VERSITA

Biologia **66**/3: 433—438, 2011
Section Botany
DOI: 10.2478/s11756-011-0031-4

First record of *Gagea szovitsii* in Central Europe

Gusztáv Jakab[1] & Attila Molnár V.[2]

[1]*Department of Environmental Sciences, Faculty of Water and Environmental Management, Szent István University, 1–3. Szabadság Str. H-5540 Szarvas, Hungary; e-mail: cembra@freemail.hu*
[2]*Department of Botany, Faculty of Sciences & Technology, University of Debrecen, PO Box: 14. H-4010 Debrecen, Hungary; e-mail: amolnarv@puma.unideb.hu*

Abstract: Morphological characters, habitat preference, and currently known distribution of the species *Gagea szovitsii* (A.F. Láng) Besser, a new indigenous vascular plant species of Central Europe, are presented. The plant was found in alkali grasslands of the south-eastern part of the Great Hungarian Plain (SE Hungary). Currently, this can be regarded to the westernmost occurrence of this pontic species. Both *G. szovitsii* and its closest relative *G. bohemica* are briefly characterized here with respect to their identification, ecology and distribution. Original illustrations on *G. szovitsii* are presented. The paper firstly emphasizes the difference of reproductive strategy between *G. szovitsii* and *G. bohemica*; the former reproduce itself primarily sexually via seeds, while the latter reproduce itself in asexual way principally by bulbils. Taking the paleo-environmental history of its habitat into consideration, the species can be regarded as an ancient, indigenous Pontic-Pannonian steppe element of Hungary.

Key words: *Gagea szovitsii*; *Gagea bohemica*; *Gagea callieri*; alkali steppe; plant geography; Hungary

Introduction

In March 2004, near village Ecsegfalva (East-Hungary, Békés county) an interesting *Gagea* species was found on the hill slope of an ancient earthwork called Ördögsánc ("Devil's Mound"). The earthwork was built by Sarmatian tribes in the 3rd century AD, and it is covered with opened loess and alkali grasslands. The discovered plant was similar to *Gagea bohemica* (Zauschner) Schultes & Schultes fil., but had taller shoots and more flowers. Moreover, the peduncules were almost bare in some cases, and the rest of the population's was far less hairy than *G. bohemica* used to be. Because of its tall habit and glabrous pedicels the identification of the specimens from Ecsegfalva was unsuccessful. Two years later Judit Kapocsi and Krisztina Nótári, botanists from the Körös-Maros National Park, reported (ex verb.) a new population near Tótkomlós from alkali grasslands. Following these new findings, more new populations were discovered in the geographic region "Tiszántúl". These populations were larger than the firstly found ones, and at the same time they were morphologically more diverse. The specimens were smaller and their pedicels were more hairy than those at the Ecsegfalva site. The latter observations clearly linked the plant to the *Gagea bohemica* group.

After looking through the appropriate keys and descriptions of Richardson (1980) and Zahariadi (1966), the plant was identified as *Gagea szovitsii* (A. F. Láng) Besser (syn. *G. callieri* Pascher in Engl.). Until now, *G. szovitsii* has been found only in the eastern part of Europe, in the Black Sea region, central and south Ukraine (Richardson 1980). The closest populations live in Dobrogea, southeast Romania (Oprea 2005). Our finding in Hungary represents the new western boundary of the distribution range of the species.

The species was described by Adolf Ferenc Láng (1827: 64.) under the name *Ornithogalum szovitsii*. The holotype was collected by Johann Nepomuk Szovits. According to Szovits, the species is common around Odessa ("*circa Odessa, frequens*"). Johann Nepomuk Szovits is a neglected pharmacist-botanist (?–1830), who migrated from Hungary to Ukraine, and firstly collected this species later named after him near Odessa. His family name sometimes spelled as Szovitz or Scovicz, as well. However, in some publications (e.g. Richardson 1980) the name is spelled erroneously as '*szovitzii*'. Later, Besser (in: Schultes – Schultes 1929. fil. Syst. Veg.: 550p. 5th edition) placed the species into the genus *Gagea*, described by Salisbury in 1806. The accepted name at the moment is *Gagea szovitsii* (A. F. Láng) Besser in Schultes & Schultes fil. 1829.

Gagea szovitsii belongs to the *G. bohemica* group. According to Rix & Woods (1981: 266.), the main cause of taxonomic problems in the group is the apparent similarity between the species. Probably this similarity led Terreciano (1906) to combine our species of interest at the subspecies level under *Gagea saxatilis* Mert. et W. D. J. Koch as subsp. *szovitsii* (A. F. Láng) A. Terr. including here also subsp. *bohemica* (Zauschner) A. Terr.. Pascher (1907) dealt with the East European and Middle Eastern taxa of *G. bohemica* group at the

Fig. 1. Habit of *Gagea szovitsii* (drawings of Judit Kóra).

species level, which was attributed to the lack of intermediate forms between them. In Stroh's (1936) synopsis Pascher's species were ranked at the species, subspecies or varietas level. Altogether Stroh discerned five different species (*G. nebrodensis, G. szovitsii, G. callieri, G. smyrnaea* and *G. bohemica* with 3 subspecies and 4 varieties). Heyn & Dafni (1977) described the *Gagea* taxa of Israel, and they united them under the name *G. bohemica*. Rix & Woods (1981: 269.), Levichev (1999) and Mosyakin & Fedoronchuk (1999: 37.) agreed with this extreme opinion. However, in the European synopsis Richardson (1980: 28.) accounted three taxa at the species level in the genus *Gagea*: *G. bohemica* (Zauschner) Schultes & Schultes fil. *, G. saxatilis* (Mert. & Koch) Schultes et Schultes fil. and *G. szovitsii* (A. F. Láng) Besser in Schultes & Schultes fil.. Richardson labeled *G. callieri,* as a synonym of *Gagea szovitsii*, and emphasized the doubtfulness of the status of these taxa.

Material and methods

The morphological descriptions and illustrations of *G. szovitsii* were based on 50 living specimens observed at Szentes. For comparison reasons *G. bohemica* populations were also measured at Budapest. Vouchers were deposited in the Herbarium of Debrecen University (DE). The habitat of *G. szovitsii* was described with phytocoenological sampling. The vegetation coverage was estimated in the middle of June, while the cover of *G. szovitsii* was estimated earlier in April in the same plots. The exact places of the quadrats were found with GPS in June (see Table 3 for details). Morphological features and habitat requirements were also studied in Romania and Ukraine. Nomenclature follows Simon (2000) for vascular plants and Orbán & Vajda (1983) for bryophytes.

Results and discussion

The flowering plant is (2–)3–8(–12) cm tall, with 2 bulbs in a common light brown tunic. Basal leaves 2, filamentous. Cauline leaf 2–10, alternate, narrowly lanceolate. Stems sometimes forked, reddish-green. Flowers numerous, (1–)2–6(–12). Perianth-segments (8–)12–13 mm, oblong-lanceolate to subspathulate, warm yellow on the upper side and red and green striae on the lower side (Fig. 1). Capsule obovoid, emarginate (Fig. 2).

Fig. 2. Capsules of *Gagea szovitsii*.

Fig. 3. Seeds of *Gagea szovitsii*.

Glabrous specimens are quite common in the population near Ecsegfalva, and only some of them have slightly hairy pedicels, as well as ciliated cauline leaves and perianth-segments. On the other hand, hairy specimens are rather frequent in other populations (e.g. near Szentes). The reddish-green stems and the red striated subspathulate perianth segments are always apparent.

Table 1 presents a morphological comparison between *G. bohemica* and *G. szovitsii*. The main mor-

Table 1. Comparison of some morphological characters of *Gagea bohemica* and *Gagea szovitsii*.

	Height (cm)		Nr. of flowers		Length of perianth segments (mm)	
	bohemica	*szovitsii*	*bohemica*	*szovitsii*	*bohemica*	*szovitsii*
Richardson 1980	c. 2	3–10	1–3	1–4	13–17	c. 12
Zahariadi 1966	–	2–5 (–8)	–	1–2(–3)	–	7–11(–12)
Hrouda 2002	2–6(–10)	–	2–3	–	–	–
Prokudin 1987	–	3–10	–	2–4(–6)	–	12–13
Bódis 1999	2–3 (–8)	–	1–2	–	–	–
Jávorka 1924–25	–	–	1–2(–4)	–	–	–
present study	(1–)2–5(–11)	(2–)3–8(–12)	1–2(–7)	(1–)2–6(–12)	12–18	(8–)12–13

Table 2. Occurrences of *Gagea szovitsii* in Hungary.

Location (settlement)	Number of specimens	Habitat	Observer persons	Date	CEM
Ördög-sánc (Ecsegfalva)	500	Artem-Fest, Agrop-Koch	JG – MVA	03. 20. 2004.	8891.3
Téglás (Szentes)	1000000	Artem-Fest	JG	04. 15. 2006.	9487.4
Nagy-Csárdai-tábla (Királyhegyes)	200	Artem-Fest	JG	04. 15. 2006.	9789.2
Száraz-ér-part (Csanádalberti)	500	Artem-Fest	JG	04. 15. 2006.	9690.3
Királyhegyesi-puszta (Csanádpalota)	20	Artem-Fest	JG – MVA	03. 13. 2007.	9790.1
Gulya-kút (Nagyér)	200	Artem-Fest	JG – MVA	03. 13. 2007.	9690.1
Teleki-dülő (Nagyér)	20	Artem-Fest	JG – MVA	03. 13. 2007.	9690.1
Fertő (Szentes)	1000	Artem-Fest	JG	03. 22. 2007.	9388.3
Külső-Ecser (Szentes)	500	Artem-Fest	JG	03. 13. 2007.	9288.3
Csárdalapos (Szentes-Magyartés)	1000	Artem-Fest.	JG	03. 13. 2007.	9287.3
Csaj-tó (Csanytelek)	2	Artem-Fest	JG	03. 22. 2007.	9486.2
Nagy-legelő (Kunmadaras)	50	Artem-Fest	JG – MA – LB – KG	03. 16. 2007.	8591.3
Teleki-tanya (Kunmadaras)	200	Achill-Fest (on kurgan)	JG – MA – LB – KG	03. 16. 2007.	8591.1
Baksi-puszta (Pusztaszer-Munkástelep)	1000	Artem-Fest	JG – NT	03. 21. 2008.	9486.1
Csaj-tó (Tömörkény)	200	Artem- Fest	JG – NT	03. 21. 2008.	9486.1
Homok-rétje (Tiszakürt)	8	Artem-Fest	SZ	03. 07. 2008.	9186.2
Pető-semlyék (Öcsöd)	5	weedy grassland	SZ	03. 07. 2008.	9088.3
Körtvélyes (Tiszaug)	14	Artem-Fest	SZ	03. 07. 2008.	9186.1
Nyártó (Berettyóújfalu)	2	Artem-Fest	SG	04. 05. 2009.	8895.1

Abbreviations: CEM, Central European Mapping grid code; JG, Gusztáv Jakab; MVA, Attila Molnár V.; MA, Attila Molnár; KG, Gábor Kovács; LB, Balázs Lesku; SZ, Zoltán Sallai; SG, Gábor Sramkó; NT, Tamás Nagy; Artem-Fest, *Artemisio-Festucetum pseudovinae*; Achill-Fest, *Achilleo-Festucetum rupicolae*; Agrop-Koch, *Agropyro-Kochietum prostratae*.

phological difference between them lays in the different length of stem and perianth-segments. Namely, *G. bohemica* has shorter stem (less than 5 cm) and longer perianth-segments (12–18 mm). But some populations of *G. szovitsii* show high variability in these parameters, e.g. in grazed habitats the stems are always shorter.

However, we have noted other differences between the taxa, which confirm the separation of *G. bohemica* and *G. szovitsii*. Firstly, a significant difference in reproduction biology of the two taxa can be mentioned. According to different publications (Slater 1990; Hrouda 2002; Bódis 1999) and to our observations, *G. bohemica* is always sterile and never seeds, but forcefully germinate vegetatively from bulbils. Though young plants germinating from bulbils form lawn-like small colonies in the moss carpets early spring, the colony rises only 1–2 flowering stems, thus mature plants are found sparsely within the colony. On the contrary, the vegetative germination of *G. szovitsii* is subordinate, therefore many mature individuals (i.e. plants in bloom) can be observed in a colony at the same time. According to our observations, *G. szovitsii* is pollinated by European honey-bees (*Apis mellifica*) and the queens of bumble-bees (*Bombus* spp.). In the emerging capsules dozens of small seeds develop. The seeds are spherical with a beak on the apex, 1.2–1.4 × 0.7–0.9 mm (Fig. 3). Their surface is finely reticulate-areolate, slight lustrous, brown.

The flowering period of *G. szovitsii* is relatively short, two or three weeks in March or in the beginning of April. According to our observations on 27 April 2006 near Szentes, 50 mature specimens had 75 flowers (out of which 26 had one, 23 had two, and 1 had three flowers). We counted on these specimens 55 capsules (out of which 31 had one, 12 had two, and 7 had no fruits). This means that 73.3 % of the flowers were fertile. By the beginning of May, the fruits were ripen containing an average of dozen seeds.

Currently, populations of *G. szovitsii* are known only from the geographic region Tiszántúl occupying the south-eastern part of the Great Hungarian Plain. Many of the populations were found in South Tiszántúl, in the environs of the cities Szentes and Tótkomlós. Towards north it became rare; the present northern boundary of distribution is at the Hortobágy territory in Nagyiváni-puszta. Fig. 4 and Table 2 summarize the

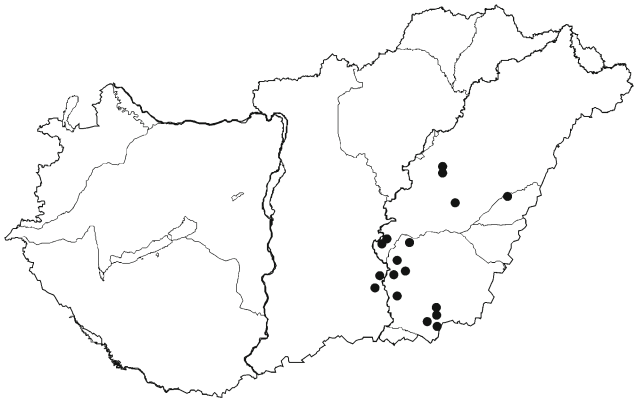

Fig. 4. Distribution of *Gagea szovitsii* in Hungary.

currently known localities and some habitat features of *G. szovitsii* in Hungary.

G. szovitsii was originally discovered at Ecsegfalva on the Ördög-sánc in open loess and alkali grass lands, more precisely in transition of associations *Agropyro-Kochietum prostratae* and *Artemisio-Festucetum pseudovinae*. However, the species did not turn up in the surrounding extensive alkali grasslands. Later, it turned out that most of the populations live on "alkali berms", and *G. szovitsii* could be regarded as a characteristic species of the alkali grassland association *Artemisio-Festucetum pseudovinae*. The micro-geomorphological term "alkali berm" refers to a micro-cliff of the relief with an intact solonetz soil profile. Above the cliff, the vegetation is rich in various alkali plant communities ("berm roof"), which also occupies the abruptly (usually 5–30 cm deep) dropping-down edge of the cliff. Below the cliff, the lower surfaces have lost the top, humus-rich soil level 'A', therefore, even their soil surface is highly salty and clayish. Consequently, only extremely drought- and salt resistant vegetation is able to survive (Tóth 2000). From coenosystematic point of view, the most typical plant community of berm roofs is *Artemisio-Festucetum pseudovinae* (Borhidi 2003). *G. szovitsii* is particularly common in where this association is opened and the bare soil surfaces are covered with moss patches. This species frequently grows on the eroded margins of berm roofs ("berm cliff"). *G. szovitsii* can proliferate best in *Artemisio-Festucetum pseudovinae* stands grazed by sheep. In apparently contrast to the above, *G. szovitsii* live exclusively in *Achilleo-Festucetum pseudovinae* association in the Hortobágy "pusta". One of these populations grows on a smaller kurgan (Bronz Age earthwork). Notwithstanding, the structure of this association is similar to lots of bare soil surfaces with extensive moss cover.

Table 3 gives a phytocoenological description of some habitats of *G. szovitsii* sampled in June. Due to the late sampling, characteristic short-lived spring ephemers and ephemeroids (e.g. *Erophila verna*, *Veronica* spp., *Myosotis* spp., *Poa bulbosa*) are missing in the relevée. The covers of *Trifolium* species (e.g. *Trifolium angulatum, T. striatum, T. retusum, T. ornithopodioides*), which characterize the early summer

Table 3. Phytocoenological relevée (4 m^2) in Hungarian habitats of *Gagea szovitsii*. Location of sample plots: 1–3: Szentes, Téglás (15. 06. 2007.) *Artemisio-Festucetum pseudovinae*, 4: Cserebökény, Külső-Ecser (15. 06. 2007.) *Achilleo-Festucetum pseudovinae*, 5–6: Ecsegfalva, Ördög-sánc (19. 06. 2007.) transition zone of *Agropyro pectinati-Kochietum prostratae* and *Artemisio-Festucetum pseudovinae*

Species	Sample plots (% cover)					
	1	2	3	4	5	6
Bare soil surface	10	10	20	2	20	10
Gagea szovitsii*	1	1	+	+	+	+
Festuca pseudovina	50	50	50	60	40	40
Artemisia santonicum	10	10	10			
Plantago lanceolata	5	5	5	10		
Trifolium striatum	2	+	+			
Gypsophila muralis	1	+	+	+	+	
Bromus mollis	1	1	+	+	+	
Trifolium angulatum	1	+	1			
Achillea setacea	+	1	+	10	+	
Podospermum canum	+		1	1		
Polygonum aviculare	+	+	+			
Limonium gmelinii subsp. *hungaricum*	+				5	2
Trifolium campestre	+			+		
Bupleurum tenuissimum	+		+			
Carex cf. stenophylla		+	+	+		
Trifolium retusum		2				
Polycnemum arvense		1				
Veronica verna		+				
Trifolium arvense			+			
Cynodon dactylon				+		
Lolium perenne				+		
Scleranthus perennis				+		
Lotus corniculatus				1		
Trifolium repens				+		
Agropyron pectinatum					10	2
Kochia prostrata					5	25
Salvia nemorosa					2	+
Galium verum					1	
Potentilla argentea					+	
Agropyron repens					+	
Ventenata dubia					+	
Carex praecox					+	
Bryophytes	20	20	5	10	10	20
Hypnum cupressiforme	20	20	4	8	1	15
Polytrichum juniperinum	+	+				
Barbula unguiculata		+	1	+	6	5
Bryum argenteum			+			
Tortula ruralis				1	1	
Homalothecium lutescens				1		
Brachythecium albicans					2	+
Phascum cuspidatum					+	

* The abundance of *Gagea szovitsii* was estimated in April.

Artemisio-Festucetum pseudovinae association, were low in 2007 due to the unusually dry weather. All of the sample plots were dominated by xerophitic and pseudohalophitic vascular species, and the large cover of xerophitic bryophytes e.g. *Hypnum cupressiforme, Polytrichum juniperinum, Barbula unguiculata, Tortula ruralis, Brachythecium albicans* were especially characteristic.

Habitat requirements of *G. bohemica* were investigated by Bauer et al (2002) in Hungary. The authors

appointed that *G. bohemica* occurs under different geological conditions: on sand, gravel, basalt, andesite, granite, dolomite, sandstone or limestone, but always on nutrient-poor, shallow soils with stone outcrops and with high bryophyte cover. These observations agree with Korneck's (1975) recognition. According to our experiences, habitat requirements of *G. szovitsii* in Dobrogea (SE Romania) are quite similar; the occurrences peak on nutrient-poor soils with rich bryophyte cover where the competition of vascular plants is weak.

Gagea szovitsii (A. F. Láng) Besser, a newly described species of the flora of Hungary, was discovered near Ecsegfalva village in 2004. Subsequently, further localities were found at Berettyóújfalu, Csanádalberti, Csanádpalota, Csanytelek, Királyhegyes, Kunmadaras, Nagyér, Nagyér, Öcsöd, Pusztaszer, Szentes, Szentes-Magyartés, Tiszakürt, Tiszaug and Tömörkény settlements, in the south-eastern part of the Great Hungarian Plain.

The paper compares the morphological features of the species. We have shown the reproduction of *Gagea szovitsii* is sexual and relies mainly on its seeds, unlike the closest relative *Gagea bohemica* (Zauschner) Schultes & Schultes fil., which reproduction is principally asexual and uses bulbils. *Gagea szovitsii* occurs in Hungary in halophytic vegetation (mainly in *Artemisia*-type alkali steppe: *Artemisio-Festucetum pseudovinae*). The species prefers the open soil surfaces with significant bryophyte cover (e.g. *Hypnum cupressiforme, Barbula unguiculata, Tortula ruralis, Brachythecium albicans, Polytrichum juniperinum, Homalothecium lutescens* etc.).

G. szovitsii proved to be a characteristic species of natural alkali grasslands of Hungary with Pontic-Pannonian distribution. This continental grassland type stretches across the central part of Eurasia, from East Mongolia, through South Ukraine, to the Carpathian basin. To the west only some isolated stands can be found (Buček et al. 2006; Ellenberg 1988; Zólyomi & Fekete 1994). Semi-natural alkali vegetation covers approximately 150,000 ha in Hungary, and includes steppes, steppe-like pastures, meadows, marshes, lakes and woodlands characterized by endemic and subendemic (e.g. *Artemisia santonicum* subsp. *patens* and subsp. *monogyna, Aster tripolium* subsp. *pannonicum, Cirsium brachycephalum, Limonium gmelinii* subsp. *hungaricum, Plantago schwarzenbergiana, Suaeda pannonica* etc.), Pontic-Pannonian (e.g. *Ajuga laxmanni, Camphorosma annua, Carex hordeistichos, Carduus hamulosus, Inula germanica, Salicornia europaea, Salvia nutans, Taraxacum serotinum, Viola ambigua* etc.), and Turanian (eg. *Agropyron pectinatum, Kochia prostrata*) species (Borhidi 2003).

Although, this typical alkali (solonetz) vegetation has expanded in historical times as a consequence of river regulations in the 19th century, it can be proven by both vegetation-historical and paleo-environmental investigations that it is a genuine component of the region Tiszántúl. The authentic alkali vegetation was characterized by contrasted vegetation mosaics, high species richness, well-developed alkali geomorphology, and the lack or subordered role of floodplain species. The primary alkali grasslands, several thousand years old, occurred in as large as patches as 100–1,000 ha in the Tiszántúl region. Though river regulations made alkali vegetation to became more widespread (Molnár & Borhidi 2003), the origin of alkali vegetation and alkalization in Great Hungarian Plain can be dated back to the Upper Pleistocene period, ca. 35,0000 yrs BP (Sümegi 2004; Sümegi et al. 2005). And if we consider that not just cold tolerant steppe elements, but temperate steppe species were documented in the region, and given the ecological and phytogeographical features of *G. szovitsii,* it can be regarded as a presumably ancient Pontic-Pannonian steppe-element in the flora of Hungary.

Acknowledgements

We would like to express our thankfulness to Lajos Somlyay for the suggestions in the identification, and Judit Kóra for the illustrations. The helpful suggestions and linguistic corrections of Gábor Sramkó are greatly acknowledged. The work of our anonymous reviewer has significantly improved our manuscript, and his work is acknowledged here. We also thank Judit Kapocsi, Krisztina Nótári, Attila Molnár, Balázs Lesku, Zoltán Sallai and Tamás Nagy for the ideas in fieldwork. We are thankful to Norbert Bauer and Gábor Papp who helped us with literature collection. This work was supported by grant NKFP 3B project No. 050/2002 and the Bolyai fellowship of Hungarian Academy of Science to A. Molnár V.

References

Bauer N., Mészáros A. & Galambos I. 2002. A *Gagea bohemica* (Zauschn.) Schult. et Schult. élőhelyválasztásának vizsgálata. Kitaibelia **7(2):** 215–224.

Bódis J. 1999: Cseh tyúktaréj – *Gagea bohemica*. p.: 275. In: Farkas S. (ed.), Magyarország védett növényei, Mezőgazda Kiadó, Budapest.

Borhidi A. 2003. Magyarország növénytársulásai. Akadémiai Kiadó, Budapest, 688 pp.

Buček A., Lacina J. & Laštůvka Z. (eds) 2006. Pannonia steppe grasslands in Moravia. Veronica **20**: 1–40.

Ellenberg H. 1988. Vegetation ecology of Central Europe. Cambridge University Press, Cambridge, 731 pp.

Heyn C.C. & Dafni A. 1977. Studies on the genus *Gagea* (Liliaceae) II. The non-platyspermous species from the Galilee, the Golan Heights and Mt. Hermon. Israel J. Bot. **26:** 11–22.

Hrouda L. 2002. *Gagea* Salisb., pp. 760–763. In: Kubát K. et al. (eds.), Klíč ke květeně České republiky, Academia, Praha.

Levichev I.G. 1999. Phytogeographical analysis of the genus *Gagea* Salisb. (Liliaceae). Komarovia. **1:** 45–57.

Jávorka S. 1924–25. Magyar Flóra (Flora Hungarica). Magyarország virágos és edényes virágtalan növényeinek meghatározó kézikönyve. Studium, Budapest, CII+1307 pp.

Korneck D. 1975. Beitrag zur Kenntniss mitteleuropäeischer Felsgrus-Gesellschaften (Sedo-Scleranthetalia). Mitt. flor.-soz. Arbeitsgem. N. F. **18:** 45–102.

Láng A.F. 1827. Illustratio Plantarum Herbarii Florae ruthenicae sistens rationem specierum novarum, minus cognitarum, aliarumve per centuriam primam distributarum. Flora **10(1)B:** 33–94.

Molnár Zs. & Borhidi A. 2003. Hungarian alkali vegetation: Origins, landscape history, syntaxonomy, conservation. Phytocoenologia **33:** 377–408.

Oprea A. 2005. Lista critica a plantelor vasculare din Romania. Editura Universităşii „Alexandru Ioan Cuza", Iaşi, 668 pp.

Prokudin Y.N. ed. 1987. Opredelitel' vysshykh rastenij Ukrainy. Naukova dumka, Kiev, 548 pp.

Mosyakin S.L. & Fedoronchuk M.M. 1999. Vascular plants of Ukraine: A nomenclatural checklist. National Academy of Sciences of Ukraine, Kiev, 346 pp.

Orbán S. & Vajda L. 1983. Magyarország mohaflórájának kézikönyve. Akadémiai Kiadó, Budapest, 518 pp.

Pascher A. 1907. *Gagea bohemica* – eine mediterrane Pflanze. Bot. Jahrb. **39:** 306–317.

Richardson L.B.K. 1980. *Gagea* Salisb., pp. 26–28. In: Tutin T.G., Heywood W.H., Burges N.A., Moore D.M., Valentine D.H. & Walters S.M. (eds), Flora Europaea Vol. 5. Cambridge University Press, Cambridge.

Rix E.M. & Woods R.G. 1981. *Gagea bohemica* (Zauschner) J.A. & J. H. Schultes in the British Isles, and a general review of the *G. bohemica* complex. Watsonia **13:** 265–270.

Schultes J.A. & Schultes J.H. 1829–1830. Systema Vegetabilium. Studtgardtiae. I–XLIV. + 1–754., XLV–CVIII + 755–1816 pp.

Simon T. 2000. A magyarországi edényes flóra határozója. Harasztok – virágos növények. – Nemzeti Tankönyvkiadó, Budapest, 846 pp.

Slater F.M. 1990. Biological Flora of the British Isles No. 168. *Gagea bohemica* (Zauschner) J. A. & J. H. Schultes (*G. saxatilis* Koch). J. Ecol. **78:** 535–546.

Stroh G. 1936. Die Gattung *Gagea* Salisb. Beih. Bot. Centralbl. **57B:** 485–520.

Sümegi P. 2004. A Hortobágy fejlődéstörténete, pp. 33–38. In: Ecsedi Z. (ed.) A Hortobágy madárvilága. Balmazújváros – Szeged.

Sümegi P., Bodor E. & Törőcsik T. 2005. The origins of alkalisation in the Hortobágy region in the light of the palaeoenvironmental studies at Zám-Halasfenék. pp. 115–126. In: Gál E., Juhász I. & Sümegi P. (eds), Environmental Archaeology in North-Eastern Hungary, Varia Archaeologica Hungarica, Budapest. **19**.

Terraciano A. 1906. Gagearum species florae Orientalis. Bull. Herb. Boiss., sér. 2, **4:** 112–115.

Tóth Cs. 2000. Anthropogenic alkali erosional processes in the buffer zone of the Hortobágy National Park, pp. 12–21. In: Jankowski A.T. & Pirozhnik I.I. (eds), Nature use in different conditions of human impact, Minsk – Sosnowiec.

Zahariadi C. 1966. *Gagea* Salisb., pp. 159–186. In: Săvulescu T. & Nyárády E.I. (eds), Flora Republicii Socialiste RomâniaXI., Editura Academiei Republicii Socialiste România, Bucureşti.

Zólyomi B. & Fekete G. 1994. Pannonian loess steppe: differentation is space and time. Abstacta Botanica **18:** 29–41.

Received March 10, 2010
Accepted October 1, 2010