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PLANT COMMUNITIES OF *CAREX DIVISA* HUDS. IN SLOVAKIA: PAST AND PRESENT

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Summary: Occurrence of *Carex divisa* is very rare in Slovakia, it is known only from the warmest areas of the Podunajská nížina Lowland, where is the northern limit of its distribution range. The species was historically documented in three associations of the *Juncion gerardii* alliance: *Scorzonero parviflorae-Juncetum gerardii*, *Agrostio-Caricetum distantis* and *Caricetum divisae*. The species at the present occurs in altered ruderalised vegetation developed on drained and damaged, formerly saline habitats. Therefore, currently sampled vegetation with the occurrence of the species cannot be clearly attributed to any particular association. We have found very scatter, depleted fragments of *Agrostio-Caricetum distantis* and *Caricetum divisae* associations, but we have not confirmed *C. divisa* in the association of *Scorzonero parviflorae-Juncetum gerardii* since the association has vanished in Slovakia.

Introduction

Carex divisa Huds. is a meridionale-west-eurasian element with subcontinental character of distribution (HOLUB and GRULICH 1999). The species has its centre of distribution range in the Mediterranean region from the Iberian Peninsula to Asia Minor, including the North African coast. In Europe, the occurrence of *C. divisa* extends north along the Atlantic coast in Belgium, the Netherlands and the British Isles, in Central Europe it is known in Austria, Slovakia and Hungary, and it extends to the east to the Black Sea Region (Romania, Bulgaria and Crimea). Furthermore, the species occupies area of the Middle East and extends also into the Caucasus (CASPER and KRAUSCH 1980, SCHULZE-MOTEL 1980, EGOROVA 1999). As alien it was found in North America and New Zealand (BALL and REZNICEK 2002).

In central Europe, at the northern limit of its distribution range, *Carex divisa* grows on poorly drained swampy pastures and wet saline meadows, but it is also typical to human-influenced habitats in ditches or along drainage canals. Habitats are usually flooded in the spring and dried in the summer. It requires dense, clay loam to sandy loam, always at least slightly salty soils adequately supplied with silt and nitrogen (DOSTÁL 1989, HOLUB and GRULICH 1999).

In Slovakia, *Carex divisa* was always known as a rare sedge species; it has been widespread only in the warmest areas of the Podunajská nížina Lowland (the Slovak part of Kisalföld). Since several historical sites disappeared (HOLUB and GRULICH 1999), it is evaluated as critically endangered and protected by law (FERÁKOVÁ et al. 2001). There were published only a small amount of phytosociological relevés of *Carex divisa* vegetation from Slovakia in the literature. The only available relevés were published by VICHEREK (1973) in his hitherto most comprehensive work on the salt steppes and meadows of the former Czechoslovakia. The author reported *C. divisa* within the alliance of *Juncion gerardii*

Wendelberger 1943 belonging to the class *Scorzonera-Juncetea gerardii* (VICHEREK 1973) GOLUB et al. 2001.

Juncion gerardii alliance associates halophytic and sub-halophytic plant communities occurring in warm lowland areas, which include several species of wet grasslands and pastures (BORHIDI 2003). Stands are usually consist of two- to three layers, plants with hemicryptophytic living form, as tufted grasses and other creeping or rhizomatous herbs dominate (ŠUMBEROVÁ et al. 2007). They are closely related to plant communities of brackish water marshes, especially to the association of *Astero pannonici-Bolboschoenetum compacti* Hejný et Vicherek ex Oťaheľová et Valachovič 2001 (OŤAHEĽOVÁ et al. 2001) and also to low-lying alluvial meadows of the *Deschampsion cespitosae* Horvatić 1930 alliance (syn. *Agrostion albae* Soó 1933) developed on moderate alkaline soils. According to VICHEREK (1962, 1965) it is also related to halophytic vegetation of alliances of *Puccinellion limosae* and *Festucion pseudovinae*. Distribution range of the *Juncion gerardii* alliance is associated to areas with significant influence of continental climate, it extends from the middle part of the river Ural (GOLUB et al. 2003), throughout Ukraine (DUBYNA et al. 2007), Bulgaria (ELIÁŠ et al. 2013), Romania (POP 2002, SANDA et al. 2008) and Hungary (MOLNÁR and BORHIDI 2003), to the northwest in Austria (WENDELBERGER 1943, 1950, MUCINA 1993) and South Moravia (VICHEREK 1962, 1973, ŠUMBEROVÁ et al. 2007). The alliance includes several associations (Wendelberger 1943, SLAVNIĆ 1948, VICHEREK 1973, MUCINA 1993, MOLNÁR and BORHIDI 2003); three of them have been documented in Slovakia: *Scorzonero parviflorae-Juncetum gerardii* Wendelberger 1943 *Agrostio-Caricetum distantis* Soó 1939 and *Caricetum divisae* SLAVNIĆ 1948. Occurrence of *Carex divisa* was historically reported in all this communities (VICHEREK 1973).

In this paper we present the results of our survey of existing vegetation residues of *Carex divisa* in Slovakia and their coenological evaluation comparing with published data.

Materials and methods

The research was conducted during 2007-2013 in the phytogeographical region of the Podunajská nížina Lowland. The phytosociological relevés were sampled according to the Zürich-Montpellier approach using the adapted nine-grade Braun-Blanquet's scale (BARKMAN et al. 1964). Nomenclature of flowering plants follows MARHOLD and HINDÁK (1998) and the names of syntaxa follow ŠUMBEROVÁ et al. (2007), communities not included in above mentioned reference are published with author abbreviations. The map was designed by program ArcGis 9.2, coordinates of localities were obtained during field research using GPS equipment. Phytogeographical divisions of FUTÁK (1980) are also used.

Results and discussion

During the field survey in the years 2007-2013 we have found *Carex divisa* in a few remaining residual fragments of saline habitats in the surroundings of villages Búč, Pribeta, Tvrdošovce, Jatov, and Močenok (Figure 1.). *Carex divisa* stands are significantly altered in most cases, enriched by several ruderal or mesophilic species, deprived of the most characteristic, especially halophytic species (Table 1.).

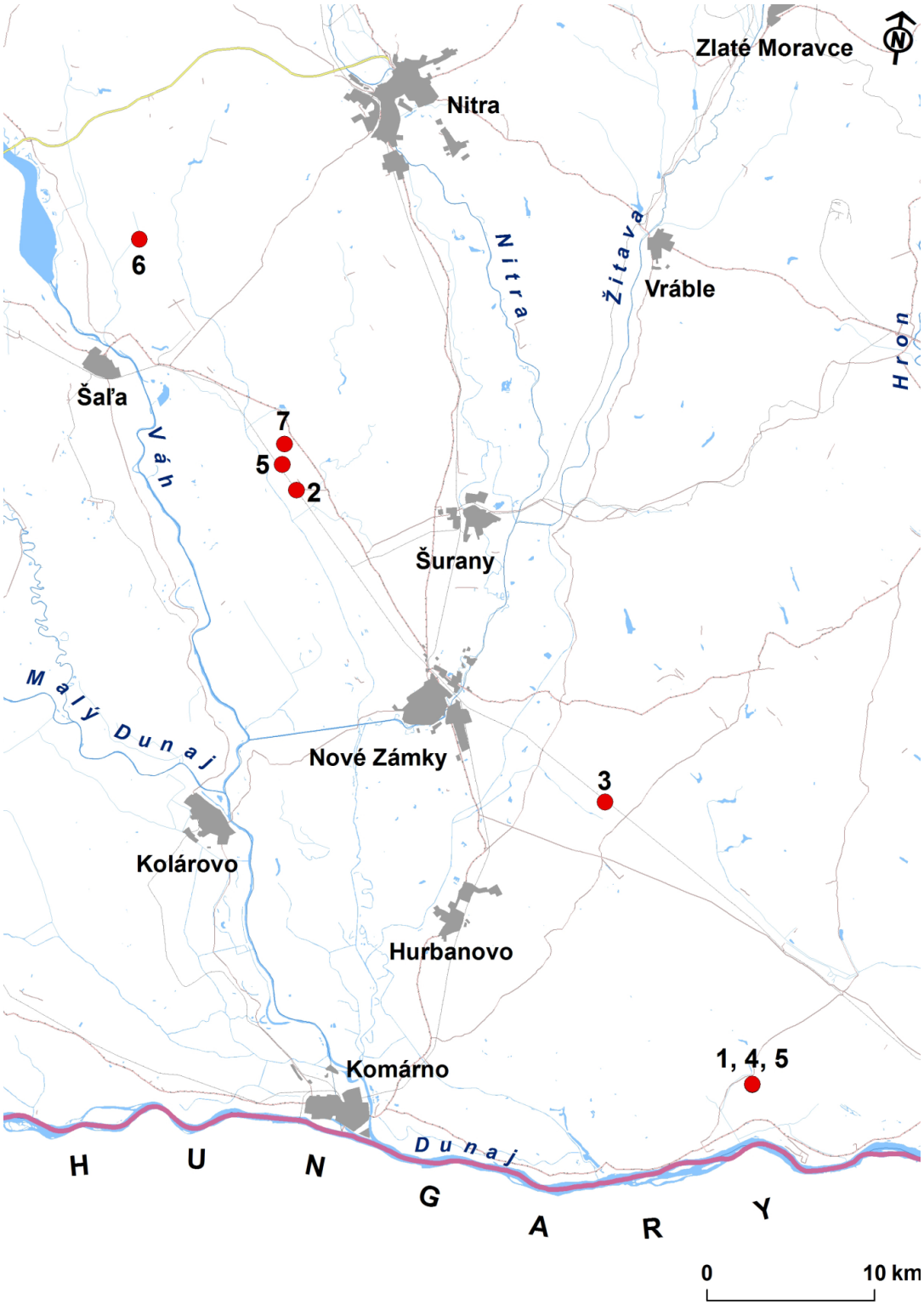

Figure 1. Distribution map of *Carex divisa* in Slovakia
1. Ábra A *Carex divisa* elterjedése Szlovákiában

Table 1. Synoptic table of communities with the occurrence of *Carex divisa* from Slovakia
1. táblázat A szlovákiai *Carex divisa* előfordulások összefogalaló cönológiai táblázata

Number of relevé	1	2	3	4	5	6	7	8
Area of relevé m²	16	16	16	16	16	16	16	16
cover E_1	70	98	80	70	90	70	70	70
cover E_0	0	0	0	3	5	0	2	0
Potentilla anserina	1	+	.	.	1	.	+	.
Pastinaca sativa	+	.	+	+	.	+	.	+
Carex divisa	4	b	b	3	b	a	b	b
Phalaris arundinacea	1	.	a	.	.	.	.	.
Agrostis stolonifera	.	4	.	.	1	.	a	.
Cynodon dactylon	.	+	.	.	.	+	.	+
Inula britannica	.	.	a	1	.	.	1	.
Potentilla reptans	.	.	a	.	a	.	.	1
Carex distans	.	.	.	b	3	+	+	+
Cirsium arvense	.	.	.	+	.	.	r	1
Drepanocladus aduncus	.	.	.	1	a	.	1	.
Ranunculus repens	.	.	.	.	a	1	.	+
Althaea officinalis	.	.	.	+	.	+	1	.
Poa angustifolia	.	.	.	.	.	1	b	b
Elytrigia repens	.	+	.	.	.	1	1	1
Convolvulus arvensis	.	.	.	.	.	+	.	+
Daucus carota	.	.	.	.	.	+	.	+
Carduus acanthoides	.	.	.	.	.	+	+	.
Carex praecox	.	.	.	.	.	+	1	.
Galium verum	.	.	.	.	.	a	.	+
Carex hirta	1	.	.	.	1	.	.	.
Juncus compressus	.	1	.	.	.	.	a	.
Alopecurus pratensis	.	.	1	.	.	.	.	+
Lathyrus tuberosus	.	.	+	.	.	.	.	1
Eleocharis uniglumis	.	.	1	.	1	.	.	.
Festuca arundinacea	.	.	.	1	.	.	.	1
Trifolium pratense	.	.	.	.	1	.	1	.
Carex vulpina	.	.	.	.	1	+	.	.
Achillea millefolium	.	.	.	+	.	.	.	a
Rumex crispus	+	.	.	.	.	.	.	r

Localities of relevés No:
1. Búč, road ditch south from the village, 18°26′41.3′′; 47°47′49.0′′, 106 m a. s. l., 15. 5. 2011. **2.** Tvrdošovce, temporary flooded former football field, 18°02′28.1′′; 48°05′36.4′′, 112 m a. s. l., 12. 9. 2011. **3.** Pribeta, Mikuláš farmstead, ditch along rails, 18°02′28.1′′; 47°56′28.0′′, 113 m a. s. l., 15. 5. 2013. **4., 5.,** Búč, Búčske slanisko Nature Reserve, shallow mowed depression in eastern part of the site, 18°26′41.2′′; 47°47′49.2′′, 106 m a. s. l., 15. 5. 2011. **6.** Tvrdošovce, Panské lúky site, left bank of the drainage channel, 18°01′40.0′′; 48°06′23.8′′, 113 m a. s. l., 20. 5. 2012. **7.** Močenok, Siky farmstead, periodically flooded edge of saline pastures, 17°53′51.4′′; 48°13′12.7′′, 115 m a. s. l., 10. 6. 2013. **8.** Jatov, abandoned remnants of saline meadows SW from the village, 18°01′41.5′′; 48°07′03.4′′, 118 m a. s. l., 15. 5. 2012.

Species recorded in one relevé only:

Mentha aquatica **1** (1*), Lycopus europaeus* **2a** (1), *Ranunculus sardous* + (1), *Bolboschoenus maritimus* agg. + (2), *Atriplex prostrata* **r** (2), *Typha latifolia* + (2), *Juncus articulatus* **1** (2), *Phragmites australis* **1** (3), *Poa pratensis* **2a** (3), *Carex tomentosa* **2b** (3), T*araxacum* sect. *Palustria* **1** (4), *Carex riparia* **2a** (4), *Ranunculus acris* + (4). *Poa trivialis* **1** (5), *Plantago major* subsp. *winteri* **1** (5), *Apium repens* + (5), *Sonchus arvensis* **2b** (6), *Asparagus officinalis* **r** (6), *Cardaria draba* + (6), *Dactylis glomerata* + (6), *Lotus tenuis* **1** (7), *Trifolium repens* + (7), *Carex melanostachya* **1** (7), *Epilobium tetragonum* + (8), *Taraxacum* sect. *Ruderalia* **r** (8), *Jacea pratensis* **2a** (8), *Calamagrostis epigejos* + (8), *Senecio jacobaea* + (8), *Linaria vulgaris* + (8), *Tetragonolobus maritimus* **1** (8), *Knautia arvensis* + (8), *Euphorbia esula* + (8), *Festuca rupicola* + (8), *Plantago lanceolata* **r** (8), *Arrhenatherum elatius* + (8), *Festuca pseudovina* + (8), *Myosotis ramosissima* + (8), *Odontites vernus* + (8), *Lotus corniculatus* **r** (8), *Rhinanthus minor* + (8).

South from the village Búč in a road ditch, we have found coenologically ambivalent stands with high abundance of *Carex divisa* (50-75%), which is typical for the *Caricetum divisae* association (Table 1, relevé 1). However, there is a lack of the most characteristic species of the association. Similarly, relevés 4 and 5 (see Table 1.) sampled in the Búčske slanisko Nature Reserve represent altered vegetation of *Caricetum divisae* directed now rather to depleted vegetation of *Agrostio-Caricetum distantis* association. *C. divisa* stands are here developed in shallow, occasionally flooded large depression in drained and desalinized habitat on sandy soil. The vegetation although represent the richest known population of the species in Slovakia.

Regarding other existing locations (Pribeta, Tvrdošovce, Jatov, Močenok), the vegetation consists of a mixture of species of mesophilic grasslands (e.g. *Carex praecox*, *Daucus carota*, *Festuca arundinacea*), species tolerant to low salt content in the soil (e.g. *Althea officinalis*, *Cynodon dactylon*, *Pastinaca sativa*, *Potentilla anserina*) and ruderal taxa as *Cirsium arvense*, *Carduus acanthoides* and *Elymus repens*. This vegetation among the similar wet meadows is relatively species-poor, includes 10 to 25 species per relevé. The exception is relevé 8 (Table 1), where we sampled *C. divisa* in a last year ploughed fragment of saline habitat, surrounded by intensive farmland. On the size of 16 m^2, 35 species of vascular plants were recorded; mesic grassland species were in a large proportion, but with minimal coverage. The common feature of each remaining occurrence is the fact that all recorded localities were largely extended saline habitats in the past, which today remained only in scattered fragments. Except *C. divisa,* only few other species (mainly subhalophytes) indicates the reduced soil salinity.

VICHEREK (1973) published 10 relevés of *Caricetum divisae* from the surrounding of villages of Búč and Mužla. *C. divisa* reaches here high abundance (50–) 75 – 100%. In addition, he recorded a very rare occurrence of the species with low cover in the *Scorzonero parviflorae-Juncetum gerardii* association north from Štúrovo near settlements of Kamenný Most and Diva. VICHEREK (l. c.) also published a single relevé with the presence of the species with low cover in the phytosociological table of the association of *Agrostio-Caricetum distantis* in saline wet meadows from the same region near the village of Kamenín. Compared with the published relevés from Slovakia in the past (see VICHEREK 1973), currently we have not recorded typical vegetation of *C. divisa* clearly allocable to any of the associations of the *Juncion gerardii* alliance.

Several authors (OSVAČILOVÁ and SVOBODOVÁ 1961, VICHEREK, 1973) reports the association of *Scorzonero parviflorae-Juncetum gerardii* from more sites between settlements of Komárno and Štúrovo (Kamenín, Kamenný Most, Diva, Gbelce, Kravany nad Dunajom, Hájske and Močenok), now these occurrences have disappeared (ELIÁŠ jun., DÍTĚ and MELEČKOVÁ ined.). The most extensive areas of this vegetation are north of Štúrovo, which were published later as well (SVOBODOVÁ and ŘEHOŘEK 1988, without relevés), but recently it was not confirmed. Similarly, we have neither confirmed the occurrence of *Carex divisa* in this area together with other species of this association such as *Scorzonera parviflora* or *Triglochin maritima*. Therefore, we believe that the association is extinct in Slovakia. The closest stands are relatively still preserved in a small area of Töltéstava near the city of Győr (SCHMIDT 2007) where the vegetation with typical species can be considered as *Scorzonero parviflorae-Juncetum gerardii* (DÍTĚ and MELEČKOVÁ 2012 ined.).

Concerning other association of *Juncion gerardii* with the presence of *Carex divisa*, *Agrostio-Caricetum distantis* still preserves stands relatively alike to *Caricetum divisae*. This community is in fact very heterogeneous (SLAVNIĆ 1948, MUCINA 1993) due to the wide ecological variability such water regime, nutrients and salinity; seven subassociations were described within its distribution range (BOZÓ 1993), while in Slovakia there were distinguished two (VICHEREK 1973). Currently recorded stands near the village of Búč (relevés 4 and 5) represent only depleted remnants and cannot be regarded as typical vegetation of this association.

Lower from the northern distribution limit, in the rest of Pannonian Lowland, *Carex divisa* dominated vegetation occupies habitats with stagnating water as micro-depressions in wet saline meadows (BAGI and MOLNÁR 2011), secondary occurs even in poorly drained ditches of warm lowland areas. In Hungary the species is also rare (KIRÁLY et al. 2009). Apart from the Kisalföld, it is known from the lower Maros river (DRĂGULESCU 1995), it is still surviving in Örsöd, part of Budapest (MELEČKOVÁ and CSATHÓ 2011, unpubl.) and it is known from the upper Bácska (CSATHÓ et al. 2012 ined.), while recently, the most typical stand was reported from Hódmezővásárhely in *Caricetum divisae* association (JAKAB 2005, DÍTĚ et al. 2012 ined.). Most of these stands are threatened by the expansion of *Phragmites australis*.

Conclusions

A limiting factor in the development of the *Carex divisa* community is a significant impact of anthropo-zoological activities (FEHÉR 2007), especially grazing and partly mowing in addition to undisturbed water regime. Due to the absence of traditional farming together with drainage, the *Caricetum divisae* in Slovakia is more uncharacteristic than in Hungary. We did not find any typical vegetation of this association in the recent, only fragments were sampled which under the persistence of negative effects are going to degrade and disappear. However, populations of the species are not endangered by extinction, since this sedge tolerates more radical disturbances such as shallow ploughing.

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Kulcsszavak: *Carex divisa,* sótűrő növények, szíkes rétek, növénytársulástan, Kisalföld

Összefoglaló: A csátés sást (*Carex divisa*) Szlovákiában ritka fajként tartjuk számon, csak a legmelegebb alföldi területekről ismert, areája északi határa a Kisalföld mentén húzódik. A faj három jellegzetes sziki szittyós (*Juncion gerardii*) társulásban fordul elő: *Scorzonero parviflorae-Juncetum gerardii*, *Agrostio-Caricetum distantis* és *Caricetum divisae* asszociációk. A csátés sás állományképe mára megváltozott, a lecsapolt, korábban szíkes élőhelyeken gyomosodó kevésbé jellegzetes növényzet alakult ki. Ezért egyetlen mai ismert állománya sem tulajdonítható cönológiailag az adott asszociációk valamelyikének. Szórványosan *Agrostio-Caricetum distantis* és *Caricetum divisae* asszociációkban sikerült a fajt dokumentálni, viszont a *Scorzonero parviflorae-Juncetum gerardii* asszociációban nem, ez a társulás már Szlovákiában eltűnt.