

Carex divisa in Slovakia: overlooked or rare sedge species?

Daniel Dítě¹, Pavol Eliáš jun.² & Zuzana Melečková^{1,*}

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Kľúčne besede: *Carex divisa*, halofiti, rozšírenosť, Slovaška.

Abstract

Historical and current occurrence of halophytic species *Carex divisa* was studied in Slovakia during 2003–2014. It is known only in the Podunajská nížina Lowland, SW Slovakia, where 19 sites were found in total including historical and recent locations. Recently, the number of records decreased markedly and we confirmed only 9 localities. Due to the sharp reduction in the number of sites and appropriate habitats, *Carex divisa* is re-evaluated as endangered (EN) plant species of the Slovak flora.

Izvleček

Proučili smo nekdanjo in sedanjost razširjenost halofitske vrste *Carex divisa* na Slovaškem v letih 2003 in 2014. Njena nahajališča so znana samo iz ravnine Podunajská nížina (jugozahodna Slovaška), kjer smo našli skupno 19 nahajališč, zgodovinskih in sedanjih. V zadnjem obdobju je število nahajališč močno upadlo in potrdili smo jih samo devet. Zaradi močnega upada števila nahajališč in primernih rastišč smo vrsto *Carex divisa* ponovno opredelili kot ogroženo (EN) rastlinsko vrsto flore Slovaške.

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¹ Institute of Botany, Slovak Academy of Sciences, Dúbravská cesta 9, SK-845 23, Bratislava, Slovakia. E-mail: daniel.dite@savba.sk, zuzana.meleckova@savba.sk

² Department of Botany, Slovak University of Agriculture, Tr. A. Hlinku 2, SK-949 76 Nitra, Slovakia. E-mail: pavol.elias.jun@gmail.com

* Corresponding author

Introduction

Carex divisa Huds. (Figure 1 and 4) is a meridionale-west- Eurasian element with subcontinental distribution (Holub & Grulich 1999). The area of the species covers the Mediterranean region from the Iberian Peninsula to Asia Minor, including the North African coast. It expands north along the Atlantic coast of Belgium, the Netherlands and the British Isles. In Central Europe, *Carex divisa* is known from Austria, Slovakia and Hungary, extending 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 & Krausch 1980, Schulze-Motel 1980, Egorova 1999). As alien species it was found in North America and New Zealand (Ball & Reznicek 2002).

In Central Europe *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 moderately dried in the summer. It requires heavy,



Figure 1: Inflorescence of *Carex divisa* (photo D. Dítě).
Slika 1: Socvetje vrste *Carex divisa* (foto D. Dítě).

clay loam to sandy loam, always at least slightly saline soils adequately supplied with silt and nitrogen (Schulze-Motel 1980, Dostál 1989, Holub & Grulich 1999).

In Slovakia, *Carex divisa* was always regarded as a rare sedge species; it has been widespread only in the warmest areas of the Podunajská nížina lowland. Since several historical sites have disappeared (Holub & Grulich 1999), it is included in the Slovak Red List of rare and endangered plants (Eliáš et al. 2015) and protected by law (Anonymous 2003).

In the past, only Vicherek (1973) published phytocoenological relevés with *Carex divisa* in Slovakia. The author reported *C. divisa* in the alliance *Juncion gerardii* Wendelberger 1943, within the class *Scorzonero-Juncetea gerardii* (Vicherek 1973) Golub et al. 2001. The alliance includes several associations (Wendelberger 1943, Slavnič 1948, Vicherek 1973, Mucina 1993, Molnár & Borhidi 2003); three of them were documented in Slovakia: *Scorzonero parviflorae-Juncetum gerardii* Wendelberger 1943, *Agrostio-Caricetum distantis* Soó 1939 and *Caricetum divisae* Slavnič 1948. Occurrence of *Carex divisa* was historically recorded in all of these communities (Vicherek 1973).

Actual coenological studies of *Carex divisa* in Slovakia provided Melečková et al. (2013a). On the recently known locations it occurs only in altered vegetation of former saline meadows, today declined due to changes in the water regime and abandonment. Since the ruderalization of the stands is high, the vegetation with *Carex divisa* cannot be regarded as one of the mentioned syntaxa. It was confirmed very rarely in impoverished fragments of associations *Agrostio-Caricetum distantis* and *Caricetum divisae*. The *Scorzonero parviflorae-Juncetum gerardii* association wherein the species was formerly recorded (Vicherek 1973), is recently missing in Slovakia (Melečková et al. 2014).

The paper is aimed to clarify in detail the historical and present distribution of *Carex divisa* in Slovakia.

Material And Methods

The study was carried out during the period 2003–2014 in the Podunajská nížina Lowland (SW Slovakia). Historical data concerning the distribution of the species were obtained from herbaria BP, BRA, BRNU, BRNM, LTM, MMI, MZ, NI, KO, OLM, PMK, PR, PRC, SAV, SLO and ZV. Floristic survey on the field was carried out to confirm recent localities of the species. Herbarium specimens collected during this research are stored in herbarium NI. Herbarium abbreviations are according to Vozárová & Sutorý (2001) and Thiers (2015). Results of this study

are presented on the point map. The map was designed by program ArcGis, version 9.2. Coordinates of historical localities were taken from Google Earth. Garmin CS 60 GPS equipment was used to obtain coordinates of recent localities. Nomenclature of flowering plants follows Marhold & Hindák (1998). Phytogeographical divisions of Slovakia follow Futák (1980).

Results

During our study, 19 reliable sites of *Carex divisa* were found (Figure 2); 13 of them have been documented by herbarium specimen, four sites were published in the literature not vouched by herbarium specimen and two *C. divisa* sites were not published yet (see Appendix). All those sites are located in the Podunajská nížina lowland (SW Slovakia), mostly on its central and southeastern part. Literature data from the Podunajská nížina Lowland, Východoslovenská nížina Lowland as well as presence of *C. divisa* in the Borská nížina Lowland we regard as doubtful.

In terms of the timeline, 7 sites disappeared before 1975 (40%), next four sites in period 1975–2000 (20%). In the recent, eight sites of *C. divisa* are recorded (40%), from which two were known already in the past (Panské

lúky site near Tvrdošovce and Búč) and six of them were found recently, between 2011 and 2014. Except one site (Búč), we found only poor populations surviving in remnant habitats.

More detailed information about the current populations of *Carex divisa* in Slovakia are listed below from the west to the east locations:

Močenok, Siky farmstead

Carex divisa grows here in a flat depression of intensively grazed saline grasslands of the alliances *Puccinellion limosae* and *Festucion pseudovinae*. Continuously from the first observation by the authors (2009) more or less stable population (more than 500 individuals) are present on 15 × 15 m area. Plants vitality and the species composition are varying in each year in accordance with the intensity of precipitation.

Jatov

The site of *Carex divisa* was discovered in 2011 in ruderalized halophytic vegetation south of Jatov settlement, the population covers approx. 10 × 10 m area. In 2012 the whole site (10 ha) was ploughed, nevertheless it was found there even later in 2013 and 2014. The species survived the ploughing and on a 5 × 5 m area the population counted 500 individuals.

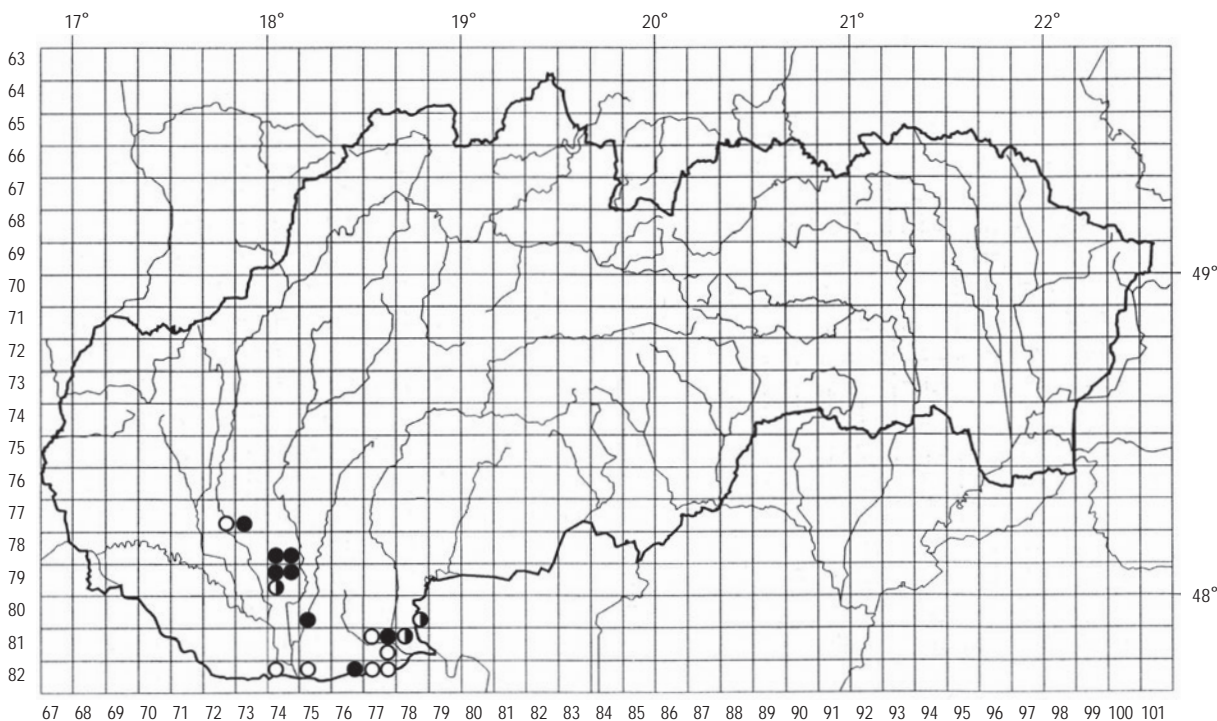


Figure 2: Distribution of *Carex divisa* in Slovakia: ○ – before 1975, ◐ – 1975–2000, ● – after 2000.

Slika 2: Razširjenost vrste *Carex divisa* na Slovaškem: ○ – pred letom 1975, ◐ – med letoma 1975 in 2000, ● – po letu 2000.

Tvrdošovce, Panské lúky Natura 2000 site

We have found a small population of *Carex divisa* on the left bank of the Jatovský kanál drainage channel west of Tvrdošovce settlement. The stands grow in ruderalized, heterogeneous vegetation on less than 15 m² area on the steep bank of the channel (slope 45°).

Tvrdošovce, railway station

Low population restricted to a small area (cca 5 × 5 m) was recorded on the abandoned rural football pitch located in the frequently flooded, ruderalized saline meadow.

Palárikovo, Malé Čiky farmstead

A small population (up to one hundred individuals) of *Carex divisa* has been found in 2014 east of Palárikovo settlement. The vegetation is degraded to mesic *Arrhenatherion* stands with *Crataegus monogyna* shrubs, halophytes (except halotolerant *Carex distans*) do not occur. The site Malé Čiky represents a formerly large area of halophytic vegetation highly attacked by agricultural activities such as ploughing and draining, today it suffers from secondary succession.

Pribeta, Mikuláš farmstead

We have found the species in a ditch next to the railway in degraded subhalophytic stands, which remained as remnants of original halophytic vegetation. *Carex divisa* has a relatively dense population occupying an area 4 × 8 m.



Búč, Jurský chlm Nature Reserve

The site was found in 2003 by M. Sádovský, but it was not published. The species grow at the foot of the terrace of the Danube River in mesophilic vegetation with the occurrence of expansive (*Calamagrostis epigejos*) and invasive species (*Solidago canadensis*). Population size, the number of individuals and current status are not known.

Búč, Búčske slanisko Nature Reserve

The largest population of *Carex divisa* and its largest area of occupancy in Slovakia is in Búčske slanisko Nature Reserve south of Búč settlement. The species was recorded mostly on the eastern part of the reserve, on 1 ha of large shallow depression with subhalophytic vegetation co-dominated with *Carex distans*. Outside of the protected area we found the species in a ditch along to the road Búč – Kravany nad Dunajom, 200 m north from the agricultural buildings.

Kamenín, Kamenínske slanisko Nature Reserve

(Figure 3a-b).

The site is considered as the largest and most interesting saline habitat in Slovakia. A number of halophytic plant communities have disappeared from the 1970s due to the drainage and abandonment. The last records of *Carex divisa* came from Kusák (1988 OLM and Holub & Grulich 1999). After re-introduction of grazing in 2013 by mixed herd (grey cattle, water buffalo, horses and goats), the species was observed on the exposed saline soil in the



Figure 3a-b: Locality Kamenínske slanisko Nature Reserve where *Carex divisa* appeared in 2015 in pioneer saline soil, shortly after re-introduction of grazing.

Slika 3 a-b: Naravni rezervat Kamenínske slanisko, kjer se je leta 2015 ponovno pojavila vrsta *Carex divisa* na pionirskem rastišču na slanih tleh, v kratkem času po ponovni vzpostavitvi paše.



Figure 4: Detail of vegetation with *Carex divisa* and *Carex distans* in Búčske slanisko Nature reserve (photo Z. Melečková).

Slika 4: Izgled vegetacije z vrstama *Carex divisa* in *Carex distans* v naravnem rezervatu Búčske slanisko (foto Z. Melečková).

wheel-tracks trampled by cattle in 2015. It shows that soil disturbance encouraged the development of this low-competitive halophyte.

Discussion

Carex divisa reaches the northern edge of its distribution in Slovakia (Holub & Grulich 1999). Its occurrence was not compiled in detail, there were published only scarce data. The first record was given relatively late. Nábělek collected it near Kamenín in 1936 (Nábělek 1936 SAV); the first published data gives Domin (1933) from the surroundings of Mužla village. Krist (1940) mentions three localities of the species (Kamenín, Ľubá, Búč), but he marked one more place in his map (p. 25) without comments. We believe that he indicated site “Irtoványi rétek” near Kamenný Most village, because the symbol is in close proximity to Kamenín which is already commented in the text. Krippelová (1967) published two sites with *Carex divisa*: at the town of Komárno near Nová Stráž and Pavel farmsteads. Vicherek (1973) provided phytosociological relevés from five locations, which were previously

mentioned by Domin (1933) and Krist (1940). The most data (seven sites), were published later, in the Red Book of the Slovak flora (Holub & Grulich 1999).

Our results showed, that the species is reliably confirmed only in the Podunajská nížina Lowland, occurrence in the Borská nížina Lowland (W Slovakia) was not documented during our study in herbaria, although Holub & Grulich (1999) mention its occurrence referring to herbarium specimen from this area. Literature data from the Východoslovenská nížina Lowland (Ložín, Olchov Nature Reserve) we regard as doubtful, too. Tkáč (1989) includes *C. divisa* as a component of floodplain forest association *Carici elongatae-Alnetum*. According to the literature and our observations, *C. divisa* is a heliophyte preferring open habitat types and its occurrence in floodplain forest vegetation is unlikely. Similarly, the historical data from Galanta, along the river Váh (Hruby 1942) is also arguable, since the *C. divisa* is mentioned with species of tall-herb floodplain vegetation and periodically flooded pioneer habitats.

Many sites of most of halophytes have declined or disappeared due to the intensification of the agriculture in the 1970s, e.g. *Acorellus pannonicus* (Eliáš et al. 2003),

Artemisia santonicum subsp. *patens* (Dítě et al. 2013), *Crypsis aculeata* and *Heleochoa schoenoides* (Eliáš et al. 2008), *Hordeum geniculatum* (Dítě et al. 2012a) etc. In the same period, the total area of halophytic vegetation in south Slovakia has significantly reduced (Sádovský et al. 2004, Fehér 2007). Similar land use changes have resulted reduction of sites with halophytic vegetation in NW Hungary in the Kisalföld region (Schmidt 2007).

Such a significant reduction in the number of sites was observed also in the case of *Carex divisa* (Figure 1). During our investigation on saline vegetation in Slovakia, we confirmed only 14% of the formerly known and documented sites, however, we discovered six new locations as well. On the other hand, our new findings also highlight that the species could be more common in the past, when saline habitats occupied larger areas, but it was probably overlooked due to confusion with the very similar *Carex praecox*. Other reason might be the intensive grazing in the past – individuals might have been completely overgrazed and the species was not determinable. Despite that *C. divisa* is a very rare representative of the Slovak flora today and its inclusion in the Red List of fern and vascular plants in the category “endangered” (EN) is eligible (Eliáš jun. et al. 2015).

Recently, vegetation with *Carex divisa* (except the stands of Búčske slanisko Nature Reserve) represents coenologically undefined remnant vegetation (Melečková et al. 2014). Ruderal species like *Cirsium arvense*, *Carduus acanthoides*, *Cardaria draba* and *Elytrigia repens* are frequent, accompanied by lowly specialized, mesic generalists such as *Dactylis glomerata*, *Alopecurus pratensis* and others. *Carex divisa* is found on highly damaged vegetation as well, it is able to survive drastic intervention like ploughing (e.g. in Jatov) and it can occupy secondary habitats where water level is still fluctuating (e.g. road ditches).

Species with marginal distribution range have special phenomenon. The span of their ecological tolerance in sub-optimal conditions tend to decrease (Dítě et al. 2012b, 2013). They are more specialized, restricted to a lower range of natural habitats and their indication value may increase (Borhidi 2003). However, *Carex divisa* has different behaviour. It is an obligate halophyte (Krist 1940) and among halophytes occurring in Slovakia, it can be found in a wider range of semi-natural grasslands and marshes, from solonchak wet meadows (alliance *Juncion gerardii*) to successional stages of mesic meadows of the alliance *Arrhenatherion elatius*.

More to the south, where it has more optimal conditions (mainly higher temperature), it is relatively common (Domac 1994, Király 2009). In the centre of its area it occupies larger variety of non-forest habitats. Except

saline meadows of the classes *Scorzonero-Juncetea gerardii* it can be found on periodically inundated meadows of the alliance *Molinion* e.g. in Vojvodina (Slavnić 1948). It is very abundant in maritime brackish wetlands of the class *Juncetea maritimi*, its cover can reach more than 75%, for instance, on the Island of Pag, Dalmatia (Dítě et al. 2015).

To preserve the species and its habitats in Slovakia, an active approach is required. It is necessary to keep on yearly mowing of the richest population in the Búčske slanisko Nature Reserve, ideally to combine with cattle grazing as it was before the 1970s. Sites in Mikuláš farmstead and Tvrdošovce, Panské lúky are also required mowing or grazing. It is necessary to avoid ploughing of halophytic vegetation remnants, since they are habitats of European importance and are protected by the Natura 2000 system.

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Appendix

List of locations of *Carex divisa* in Slovakia
 (localities were arranged in direction west – east).

Distr. 2. Ipel'sko-rimavská brázda area: between villages of Malé Kosihy and Pastovce (Holub & Grulich 1999).

Distr. 6. Podunajská nížina Lowland: Zlatná na Ostrove, Pavel farmstead, E – Komárno, Nová Stráž (both data Krippelová 1967). – Palárikovo, fragment of saline vegetation E from the village and aprox. 1 km S from the train station (Grulich 1988 MMI; Holub & Grulich 1999). – Palárikovo, Malé Čiky farmstead (Sádovský 2014 ined.). – Tvrdošovce, Panské lúky (Hejný 1953 PR; Hlobilová et Grulich 1988 OLM; Holub & Grulich 1999; Dítě 2012 NI). – Tvrdošovce, near train station (Dítě 2011 NI; Eliáš jun. et Dítě 2012 NI). – Jatov, salt meadows S from the village (Dítě 2012 NI). – Močenok, Siky farmstead (Eliáš jun. et Dítě 2010, 2013 NI). – Chorín, Dolné Konopište site [Kenderlap] (Jos. Dostál 1960 PR). – Pribeta, Mikuláš farmstead (Melečková, Dítě et Grulich 2012 NI; Eliáš jun., Dítě et Melečková 2013 NI). – Búč, meadows in S edge of the village (Krist 1938 BRNU; Krist 1940; Vicherek 1962 BRNU; Dvořák 1963 BBA, PR; Vicherek 1973; Holub & Grulich 1999; Eliáš jun., Dítě et Melečková 2011 NI). – Búč, Jurský chlm farmstead (Sádovský 2003 ined.). – Čenkov (Domin 1933). =? between settlements of Mužla and Kravany nad Dunajom, Čenkovské lesy site

(Moravec 1948 PR). – Mužla, saline site SW from the settlement near road no. 63 (Dvořák 1962 BRA; Vicherek 1962 BRNU; Vicherek 1973; Holub & Grulich 1999). – Ľubá, Korytnisko site [Libád, Teknyós-völgy] (Krist 1938 BRNU, Krist 1940). = Diva (Vicherek 1973). – Kamenín (Nábělek 1936, 1937 BRA, BRNU, SAV; Deyl 1951 PR; Unar 1965 BRNU; Vicherek 1973; Kusák 1988 OLM; Holub & Grulich 1999). – between settlements of Kamenín and Kamenný Most (Dvořák 1957 BRNU). – Kamenný Most, Alsó rétek (Šourek 1951 PR). = Kamenný Most, Irtoványi rétek (Šourek 1951 PRC; Smejkal et Vicherek 1962 BRNU; Vicherek 1973; Holub & Grulich 1999). = Kamenný Most, near the drainage channel (Černoch 1953 PR). = Kamenný Most, salt meadows near railway (Dvořák 1953 BRA, 1957 BRA, OLM; Manica 1962 ZV). – Kamenný Most, N of the mouth of the Paríž stream to Hron river (Svobodová & Řehořek 1988, p. 24).

Doubtful data (not mapped): Galanta, marsh and floodplain meadows along the Váh River NE from town (Hruby 1942: 108). – Kamenný Most, Irtoványi rétek (recently named as PR Čistiny Nature Reserve): confused with *C. praecox* (Melečková et al. 2013b). – Ložín, Olchov Naure Reserve, floodplain forest (Tkáč 1989).

General information: Borská nížina Lowland (Holub & Grulich 1999). – saline habitats in southern Slovakia (Novák 1954). – area around Dunaj river – around Štúrovo – Dolné Pohronie region (all data Dostál 1989; Dostál & Červenka 1992).