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GAGEA BOHEMICA IN SLOVAKIA: 1. TAXONOMY AND DISTRIBUTION

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Abstract
Distribution, morphological types and coenotic affinity of *Gagea bohemica* in Slovakia was studied during 2008–2011. Revision of herbarium material showed presence of three taxa in the flora: 1) subsp. *bohemica*, 2) subsp. *bohemica* var. *stenochlamydea* and 3) subsp. *saxatilis*. Taxonomic status of var. *stenochlamydea* is uncertain and requires further research. In total, 42 localities of *G. bohemica* sensu lato were documented. Nominate subsp. *bohemica* (including var. *stenochlamydea*) predominated and it was recently confirmed at 21 localities. These current sites represent about 50% of all known sites, therefore we re-assessed the status of *G. bohemica* in the Slovak Red List and we proposed the IUCN category EN (endangered) for this taxon. Subsp. *saxatilis* was found as new to Slovakia. The taxon occurred only at single locality (Vinosady) and it was not confirmed recently. We assessed it as data deficient (DD).
Keywords: dry grasslands, IUCN criteria, occurrence, pioneer vegetation, taxa.

Izvleček
Proučevali smo razširjenost, morfološke tipe in fitocenološko navezanost vrste *Gagea bohemica* na Slovaškem v obdobju 2008–2011. Z revizijo herbarijskega materiala smo dokazali prisotnost treh taksonov: 1) subsp. *bohemica*, 2) subsp. *bohemica* var. *stenochlamydea* in 3) subsp. *saxatilis*. Taksonomski status var. *stenochlamydea* je negotov in potrebne so dodatne raziskave. Skupno smo zabeležili 42 lokalitet vrste *G. bohemica* sensu lato. Podvrsta subsp. *bohemica* (ki vključuje tudi var. *stenochlamydea*) prevladuje in je bila potrjena na 21 lokalitetah. Ta rastišča predstavljajo približno polovico vseh znanih, zato smo ponovno ocenili status vrste *G. bohemica* v Rdečem seznamu Slovaške in za ta takson predlagamo IUCN kategorijo EN (prizadeta vrsta). Pojavljenje podvrste subsp. *saxatilis* je novo na Slovaškem. Našli smo jo samo na eni lokaliteti (Vinosady) in uspevanje v zadnjem času ni bilo potrejno. Ocenjujemo jo s kategorijo DD (premalo podatkov).
Ključne besede: suha travišča, IUCN kategorija, pojavljanje, pionirska vegetacija, taksoni.

1. INTRODUCTION

Gagea bohemica (Zauschn.) J. A. et J. H. Schult. is an Eastern-Mediterranean and Euro-continental taxon with the centre of distribution range in the Mediterranean area to the east to Turkey and Israel, with the westernmost localities found in Wales (Rix & Woods 1981, Slater 1990, Barina et al. 2010). In Central Europe, it occurs mainly in Germany (Saxony-Anhalt and Rhineland Palatinate), in the Bohemian basin (Czech Republic), in the Vienna basin and in the north and northwest of the Pannonian basin (Austria, Moravia, Hungary and Slovakia) (Hrouda 1989a, b, Gruna et al. 1999, Király & Mesterházy 2009, Peterson et al. 2010).

The species is a member of the section *Didymobulbos* which includes *Gagea* species without subcylindrical and/or without broadly hollow first basal leaf as well as solid first cauline leaf (Richardson 1980, Tison 2009). Infraspecific variability of *Gagea bohemica* was assessed at three dif-

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ferent levels: (1) as two separate species *Gagea bohemica* and *G. saxatilis* (Richardson 1980), (2) two subspecies *bohemica* and *saxatilis* (Mert. & W. D. J. Koch) Asch. & Graebn. (Hrouda 1989, 2010, John et al. 2004, Peterson et al. 2004, Fischer et al. 2008) or (3) as an extremely variable single species *G. bohemica* (Slater 1990, Peruzzi & Gargano 2005). Recently, Peterson et al. (2010) found that a differentiation between specific and infraspecific taxa is not possible based on the molecular and morphological data of 43 populations from Western Europe to the Mediterranean area and eastern Caucasus. Although they recognized two extreme morphological types (subsp. *saxatilis* and subsp. *bohemica*) of four morphological key features (form and length of the perianth segments and the pilosity of the peduncle and pedicels), several *G. bohemica* individuals were found with intermediate morphological characters and several populations displayed different morphological types. The same morphological types were found in populations from different regions, e.g. in Mediterranean and Central European populations. These results indicate that the distribution of morphological types is not connected with geographical distribution (Peruzzi & Tison 2004, Peterson et al. 2010).

Gagea bohemica is rare in many countries of Central Europe and it was also included in some Red Lists. While in Slovakia the species is evaluated as critically endangered (Feráková et al. 2001), it is included in lower categories in other neighbouring countries – in Austria and the Czech Republic it is evaluated as vulnerable (Niklfeld & Schratt-Ehrendorfer 1999; Procházka 2001) and it is considered near threatened in Hungary (Király 2009).

The aims of this study were (1) to describe in detail historical and current distribution of *G. bohemica* in Slovakia and (2) to assess the occurrence of different morphological types.

2. MATERIAL AND METHODS

The study was carried out during the period 2008–2011. The historical data concerning the distribution of the species were achieved from herbaria BP, BRA, BRNU, BRNM, LTM, NI, KO, PMK, PR, PRC, SAV, SLO and ZV. Specimens collected during this research are stored in herbarium NI. Herbarium abbreviations are according to Holmgren et al. (1990) and Vozárová & Sutorý (2001). The active floristic survey was carried out to confirm recent localities of the species. Results of this study are presented on the point map. The map was designed by program ArcGis, version 9.2. The grid on the map follows one that was described by Niklfeld (1971). Coordinates of historical localities were taken from Google Earth. Coordinates of recent localities were obtained during field research using GPS equipment Garmin CS 60. The abbreviations of works published before 1956 are cited following Futák & Domin (1960), the nomenclature of flowering plants follows Marhold & Hindák (1998) and phytogeographical divisions follow Futák (1980).

4. RESULTS AND DISCUSSION

From the taxonomic point of view, three different *G. bohemica* taxa were distinguished in Slovakia: subsp. *bohemica*, subsp. *saxatilis* and subsp. *bohemica* var. *stenochlamydea* Borbás (Fig. 1, 2).

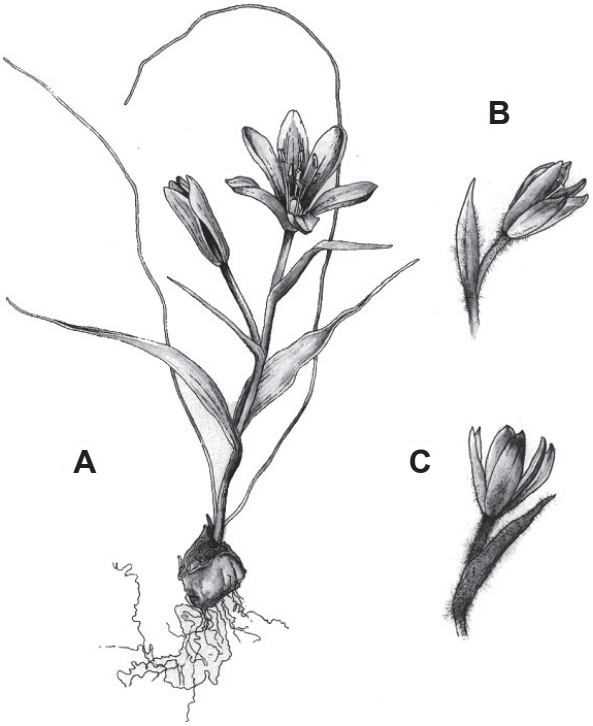

Figure 1: *Gagea bohemica*: A – growth habit of *G. bohemica* subsp. *bohemica*, B – detail of flower of *G. bohemica* subsp. *bohemica* var. *stenochlamydea*, C – detail of flower of *G. bohemica* subsp. *saxatilis* (drawn by Renata Grošaftová, 2011).

Slika 1: *Gagea bohemica*: A – rastne značilnosti *G. bohemica* subsp. *bohemica*, B – podroben prikaz cveta *G. bohemica* subsp. *bohemica* var. *stenochlamydea*, C – podroben prikaz *G. bohemica* subsp. *saxatilis* (risba Renata Grošaftová, 2011).

Occurrence of the nominate subspecies and var. *stenochlamydea* was known relatively long ago (Hrouda 1998a, b, Gruna et al. 1999), but the occurrence of subsp. *saxatilis* was not found until our study. Individuals of *G. bohemica* subsp. *saxatilis* have lanceolate perianth segments, 10 to 13.5 mm in length and are very hairy on the stem and the pedicels. On the contrary, *G. bohemica* subsp. *bohemica* is characteristic by spathulate perianth segments, 13 to 16.5 mm in length, with sparse pilosity of the stem, rarely there are even individuals without hairs (Hrouda 1998a, b, Peterson et al. 2004). According to Peterson et al. (2010), populations of subsp. *bohemica* var. *stenochlamydea* represented morphological type different from the two morphologically extreme forms evaluated as subsp. *saxatilis* and subsp. *bohemica*. Hrouda (1989b) considers the morphological differences so serious, that he evaluated the taxon to the subspecies level as *G. bohemica* subsp. *stenochlamydea* (Borbás) Hrouda ined. For confirmation of this assessment the plants from the Tribeč Mts have to be analyzed by the molecular methods in the future. According to Gruna et al. (1999), we believe that the use of the temporary name subsp. *bohemica* var. *stenochlamydea* is warranted for now.

In total, 41 localities of *Gagea bohemica* sensu lato were found in Slovakia when compiling together data from field research, herbarium revisions and excerption of published and unpublished works (Fig. 2). Our data confirmed earlier knowledge on distribution of the species (Dostál & Červenka 1992, Hrouda 1998b, Gruna et al. 1999), but the information now is much more clear and expanded. The species has occurred in the five, more or less separate, areas at the edges of Pannonicum and Carpaticum phytogeographical districts (see Appendix): 1) in a wider area of Bratislava, 2) in the Zoborské vrchy Hills near Nitra, 3) in the Burda Hills near Štúrovo, 4) around the municipalities of Hronský Beňadik and Tlmače, and 5) around the town of Zvolen. During the study of herbarium material we came across one doubtful locality – Veľká Stožka Hill in the Muránska Planina Mts. (Soják 1958 PRC, subsp. *bohemica*). We believe that this represent a confusion of the herbarium material, because species occurrence at an altitude of about 1000 m above sea level is highly unlikely. Also, no other data on the incidence of the species in this area are known (Hrouda 1998a, b, Gruna at al. 1999, Kochjarová et al. 2004).

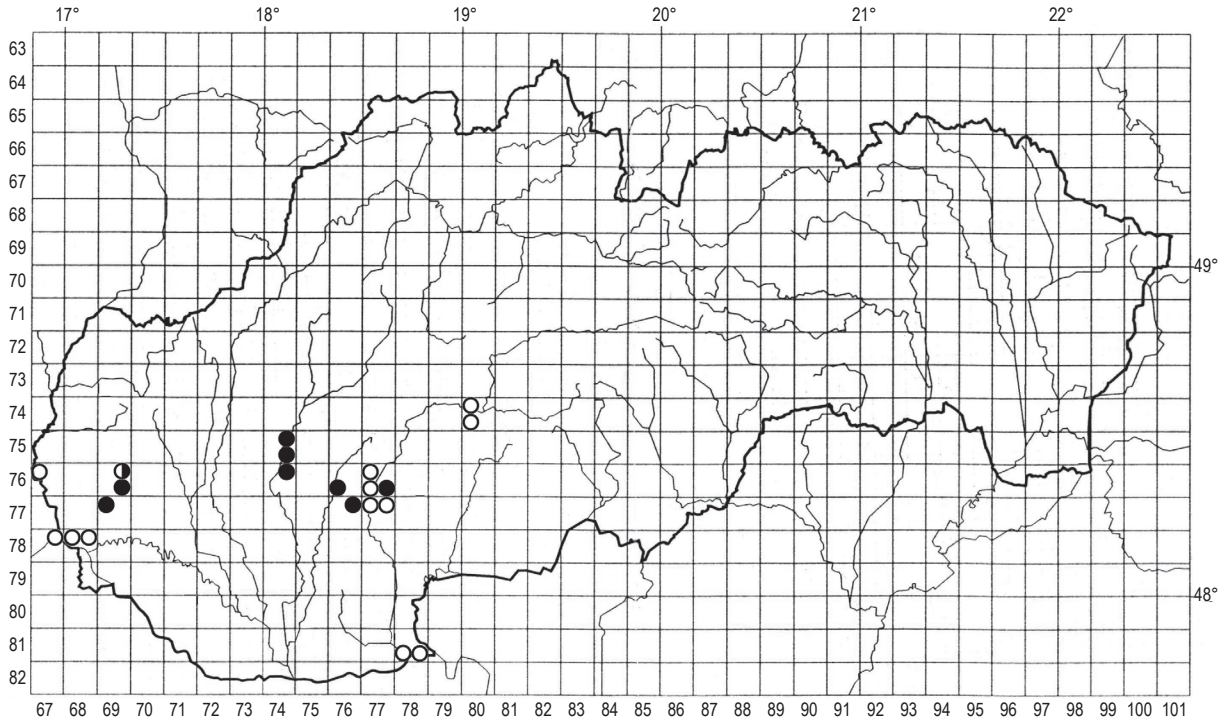

Figure 2: Distribution of *Gagea bohemica* in Slovakia: ○ – historical occurrence of the species, ● – recent localities of *G. bohemica* subsp. *bohemica*, ◑ – occurrence of *G. bohemica* subsp. *saxatilis*.

Slika 2: Razširjenost vrste *Gagea bohemica* na Slovaškem: ○ – zgodovinski podatki, ● – trenutne lokalitete *G. bohemica* subsp. *bohemica*, ◑ – pojavljanje *G. bohemica* subsp. *saxatilis*.

Revision of herbarium material revealed that nominate subsp. *bohemica* predominated in all above mentioned areas (13 sites) except at the Zoborské vrchy Hills and the area around Zvolen. As mentioned above, the different taxon named subsp. *bohemica* var. *stenochlamydea* was recognized in the Zoborské vrchy Hills (Hrouda 1998b, Gruna et al. 1999, Fig. 3). Only 3–5 localities of this taxon were published in the past (Halada 1991, Svobodová et al. 2007), but at present 15 sites are known (for details see Košťál & Rosinová 2010).

Accurate differentiation of *Gagea bohemica* taxa in the Zvolen area (3 sites) was not possible because herbarium vouchers are missing and there are only literature data. According to Hrouda (1998b), we believe that it was the nominate subs. *bohemica* there. On the other hand, it is also possible, that the species did never grow in this area and published data represent confusion with other species of the genus *Gagea*. Despite a fairly intensive research (Manica 1975, 1984, 2004, Vlčko & Manica 1989, Hrivnák & Letz 2010 ined.), the species was not confirmed here at least for more than 50 years. Similar situation is at some localities on the south-western foothills of the Štiavnické vrchy Mts. – around Hronský Beňadik (3 localities), at Burda Hills (2 localities) and at sites around Bratislava – in the Devínska Kobyla Hills (Feráková et al. 1997), near Záhorská Ves (1 locality) and in the Malé Karpaty Mts. (6 localities). Finally, recent occurrence of subsp. *bohemica* (including var. *stenochlamydea*) was confirmed at 20 localities; this means that there still exist about 50% of all identified sites of nominate subspecies in Slovakia. The sizes of local populations were very variable during our surveys (varying from a few individuals to thousands of individuals per single local population), mostly depending on weather conditions of the particular year. As the main threats of the subspecies survival we consider changes in habitat quality – local populations are threatened especially by quarrying and secondary succession (overgrowing of open space by perennial plants and trees). Using all available field data and IUCN criteria (IUCN 2001), we suggest to move the subspecies from IUCN category CR (critically endangered, Feráková et al. 2001) to category EN B1a(i)c(iv) (endangered).

Subsp. *saxatilis* was found only at a single locality near the Vinosady settlement (Fig. 2). The taxon (as *G. bohemica*) was mentioned here since the end of the fifties of the last century (Ptačovský

Figure 3: *Gagea bohemica* subsp. *bohemica* var. *stenochlamydea* in Žibrica Nature Reserve (Tríbeč Mts., photo J. Košťál).
Slika 3: *Gagea bohemica* subsp. *bohemica* var. *stenochlamydea* v naravnem rezervatu Žibrica (gorovje Tríbeč, foto J. Košťál).

1959), but it was reliably documented by herbarium voucher only in the eighties (Ondrášek 1983 BRA). The locality has not been confirmed at present. Using IUCN criteria (IUCN 2001), we evaluated the taxon in the category DD (data deficient). The subspecies *saxatilis* is regarded as a western-European taxon, and it is reported from the Iberian Peninsula, France, Wales, Germany, Czech Republic (Moravia) and the north-western Hungary (Hrouda 2010, Peterson et al. 2010). The site in Slovakia fill the gap in the distribution of the species between the sites in Moravia (Náměšť na Hané, Senička na Hané) and in Hungary (near the Tihany). Based on our data we believe, that the eastern limit of the subspecies range passes through the territory of western Slovakia and potentially new localities will be here discovered.

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APPENDIX

List of localities of *Gagea bohemica* taxa in Slovakia [numbers of phytogeographical regions according to Futák (1980)].

1. Burda Hills: Burda Hill (F. A. Novák 1922 PRC, subsp. *bohemica*). – Kováčovské kopce Hills (Májovský et Jurko 1958). = Skaly site, rare, 120 m a. s. l. (F. A. Novák 1922 PRC, subsp. *bohemica*). **2. Ipeľsko-rimavská brázda Region:** Rybník – Čajkov – Tekovská Nová Ves (Suza 1945: 5). **4. Borská nížina Lowland:** Záhorská Ves (Neilreich 1859: 49, 1870: 254; Knapp 1864b: 305). **5. Devínska Kobyla Hills:** Bratislava [Pressburg], Devínska Kobyla (F. A. Novák 1923a: 72; Černý 1934 PRC, subsp. *bohemica*). – Bratislava, Bôrik [Tümlerberg] (Scheffer 1926: 22; Neumeyer 1929: 400; Schidlay sine data BRA, subsp. *bohemica*). **6. Podunajská nížina Lowland:** Bratislava, Mudroňova ul. [Pozsony, Császár út mell.] (Mergl 1902 SAV, subsp. *bohemica*). – Svätý Jur, dry grasslands upper the village, 150 m a. s. l. (Weber 1929 BRA, subsp. *bohemica*; Schidlay 1930 BRA, subsp. *bohemic*a; Černý et Weber 1932 BRA, subsp. *bohemica*; Černý 1935 PR, subsp. *bohemic*a; Nábělek sine data SAV, subsp. *bohemica*; Ptačovský 1936 BRA, subsp. *bohemica*; Schidlay 1941 BRA, SLO, subsp. *bohemica*). – Svätý Jur, grasslands upper the chapel (Ptačovský 1924, 1931 SAV, subsp. *bohemica*; Košťál et Rosinová 2010). – Svätý Jur, railway embankment under the chapel (Ptačovský 1937 SAV, subsp. *bohemica*). – Svätý Jur, edge of Šúr site near chapel (Ptačovský 1938 SAV, subsp. *bohemica*). – Vinosady, Holubyho lúka site – Vinosady, Brablecova lúka site (both Košťál 2009; Válková 2010 in verb., subsp. *bohemica*). – Vinosady [Malé Tŕnie] (Michálková 1957 in Ptačovský 1959; Ondrášek 1983 BRA, subsp. *saxatilis*). – Nitra, Kalvária Hill, near the chapel on the top (Košťál et Rosinová 2010; Eliáš jun. 2008 NI, subsp. *bohemica* var. *stenochlamydea*). – Nitra, Kalvária Hill, near the water tank (Košťál et Rosinová 2010, subsp. *bohemica* var. *stenochlamydea*). – Psiare (Suza 1945: 5; Novák 1954). – Mochovce (Suza 1945: 5). – Kozárovce, Plešovica Hill, SW stony slope, 260 m a. s. l. (David 1984 LTM, subsp. *bohemica*; Košťál 2011, subsp. *bohemica*). – Kozárovce, Chríb Hill, andesitic hill near the village above train, 210 m a. s. l. (David 1990 LTM, subsp. *bohemica*; Eliáš jun. 2011 NI, subsp. *bohemica*). – Kozárovce, elevation point 236 m a. s. l. (Suza 1945: 5; Futák 1947: 30; Novák 1954; Májovský et Jurko 1958). = Kozárovce, Skala hill (David 1988 LTM, subsp. *bohemica*; Košťál et Rosinová 2009, subsp. *bohemica*). **12. Tríbeč Mts.:** Lupka Hill, quarcitic rocks (Košťál et Rosinová 2010, subsp. *bohemica* var. *stenochlamydea*). – Malá Skalka Hill (Košťál et Rosinová 2010; Eliáš jun. 2011 NI, subsp. subsp. *bohemica* var. *stenochlamydea*). – Nitra, grasslands upper the monastery = Nitra, Zoborská lesostep Nature Preserve (Vlach 1925, 1926 PRC, subsp. *bohemica* var. *stenochlamydea*; Vlach 1929: 271–273; Košťál et Rosinová 2010, subsp. *bohemica* var. *stenochlamydea*). – small dolomite hill west from the Zoborská lesostep Nature Preserve, ca 403 m a. s. l. – elevation point 400 m a. s. l. between Plieška Hill and Meškov vrch Hill – Plieška Hill – Meškov vrch Hill (all data Košťál et Rosinová 2010, subsp. *bohemica* var. *stenochlamydea*) – Zobor Hill (Knapp 1865: 23; Pax 1908: 179; Šourek 1951 PR, subsp. *bohemica* var. *stenochlamydea*; Košťál et Rosinová 2010, subsp. *bohemica* var. *stenochlamydea*). – Pyramída Hill, southern and southwestern slopes (Košťál et Rosinová 2010; Eliáš jun. 2008 NI, subsp. *stenochlamydea*). – Nitrianske Hrnčiarovce, elevation point 220 m a. s. l. (Vlach 1929: 271–273). – Dolné Štitáre, vrch Haranč [Garanč], SW slope near the top (Svobodová 1974 NI, subsp. *bohemica* var. *stenochlamydea*; Košťál et Rosinová 2010, subsp. *bohemica* var. *stenochlamydea*). – Dolné Štitáre, meadows under the Žibrica Hill (Eliáš jun. 2008 NI, subsp. *bohemica* var. *stenochlamydea*; Košťál et Rosinová 2010, subsp. *bohemica* var. *stenochlamydea*). – Vápeník Hill, southern slopes (Košťál et Rosinová 2010, subsp. *bohemica* var. *stenochlamydea*). **14a. Pohronský Inovec Mts.:** Hronský [Svatý] Beňadik (Suza 1945: 5). **14c. Kremnické vrchy Mts.:** Budča, Bučan Hill – Zvolen, Veľká Stráž Hill (both data Májovský et Jurko 1958). **14e. Štiavnické vrchy Mts.:** Psiare, Krivín Hill (Futák 1943: 25; Májovský et Jurko 1958; Jochimová 2011 in verb, subsp. *bohemica*?) – Zvolen, Veľký vrch Hill upper the Neresnická dolina Valley (Suza 1945: 5; Futák 1943: 28; Dostál & Červenka 1992)

Doubtful locality: 16. Muránska planina Mts.: Veľká Stožka Hill, 1100–1250 m a. s. l. (Soják 1958 PRC, subsp. *bohemica*).

General data (not maped): 10. Malé Karpaty Mts. (F. A. Novák 1954).