



Distribution of plant species *Iris sibirica* and its vegetation affinity in Slovakia

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Abstract

Iris sibirica is a threatened plant species of the Central European flora, but its distribution and vegetation ecology in Slovakia have not been studied so far. Therefore, we aimed to compile a complex chorology of this species and to analyse phytosociological plots with the species occurrence. Our results suggest that *Iris sibirica* occurs almost in the whole Slovakia, with two distributional centres situated in the south-western region (Pannonian bioregion) and in the southern regions of central Slovakia (Carpathian bioregion), but a higher proportion of recent records was identified in the Carpathians. Vegetation classification using the TWINSpan algorithm divided 80 vegetation plots into 5 clusters. They were interpreted syntaxonically as follows: i) *Calthion palustris* alliance, ii) *Deschampsion cespitosae* alliance, iii) *Molinion caeruleae* alliance, iv) vegetation of the successional stages and transitional status between wet meadows (*Calthion palustris* and *Molinion caeruleae*) and fens (*Scheuchzeria palustris*-*Caricetea fuscae*), and v) vegetation with a transitional status between hygrophilous, fen vegetation of the alliances *Molinion caeruleae*, *Caricion davallianae*, *Caricion fuscae* and mesic habitats. Variation in the species composition of vegetation plots, analysed using detrended correspondence analysis (DCA) and interpreted using Ellenberg indicator values for vascular plants, showed a shift along the first DCA axis from taxa typical for nutrient-rich and shaded but thermophilic sites to taxa of open and relatively cold habitats on nutrient-poor soils. The second DCA axis corresponded to the moisture gradient, which controlled the pattern of plant species richness.

Keywords Central Europe · Chorology · Herbaria · Plant records · Phytosociology · Threatened plant · Wet meadows

Introduction

European non-forest wetlands, such as fens, floodplain and wet meadows on mineral and peaty soils, are considered threatened habitats. The main threats of their stand structure and community diversity are related to changes in water regimes, abandonment of agricultural utilization or traditional farming and conversion of meadows into intensively

used agricultural land (Brinson and Malvárez 2002; Verhoeven 2014; Straubinger et al. 2023). These landscape treatments, exacerbated by ongoing climate change, also have a negative impact on many vascular plants specialised in these habitats. Wetlands evenly harbour abundant group of rare species, including the Siberian Iris (*Iris sibirica*) that is threatened in several Central European countries (Schnittler and Günther 1999; Király 2007; Grulich 2012). The species is also listed in the Slovak Plant Red List in the near threatened category (Eliáš et al. 2015).

Iris sibirica L. (family *Iridaceae*) is a rhizomatous herbaceous perennial species. It has a rhizome and hollow, frequently branched and somewhat vertically compressed stems, 50–120 cm tall. Several basal leaves (25–80 cm × 4–10 mm) are accompanied by only a few small leaves on the stem. The plants have 1–3 (rarely 5) mid-blue to violet-blue (rarely white) flowers, with 5–7 cm

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in diameter. The fruit is a capsule of 2–4 cm long with an ellipsoidal to sub-cylindrical shape with flat seeds (POWO 2023). This boreal Euro-Siberian species is primarily distributed in the temperate biome. In Europe, *I. sibirica* grows except for its northern regions and most of the Mediterranean area. It occurs from western France and Central Europe to the Baltic States in the north, the Balkan Peninsula in the south and European Russia in the east. The Asian distribution range extends from western and south-western Siberia to Mongolia, with some isolated occurrences recorded in the Caucasus Mts and Anatolia region (Meusel and Jäger 1992). The species is relatively common with a scattered distribution pattern in Central Europe. It is documented in the Germany (Meusel and Jäger 1992), Czech Republic (Hroudá and Grulich 2010), Austria (Fischer et al. 2008), Hungary (Bartha et al. 2015) and Poland (Zajac and Zajac 2001). In Slovakia, it has a similarly scattered distribution throughout the country (Dostál and Červenka 1992). *I. sibirica* is a typical wetland species with a strong affiliation to wet meadows of the *Molinio-Arrhenatheretea* class, mainly to the order *Molinietales caeruleae* (Botta-Dukát et al. 2005), and the alliances *Calthion palustris*, *Molinion caeruleae* and *Deschampsion cespitosae* (e.g. Matuszkiewicz 2008; Chytrý 2010; Borhidi et al. 2012; Hegedúšová Vantarová and Škodová 2014). The association *Iridetum sibiricae* was described as a plant community with the dominance of this species and it has been reported especially from Central European countries (Salamon-Albert et al. 2010).

The distribution pattern, vegetation and ecological affinities of the target species in Slovakia have been published almost exclusively in local floristic and phytosociological studies, but there is no complex synthesis at the national level. Therefore, the aims of this study were i) to revise and complete the chorological data of *Iris sibirica* in Slovakia, and ii) to describe the vegetation with the species occurrence and to analyze its ecological pattern.

Materials and methods

Distributional data

The distribution data of *Iris sibirica* in Slovakia were collected from the following sources: public Central European herbaria (BP, BRA, BRNM, BRNU, EGR, HLO, HNTS, KO, LTM, MMI, MOP, MPS, NI, OL, OLM, PMK, PR, PRC, SAV, SLO, SMBB, SNV, TM, VSM, ZAM, ZV and W), JACQ – Virtual herbaria database (<https://www.jacq.org>), public photo galleries (FotoNet – wild nature photography, <https://www.fotonet.sk>, <https://www.nahuby.sk>), Slovak floristic and vegetation databases (Institute of Botany, Plant Science and Biodiversity Center, Slovak Academy of Sciences in Bratislava, DAPHNE – Institute of Applied Ecology

in Bratislava, Slovak Vegetation Database, <https://ibot.sav.sk/cdf/>) and field research of the authors. Herbarium codes followed Thiers (2022+) and small local museum collections were unified according to Vozárová and Sutorý (2001). These sources were only used if the record was georeferenced and the locality had not been published or supported by a herbarium specimen.

The map of *Iris sibirica* distribution was prepared in the program ArcGis version 9.2 using the grid template of the Central European Flora Mapping System (Niklfeld 1971). All localities were geographically sorted according to the traditionally used phytogeographical division of Slovakia (Futák 1984).

Vegetation and ecological data

Vegetation affinity of *Iris sibirica* was analysed based on the phytosociological relevés provided by the Slovak Vegetation Database (code EU-SK-001 in the Global Index of Vegetation-Plot Databases; Šibík 2012) and completed by our unpublished relevés. Finally, we used 82 relevés (80 treeless, whose sources are listed below in the Table 1, and two relevés of shrub and forest vegetation which are listed in Appendix 2) stored in the Turboveg database (Hennekens and Schaminée 2001). They were subsequently processed in the Juice program (Tichý 2002). Species taxonomy was unified using the concept of broadly defined plant taxa with few aggregate taxa, namely *Agrostis stolonifera* agg. (*A. gigantea*, *A. stolonifera*), *Eleocharis palustris* agg. (*E. palustris*, *E. uniglumis*), *Galium palustre* agg. (*G. elongatum*, *G. palustre*), *Luzula campestris* agg. (*L. campestris*, *L. multiflora*), *Molinia caerulea* agg. (*M. arundinacea*, *M. caerulea*), *Poa pratensis* agg. (*P. angustifolia*, *P. pratensis*) and *Solidago canadensis* agg. (*S. canadensis*, *S. gigantea*). Bryophytes were excluded from the dataset because they were only identified in some relevés. In order to homogenise the vegetation dataset, two relevés of shrub and forest vegetation were excluded before the statistical analyses. Numerical classification was performed with species merged into a single layer using the modified TWINSpan algorithm (Roleček et al. 2009). We used five pseudospecies cut levels (0%, 5%, 25%, 50% and 75%) and total inertia as a measure of cluster heterogeneity. The differential species of each cluster were determined using frequency and fidelity thresholds (Φ – phi coefficient; Chytrý et al. 2002). They were set at frequency $\geq 20\%$, phi coefficient ≥ 0.30 and difference in frequency between clusters $\geq 20\%$. If a particular species was constant (frequency reached $\geq 50\%$) in two or more clusters, it was not accepted as a differential. The Fisher's exact test ($p < 0.05$) was used to eliminate species with a non-significant occurrence in a given cluster (Tichý and Chytrý 2006). Detrended correspondence analysis (DCA) and Ellenberg indicator values (EIVs) for vascular plants, calculated for temperature, moisture, light, soil reaction, nutrients and continentality (Ellenberg et al. 1992),

Table 1 Shortened synoptic table of treeless vegetation with the presence of *Iris sibirica* in Slovakia. Taxa are presented with percentage frequency and phi-values (*100; upper index). Only taxa with the frequency $\geq 20\%$ in the dataset are shown (164 taxa are hidden)

Cluster No	1	2	3	4	5
Number of relevés	9	29	11	10	21
Diagnostic taxa of the first cluster					
<i>Carex buekii</i>	78 ^{78.9}	10 ⁻⁻⁻	---	---	---
<i>Mentha longifolia</i>	56 ^{70.7}	---	---	---	---
<i>Cirsium oleraceum</i>	56 ^{70.7}	---	---	---	---
<i>Anthriscus sylvestris</i>	44 ^{56.3}	7 ⁻⁻⁻	---	---	---
<i>Galium aparine</i>	56 ^{56.3}	10 ⁻⁻⁻	---	10 ⁻⁻⁻	---
<i>Caltha palustris</i>	78 ^{56.1}	21 ⁻⁻⁻	---	30 ^{2.7}	10 ⁻⁻⁻
<i>Aegopodium podagraria</i>	44 ^{55.2}	3 ⁻⁻⁻	---	---	5 ⁻⁻⁻
<i>Hypericum maculatum</i>	22 ^{43.1}	---	---	---	---
<i>Impatiens noli-tangere</i>	22 ^{43.1}	---	---	---	---
<i>Galium album</i> s.lat	33 ^{41.2}	3 ⁻⁻⁻	---	10 ^{1.1}	---
Diagnostic taxa of the second cluster					
<i>Alopecurus pratensis</i>	11 ⁻⁻⁻	100 ^{75.6}	36 ^{6.4}	---	5 ⁻⁻⁻
<i>Carex praecox</i>	---	52 ^{67.9}	---	---	---
<i>Rumex crispus</i>	---	48 ^{65.4}	---	---	---
<i>Carex vulpina</i>	---	55 ^{59.4}	---	10 ⁻⁻⁻	5 ⁻⁻⁻
<i>Glechoma hederacea</i> agg	---	38 ^{57.3}	---	---	---
<i>Taraxacum</i> sect. <i>Ruderalia</i>	33 ^{13.0}	69 ^{55.7}	---	10 ⁻⁻⁻	---
<i>Trifolium hybridum</i>	---	45 ^{54.9}	9 ⁻⁻⁻	---	---
<i>Phalaris arundinacea</i>	---	34 ^{54.4}	---	---	---
<i>Selinum dubium</i>	---	34 ^{54.4}	---	---	---
<i>Potentilla reptans</i>	---	66 ^{53.0}	9 ⁻⁻⁻	20 ⁻⁻⁻	14 ⁻⁻⁻
<i>Elymus repens</i>	---	38 ^{52.6}	---	---	5 ⁻⁻⁻
<i>Gratiola officinalis</i>	---	41 ^{51.2}	---	10 ⁻⁻⁻	---
<i>Symphytum officinale</i>	22 ⁻⁻⁻	62 ^{48.7}	---	20 ⁻⁻⁻	5 ⁻⁻⁻
<i>Rumex confertus</i>	---	28 ^{48.3}	---	---	---
<i>Pseudolysimachion longifolium</i>	---	48 ^{47.9}	---	10 ⁻⁻⁻	14 ⁻⁻⁻
<i>Carex hirta</i>	11 ⁻⁻⁻	66 ^{47.0}	9 ⁻⁻⁻	10 ⁻⁻⁻	29 ^{4.3}
<i>Rorippa austriaca</i>	---	24 ^{45.0}	---	10 ⁻⁻⁻	---
<i>Clematis integrifolia</i>	---	24 ^{45.0}	---	---	---
<i>Inula britannica</i>	---	21 ^{41.6}	---	---	---
<i>Veronica serpyllifolia</i>	---	21 ^{41.6}	---	---	---
<i>Viola pumila</i>	---	21 ^{41.6}	---	---	---
<i>Ranunculus repens</i>	44 ^{5.4}	79 ^{41.1}	18 ⁻⁻⁻	30 ⁻⁻⁻	24 ⁻⁻⁻
<i>Poa palustris</i>	22 ^{5.9}	48 ^{40.0}	18 ⁻⁻⁻	---	---
Diagnostic taxa of the third cluster					
<i>Carex pallescens</i>	---	14 ⁻⁻⁻	100 ^{87.4}	---	10 ⁻⁻⁻
<i>Luzula campestris</i> agg	---	3 ⁻⁻⁻	91 ^{83.9}	---	14 ⁻⁻⁻
<i>Dactylorhiza majalis</i>	---	---	91 ^{80.4}	20 ⁻⁻⁻	5 ⁻⁻⁻
<i>Juncus conglomeratus</i>	---	7 ⁻⁻⁻	100 ^{79.9}	10 ⁻⁻⁻	24 ⁻⁻⁻
<i>Carex umbrosa</i>	---	---	55 ^{70.0}	---	---
<i>Viola canina</i>	---	---	55 ^{70.0}	---	---
<i>Myosotis scorpioides</i> agg	11 ⁻⁻⁻	17 ⁻⁻⁻	82 ^{61.8}	20 ⁻⁻⁻	5 ⁻⁻⁻
<i>Cruciata glabra</i>	---	7 ⁻⁻⁻	45 ^{57.1}	---	---
<i>Trollius europaeus</i>	---	---	64 ^{52.9}	40 ^{23.8}	---
<i>Achillea ptarmica</i>	---	3 ⁻⁻⁻	36 ^{52.5}	---	---
<i>Agrostis canina</i>	---	---	45 ^{51.7}	---	14 ^{3.6}
<i>Carex flava</i>	---	---	36 ^{51.2}	---	5 ⁻⁻⁻
<i>Carex canescens</i>	---	---	27 ^{48.0}	---	---
<i>Scorzonera humilis</i>	---	---	27 ^{48.0}	---	---
Diagnostic taxa of the fourth cluster					
<i>Lythrum salicaria</i>	22 ⁻⁻⁻	24 ⁻⁻⁻	18 ⁻⁻⁻	100 ^{69.9}	5 ⁻⁻⁻
<i>Calamagrostis epigejos</i>	---	3 ⁻⁻⁻	18 ^{5.5}	50 ^{50.9}	---

Table 1 (continued)

Cluster No	1	2	3	4	5
Number of relevés	9	29	11	10	21
<i>Sesleria uliginosa</i>	---	---	---	30 ^{50.5}	---
<i>Juncus inflexus</i>	11---	---	---	40 ^{42.7}	10---
<i>Geum rivale</i>	---	---	---	20 ^{40.8}	---
<i>Salix purpurea</i>	---	---	---	20 ^{40.8}	---
<i>Dactylorhiza incarnata</i>	---	---	---	20 ^{40.8}	---
<i>Phragmites australis</i>	11---	10---	---	50 ^{39.4}	24 ^{6.1}
<i>Salix cinerea</i> juv	---	3---	18 ^{4.2}	40 ^{34.6}	14---
Diagnostic taxa of the fifth cluster					
<i>Linum catharticum</i>	---	---	---	---	57 ^{71.8}
<i>Genista tinctoria</i>	---	---	---	---	52 ^{68.4}
<i>Leontodon hispidus</i>	---	---	9---	---	62 ^{68.3}
<i>Briza media</i>	---	---	27---	30 ^{3.7}	76 ^{55.9}
<i>Trifolium montanum</i>	---	7---	---	---	43 ^{55.0}
<i>Centaurea jacea</i>	---	17---	27---	20---	76 ^{53.4}
<i>Plantago lanceolata</i>	---	28 ^{9.9}	9---	---	62 ^{53.0}
<i>Prunella vulgaris</i>	---	38 ^{18.1}	9---	---	67 ^{52.4}
<i>Valeriana dioica</i>	---	---	---	40 ^{24.4}	62 ^{51.5}
<i>Dactylis glomerata</i>	---	7---	---	---	38 ^{50.8}
<i>Epipactis palustris</i>	---	---	9---	10---	48 ^{50.4}
<i>Allium carinatum</i>	---	3---	---	---	33 ^{49.8}
<i>Carex buxbaumii</i>	---	---	---	---	29 ^{49.2}
<i>Betonica officinalis</i>	---	7---	27 ^{13.2}	---	52 ^{46.3}
<i>Silaum silaus</i>	---	3---	---	---	29 ^{45.3}
<i>Achillea millefolium</i> agg	---	28 ^{8.4}	9---	10---	57 ^{44.8}
<i>Orchis palustris</i>	---	---	---	---	24 ^{44.7}
<i>Dianthus superbus</i>	---	---	---	---	24 ^{44.7}
<i>Scirpoides holoschoenus</i>	---	---	---	10 ^{2.4}	33 ^{43.8}
<i>Gymnadenia conopsea</i>	---	---	---	10 ^{2.4}	33 ^{43.8}
<i>Gentiana pneumonanthe</i>	---	---	18 ^{11.0}	---	38 ^{42.5}
<i>Juncus articulatus</i>	---	3---	9---	20 ^{6.9}	43 ^{38.8}
<i>Lotus corniculatus</i>	---	17---	18---	20---	52 ^{37.5}
<i>Holcus lanatus</i>	---	31 ^{6.4}	9---	30 ^{5.2}	57 ^{36.4}
Common taxa of the 3–5 clusters					
<i>Molinia caerulea</i> agg	---	---	82 ^{31.4}	80 ^{29.5}	90 ^{40.0}
<i>Potentilla erecta</i>	---	---	100 ^{56.0}	60 ^{15.7}	62 ^{17.6}
<i>Succisa pratensis</i>	---	3---	55 ^{22.1}	20---	90 ^{60.1}
<i>Carex nigra</i>	---	7---	91 ^{54.5}	40 ^{2.0}	52 ^{14.8}
<i>Galium uliginosum</i>	11---	7---	64 ^{31.6}	30---	57 ^{24.7}
<i>Carex hartmanii</i>	---	3---	18 ^{4.5}	20 ^{7.0}	33 ^{25.7}
<i>Juncus effusus</i>	---	3---	36 ^{28.0}	30 ^{19.3}	10---
Common taxa of the 4–5 clusters					
<i>Cirsium rivulare</i>	22---	3---	9---	60 ^{36.4}	43 ^{17.2}
<i>Carex davalliana</i>	---	---	---	50 ^{34.8}	57 ^{43.5}
<i>Carex hostiana</i>	---	---	---	30 ^{26.1}	33 ^{31.1}
<i>Salix repens</i> subsp. <i>rosmarinifolia</i>	---	---	---	20 ^{13.1}	38 ^{41.3}
Other taxa					
<i>Iris sibirica</i>	100---	100---	100---	100---	100---
<i>Ranunculus acris</i>	33---	72---	91 ^{18.1}	80 ^{5.4}	100 ^{28.6}
<i>Sanguisorba officinalis</i>	22---	79 ^{16.2}	91 ^{28.3}	50---	76 ^{13.0}
<i>Deschampsia cespitosa</i>	---	31---	100 ^{40.6}	70 ^{10.0}	100 ^{40.6}
<i>Poa pratensis</i> agg	33---	79 ^{30.9}	18---	40---	71 ^{23.0}
<i>Lathyrus pratensis</i>	67 ^{7.9}	52---	64 ^{4.8}	60 ^{1.1}	52---
<i>Filipendula ulmaria</i>	89 ^{28.1}	41---	55---	80 ^{19.0}	43---

Table 1 (continued)

Cluster No	1	2	3	4	5
Number of relevés	9	29	11	10	21
<i>Carex panicea</i>	---	31 ⁻⁻⁻	91 ^{37.4}	70 ^{16.4}	76 ^{22.6}
<i>Serratula tinctoria</i>	---	55 ^{12.3}	64 ^{20.8}	20 ⁻⁻⁻	76 ^{33.5}
<i>Galium boreale</i>	---	24 ⁻⁻⁻	82 ^{32.5}	50 ⁻⁻⁻	90 ^{41.2}
<i>Lysimachia nummularia</i>	56 ^{15.2}	83 ^{42.9}	36 ⁻⁻⁻	---	29 ⁻⁻⁻
<i>Lysimachia vulgaris</i>	44 ⁻⁻⁻	21 ⁻⁻⁻	91 ^{36.3}	70 ^{15.3}	48 ⁻⁻⁻
<i>Lychnis flos-cuculi</i>	22 ⁻⁻⁻	69 ^{30.1}	73 ^{33.9}	10 ⁻⁻⁻	24 ⁻⁻⁻
<i>Festuca pratensis</i>	---	62 ^{27.0}	36 ⁻⁻⁻	30 ⁻⁻⁻	52 ^{16.9}
<i>Vicia cracca</i>	---	41 ^{5.3}	9 ⁻⁻⁻	50 ^{14.3}	81 ^{46.4}
<i>Ranunculus auricomus</i> s.lat	44 ^{2.2}	62 ^{20.1}	100 ^{58.5}	---	5 ⁻⁻⁻
<i>Galium verum</i>	33 ⁻⁻⁻	17 ⁻⁻⁻	---	60 ^{19.1}	95 ^{54.9}
<i>Cardamine pratensis</i> agg	---	79 ^{52.9}	64 ^{35.9}	10 ⁻⁻⁻	---
<i>Agrostis stolonifera</i> agg	22 ⁻⁻⁻	59 ^{30.6}	18 ⁻⁻⁻	20 ⁻⁻⁻	33 ^{3.1}
<i>Galium palustre</i> agg	22 ⁻⁻⁻	34 ^{6.3}	9 ⁻⁻⁻	40 ^{12.4}	38 ^{10.3}
<i>Rumex acetosa</i>	11 ⁻⁻⁻	48 ^{28.3}	27 ^{3.7}	10 ⁻⁻⁻	24 ⁻⁻⁻
<i>Filipendula vulgaris</i>	---	21 ⁻⁻⁻	45 ^{22.7}	---	62 ^{41.6}
<i>Equisetum palustre</i>	67 ^{28.7}	3 ⁻⁻⁻	---	90 ^{52.7}	33 ⁻⁻⁻
<i>Festuca rubra</i> agg	---	7 ⁻⁻⁻	73 ^{46.0}	20 ⁻⁻⁻	52 ^{23.9}
<i>Poa trivialis</i>	22 ⁻⁻⁻	45 ^{21.5}	18 ⁻⁻⁻	40 ^{16.0}	5 ⁻⁻⁻
<i>Cirsium canum</i>	33 ^{4.5}	24 ⁻⁻⁻	---	60 ^{33.9}	29 ⁻⁻⁻
<i>Anthoxanthum odoratum</i>	---	14 ⁻⁻⁻	27 ^{4.3}	20 ⁻⁻⁻	57 ^{39.4}
<i>Colchicum autumnale</i>	---	21 ^{5.5}	9 ⁻⁻⁻	20 ^{4.5}	33 ^{22.4}

Cluster 1: Háberová (1978, Acta Bot. Slov. Acad. Sci., Slov. Ser. A. 4: 123–135), Slovenský kras Mts, 1 rel.; Háberová et al. [1985, Vegetácia krasových oblastí SSR z hľadiska ochrany prírody, Final task research report VI–3–3/03 (msc.) depon. in PriF UK Bratislava], Slovenský kras Mts, 1 rel.; Vološčuk (1993, Ochr. Prír. 12: 57–103), Slovenský kras Mts, 1 rel.; Sitášová (1995, Nat. Carpatica 36: 35–38), Slovenský kras Mts, 2 rels; Balátová-Tuláčková (1996, Tuexenia 16: 227–250), Slovenský kras Mts, 2 rels; Bernátová et al. (2018, Ochr. Prír. 32: 16–41), Turčianska kotlina basin, 1 rel.; Dudáš, M. (2019, ined.), Nízke Beskydy Mts, 1 rel. **Cluster 2:** Balátová-Tuláčková (1968, Pír. Pr. Ústavu ČSAV 2: 1–37), Borská nížina lowland, 1 rel.; Svobodová & Řehořek (1972, Fytocenologický a ekologický výskum lúčnych spoločenstiev v povodí Ipľa a Slanej, Final task research report II–5–8/7 depon. in: BÚ SAV), Ipeľská kotlina basin, 8 rels; Škovirová (1974, Kmetianum 3: 205–233), Turčianska kotlina basin, 1 rel.; Zlinská (1993, Biologia 48: 411–415), Borská nížina lowland, 1 rel.; Banášová et al. (1995, Bull. Slov. Bot. Spoločn. 17: 75–78), Borská nížina lowland, 2 rels; Zlinská & Stanová (1995, Bull. Slov. Bot. Spoločn. 17: 82–84), Borská nížina lowland, 1 rel.; Balátová-Tuláčková (1996, Tuexenia 16: 227–250), Slovenský kras Mts, 1 rel.; Posltová [1997, Fytocenologická charakteristika a dynamika spoločenstiev nízkych a vysokých ostríc v NPR Abrod, Dipl. thesis (msc.) depon. in: PriF UK Bratislava], Borská nížina lowland, 1 rel.; Šeffler & Stanová (1999, Aluviálne lúky rieky Moravy – význam, obnova a manažment, DAPHNE, Bratislava), Borská nížina lowland, 6 rels; Hájek, M., Hájková, P., Hrivnák, R., Řezníčková, M. (2001, ined.), Lučenská kotlina basin, 2 rels; Hrivnák, R. (2002, ined.), Lučenská kotlina basin, 1 rel.; Hrivnák, R. (2009, ined), Ostržky Mts, 1 rel.; Hrivnák, R., Ujházy, K. (2010, ined.), Zvolenská kotlina basin, 1 rel.; Dudáš, M. (2019, ined.), Nízke Beskydy Mts, 1 rel.; Dudáš, M. (2019, ined.), Slanské vrchy Mts, 1 rel. **Cluster 3:** Ružičková (1985, Zborník XXI. TOPu, Počúvadlo, 5–13), Štiavnické vrchy Mts, 2 rels; Balátová-Tuláčková & Kontrišová (1999, Tuexenia 19: 351–392), Poľana Mts, 6 rels; Hadač, E. (1984, ined.), Laborecká vrchovina Mts, 1 rel.; Hrivnák, R. (2012, ined), Ostržky Mts, 1 rel.; Hrivnák, R. (2022, ined.), Štiavnické vrchy Mts, 1 rel. **Cluster 4:** Balátová-Tuláčková (1968, Pír. Pr. Ústavu ČSAV 2: 1–37), Borská nížina lowland, 2 rels; Bosáčeková (1975, Čs. Ochr. Prír. 15: 173–273), Borská nížina lowland, 1 rel.; Ružičková (1985, Zborník XXI. TOPu, Počúvadlo, 5–13), Štiavnické vrchy Mts, 1 rel.; Klíčová (1993, Porovnanie rozšírenia a druhového zloženia vlhkých a slatinných lúk Záhorkej nížiny v období ochrany výskumu v rokoch 1966–1969 a v roku 1992, Dipl. thesis (msc.), depon. in: PriF UK, Bratislava, 56 pp.), Borská nížina lowland, 1 rel.; Malovcová-Stanišková (2005, Acta Rer. Natur. Mus. Nat. Slov. 51: 40–47), Borská nížina lowland, 1 rel.; Bernátová et al. (2018, Ochr. Prír. 32: 16–41), Turčianska kotlina basin, 3 rels; Dítě, D. (2020, ined.), Borská nížina lowland, 1 rel. **Cluster 5:** Bosáčeková (1975, Pr. Stud. Čs. Ochr. Prír. 2: 1–83), Borská nížina lowland, 5 rels; Bosáčeková (1975, Čs. Ochr. Prír. 15: 173–273), Borská nížina lowland, 13 rels; Banášová et al. (1995, Bull. Slov. Bot. Spoločn. 17: 75–78), Borská nížina lowland, 1 rel.; Hadač et al. (1997, Thaiszia – J. Bot. 7: 191–220), Nízke Beskydy Mts, 1 rel.; Posltová (1997, Fytocenologická charakteristika a dynamika spoločenstiev nízkych a vysokých ostríc v NPR Abrod, Dipl. thesis (msc.), depon. in: PriF UK Bratislava), Borská nížina lowland, 1 rel

were used to explain species-environmental relationships in the vegetation dataset. Species cover values were logarithmically transformed prior to analysis and EIVs were used as supplementary variables in the DCA ordination. The analysis was carried out in CANOCO for Windows 5.0 software (Ter Braak and Šmilauer 2012). Mean annual temperature and total annual precipitation of vegetation plots were retrieved from WorldClim version 2 [<http://www.worldclim.org>] on a grid background with a spatial resolution of 30 arc-seconds.

Nomenclature

Nomenclature of vascular plants and higher vegetation syntaxa follows the checklists of Marhlod and Hindák (1998) and Mucina et al. (2016), respectively. Association names of plant communities are mentioned according to Slovak vegetation overviews (Valachovič 2001; Hegedüšová Vantarová and Škodová 2014; Valachovič et al. 2021).

Results

Distribution of *Iris sibirica* in Slovakia

Iris sibirica occurs almost throughout Slovakia. Although it has been found in 73 grid-cells (~19% of the total) in Slovakia using the Central European Flora Mapping System

(Fig. 1, Appendix 1), the distribution is concentrated in the south-western Slovakia (Záhorská nížina lowland) and in the southern regions of central Slovakia (volcanic mountains – Štiavnické vrchy Mts, Poľana Mts, Javorie Mts and Ipeľská kotlina basin). Similar numbers of localities are reported from the Pannonian and Carpathian bioregions (51% vs 49%). In the Carpathians, a much higher ratio of recent localities (≥ 1990 – 69%) was found compared to the Pannonian bioregion (≥ 1990 – 45%; see Appendix 1).

Vegetation affinity and ecological characteristics

Altogether 283 vascular plant taxa were identified in 80 phytosociological relevés with the occurrence of *Iris sibirica*. The most common plant species in the dataset were *Ranunculus acris* (occurrence in 79% of the relevés), *Sanguisorba officinalis* (70%) and *Deschampsia cespitosa* (60%), followed by *Poa pratensis* agg. (59%), *Lathyrus pratensis* (56%), *Filipendula ulmaria* (54%), *Carex panicea* (53%), *Serratula tinctoria* (51%) and *Galium boreale* (50%). TWINSpan analysis indicated five relatively well distinguished clusters of vegetation relevés. First cluster was differentiated by a set of wetland and eutrophic tall plants such as *Caltha palustris*, *Carex bukkii*, *Equisetum palustre*, *Filipendula ulmaria* and *Lathyrus pratensis* (Table 1). It corresponded to the *Calthion palustris* alliance [previously recognised as suballiance *Filipendulenion ulmariae* (Lohmeyer

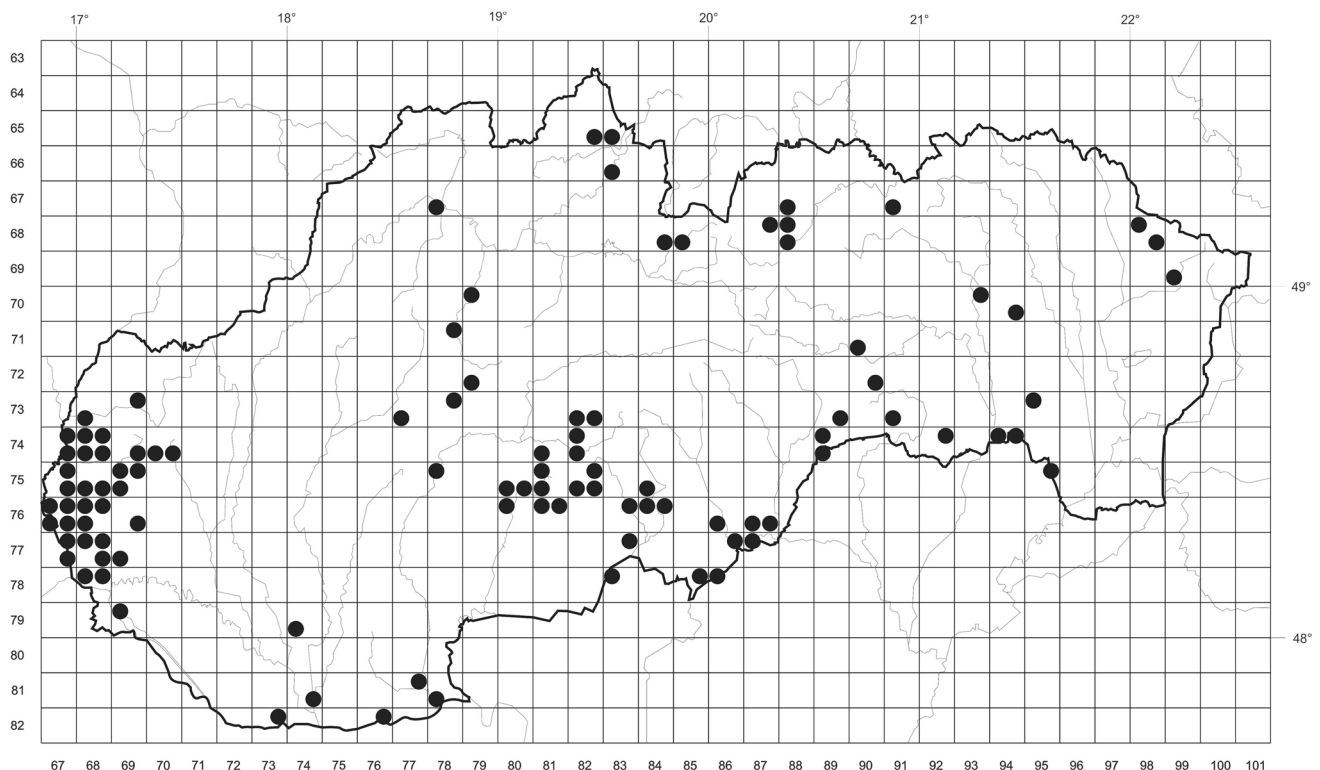


Fig. 1 Distribution of plant species *Iris sibirica* L. in Slovakia

in Oberd et al. 1967) Balátová-Tuláčková 1978 (Fig. 2). This type of vegetation is distributed mainly in the Slovenský kras Mts, rarely in the other parts of Slovakia (Fig. 3). Plant species of lowland floodplain meadows (e.g. *Alopecurus pratensis*, *Carex praecox* agg., *Lychnis flos-cuculi*, *Lysimachia nummularia*, *Poa pratensis* agg., *Ranunculus acris*, *R. repens*, *Sanguisorba officinalis* and *Taraxacum* sect. *Ruderalia*) were typical for the stands of the second cluster. This vegetation, with a geographical affinity to lowlands and basins, was classified in the *Deschampsion cespitosae* alliance (previously distinguished alliances *Alopecurion pratensis* and *Cnidion venosi*; Figs. 2 and 3). Vegetation of the third cluster was mainly formed by plants of wet meadows and fens (such as *Carex nigra*, *C. panicea*, *Dactylorhiza majalis*, *Deschampsia cespitosa*, *Juncus conglomeratus*, *Lysimachia vulgaris*, *Myosotis scorpioides* agg., *Potentilla erecta*, *Ranunculus acris*, *Sanguisorba officinalis*), which

were accompanied by mesophilous species (e.g. *Carex pallescens*, *Ranunculus auricomus* agg., *Viola canina*). These stands were also enriched by plants of nutrient-poor soils adapted to annual water level fluctuations, such as *Carex umbrosa*, *Galium boreale*, *Molinia caerulea* agg., *Serratula tinctoria* and *Succisa pratensis*. This species composition is typical for the alliance *Molinion caeruleae* (Fig. 2), which was reported especially from the volcanic mountain ranges of central Slovakia (Fig. 3). The fourth cluster is characterised not only by plants of wet meadows and fens, but also by physiognomically and competitively strong tall plant species such as *Calamagrostis epigejos*, *Lythrum salicaria*, *Phragmites australis*, and by the shrub species *Salix cinerea* and *S. purpurea*. This cluster grouped vegetation of different successional stages between wet meadows (*Calthion palustris* and *Molinion caeruleae*) and fens (*Scheuchzeria palustris*-*Caricetea fuscae*; Table 1 and Fig. 2). They were

Fig. 2 The main vegetation types with the occurrence of *Iris sibirica* in Slovakia: *Calthion palustris* (cluster 1): Photo 1, Silica, R. Šuvada, 2007; *Deschampsion cespitosae* (cl. 2): 2, Nižná Jablonka, M. Dudáš, 2022, 3, Breznička, R. Hrivnák, 2005, 4, Malé Kosihy, J. Košťál, 2019; *Molinion caeruleae* (cl. 3): 5, Banský Studenec, R. Hrivnák, 2023, 6, Budiná, R. Hrivnák, 2022, 7, Detva, D. Galvánec, 2014; Successional stages between wet meadows (*Calthion palustris* and *Molinion caeruleae*) and fens (*Scheuchzeria palustris*-*Caricetea fuscae*; cl. 4): 8, Krupina, M. Mokrání, 2013, 9, Socovce, D. Tomášiková, 2010; Transition between the hygrophilous vegetation of *Molinion caeruleae*, fen vegetation of *Caricion davallianae* and/or *Caricion fuscae* alliances and mesic habitats (cl. 5): 10, Veľké Leváre, V. Šefferoová-Stanová, 2015. Photos are numbered in row order



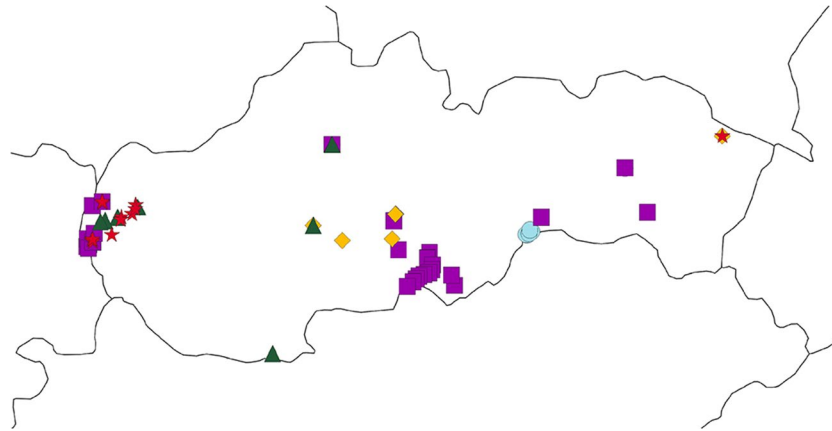


Fig. 3 Distribution of individual vegetation clusters in Slovakia (*Calthion palustris*, cluster 1=blue circles, *Deschampsion cespitosae*, cl. 2=purple squares, *Molinion caeruleae*, cl. 3=yellow diamonds, successional stages between wet meadows (*Calthion palustris* and *Molinion caeruleae*) and fens (*Scheuchzeria palustris*-*Caricetea*

fuscae, cl. 4=green triangles and transitions between the hygrophilous vegetation of *Molinion caeruleae*, fen vegetation of *Caricion davallianae* and/or *Caricion fuscae* alliances and mesic habitats, cl. 5=red stars)

distributed in the Borská nížina lowland, occasionally in the Štiavnické vrchy Mts and Turčianska kotlina basin (Fig. 3). Vegetation of the fifth cluster occurred only in the Borská nížina lowland (Fig. 3). It was composed of plants with an affinity to wet meadows on nutrient-poor soils (e.g. *Carex panicea*, *Galium boreale*, *Molinia caerulea* agg., *Ranunculus acris*, *Sanguisorba officinalis*, *Serratula tinctoria* or *Succisa pratensis*). The herb-layer mosaic was created by species of fens (e.g. *Carex davalliana*, *C. nigra*, *Epipactis palustris* or *Galium uliginosum*) and abundant group of mesophilous species (e.g. *Anthoxanthum odoratum*, *Centaurea jacea*, *Filipendula vulgaris*, *Galium verum*, *Leonodon hispidus* or *Plantago lanceolata*; Table 1, List of sources). The cluster showed transitions between the hygrophilous vegetation of *Molinion caeruleae*, fen vegetation of *Caricion davallianae* and/or *Caricion fuscae* alliances and mesic habitats (Fig. 2). Finally, *I. sibirica* was rarely recorded in the shrub and forest vegetation of the alliances *Salicion traindrae* and *Salicion albae*, respectively (Appendix 2).

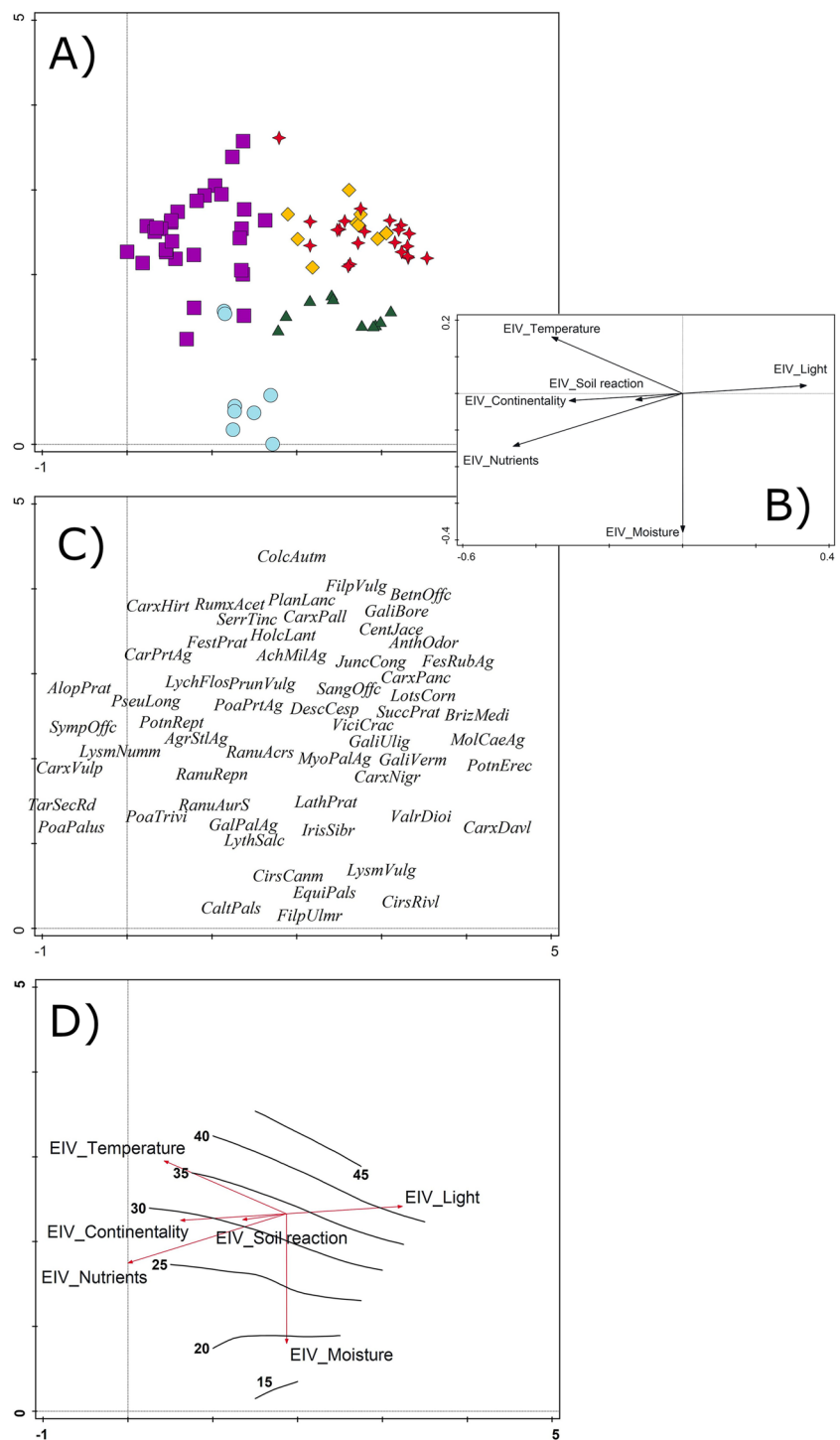
DCA scatterplot diagram showed good differentiation of the first, second and fourth clusters. On the other hand, the remaining plots partially overlapped (Fig. 4A). The first DCA axis was interpreted as a combined EIV gradient of light, continentality as well as temperature and nutrients, while the second DCA axis represented the EIV moisture gradient (Fig. 4B). Along the first DCA axis, species of nutrient-rich and thermophilous sites were replaced by plants of relatively cold and open habitats on nutrient-poor soils (Fig. 4C). These patterns were also confirmed by mean values of EIVs (Table 2). Species richness highly varied along the second DCA axis, i.e. the number of vascular plants (alpha diversity) decreased from typical wet to semi-wet habitats in the order 2, 3 and 5 → 4 → 1 (Fig. 4D).

Clusters 1 and 3 had the highest mean elevation and the lowest mean annual temperature, while the values of total annual precipitation in cluster 1 were lower than in clusters 3, 4 and 5. The lowest elevation and the highest temperature values were found in cluster 5, while the lowest precipitation values were identified in cluster 2 (Table 2).

Discussion

A revision of herbarium specimens, available literature and electronic database sources showed that *Iris sibirica* is a relatively common plant species with a scattered distribution in Slovakia. Most of the localities were found in south-western Slovakia and southern parts of central Slovakia. However, several localities situated in the lowland areas of the Pannonian bioregion are only historical, i.e. recent records of the species indicate its rarity there, with apparent occurrences in sites embedded in the national network of protected areas. This could be explained by the fact that the Slovak lowlands (e.g. Záhorská and Podunajská nížina lowlands) are intensively used for agriculture and are relatively densely populated with a long history of human settlement (Miklos 2002). This landscape utilization often leads to direct habitat destruction accompanied by changes in site ecology and vegetation, which in turn negatively affect populations of the *I. sibirica*. In addition, the increasing homogenisation of the landscape reinforced by a reduction in the mosaic structure and secondary succession of grasslands, has a negative impact on the availability of suitable sites for the species, particularly in mountainous regions. In the last decades, these changes have reduced plant diversity and negatively controlled the species compositional pattern of grasslands across Europe (Habel

Fig. 4 DCA ordination diagrams of (A) samples (*Calthion palustris*, cluster 1 = blue circles, *Deschampsion cespitasae*, cl. 2 = purple squares, *Molinion caeruleae*, cl. 3 = yellow diamonds, Successional stages between wet meadows (*Calthion palustris* and *Molinion caeruleae*) and fens (*Scheuchzeria palustris*-*Caricetea fuscae*, cl. 4 = green triangles and Transition between the hygrophilous vegetation of *Molinion caeruleae*, fen vegetation of *Caricion davallianae* and/or *Caricion fuscae* alliances and mesic habitats, cl. 5 = red stars), (B) Ellenberg indicator values (EIVs) as supplementary variables, (C) species with the occurrence at least 20% of all relevés, and (D) species richness-EIVs relationship. The first two DCA ordination axes are shown (horizontal axis = axis 1 and vertical axis = axis 2). First four letters of genus and species name are shown, e.g. *JuncCong* = *Juncus conglomeratus* (see Appendix 3 for full names and abbreviations of all species)



et al. 2013), including Slovakia (Špulerová 2008; Halada et al. 2017). However, populations developed on sandy soils (e.g. in the Záhorská nížina lowland) are under less human pressure than those in the Podunajská nížina lowland due to unsuitable conditions for intensive agricultural activities. The situation seems to be different in the mountainous areas of central Slovakia. Here, the traditional management of wet meadows still persists, which in turn facilitates the presence of species in

many localities. Several of them have been newly discovered (Hrivnák et al. 2005, 2016). These facts are fully reflected in the recent conservation status of species in Slovakia (Eliáš et al. 2015). In spite of the relatively widespread distribution of the species in Slovakia, wetland plant communities with its occurrence are under strong negative human impact. Therefore, the classification of *Iris sibirica* as a “near-threatened” species is correct.

Table 2 Mean EIV values and climatic characteristics of vegetation plots in each cluster

Cluster	1	2	3	4	5
EIV for light	6.83	6.88	6.90	7.20	7.18
EIV for temperature	5.50	5.77	5.23	5.28	5.51
EIV for continentality	4.21	4.29	3.90	4.16	3.90
EIV for moisture	7.27	6.61	6.70	7.36	6.49
EIV for soil reaction	6.90	6.61	5.48	6.58	6.64
EIV for nutrients	5.42	5.11	3.39	3.99	3.35
Elevation (m)	512	244	696	291	187
Temperature (°C)	7.4	9.0	6.5	8.9	9.6
Precipitation (mm)	636	625	805	749	739

Our vegetation analyses showed that *I. sibirica* thrives in a wide range of wetland habitats. These include wet meadows of the alliances *Calthion palustris* and *Molinion caeruleae*, floodplain meadows of the alliance *Deschampsion cespitosae* and transitional plant communities towards fens (alliances *Caricion davallianae* and *Caricion fuscae*). A coenological affinity to wet and flooded meadows has been frequently reported from adjacent countries (Matuszkiewicz 2008; Chytrý 2010; Borhidi et al. 2012). The association *Iridetum sibiricae* has been previously mentioned from several European regions (e.g. Salamon-Albert et al. 2010), but contemporary vegetation revisions did not distinguish this community at the association level due to floristic heterogeneity and absence of diagnostic species (Chytrý 2010; Hegedúsová Vantarová and Škodová 2014). Occasionally, the species was also found in shrub and forest swamps, which represent later successional stages of the wet meadows. Similar occurrence of *I. sibirica* in forest understorey has been documented in Poland, where it grows along rivers in floodplain forests, in mesic sites overgrown by oak-hornbeam and oak forests, but also in different types of open pine forests (Kostrakiewicz 2001). In Central Europe, the present vegetation niche can also include spring and fen communities (e.g. in the Czech Republic, Hrouda and Grulich 2010), or swamp willows dominated by *Salix cinerea* (e.g. in Hungary, Salamon-Albert et al. 2010).

Most of the phytosociological relevés in our study belong to herbaceous vegetation previously classified as *Filipendulenion ulmariae* (= *Calthion palustris*) or to transitional stages of wet meadows (*Molinion caeruleae*) and fens. They were commonly composed of competitively dominant plant species (*Calamagrostis epigejos*, *Deschampsia cespitosa*, *Molinia caerulea*, *Phragmites australis*) and shrub species of the *Salix* genera (*S. cinerea*, *S. purpurea*), which importantly shaped the patterns of community diversity. These resource-acquisitive species enriched by other tall herbs of wet meadows (e.g. *Filipendula ulmaria*, *Lythrum salicaria*) indicate early successional stages following the

abandonment of traditional management practices (primarily mowing). These stands can be considered as optimal habitats for *I. sibirica* (see also Kostrakiewicz-Gierałt 2013). European Ellenberg-type indicator values proposed by Tichý et al. (2023) for vascular plants evenly suggest an affinity to non-forest and wet vegetation. In more detail, *I. sibirica* was categorized as a light and moisture demanding species, with an intermediate value for temperature and a preference to nutrient-poor habitats. It has already been found that the moisture regime seems to be an important factor for the vitality of *I. sibirica*. When population structure was considered as an indicator of species vitality, populations on drier sites were less abundant but in better condition than those on wetter sites (Kostrakiewicz 2008).

Our study provides a first revision of the chorological records and vegetation preferences of *Iris sibirica* in Slovakia with respect to the Central European context. Although the species was found in many localities throughout Slovakia, we identified two main centres of distribution situated in south-western and central Slovakia. The species prefers flooded meadows developed in lowlands (*Deschampsion cespitosae*) and wet meadows (*Calthion palustris*, *Molinion caeruleae*). An abundant group of relevés also showed transitional features towards fen habitats (*Caricion davallianae* and *Caricion fuscae*) or corresponded to successional stages of wet meadows.

Appendix 1

List of revised herbarium specimens examined and locations with affiliation to phytogeographical units according to Futák (1984).

Pannonicum

1. Burda Mts: Kováčov, wet meadows from Štúrovo [Parkaň] to Hron River, infrequent (Domin & Podpěra, Klíč, p. 784, 1928). **2. Ipeľsko-rimavská brázda Region:** Rimavské Jánovce, right bank of Rimava River, terrain depressions on meadows (Řehořek, Acta Fytotech. Nitra 13: 182, 1966). – scattered on wet meadows from Pinciná [Pinc] to Muľa (Svobodová & Řehořek, Agrotechn. Nitra 10: 187, 1964). – Pinciná, Ipeľ River, meadow on right bank (Svobodová 1962 NI). – Rimavská Sobota (ut Rimaszombat, alsó Kavló; Fábry s. dato SLO). – Rimavská Sobota, Kurinec, only locally on wet meadows, 200 m (Hendrych, Acta Univ. Carol. 2: 145, 1967). – Breznička, alluvium of Ipeľ River south from the village, between settlement Červeň and Hrádok, 217 m. – Kalinovo, Hrabovo, Nature Reserve Hrabovo, 198 m (both Hrivnák et al. Bull. Slov. Bot. Spoločn. 27: 135, 2005). – Kalinovo, Pod Šťavicou (Hrivnák in Urban & Hrivnák, Poiplie, SAŽP, Banská Bystrica, p. 17, 1997). – Vidiná (Kunszt,

Magy. Növ. Lapok 2: 23, 1878). – Hajnáčka, Šťavica (220 m), flooded meadow. – Dubno. – Šiková (240 m). – Jesenské. – Šimonovce. – Drňa. – River Rimava between Chrámec and Dubovec. – Rimavská Seč. – between Číž and Lenártovce. – Kurinec. – Rimavské Jánovce. – Pinciná, Ipeľ River (all data Hendrych, I. c., 1967). – Muľa (Svobodová & Řehorěk, Sborn. Vys. Školy Pňohosp. Agr. Fak. 10: 193, 1964; Hendrych, I. c., 1967). – Veľká nad Ipľom, gravel pit (Hrivnák in Urban & Hrivnák, Poiplie, I.c.). **3. Slovenský kras Karst:** Drnava, Pod výhonom (Balátová-Tuláčková & Háberová, Tuexenia 16: 241, 1997; Karasová 2000 in GIS DAPHNE; Virók et al. Fl. Gem.-Turn. krasu, Enumerácia, p. 783, 2016). – Silická Brezová, Nature Reserve Kráľová studňa, terrain depression along stream (Sitášová, Nat. Carp. 36: 38, 1996; Balátová-Tuláčková & Háberová, Tuexenia 16: 41, 43, 1997). – Silica, Pod Fabiánkou (Humeňanský, Pamiatky Prír. 1: 32, 1984; Vološčuk, Ochr. Prír. 12: 66, 1993; Balátová-Tuláčková & Háberová, Tuexenia 16, Table 9, rels 3, 4, 1997; Karasová 1999 in GIS DAPHNE). – Silica, Majkova dolina (Háberová, Acta Bot. Slov. Acad. Sci., Slov. Ser. A. 4, Table 2, rel. 7, 1978, ut „Májková jama“; Háberová et al. Vegetácia krasových oblastí SSR z hľadiska ochrany prírody, Final task research report VI-3–3/03, msc., depon. in PriF UK Bratislava, 1985; Virók et al. I. c., 2016). – Háj, between Hills 577 and 692, forest (Kláštorský & Deyl 1933 PR). **4. Záhorská nížina Lowland:** Stupava, Stupavské piesky, wet meadows (Dočolomanský 1958 SLO). – Kúty, wet meadows at railway line towards Brodské, 156 m (Dvořák 1979 SLO). – Vysoká pri Morave (Bertová & Zahradníková 1984 SAV; Ondrášek, Bull. Slov. Bot. Spoločn. 24: 136, 2002). – Vysoká pri Morave, wet meadows north from village (Hegedüšová & Škodová, Bull. Slov. Bot. Spoločn. 26: 81, 2004). – Vysoká pri Morave, wet meadows under railway 0,5 km NW from the village (Grulich 1986 MMI). – Vysoká pri Morave, “Horný les” [Jarolímek, Ekológia (Bratislava), Suppl. 1, Table 1, rel. 2, 1994]. – Vysoká pri Morave, inundation area of the Morava river, “Hajprot” (Banášová et al. Bull. Slov. Bot. Spoločn. 17, Table 1, rels 2–4, 1995). – Vysoká pri Morave, river km 14.5 (Šeffler & Stanová, Aluviálne lúky rieky Moravy – význam, obnova a manažment, DAPHNE, Bratislava, Table 2, rels 7, 1999). – Jakubov pri Uhorskej Vsi, 148 m (Valenta 1935 SLO). – Láb, wet meadows (Futák 1949 BRA; Balátová-Tuláčková, Přír. Pr. Ústavu ČSAV 2, Table 2, rel. 13, 1968). – meadows along a channel between Zohor and Láb (Bosáčková, Pr. Stud. Čs. Ochr. Prír. 2, Table 10, rels 15, 16, 21, 1975; Kosorínová 2000 in GIS DAPHNE). – Plavecký Štvrtok, uncut wet meadows opposite to Nature Reserve Bezedné [Černý 1924 SLO; Rácová, Dipl. thesis (msc.), p. 106, depon. in PriF UK Bratislava, 1987; Hegedüšová & Škodová, I. c., 2004). – Gajary, meadow approx. 2.9 km NW from the village on the Eastern side of Morava River dam (Kosorínová 1999 in GIS DAPHNE). – Gajary, meadow on a southern edge of gravel pit nearby Rudava-Morava confluence

(Kosorínová 1999 in GIS DAPHNE). – Plavecký Štvrtok, fish pond (Pospíšil 1948 BRNM). – Plavecké Podhradie (Bosáčková, Pr. Stud. Čs. Ochr. Prír. 2, Table 9, rel. 14, 1975). – Plavecký Mikuláš, several localities near the village [Bosáčková, Práce a štúdie čsl. Ochr. Prír. pri SÚPSOP v Brat., II, spis 1, Table 9, rel. 21, Table 10, rels 12, 24, 26, 1970; Klíčová, Porovnanie rozšírenia a druhového zloženia vlhkých a slatinných lúk Záhorskej nížiny v období ochrannárskeho výskumu v rokoch 1966–1969 a v roku 1992, Dipl. thesis (msc.), depon. in: PriF UK, Bratislava, p. 34, 1993]. – Plavecký Mikuláš, Nature Monument Bukovina [Magic, Správa (msc.), depon. in: Správa CHKO Malé Karpaty, Trnava, 1990; Hrbatý 2001 in GIS DAPHNE). – Malacký (Balátová-Tuláčková, Přír. Pr. Ústavu ČSAV 2, Table 2, rel. 18, Table 3, rel. 28, 1968). – Lúčky, along the railway between Pernek and Kuchyňa (Králik 1969 BRA). – Kuchyňa, wetland with spring between road towards hunting lodge Vývrat pod Vysokou and Vývrat brook (Králik, Bull. Slov. Bot. Spoločn. 28: 110, 2006). – wetland between Zohor and Lozorno, 160 m (Jos. Dvořák 1948 BRNM; Soják 1957 PR). – Lozorno, wet meadow (Jos. Dvořák 1948 BRNU; Skřivánek 1951 BRNM). – Jablonové, NE from the village, “Pod hájom” (Bosáčková, Pr. Stud. Čs. Ochr. Prír. 2, Table 10, rel. 22, 1975). – Zohor, meadow near Morava River, behind the channel (Staněk 1921 BRNU). – Zohor, the channel, 145 m (Mikeš, Kvet. okr. Bratislava, p. 155, 1938; Valenta 1944 SLO; Dvořák 1970 SLO). – Kuchyňa, wet meadows (Degen, Gáyer & Scheffer, Magy. Bot. Lap. 22: 72, 1923). – Malé Leváre, Struha brook, meadows (Hegedüšová & Škodová, I. c., 2004). – Malé Leváre, meadows along Kremenica brook (Kosorínová 1999 in GIS DAPHNE). – Malé Leváre – Rudavné jazero (Stanová et al. 1999). – Malé Leváre – Panská Morávka (Stanová et al. 1999). – Malé Leváre, alluvium of the Morava River (Zlinská, Biologia 48, Table 1, rel. 13, 1993). – Veľké Leváre, wet depression in pine forest with birch and alder, Veľká Pláňava, 165 m (Řepka 1986 OLM). – Závod, 149 m (Kučera 2008 SLO). – Závod, Nature Reserve Abrod (Weber 1933 SLO; Futák 1947 ined.; Jos. Dvořák 1951 BRNM; Šmarda 1951 BRNM; Černoch 1957 BRNM; Krippel 1959 SAV; Lizoň 1964 SLO; Bosáčková, Práce a štúdie čsl. Ochr. Prír. pri SÚPSOP v Brat., II, spis 1: 54, Table 5, rel. 14, Table 8, rels 2, 3, 4, 6, 1970; Čvančara 1973 OLM; Hodoval 1982 SLO; Posltová, Fytoocenologická charakteristika a dynamika spoločenstiev nízkych a vysokých ostríc v NPR Abrod, Dipl. thesis (msc.), depon. in: PriF UK Bratislava, Table 3, rel. 1, Table 11, rel. 3, 1997; Stanová 2003; Kučera & Slovák 2008 SLO). – Moravský Svätý Ján, floodplain, meadows along the Morava River (Stanová et al. 1999). – Borský Jur, Tomky Settlement, bog pastures at brook, 1.7 km NE from the settlement (Grulich 1986 MMI). – Borský Svätý Jur, meadows 0.8 km NW from Húšky Settlement (Kosorínová 2000 in GIS DAPHNE). – Studienka, Rudava River, bog, 2 km SW from village (Grulich 1985 MMI). – Studienka, Rudava River (Trávníček 1992 OL).

– Studienka, meadow along Rudava River nearby a settlement of Juríkovci (Kosorínová 2001 in GIS DAPHNE). – Rohožník, wet meadows along the railway (Králík 1969 BRA; Pr. Stud. Čs. Ochr. Přír. 2, Table 8, rel. 29, Table 10, rel. 31, 1975). – Rohožník, protected area Konopiská, near a lake, 205 m (Feráková & Králík in Eliáš jun. (ed.), Bull. Slov. Bot. Spoločn. 32/2: 277, 2010). – Rohožník, wetland (D. Tomášiková 2017 <http://www.fotonet.sk/>, ID 137530). – Rohožník, water reservoir Vývrat, 235 m (Hrbatý 2002 in GIS DAPHNE; Feráková & Králík in Eliáš jun. (ed.), Bull. Slov. Bot. Spoločn. 31/1: 108, 2009). – meadows between Pernek and Rohožník (Májovský 1965 BRA). – Rohožník, WSW from the town (Malovcová-Staníková, Acta Rer. Natur. Mus. Nat. Slov. 51, Table 1, rel. 4, 2005). – Šajdíkové Humence, meadows near Hrušovský revír (Šmarda 1949 BRNM). – Šajdíkové Humence (Weber 1930 SLO). – Sološnica, swamp (Schidlay 1932 SLO). – Abrod, Jablonica, Pustý Mlyn, Horné Valy (all data Háberová, Acta Fac. Rerum Natur. Univ. Comen., Bot. 27: 49, 1979). – Devínska Nová Ves, alluvium of Morava River W from the village, 140 m (Letz, Bull. Slov. Bot. Spoločn. 20: 134–135, 1998). – Devínska Nová Ves, Mäsiarky, meadow in inundation area of Morava River, between river kilometre 13 and 14, 139 m [Zaliberová, Ekológia (Bratislava), Suppl. 1, Table 2, rel. 5; Zlínska & Stanová, Bull. Slov. Bot. Spoločn. 17: 83, 1995; Šeffler & Stanová, Aluviálne lúky rieky Moravy – význam, obnova a manažment, DAPHNE, Bratislava, Table 2, rels 1, 19, 1999]. – Devínska Nová Ves, “Majsterka” (Šeffler & Stanová, Aluviálne lúky rieky Moravy – význam, obnova a manažment, DAPHNE, Bratislava, Table 2, rels 11, 1999). – Devínska Nová Ves, near Malina stream (Šeffler & Stanová, Aluviálne lúky rieky Moravy – význam, obnova a manažment, DAPHNE, Bratislava, Table 2, rel. 3, 1999). – floodplain meadows between Devínska Nová Ves and Devínske Jazero (Stanová et al. l. c.). **6. Podunajská nížina Lowland:** Bratislava, meadow left from Pekná cesta [Šínweg] (Ptačovský 1925 SAV). – Dynamitka (= Istrochem), wet meadows (Nábělek 1937 SAV; Schidlay 1937 BRA; Ptačovský 1937 SLO). – [Bratislava] between Dynamitka and Zriaďovacie nádraží (Futák 1945 BRA). – Lamač, swamp south from railway station, Lamačská dolina [Lamacser Becken] (Scheffer ined.; Hodálová et al. Bull. Slov. Bot. Spoločn. 22: 94, 1999). – Jur pri Bratislave, Nature Reserve Šúr, the channel in alder forest, 150 m [Holuby, Sozn. Okr. Pezinok (msc.), 1920; Vozárová 1959 LTM]. – Pezinok [Bazinium], meadows, rare (Holuby 1915 SLO). – Ostrov kormoránov, floodplain forest (Feráková & Javorčíková, Acta Fac. Rerum Natur. Univ. Comen., Bot. 22: 118, 1974). – Nové Zámky, Bažantica, Palárikovo (s. coll. 1955 BRA). – Veľký Lél, river island (s. coll. 1968 PMK). – Nitra River between Martovce and Lándor, meadows Komočín (Chrtek et al. Preslia 44: 59, 1972; Křísa et al. Ochr. přír. 28/4: 87, 1973). – Komárno, Kava, between left bank of Váh River and dam (Juhászová 1988

PMK). – Komárno, wet meadow between Moča and Kravany, 115 m (Jos. Dostál 1960 PR). – Jurský Chlm, Búčska lúka (Benediktová & Benedikt in Eliáš jun. (ed.), Bull. Slov. Bot. Spoločn., 45/1: 79, 2023). – Kamenín, saline meadows in Nature Reserve (Svobodová 1966 BRA). **7. Košická kotlina Basin:** Veľká Ida, meadows SW from the village (Sitášová 2001 in GIS DAPHNE). **8. Východoslovenská nížina Lowland:** Čerhov, Nižná Lúka, cutted meadows (Hrouda in Mártonfi (ed.), Bull. Slov. Bot. Spoločn. 36, Suppl. 1: 56, 2009).

Carpaticum occidentale

10. Malé Karpaty Mts: Trstínsko-Bukovské kopce Mts: Holý vrch, dolomite (Medovič, Přír. Sborn. Slov. Nár. Múz., přír. vedy 5: 81, 1959). – Buková, water reservoir, bog meadow (Vavro 1981 HLO; Hrbatý 2001 in GIS DAPHNE; Váľková 2005 BRNU; Danihelka et al. Bull. Slov. Bot. Spoločn. 28/2: 164, 2016; P. Bagin 2018 <http://www.fotonet.sk/>, ID 151274). – Buková, surroundings of the village (Zborník vedeckých prác doktorandov a mladých vedeckých pracovníkov “Mladí vedci 2009“, Nitra, p. 45, 2009). – Borinka, valley of brook, meadow (Krippelová 1975 SAV). – Bratislava, Kamzík [Gemsensberg], swamp near the Cross (Lumnitzer, Fl. Poson., p. 19, 1791; Endlicher, Fl. Poson., p. 155, 1830). – Vinosady, Trniansky potok (Územný plán obce Vinosady, p. 60, 2018). **13. Strážovské and Súľovské vrchy Mts:** Žilina, Veľké Hradisko (Urbanová 2000 ZAM). **14b. Vtáčnik Mts:** Kosorín, north-western from the village, alluvium of the Peklo stream, stands of the *Molinion caeruleae*, 430–450 m (Cvachová & Hrivnák, Ochr. Přír. 24: 112, 2005). – Oslany, Žarnov, meadows SW from hill, 420–600 m (Vlčák in Ambros, Florist. kurz Partizánske, p. 96, 1994; Slezák 2023 ined.). **14c. Kremnické vrchy Mts:** Kremnické Bane, meadow, 842 m [Slašťan in Eliáš jun. (ed.), Bull. Slov. Bot. Spoločn. 32/2: 281, 2010; P. Salenka 2017 <http://www.fotonet.sk/>, ID 138542]. – Kremnica (Zechenter 1887 SLO). **14d. Poľana Mts:** Dúbravy, Iviny, confluence of streams Hradný potok and Mačinová stream, 530–570 m (Janišová et al. Bull. Slov. Bot. Spoločn. 26, Suppl. 13, p. 94, 2004). – Dúbravy, Hradné lúky meadows (many data on fotonet.sk, e.g. D. Tomášiková 2018 <http://www.fotonet.sk/>, ID 151934). – Očová, Ďurečkin laz, pasture near stream, 1150 m NNW from Horáreň Bujačie, 485 m (Hrivnák et al. Bull. Slov. Bot. Spoločn. 27: 135, 2005). – Ostrôžky, Polichno, WNW from village, meadows on right side of road from Polichno to Ábelová, 618 m [Hrivnák et al. in Eliáš jun. (ed.), Bull. Slov. Bot. Spoločn., 40/1: 89, 2018]. – Iviny, Podhájno (711 m) hill, wet meadow, 630 m (Hrivnák et al. Bull. Slov. Bot. Spoločn. 38/2: 231, 2016). – Iviny, Valockovci. – Kalamárka, Hradná studňa (see also Smutný, Ochr. Přír. 24/1, Ochranařský průzkum 1, p. 17, 1969). – Dúbravy, Dvorce. – Detva, Kostolná, Nature Reserve Horná Chrapková, wetlands, 810–830 m (all data Janišová et al. l. c., 2004; NR Horná Chrapková see also Kontrišová et al. Flóra

Poľany, TUZVO, Zvolen, p. 97, 1994; Balátová-Tuláčková & Kontrišová, Tuexenia 19: 384–385, 1999). – Dúbravy, Hradné lúky N from the village (Smutný, I. c., 1969). – Zvolenská kotlina, Dúbravy, terrain depressions on meadows on right bank of Hradná stream, 445 m (Jasík & Dítě, Bull. Slov. Bot. Spoločn. 39/1: 76, 2017). **14e. Štiavnické vrchy Mts:** Krupina, Babiná, Holý vrch, cutted and uncutted meadows (Ružičková, Zborn. I. XXI. TOP Počúvadlo, p. 11, 1985; Galváne 1999 in GIS DAPHNE; M. Fekiač 2009 <http://www.fotonet.sk/>, ID 33315; Galváne 2022 ined.). – Krupina, meadows 1.8 km SSE from the settlement Holý vrch (Galváne & Lasák 1999 in GIS DAPHNE). – Krupina, Odrobinovo pole (Galváne 1999 in GIS DAPHNE; Galváne 2022 ined.). – Krupina, Stará hora (Jasík 2021 ined.; Galváne 2022 ined.). – Krupina, meadow nearby a crossroad to Šváb settlement (Jasík 2021 ined.). – Krupina, wet meadows N from settlement Gubáň, close to the road to Žibritov. – Krupina, meadow N from settlement Kukučka, close to the road to Široké lúky. – Krupina, meadows S from Nový háj Mt. (543 m). – Krupina, wet meadows along Bebrava river, 2 km NW from the western edge of water reservoir (all data Galváne 2022 ined.). – Žarnovica (Bohúňová 1954 SMBB; Martincová, Stredoslov. múz. Banská Bystrica 5: 53, 1989). – Krupina, meadows over the city (s. coll. s. dato PR; Kupčok, Biol. práce 2/9: 52, 1956). – Banský Studenec, Gajdošovo, wet meadows in the end of valley Bystrá dolina (Háberová in Benčaťová & Ujházy, Florist. kurz Zvolen, p. 32, 1997; Galváne 1999 in GIS DAPHNE; Hrivnák 2022–2023 ined.). **14f. Javorie Mts:** Senohrad (D. Tomášiková 2013 <http://www.fotonet.sk/>, ID 95831). – Zaježová, Struhárňa, hill Lipový kopec in direction to Podrimáň, meadows [Šumberová & Uhliarová in Benčaťová & Ujházy (eds), Florist. kurz Zvolen, p. 32, 1997]. – Kráľová, small fish pond on north edge of village [Kaplan in Benčaťová & Ujházy (eds), I. c., 1997]. – Zaježová, alluvium of Rimánsky potok, meadow, 550 m. – Stožok, NE from village, uncutted meadow, 365 m. – Detva, alluvium of Krivánsky potok between railway station and houses, uncutted meadow, 375 m. – Budiná, Sihla, along road, 670 m. – Madačka, Chrapanovci, spring area, 675 m (all data Hrivnák et al. Bull. Slov. Bot. Spoločn. 27: 135, 2005). – Dobrá Niva, part Hanzelky between settlements Lomno and Kráľová, wet meadows, 680 m. – Zaježová, part Dolinky, wet meadow, 670 m. – Zaježová, Kostolný vrch (660,4 m), wet meadow, 640 m [all data Galváne in Eliáš jun. (ed), Bull. Slov. Bot. Spoločn. 35/1: 80, 2013]. – Zaježová, meadow in the forest 0.6 km E from Štetka Mt. (771,0 m) (Jančo 2004 in GIS DAPHNE). – Kráľová, settlement Lomno, 680 m [Duchon in Eliáš jun. (ed), Bull. Slov. Bot. Spoločn. 42/ 2: 221, 2020]. – Krupinská planina, Pliešovce, Čárda, cutted meadows, 570 m. – Pliešovská kotlina, Pliešovce, part Zábava, alluvium of Krupinica brook, wet meadow, 450 m [Galváne in Eliáš jun. (ed), Bull. Slov. Bot. Spoločn., 35/1: 80, 2013]. – Pliešovce, 0,7 km NE from the settlement Neresnica (Jančo

2004 in GIS DAPHNE). – Ostrôžky Mts, Polichno, meadows near Timravina studnička, 630–640 m (Slezák et al. Bull. Slov. Bot. Spoločn. 32/1: 63, 2010). – Lešť, military training area, meadow along Plachtinský potok stream (Ružičková 2000 in GIS DAPHNE). – Lešť, military training area, locality Močiar (Háberová & Manica 1995). – Lešť, military training area, upper part of Krtíš stream valley (Potocký 2015 ined.). **15. Slovenské rudohorie Mts:** Spišsko-gemerské rudohorie Mts, Stará Voda, meadow (Nižňanská 1989 SNV). – Stará Voda, Starovodské lúky, meadows over railway between Švedlár and Stará Voda, 480–525 m [Mráz in Mráz & Mrázová (eds), Bull. Slov. Bot. Spoločn. 25, Suppl. 9, p. 55, 2003]. – Stará Voda, upper part of village near spring, 565 m (Halada & David in Mráz & Mrázová (eds), I. c., 2000). – Volovské vrchy Mts, Švedlár (Nižňanská & Vlčáková 1986 SNV). – Švedlár (Dostál, Zborn. Východoslov. múz. v Košiciach, príř. vedy 26: 39, 1985). – Štós [Stósz], Mt. Raubestein, mountain meadow (Thaisz 1910 BP). **19. Slanské vrchy Mts:** Prešov [Eperjes], Šalgovík [Salgo] (Hazslinszky s. dato BP). – Teriakovce, alder forest near well, single bunch (Dostál, Zborn. Východoslov. múz., príř. vedy 22: 57, 1981). – Teriakovce, NE, brook Šalgovský potok, wet meadows (Kollár 1971 MPS; Kollár, Biológia 28/7: 581, 1973). – Zlatá Baňa, Pusté pole, 600–620 m [Ščavnický, Dipl. thesis (msc.), p. 45, 1967; Dostál, I. c., p. 222, 1981]. – Abramovce, near road between Záborské and Dúbrava, wet meadow (Kollár 1971 MPS; Kollár I. c., p. 582). – Mirkovce, Nature Reserve Mirkovská kosatcová lúka [Palášthy et al. Příř. okr. Prešov a jej ochr., p. 102–110, 1987; Labovská, Bachelor thesis (msc.) depon. in: Příř. UPIŠ, Košice, 2021]. – Ruskov, Mt. Bogota, Regeta, mountain wet meadow (Šmídt 1992 KO). – Slančík, hill Okružly vrch, mountain wet meadow (Dudáš 2015, 2019 not.). – Slanská Huta, edge of cemetery (Dudáš 2021 not.). – Slanská Huta, Izra, meadow (E. Sitášová 2006 <http://www.fotonet.sk/>, ID 8146; Sitášová, Zborn. XXXII. Východoslov. táb. ochr. příř., Slanská Huta, p. 21). – Slanská Huta, border meadow Drahoše, 500–540 m (Stano 2003 in GIS DAPHNE; Sitášová I. c.; Farkas, Thaiszia – J. Bot. 31/1: 108, 2021). – Skároš, Vlášská lúka (Stano 2002 in GIS DAPHNE). **25. Turčianska kotlina:** Valentová, SW from the village in right bank of the Turiec river (Škovirová, Kmetianum 3: 277, 1974). – Socovce, Nature Reserve Klášterské lúky, wet meadows near confluence of Turiec River and Vríca stream [Darola & Svatoň 1967 TM; Urbanová 1973 ZAM; Škovirová 1973, 1975, 1986 TM; Runkovič 1987 SLO; Chilová 2002 in GIS DAPHNE; M. Krivuš 2016 <http://www.fotonet.sk/>, ID 128858; Bernátová et al. Ochř. příř. 32: 16–41, 2018]. – Dubové, meadow nearby a cemetery (Chilová 2003 in GIS DAPHNE). **26a. Liptovská kotlina Basin:** Pribylina, Potôčky, wet meadows, 780 m (Horníčková 1974 SLO, 1984 MOP). – Švihrová, wet meadow (Urbanová 1999 MOP; Hatinová 2000 in GIS DAPHNE). **26b. Spišské kotliny Basins:** Tatranské Matliare, horáreň Medvedová, meadow, 815 m

[Dítě in Mráz (ed), Bull. Slov. Bot. Spoločn. 24: 216, 2002]. – Malý Slavkov, Nature Reserve Slavkovský jarok, 740 m [Bernátová & Kliment in Eliáš jun. (ed), Bull. Slov. Bot. Spoločn. 42/2: 219, 2020]. – Malý Slavkov, Nature Reserve Kút, alder forest near water area [Bernátová & Kliment in Eliáš jun. (ed), Bull. Slov. Bot. Spoločn. 42/2: 219, 2020]. – Kežmarok, Rakúsy (Sagorski & Schneider 1891 ined.). – National Nature Reserve Belianske lúky (Stanová 2001 in GIS DAPHNE). **28. Západné Beskydy Mts:** Orava [Arva], Tvrdošín [Turdosin], Bobrov [Bobró] (Greschik 1925 BRA; Szontagh, Enumeratio, p. 1058). – Horná Orava, Klin, along stream towards hill Grapa, locally frequent, 660 m [Bača in Eliáš jun. (ed), Bull. Slov. Bot. Spoločn. 41/1: 90, 2019]. – Oravská Magura, Nižná, wet ditch by the mountain road (J. Staňo 2014 <http://www.fotonet.sk/>, ID 107657). **29. Spišské vrchy Mts:** Levoča [Leutschau] (Greschik 1930 BRA). – Pusté Pole, wet places towards Vislanka [Ščavnický, Dipl. thesis (msc.), p. 45, 1957]. – Pusté Pole, south from railway station (Ščavnický, l. c., p. 80, 1957). **30a. Šarišská vrchovina hill area:** Solivar pri Prešove (Hazslinszky, Magy Orv. Term. Viszg. Vánd.-gyűl. Munk, 7, 1847). **30c. Nízke Beskydy hill area:** Nižná Jablonka, meadows towards Hostovice [= Nature Reserve Hostovické lúky] (Májovský 1975 BRA; Hadač 1984 ined.; Hadač et al. Thaiszia – J. Bot. 7, Table 7, rel. 4, 1997; Terray 2000 in GIS DAPHNE; Galvánek 2020 ined.; Dudáš 2023 ined.). – Užská hornatina hill area, valley of Uda River SW from confluence with Hostinský stream [= Hostovický potok?] (Gašpar 1975 HNTS). – Svetlice, NE from hill Čierniny, 560 m (Dostál, l. c., 1985).

Carpaticum orientale

31. Bukovské vrchy Mts: Stakčín, valley of Chotinka stream (Dostál, l. c., 1985).

Unclear or general data (not mapped): Záhorie (Futák 1948 BRA; Futák & Hejná 1949 BRA). – Záhorie, large bogs in foothills (Krippel, Sbor. pr. ochr. príř. západoslov. kraja, p. 101, 1962). – Lučenská kotlina basin, Ipľ river catchment area (Svobodová & Řehořek, Fytoecologický a ekologický výskum lúčnych spoločenstiev v povodí Ipľa a Slanej, Final task research report II-5–8/7. depon. in: BÚ SAV, Table 8, rels 5, 9–10, 12–16, 1972). – Scattered on wet meadows in southern part of Východoslovenská nížina (Jurko et al. Ochr. príř. na vých. Slov., II/3: 121, 1966). – between Slovenské Nové Mesto and Chop [Čop], wet meadows along railway (Domin 1931 ined.). – CHKO Štiavnické vrchy, in southern parts, rare on wet meadows and in swamps (Hlavaček, Flóra CHKO Štiav. vrchy, p. 268, 1985). – valley of Hornád River, on meadows (Hayek, Pflanz. Oesterr. Hung. p. 407, 1916). – Liptov, Bialka (Ullepitsch 1894 BP). – Košice, meadows (Pawlowski, Verh. Ver. Nat. Presb. I: 26, 1856). – Biele

Karpaty: rare on wet meadows (Sillinger, Biele Karpaty, p. 62, 1929). – Spišská Nová Ves, surroundings, wet meadows (Greschik, Krásy Slov. 8: 312, 1929).

Incorrect data: Turová, stream Turová near road in village over church, 562 m (Hrivnák et al. Bull. Slov. Bot. Spoločn. 38/2: 231, 2016). The species was newly determined as *Iris sanguinea* based on photos by Roman Dominik Letz (see Bull. Slov. Bot. Spoločn., 46: 69–74, 2024).

Appendix 2

Shrub and forest phytosociological relevés.

1. Relevé number in Slovak Vegetation Database: 622032.

Biblioreference: Zaliberová M (1994) Die Strauchweidengesellschaften im March Alluvium. Ekológia, Suppl. 1: 107–114., Table 2, rel. 5.

Date (year/month/day): 1994/07/19.

Relevé area: 80 m².

Cover shrub layer (E₂): 95%, herb layer (E₁): 70%.

Locality: Borská nížina lowland, alluvium of the Morava river near Devínska Nová Ves village, Mäsiarky, 16° 55' 24"E, 48° 17' 36"N.

E₂: *Salix triandra* 5.

E₁: *Aster novi-belgii* 3, *Persicaria hydropiper* 3, *Phalaroides arundinacea* 3, *Chenopodium polyspermum* 2b, *Galium palustre* 1, *Glechoma hederacea* 1, *Solanum dulcamara* 1, *Symphytum officinale* 1, *Carex acuta* +, *Cirsium arvense* +, *Iris pseudacorus* +, *I. sibirica* +, *Myosotis scorpioides* agg. +, *Persicaria amphibia* +, *Poa trivialis* +, *Selinum dubium* +, *Stachys palustris* +, *Urtica dioica* +.

2. Relevé number in Slovak Vegetation Database: 624701.

Biblioreference: Jarolímek I (1994) Contribution to knowledge of forest communities along the Morava river, Ekológia, Suppl. 1: 115–124, Table 1, rel. 2.

Date (year/month/day): 1992/05/05.

Relevé area: 400 m².

Cover tree layer (E₃): 75%, shrub layer: 5%, herb layer: 95%.

Locality: Borská nížina lowland, Vysoká pri Morave village, Horný les, 16° 52' 51"E, 48° 20' 28"N.

E₃: *Salix rubens* 4, *Ulmus laevis* 2a, *Populus nigra* 1.

E₂: *Salix rubens* 1.

E₁: *Aster novi-belgii* agg. 3, *Urtica dioica* 3, *Glechoma hederacea* 2b, *Galium aparine* 2a, *Humulus lupulus* 2a, *Ficaria bulbifera* 2 m, *Rubus caesius* 1, *Angelica sylvestris* +, *Impatiens parviflora* +, *Stellaria media* +, *Symphytum officinale* +, *Iris sibirica* r.

Appendix 3

Full names and abbreviations of all plants used in the Fig. 3

AgrStlAg – *Agrostis stolonifera* agg., AchMilAg – *Achillea millefolium* agg., AlopPrat – *Alopecurus pratensis*, AnthOdor – *Anthoxanthum odoratum*, BetnOffc – *Betonica officinalis*, BrizMedi – *Briza media*, CaltPals – *Caltha palustris*, CarPratAg – *Cardamine pratensis* agg., CarxDavl – *Carex davaliana*, CarxHirt – *Carex hirta*, CarxNigr – *Carex nigra*, CarxPanc – *Carex panicea*, CarxPall – *Carex pallescens*, CarxVulp – *Carex vulpina*, CentJace – *Jacea pratensis*, CirsCanm – *Cirsium canum*, CirsRivl – *Cirsium rivulare*, ColcAutm – *Colchicum autumnale*, DescCesp – *Deschampia cespitosa*, EquiPals – *Equisetum palustris*, FestPrat – *Festuca pratensis*, FestRubAg – *Festuca rubra* agg., FilpUlmr – *Filipendula ulmaria*, FilpVulg – *Filipendula vulgaris*, GaliBore – *Galium boreale*, GaliPalAg – *Galium palustris* agg., GaliVerm – *Galium verum*, GaliUlig – *Galium uliginosum*, HolcLant – *Holcus lanatus*, IrisSibr – *Iris sibirica*, JuncCong – *Juncus conglomeratus*, LathPrat – *Lathyrus pratensis*, LotsCorn – *Lotus corniculatus*, LychFlos – *Lychnis flos-cuculi*, LythSalc – *Lythrum salicaria*, LysmNumm – *Lysimachia nummularia*, LysmVulg – *Lysimachia vulgaris*, MolCaeAg – *Molinia caerulea* agg., MyoPalAg – *Myosotis scorpioides* agg., PlanLanc – *Plantago lanceolata*, PoaPalus – *Poa palustris*, PoaPratAg – *Poa pratensis* agg., PoaTrivi – *Poa trivialis*, PotnErec – *Potentilla erecta*, PotnRept – *Potentilla reptans*, PruVulg – *Cirsium avium*, PseuLong – *Pseudolysimachion longifolium*, RanuAcrs – *Ranunculus acris*, RanuAurS – *Ranunculus auricomus* s. lat., RanuRepn – *Ranunculus repens*, SangOffc – *Sanguisorba officinalis*, SerrTinc – *Serratula tinctoria*, SuccPrat – *Succisa pratensis*, SympOffc – *Symphytum officinale*, RumxAcet – *Rumex acetosa*, TarSecRd – *Taraxacum* sect. *Ruderalia*, ValrDioi – *Valeriana dioica*, ViciCrac – *Vicia cracca*.

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Author contribution Richard Hrivnák: Investigation, Conceptualization, Methodology, Formal Analyses, Writing original draft; Michal Slezák: Investigation, Writing original draft; Matej Dudáš: Investigation, Conceptualization, Writing original draft; Dobromil Galváněk: Investigation, Writing original draft; Tereza Labovská: Investigation; Tatiana Miháliková: Investigation and Distribution map preparing. All authors commented the original and revised version of the manuscript.

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Data availability All distribution data are available in appendices of the paper and relevant cited references, phytosociological data in the Slovak Vegetation Database (code EU-SK-001 in the Global Index of Vegetation-Plot Databases) for request.

Declarations

Ethical approval "N/A".

Informed consent Informed consent was obtained from all individual participants included in the study.

Conflict of interest The authors declare there is no conflict of interest.

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