or communities of these particular species are at any time hidden in the soil propagule bank (POSCHLOD, 1993). The extreme moist conditions enable the species to supplement or renew the seed bank and increase the probability of their long-term survival.

All the species discussed in this paper belong to the most threatened plant

species in Slovakia. The question of conservation management is thus arising. The occurrence of temporary field pools in arable landscape is irregular, considering both temporal and spatial aspect. LUKÁCS et al., (2013) recommend many temporary pools in arable fields left alone (i.e. maintaining traditional farming); and NĚMEC & ŽÁKOVÁ (2012) proposed to eliminate the herbicides use in the surrounding area. At all events, the conservation of endangered species in agricultural landscape, i.e. out of protected area, requires specific approach; and when favourable conditions occur, the repeated observations are necessary to accurate records.

## **Conclusion**

During extreme moist years temporary pools in arable fields may appear more frequently and at larger area than usually. Vernaly inundated field depressions at salinised stands at Podunajská nížina lowland may serve as refugium for several rare or endangered halophytous plant species in agricultural landscape, and thus these species are able survive outside of protected areas. The repeated observations of this type of ephemeral wetlands are necessary to clearly understand the long-term dynamics of this specific plant community for effective conservation management of the rare species populations.

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### **Summary**

Biotopy slaných pôd sa na Slovensku vyskytovali v teplých a suchých oblastiach Podunajskej a Východoslovenskej nížiny. Ich plocha však bola výrazne zredukovaná počas posledných desaťročí; zástupcovia halofytnej vegetácie sa týmto stali ohrozenými druhmi slovenskej flóry. Rastlinné spoločenstvá periodicky zaplavovaných slanísk predstavujú jedinečné iniciálne štádiá sukcesie a ich vytváranie je závislé na poklese hladiny vody a zvyčajne sa vytvárajú v druhej polovici vegetačnej sezóny. Poľné depresie zaplavované v jarných mesiacoch môžu poskytnúť vhodné refúgium pre tieto rastlinné spoločenstvá v poľnohospodárskej krajine. Počas extrémne vlhkého počasia v roku 2010 boli vytvorené vhodné podmienky pre výskyt poľných depresí v oveľa väčšej miere ako počas normálne vlhkých alebo suchších rokov. Mapovanie vegetácie zaplavených depresí prebiehalo na Podunajskej nížine počas mesiacov máj až október v roku 2010. Na lokalitách s výskytom zriedkavých a vzácnych druhov bol vykonaný fytoocenologický zápis, pomocou GPS bola odhadnutá plocha na ktorej sa spoločenstvo vyskytovalo a odhadnutý bol aj počet jedincov záujmových druhov. Zaujímavejšie nálezy boli zaznamenané na zasolených pôdach poľí v okolí Komárna, Hurbanova a Štúrova. Zaznamenali sme nové lokality ohrozeného druhu (EN) pichliača úzkolistého (*Cirsium brachycephalum*), nové lokality piatich kriticky ohrozených

druhov (CR): bahienka psiarkovitá (*Heleochloa alopecuroides*), bahienka šašinovitá (*H. schoenoides*), lindernia puzdiekatá (*Lindernia procumbens*), vrbica drobná (*Lythrum tribracteatum*) a škripinec nízky (*Schoenoplectus supinus*). Pre mrlík slanmilný (*Chenopodium chenopodioides*), považovaný za pravdepodobne vyhynutý (EX?) na Slovensku, sme zaznamenali jednu novú lokalitu. Odhadovaná veľkosť sledovaných poľných depresí bola rôzna, od 100 do 1200m<sup>2</sup>, pričom na niektorých z lokalít sme zaznamenali výskyt dvoch aj troch druhov súčasne. Odhadované počty jedincov jednotlivých druhov a ich zastúpenie bolo rôzne na jednotlivých lokalitách, väčšinou sa pohybovali okolo niekoľko desiatok jedincov. Na dvoch najväčších poľných depresiách (1000, 1200m<sup>2</sup>) sme zaznamenali až tisíce jedincov bahienky šašinovitej a škripinca nízkeho, druhy boli zároveň aj dominantami na týchto lokalitách. Podľa PDSI boli všetky mesiace v roku 2010 definované ako vlhké v sledovanom území, od mája do konca roka boli mesiace definované ako extrémne vlhké podľa tejto klasifikácie. Zriedkavosť sledovaných druhov je spôsobená viacerými aspektmi: druhy majú na Slovensku severnú hranicu svojho areálu, rastú na veľmi špecifických stanovištiach (obnažené dná, zasolené stanovištia), väčšina z nich sú nízkeho vzrastu s malou konkurenčnou schopnosťou. Pokles počtu lokalít a plochy so špecifickými stanovištnými podmienkami a čoraz častejší výskyt suchých rokov považujeme za kľúčové negatívne faktory. Z tohto dôvodu sú zaplavované depresie na zasolených pôdach cennými lokalitami, kde môžu takéto druhy prežívať aj mimo chránených území. Ich výskyt v krajine je však nepravidelný tak z časového ako aj priestorového hľadiska. Vzhľadom na túto skutočnosť ako aj to, že tieto spoločenstvá majú veľmi špecifickú ročnú ako aj dlhoročnú dynamiku sú opakované sledovania potrebné pre pochopenie dlhodobej dynamiky a zabezpečenie efektívneho manažmentu a zachovania týchto vzácných rastlinných spoločenstiev a druhov.

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