

Distribution and origin of *Aegilops* species in Slovakia

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Abstract: Historical and recent distribution of two *Aegilops* species was studied during 2002–2012 in Slovakia. *Aegilops cylindrica*, regarded as native species in Slovakia, was found at overall 16 localities in south-western and south-eastern Slovakia. More than half of those sites are considered to be adventive. Ten localities were confirmed during our field research including three natural localities on northern border of its original range (Kamenica nad Hronom) and seven adventive sites (Dunajská Streda, Sered', Galanta, Trnovec nad Váhom, Chľaba, Dobrá, Čierna nad Tisou). Our results showed that the species belongs to rare termophilic archaeophytes of the Slovak flora; we confirmed its status in the Slovak Red List of Vascular Plants as vulnerable [VU B1a(i)b(iii)+2a(i)b(iii)]. *Aegilops geniculata* was reliably confirmed as a new species to the Slovak flora during revision of herbarium material. The species was found as casual alien in the surrounding of the Štúrovo railway station in 1960 and its occurrence was not confirmed recently. Distribution map of both species is given.

Keywords: *Aegilops*, distribution, origin, Slovakia.

Introduction

The genus *Aegilops* (family *Poaceae*, tribe *Triticeae*) is characterized as a Mediterranean–Western Asiatic element and its centre of diversity follows the central part of the Fertile Crescent arc in West Asia (VAN SLAGEREN 1994). The

genus has an important potential utilization in wheat improvement due to its resistance to different biotic and abiotic stresses. Therefore, a better knowledge of the eco-geographical distribution of *Aegilops* species and their collection and conservation are required (ZAHARIEVA et al. 2004). Worldwide, the genus contains 22 species of annual grasses with mainly out crossing breeding system close related to genus *Triticum* and it caused the evolution of hexaploid wheat (VAN SLAGEREN 1994; WAINES & BARNHART 1992). In southern Europe, 12 taxa were distinguished (HAMMER 1980; TUTIN & HUMPHRIES 1980; SPETSOV et al. 2006), whereas only *Ae. cylindrica* Host (jointed goatgrass, Fig. 1) and

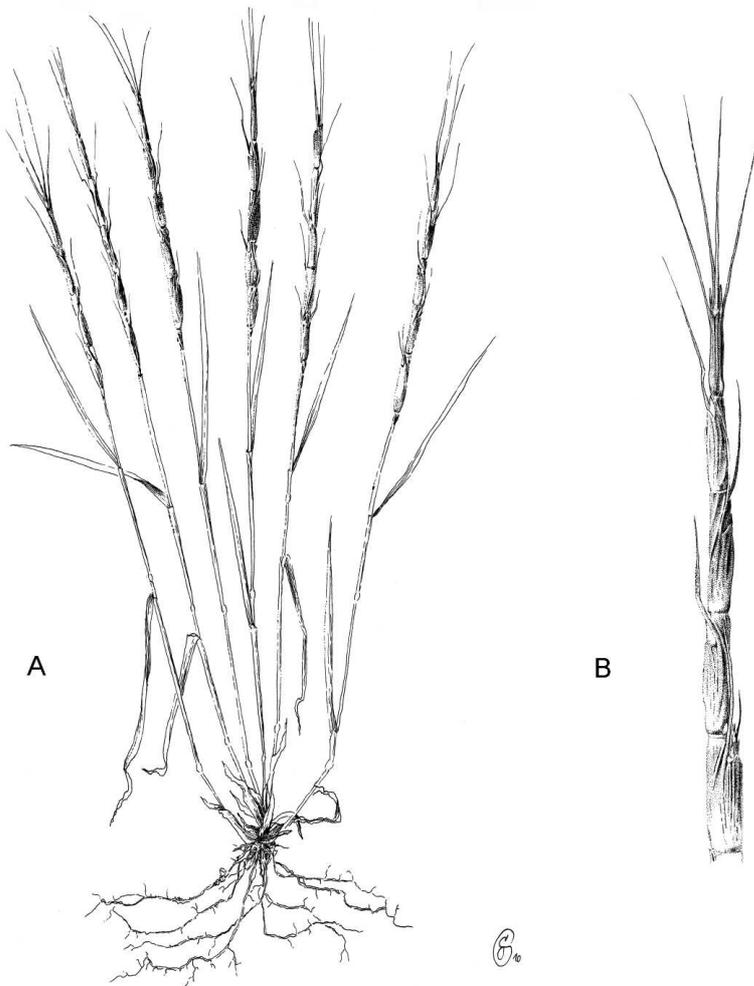


Fig. 1. *Aegilops cylindrica* Host. A – habit of the plant, B – detail of the inflorescence (orig. P. Čepček).

Ae. geniculata Roth (ovate goatgrass, Fig. 2) are known in eastern part of Central Europe (Soó 1973; CONERT 1998; KUBÁT et al. 2002) (Figs. 3, 4). The first mentioned species is reliably documented also from the territory of Slovakia (DOSTÁL & ČERVENKA 1992; MARHOLD & HINDÁK 1998; ELIÁŠ & MAGLOCKÝ 1999), the second one is mentioned only in a single work (DOSTÁL 1950).

The ecological requirements of the two taxa are very similar, both species frequently occur along roadsides, edges of fields, dry hills, slopes and grassy steppes where they tolerate disturbance. Similarly, the occurrence of both species is concentrated from the Mediterranean area to central Asia, but the native range of *Ae. cylindrica* extends much more to the north. Both taxa are also adventive in other temperate countries and the USA (TUTIN & HUMPHRIES 1980; VAN SLAGEREN 1994; CONERT 1998).

Up to now, detailed study of occurrence of the *Aegilops* taxa is missing in Slovakia. Therefore, the paper aims to clarify the recent and historical distribution and the origin of the taxa in the region as well.

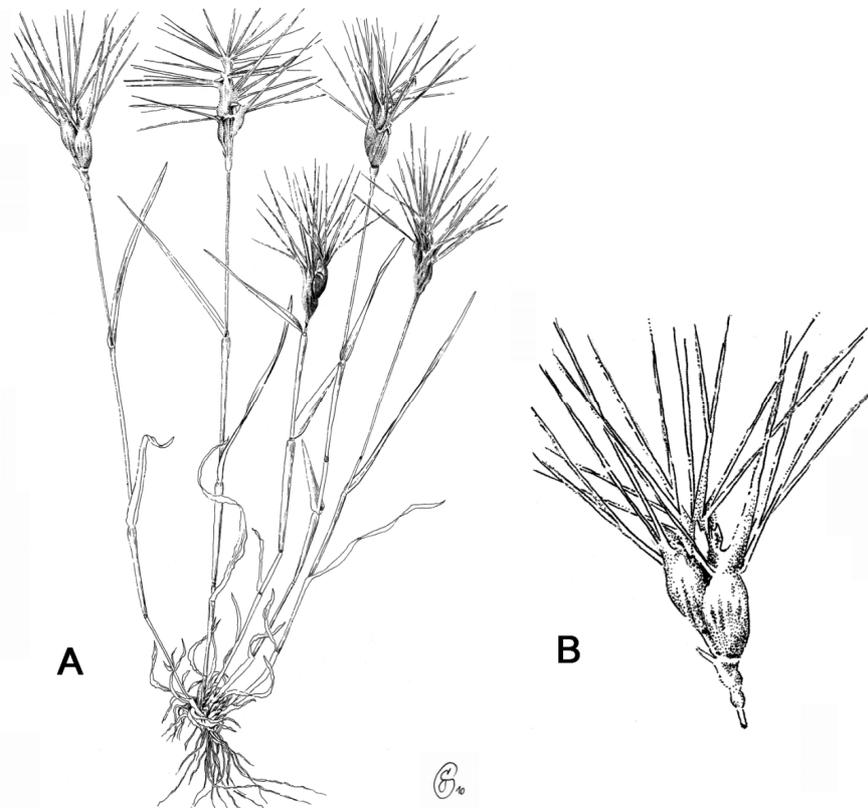


Fig. 2. *Aegilops geniculata* Roth. A – habit of the plant, B – detail of the inflorescence (orig. P. Čepček).

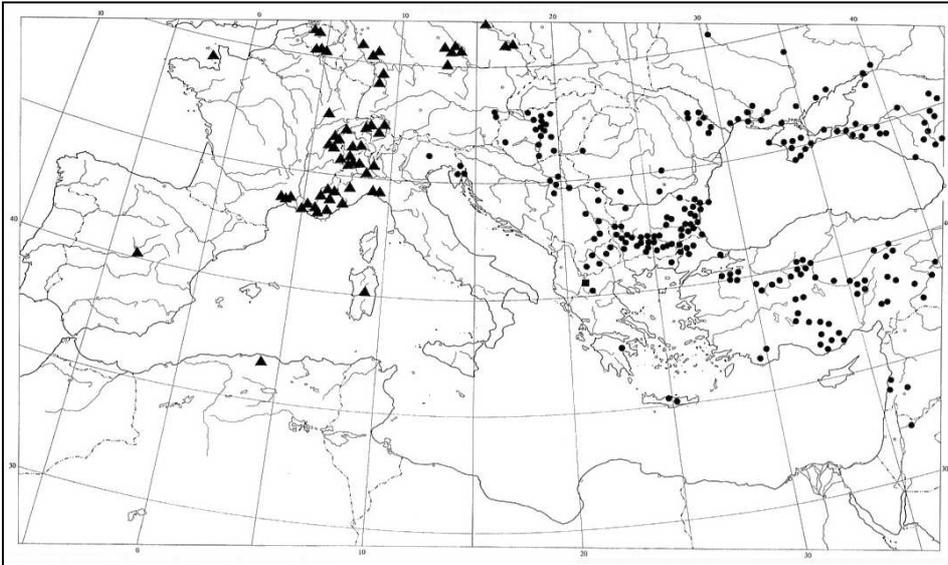


Fig. 3. Distribution of *Aegilops cylindrica* Host in Europe and West Asia. ● – locations, ▲ – adventive locations (according to van Slageren 1994).

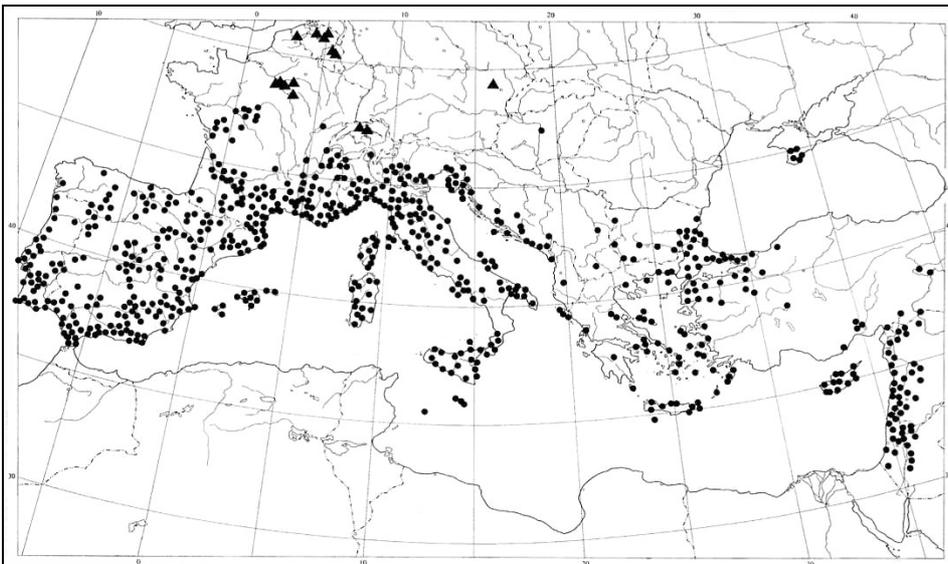


Fig. 4. Distribution of *Aegilops geniculata* Roth in Europe and West Asia. ● – locations, ▲ – adventive locations (according to van Slageren 1994).

Material and methods

The study was carried out during the years 2002 – 2012 including herbarium data revision, literature data excerption and field research. The data concerning the distribution of the species were achieved from herbaria BP, BRA, BRNU, BRNM, KO, LTM, MZ, NI, OLM, PMK, PR, PRA, PRC, SAV, SLO, and ZV. Herbarium abbreviations are according to HOLMGREN et al. (1990) and VOZÁROVÁ & SUTORÝ (2001).

Nomenclature of *Ae. geniculata* follows VAN SLAGEREN (1994); nomenclature of other flowering plants follows MARHOLD & HINDÁK (1998). The nomenclature of syntaxa follows JAROLÍMEK et al. (2008). The results of this study are presented on the point map. Coordinates of historical localities were taken from Google Earth. Coordinates of recent localities were obtained during the field research using GPS equipment Garmin CS 60; the numbers of grid squares follow one that was described by NIKLFELD (1971). A list of localities is compiled according to directives of the Flóra Slovenska VI/1 (GOLIAŠOVÁ & ŠÍPOŠOVÁ 2008). The abbreviations of the works published before 1956 follow FUTÁK & DOMIN (1960). Phytogeographical divisions of FUTÁK (1984) are also used.

Two terms are used in the characterization of the origin of *Aegilops* species. The term "natural locality" refers to the *Aegilops cylindrica* sites where species grows in natural or semi-natural xerothermic vegetation. Locations marked as "adventive" represent places where each *Aegilops* species were clearly introduced, particularly by rail transport.

Results

The occurrence of two *Aegilops* species was confirmed in Slovakia during our study: *Ae. cylindrica* Host and *Ae. geniculata* Roth (syn. *Ae. ovata* L.) (Figs. 1, 2). Both species were found exclusively in the Pannonian phytogeographical region.

Overall, the occurrence of *Ae. cylindrica* was recorded on 16 localities belonging to three phytogeographical districts. Largest number of sites was situated in the district Podunajská nížina Lowland (7 localities). Here, the species was found either on anthropogenic habitats such as railway stations (Dunajská Streda, Sered', Galanta, Trnovec nad Váhom), field edges, river dams (three localities around the town of Štúrovo), and in semi-natural habitats on south-eastern slopes of the Belianske kopce Hills (Nána, Kamenný Most). Five localities were documented in the district Burda Hills. Here, the occurrence has been mostly concentrated to natural sub-xerothermic habitats on foothills and south slopes of the Burdov Nature Reserve (Kamenica nad Hronom, Kováčov settlement); one locality was located near the train station (Chľaba). In the district Východoslovenská nížina Lowland, two localities were recorded on railway stations in the settlements of Dobrá and Čierna nad Tisou.

Recently, we have confirmed ten localities of jointed goatgrass in the field (Fig. 5). Three localities were confirmed in natural habitats (Kamenica nad Hronom) and seven sites in railway stations (Dunajská Streda, Sered', Galanta, Trnovec nad Váhom, Chľaba, Dobrá, Čierna nad Tisou). Three of them were found as

new localities during our research (Sereď, Galanta, Trnovec nad Váhom). We were not succeed to confirm any locations in the Belianske kopce Hills.

Our results showed that the species belongs to rare native termophilic taxa of the Slovak flora, which is spreading by the railway northwards. On the basis of our field data, we evaluate *Ae. cylindrica* as vulnerable species of the Slovak flora [VU B1a(i)b(iii)+2a(i)b(iii)] using IUCN categories and criteria.

Aegilops geniculata was reliably confirmed as a new species to the Slovak flora during revision of unsorted Josef Dostál's collection deposited in the Herbarium of National Museum in Prague (herbarium acronym PR, the Czech Republic). The species was collected in the surroundings of Štúrovo railway station in 1960. Actually, the presence of the species was not confirmed there, but its reintroduction is possible in the future.

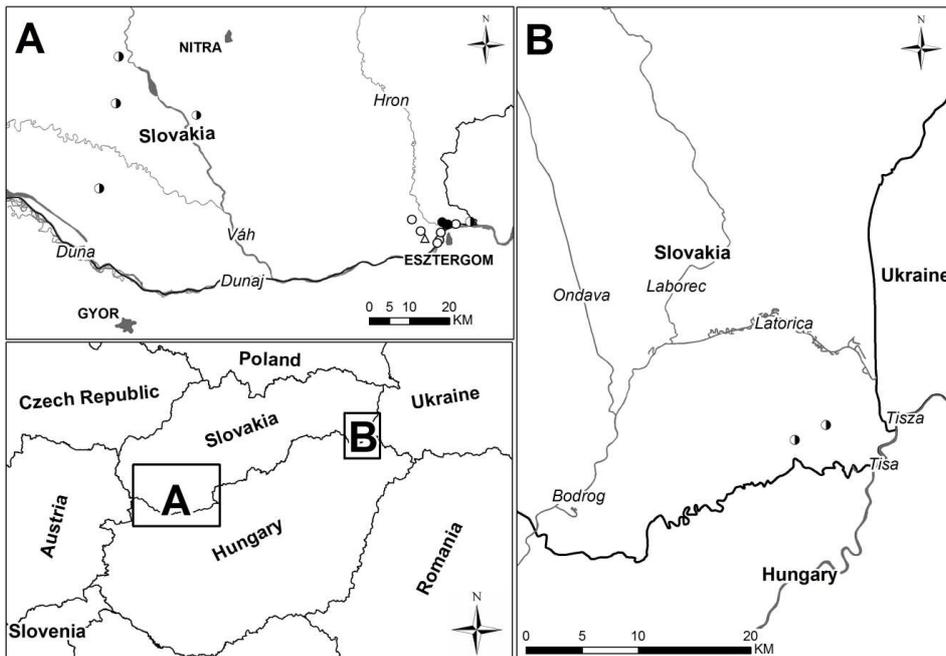


Fig. 5. Historical location (Δ) of *Aegilops geniculata* Roth in Slovakia; historical (\circ), current natural (\bullet) and current adventive (\circ) occurrence of *Aegilops cylindrica* Host in Slovakia.

List of localities of *Aegilops* species:

***Aegilops cylindrica* Host**

District 1. Burda Hills: Kamenica nad Hronom, north edge of the village north-east from the church, 128 – 165 m a. s. l. (ELIÁŠ jun. 2005 NI). – Kamenica nad

Hronom, xerothermic vegetation on north edge of the village, 150 m a. s. l. (FEICHTINGER 1866 PRC and 1899: 365; DOMIN 1933v: 247; DEYL 1951 PR; HOLUBIČKOVÁ & ONDRÁKOVÁ 1952 PR; NOVÁK 1954; VICHEREK 1967 BRNU; DEYL 1977 OLM; SVOBODOVÁ 1988; HOLUBEC & KÜHN 1992; ELIÁŠ jun. et ŠTRBA 2001 NI; ELIÁŠ jun. 2005 NI; ELIÁŠ jun. et DÍTĚ 2012 NI). – Kamenica nad Hronom, east edge of the village near railway bridge, 126 m a. s. l. (SVOBODOVÁ 1977 NI; ELIÁŠ jun. 2002 NI; ELIÁŠ jun., ELIÁŠ sen. et P. HAUPTVOGEL 2005 NI; ELIÁŠ jun. 2010 NI). – Kováčov settlement, 160 m a. s. l. (FEICHTINGER 1899: 365; DOMIN 1933v: 247; NEVRLÝ 1955 BRNM; POKLUDA 1960 BRNM; ŠÍPOŠOVÁ et GOLIAŠOVÁ 1992 SAV). – Chľaba, vineyards near the Danube River (RICHTER 1889 PR). = Chľaba, around railway station, 110 m a. s. l. (GRUNDL 1861 BRNM, PRC; SOJÁK 1950 BRNU, 1958 PR; POKLUDA 1960 BRNM; ŠOUREK 1960 PR; WEBER 1960 BRA, 1962 BRNM, PR; ČERNOCH 1961 BRNM, SAV; SKŘIVÁNEK 1961 BRNM; DVOŘÁK 1960 BRA, BRNM, 1977 OLM, 1980 BRA, OLM; SAUL 1980 BRNM; SVOBODOVÁ 1988 ined.; MURÍN & SVOBODOVÁ 1992, ELIÁŠ jun., ELIÁŠ sen. et P. HAUPTVOGEL 2005 NI; ELIÁŠ jun. et FERUS 2011 NI).

District 6. Podunajská nížina Lowland: Dunajská Streda, railway station, 115 m a. s. l. (ELIÁŠ 1984, ELIÁŠ & MAGLOCKÝ 1999; ELIÁŠ jun., ELIÁŠ sen. et P. HAUPTVOGEL 2005 NI; ELIÁŠ jun. et FERUS 2011 NI). – Sered', around military barracks near the railway station and at the railway station, 145 m a. s. l. (ELIÁŠ jun. 2002 NI; ELIÁŠ jun., ELIÁŠ sen. et P. HAUPTVOGEL 2005 NI; ELIÁŠ jun. 2010 NI). – Galanta, railway station (ELIÁŠ jun. 2010, 2011 NI). – Trnovec nad Váhom, railway station (ELIÁŠ jun. 2010 NI). – Štúrovo (GREBENSČIKOV sine data SAV). – Štúrovo, ca 1,5 km south from the town near the Danube River, 115 m a. s. l. (OSVAČILOVÁ 1955 NI; SMEJKAL et VICHEREK 1967 BRA, BRNU, BRNM, SAV). – Štúrovo, ca 1,5 km south-east from the settlement, field edge near the Danube River (SMEJKAL et VICHEREK 1967 BP, BRNU, PR; DOSTÁL 1968 PR). – Nána, vineyard edge under the Modrý vrch Hill near the Nový Dvor farmstead, 130 m a. s. l. (JEDLIČKA 1950 BRNU). = Nána, the Belianske kopce Hills (DEYL 1951 PR; HEJNÁ 1951 SLO; SOUČKOVÁ 1952 BRNM). = Nána, Belianske kopce Hills, south and south-east slopes of the Modrý vrch Hill, 140 m a. s. l. (SMEJKAL 1960 BRA; 1963 BRNU). – Kamenný Most, Belianske kopce Hills, south-east foothill of the Modrý vrch Hill, 120 m a. s. l. (SMEJKAL 1950 BRNU; KOMÁREK 1950 MZ; DOSTÁL 1968 PR).

District 8. Východoslovenská nížina Lowland: Dobrá (HOLUBEC & KÜHN 1992; DOSTÁLEK, JEHLÍK et LANDA 1998 PRA; ELIÁŠ & MAGLOCKÝ 1999; HOLUBEC 2005 in verb.; JEHLÍK & DOSTÁLEK 2008). – Čierna nad Tisou, railway station yard (DOSTÁLEK, JEHLÍK et LANDA 1998 PRA; JEHLÍK & DOSTÁLEK 2008; ELIÁŠ jun., BARANEC et ZLACKÁ 2005 NI; ELIÁŠ jun. et FERUS 2011 NI).

A. geniculata Roth

District 6. Podunajská nížina Lowland: Štúrovo, surrounding of the railway station (DOSTÁL 1960 PR).

Discussion

In the southeast part of Central Europe, *Aegilops cylindrica* is considered either a native species (NOVÁK 1954; HOLUBEC & KÜHN 1992; ELIÁŠ & MAGLOCKÝ 1999) or an archeophyte (HALADA 1997; TERPÓ et al. 1999). Considering the archaeological findings of *Ae. cylindrica* grains in Hungary (Szigetszentmiklós; Albertfalva) dated to the early Bronze Age (1800 – 1600 BC) (GYULAI 2004), we may refuse that the species is archeophyte in this region. Although no similar archaeobotanical data of the species are known from Slovakia up to now (M. HAJNALOVÁ, pers. communication; HAJNALOVÁ 2012), we are inclined to believe (in accordance with the above data from Hungary) that jointed goatgrass is at least an archaeophyte in this area. According to MEDVECKÁ et al. (2012) *Ae. cylindrica* is native, as they did not include it in the list of alien taxa (including archaeophytes) of Slovakia.

It is possible that the species could occur here as early as in the period around 5000 B. P. during the introduction of barley and wheat in Central Europe (ZOHARY & HOPF 1993) like some typical cereal weeds as *Agrostemma githago* or *Bromus secalinus* (FIRBANK 1988; CANEPILLE et al. 2003). Opinions about the authenticity of the species in SW Slovakia were also supported by analysis of seed storage protein patterns. VÖRÖSVÁRY et al. (2007) found that protein type from Kamenica nad Hronom population contain similarity bands with Bokros population from SE Hungary. Thus, it is clear, that SW Slovakia is really the northern border of the natural range of species, occurrence of the species follows the mentioned sites in NW Hungary. Jointed goatgrass was found around the Slovak-Hungarian border near settlements of Letkés and Esztergom (Z. BARINA, pers. communication) and around the town of Vác (VÖRÖSVÁRY et al. 2004). However, the westernmost natural localities were found near the Balaton Lake (SOÓ 1973; VAN SLAGEREN 1994; VÖRÖSVÁRY et al. 2004) and temporary occurrence was recorded near Hegyeshalom in NW Hungary (G. KIRÁLY, pers. communication). Occurrence of *Ae. cylindrica* is considered as adventive in the rest of Central and Western Europe. The species extends north into Poland and Germany (LATOWSKI 1978; CONERT 1998; WRZESIEŃ & ŚWIĘS 2006) and the northwestern limit of adventive distribution in Eurasia is in Switzerland (GUADAGNUOLO et al. 2001).

Jointed goatgrass (*Ae. cylindrica* Host) is a noxious annual weed in winter wheat-growing areas of south-eastern Europe and the western United States. However, the species often appears in ruderal habitats as well as in semi-natural and natural xerothermic communities in native range of its distribution (DONALD & OGG 1991; VAN SLAGEREN 1994). *Ae. cylindrica* can be found in Central Europe as weed only rarely where it almost exclusively occupies above mentioned types of habitats (SOÓ 1973; ELIÁŠ & MAGLOCKÝ 1999; own observation). It has been found as a member of xerothermic vegetation of alliances *Festucion valesiaceae* Klika 1931 and *Asplenio septentrionalis-Festucion pallentis* Zólyomi 1936 corr. Soó 1971 (Soó 1973), but it has occurred here rather incidentally. The species has been found more frequently in ruderal communities of alliance *Sysimbrion*

officinalis R. Tx. et al. in R. Tx. 1950 §, especially in the association *Aegilopsietum cylindricae* Eliáš 1981. The community occupied gravel and sandy soils in open locations, mainly at the edges of roads and railway stations yards (ELIÁŠ 1981, 1984; ELIÁŠ & MAGLOCKÝ 1999).

As we mentioned above, we do not have any ancient data of *Ae. cylindrica* from the territory of Slovakia. The species was found first by IGNÁC GRUNDL in 1861 near the village of Chľaba. Only a few years later, in 1866, SÁNDOR FEICHTINGER (1899) collected the species at Kamenica nad Hronom village. Most sites were confirmed and newly recorded from the fifties to the seventies of the 20th century (see chapter Results). Species distribution was already published in several works in the past, but it was characterized only in general and/or incompletely. Some authors (DOSTÁL 1989; DOSTÁL & ČERVENKA 1992) mentioned only the species distribution in the Belianske kopce Hills and in surroundings of the Štúrovo town. On the other hand, ELIÁŠ & MAGLOCKÝ (1999) mentioned the species presence at railway stations in Dunajská Streda and Dobrá, but they did not present the occurrence at the Belianske kopce Hills as well as locations around the town of Štúrovo. Therefore, our work has closely summarized the occurrence of jointed goatgrass in this area of range including also newly discovered (adventive) localities in Sered', Galanta and Trnovec nad Váhom (Figure 5). The species was also reported by JEHLÍK & DOSTÁLEK (2008) from the transshipment station of the Veľké Kapušany town, but as the authors mentioned in personal communication, this data is a mistake, which was caused during the process of manuscript preparation.

As the jointed goat grass does not belong to common species of Central Europe, it is listed as a threatened species in Hungary (IUCN category "NT") and Slovakia (IUCN category "CR") (ELIÁŠ & MAGLOCKÝ 1999; FERÁKOVÁ et al. 2001; KIRÁLY 2007). During our research, only three natural localities were found in surrounding of Kamenica nad Hronom. The occurrence of *Ae. cylindrica* there was often temporary, it has grown near man-affected sites and the micro-populations at the natural habitats (pioneer xerothermic grassland habitats) often included only a small number of individuals. Moreover, all localities in the Belianske kopce Hills have been vanished. We believe that the disappearance of the species was caused by succession of xerothermic pastures and vineyards edges. Those open habitats were abandoned due to change of land use during the last fifty years (collectivization, uneconomic conditions in management of arable land) and shrubs gradually replaced grassland vegetation. Jointed goatgrass is poorly tolerant to shade (ELIÁŠ & MAGLOCKÝ 1999), therefore, it retreats from overshadowed areas relatively quickly. Besides, jointed goatgrass seeds have an intermediate level of persistence; remaining viable in the soil for 3 to 5 years (EVANS et al. 1999). This means that even large local population may disappear during the decade under the influence of secondary succession. On the other hand, the species is spreading to the north by train transport; seven adventive sites (Dunajská Streda, Sered', Galanta, Trnovec nad Váhom, Chľaba, Dobrá, Čierna nad Tisou) were confirmed. Based on our findings and in

accordance to IUCN Red List Categories and Criteria (IUCN 2003), we propose to include the species as vulnerable [VU B1a(i)b(iii)+2a(i)b(iii)] in the Slovak Red list of Vascular Plants.

To prevent the extinction of other jointed goatgrass sites (both natural and adventive), the collection of genetic material from most existing populations (Dunajská Streda, Sered', Kamenica nad Hronom, Chľaba, Čierna nad Tisou) was carried out for the Gene Bank at the Research Institute of Plant Production in Piešťany in 2005 and 2006. In addition, *Ae. cylindrica* plants from three indigenous populations has been also cultivated in the Botanical Garden of Slovak University of Agriculture in Nitra since the last year. These measures should ensure the long-term survival of the species at the northern limit of its native range.

The second representative of the genus in Slovakia, *Ae. geniculata*, is native to the Mediterranean and western Asia; it has been introduced elsewhere in Europe and in the United States of America (California) (HAMMER 1980; TUTIN & HUMPHRIES 1980; VAN SLAGEREN 1994; CONERT 1998). The species was already found in central Europe in the past. There are first data from beginning of the 20th century from Germany and Switzerland (CONERT 1998). In the eastern part of the region, *Ae. geniculata* was temporarily introduced only into the Czech Republic in the twenties of the 20th century (Roudnice nad Labem) (NOVÁK 1922; DOSTÁL 1989; KUBÁT et al. 2002). J. ZÁZVORKA (pers. communication) considered that the species escaped from the Botanical Garden of the local business high school.

Occurrence of the species in Slovakia was reported only by DOSTÁL (1950) as "occasionally introduced to southern Slovakia". However, he has not mentioned *Ae. geniculata* from Slovakia in his another works (DOSTÁL 1989, DOSTÁL & ČERVENKA 1992). The data were therefore rated as unreliable and *Ae. geniculata* was not included in the Slovak flora (MARHOLD & HINDÁK 1998; MEDVECKÁ et al. 2012). During our revision of unsorted herbarium material of JOSEF DOSTÁL deposited in the Herbarium of National Museum in Prague (PR, the Czech Republic), we found herbarium specimen of *Ae. geniculata* collected by him in the surroundings of Štúrovo railway station in 1960, so its occurrence in Slovakia was reliably confirmed. The most likely possibility seems to be the introduction with cereals from some former communist Balkan countries (Romania, Bulgaria, and former Yugoslavia). The cereals were imported exclusively by rail to former Czechoslovakia. Significant amount of adventive plant species were introduced through this Pannonian Route of aliens, e.g. *Amaranthus albus*, *Consolida orientalis* and *Rumex patientia* (JEHLÍK & HEJNÝ 1974; JEHLÍK 1998). *Ae. geniculata* failed to survive in this area; it was neither confirmed here in the seventies of the 20th century (JEHLÍK 1998) nor during our research. The species extinct on this site, probably because it did not create viable seeds or the seedlings died due to winter frost or plants were destroyed by herbicides during the maintenance of railway tracks. Therefore, we regarded it as a casual alien of the Slovak flora.

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