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The influence of the Eastern migration route on the Slovak flora – a comparison after 40 years

Der Einfluss des östlichen Migrationsweges auf die slowakische Flora – ein Vergleich nach 40 Jahren

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Abstract

Transport is an important source of introduction and spread of alien plants into new areas and countries. This study provides comprehensive research of selected railway localities in South-Eastern Slovakia to determine the influence of the Eastern Migration Route on the Slovak flora. Railway trans-shipment yards in Čierna nad Tisou, Dobrá, Veľké Kapušany and Maťovce were studied from 1964 to 2013; with historic data sampled 1964–1998 and recent data sampled 2012–2013. These data sets were compared to determine differences in species structure following the decreased use of the trans-shipment yards.

A total of 657 vascular plant taxa were recorded in all localities (566 taxa in the historic and 431 taxa in the recent data set). Native species prevailed over aliens and archaeophytes over neophytes in both time periods. The most frequent aliens were naturalised taxa, where Asiatic and European species prevailed. The most frequent families were *Poaceae*, *Asteraceae* and *Brassicaceae*, and while many species introduced with Russian wheat were recorded only in the past, several taxa are also recorded only recently. Hemicryptophytes were the most abundant life form. Most recorded species were competitors, reproducing by seed and pollinated by insects. Zoochory and hemerochory were the most frequent dispersal types. The proportion of species traits has not changed over time. We identified 49 threatened taxa (38 in the historic and 27 in the recent data set).

The Eastern migration route significantly increases the species number of alien vascular plants in the Slovak flora. Although this route had much greater importance in the past, when the role of the Eastern Slovak trans-shipment railway yards was much higher, the studied yards remain an important gateway to Eastern Central Europe and they continue to support agestochory migration of adventive plants.

Keywords: adventive species, agestochory, alien plants, Eastern Central Europe, introduction, railway, Slovakia, threatened species, transport

Erweiterte deutsche Zusammenfassung am Ende des Artikels

1. Introduction

The discovery of new continents and countries, new and improved types of traffic and vast transport of people and goods have led to a huge migration of organisms over past decades and centuries (JEHLÍK 1998). Plant diaspores reach new areas both directly and indirectly

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through human activities. Many plants have been anthropogenically introduced because of their edible, medicinal, melliferous, ornamental or dye qualities. In addition to this deliberate introduction, many species have been introduced accidentally. Plants and their parts can be transferred by vehicle or with different transported goods and materials.

Agestochory – a term used for the first time by LEVINA (1944) – is a type of anthropochory, meaning spread of plant diaspores via transport; rypochory is spread with transported material (LHOTSKÁ 1968); speirochory is spread with crop seeds (LEVINA 1944, MÜLLER-SCHNEIDER & LHOTSKÁ 1971). HEJNÝ (1964) reports that *Artemisia sieversiana*, *Bidens frondosa* and *Iva xanthiifolia* are typical examples of agestochory migration.

Ferroviatic migration, where plants spread along railways (DOMIN 1947), and ship migration were the major sources of introduction of alien plant species to Slovakia in the past (JEHLÍK & HEJNÝ 1974, JEHLÍK 1998), while today, road traffic plays a greater role in alien species spread (KOCIÁN 2014).

There are three main migration routes of adventive plants in Slovakia and Eastern Central Europe (JEHLÍK & HEJNÝ 1974, JEHLÍK 1998). The Elbe route has little importance in Slovakia; as it involves mostly weeds of oil plants, such as soya, cultivated in North America imported through Hamburg by inland navigation on the river Elbe. The Pannonian route allows adventive spread with transported agricultural products from the Balkans by railway or inland navigation on the Danube, and the Eastern route enables cereal weeds from the former Soviet Union to reach Slovakia by railway. The Eastern route main entrance gateway was via the large Čierna nad Tisou trans-shipment yard, and this was then supported by the Maťovce yard which was constructed later.

This important Eastern route began to markedly affect Slovak flora after 1946 (JEHLÍK 1998). This period heralded a sharp increase in imported cereals, especially wheat, from Ukraine, Russia and Central Asia. An exception occurred in 1980 when American cereal was also imported. Many alien species were introduced with grain as typical "companions of Russian wheat". Examples included *Bunias orientalis*, *Lactuca tatarica* and *Sisymbrium volgense* (JEHLÍK & SLAVÍK 1968, JEHLÍK 1980, 1981). Although the import of Soviet cereal decreased in 1979–1980 (and did not raise again) and current cereal import from Ukraine is sporadic, vast amounts of iron ore still arrive by the Eastern route from Ukraine (JEHLÍK 1998).

When Čierna nad Tisou and other South-Eastern Slovak transition stations became important introduction points for adventive plants, they aroused attention from botanical researchers. Eminent Czech botanists Slavomil Hejný and then Vladimír Jehlík studied this mode of adventive plant spread to Slovakia.

Integral results from these research workers are not yet published and only the first occurrences of aliens in Slovakia and other partial results have been published (HEJNÝ 1958, 1964, KRIPPELOVÁ & ŠPÁNIKOVÁ 1963, JEHLÍK & SLAVÍK 1968, JEHLÍK 1971, 1980, 1981, JEHLÍK & DOSTÁLEK 2008, JEHLÍK et al. 2013, MÁJEKOVÁ et al. 2013).

The aims of our study are: (1) to summarize Jehlík's 1964–1998 historical data from Čierna nad Tisou, Dobrá, Veľké Kapušany and Maťovce; (2) to report recent floristic research in these localities; (3) to compare these data sets and evaluate past and recent influence of the Eastern migration route on Slovak flora and (4) to determine native, alien and threatened species, plant families and species traits; including life form and different types of reproduction, strategy, pollen vector and dispersion.

2. Study area

The research was conducted at four localities in south-eastern Slovakia: Veľké Kapušany and Maťovce in the Michalovce district close to the Slovak-Ukrainian border and Čierna nad Tisou and Dobrá in the Trebišov district near the Slovak-Ukrainian-Hungarian borders (Fig. 1). The localities lie in the Východoslovenská rovina Plain in alluvia of the Latorica, Tisa and Uh rivers. They belong to the warm climatic region with warm dry climate and cool winters (LAPIN et al. 2002). The mean annual temperature recorded at Kráľovský Chlmec, the closest meteorological station, is 9.6 °C and the mean annual precipitation is 598 mm. July is the warmest month, January is the coldest one and June supplies the most rain. The Východoslovenská rovina Plain has the most continental character in Slovakia. Thermal continentality of climate for Kráľovský Chlmec is 35% (according to Gorczynski index of continentality which is 0% in oceanic areas and 100% in the most continental areas). In comparison, Košice has a continentality index of 30%. Despite relatively high continentality, ocean impact prevails in our study area (PETROVIČ et al. 1966).

Phytogeographically (FUTÁK 1980), all localities are in the Východoslovenská nížina district (province of Eupannonian xerotherm flora – Eupannonicum of the Pannonian flora region – Pannonicum) and potential natural vegetation is elm floodplain woods (MICHALKO et al. 1986).

2.1 Characteristics of the individual localities

1) Čierna nad Tisou (Fig. 2a): railway trans-shipment yard and passenger railway station, altitude: 102 m a.s.l., number of square and subsquare on the Slovak flora grid map (JASIČOVÁ & ZAHRADNÍKOVÁ 1976): 7598d. The railway line from Sátoráljaújhely to Chop with the station Čierna nad Tisou was opened on 25.8.1872. Broad-gauge rail was then built in 1947 and connected with Ukrainian broad-gauge railway for trans-shipment of goods between standard and broad-gauge waggons. At that time, 3500 tons of goods were trans-shipped daily; 0.4 million tons per year; with imported goods trans-shipped in Čierna nad Tisou and exported goods in Chop in the Ukraine. The change to totalitarian regime led to a huge

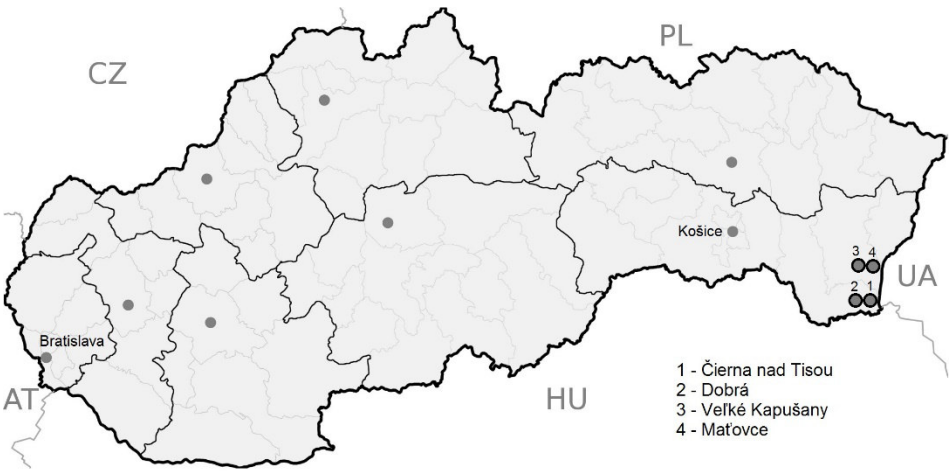

Fig. 1. Location of the studied biotopes.

Abb. 1. Die geographische Lage der untersuchten Biotope.

Fig. 2. Examples of railway trans-shipment yards: **a)** Čierna nad Tisou; **b)** *Senecio vernalis* in Maťovce (Photos: J. Májeková, April 2013).

Abb. 2. Beispiele von Eisenbahn-Umschlagplätzen: **a)** Čierna nad Tisou; **b)** *Senecio vernalis* im Maťovce (Fotos J. Májeková, April 2013).

increase in Soviet Union goods, to equal two-thirds of total Slovak imports. These imports included: ore, coal, cereal, fertilizers, timber, agricultural machines, cars, military equipment, cotton, oil. Cereal was one of the most important components to late 1960's, and a significant part of import was intended for the Czech Republic.

Thus, Slovak railways had become the busiest conduit in 1950's Europe. The trans-shipment yard was expanded and developed, mainly in 1948–1959, and Čierna nad Tisou currently has 160 km of rails and almost 500 railroad switches on its 10 km^2 area. The import vigorously decreased after 1989. The trans-shipment trend is as follows: 1947 – 0.4 million tons per year, 1950 – 1.9, 1960 – 9.6, 1965 – 11.7, 1980 – 8.9, 1995 – 5.1 million tons per year (KUBÁČEK et al. 2013). In 2012, 7.3 million tons, consisting mainly of iron ore, were transported in Čierna nad Tisou (JANDOŠEK 2013).

2) Dobrá: railway trans-shipment yard and cereal silo, 101 m a.s.l, 7598c. The locality is situated at the western end of the railway station Čierna nad Tisou (ca 5 km). Construction of the railyard lasted in 1953–1969 (KUBÁČEK et al. 2013). Through this Combined Transport Terminal freights are also routed in the West–East direction, mainly to Russia and Asia (REMÁKOVÁ 2013a).

3) Veľké Kapušany: railway trans-shipment yard, 106 m a.s.l, 7498b. Railway line Vojany – Uzhhorod with stations at Veľké Kapušany and Maťovce was opened on 30.10.1910 (KUBÁČEK et al. 2013). Broad-gauge trans-shipment yard in Veľké Kapušany served grain trans-shipment from the Soviet Union until 1961 (or 1962), and it then concentrated on coal transport.

4) Maťovce (near Maťovské Vojkovce village, Fig. 2b): railway trans-shipment yard and railway station, 106 m a.s.l., 7498b. The railway line follows to Ukraine and is connected with Uzhhorod. The broad-gauge line was built in 1965 and proceeds to Haniska pri Košiciach. This town is the gateway for the largest metallurgical combined company U.S. Steel Košice. In 2012, 7.6 million tons of mainly ore substrates were transported via Maťovce trans-shipment yard to Haniska pri Košiciach (JANDOŠEK 2013).

The service in Čierna nad Tisou and Maťovce is called the East Slovak Transhipment Yards (ESTY) and together with the Combined Transport Terminal in Dobrá, they have great strategic importance for transport on a European scale, as 15 million tons of goods

were transported East–West across ESTY in 2012. Ore substrates comprised the majority of transported goods. In the same year, 209,000 tons of goods were transported West–East across Maťovce and 377,000 tons across Čierna nad Tisou (JANDOŠEK 2013).

3. Methods

Field research was carried out irregularly between 1964 and 2013, and the studied localities were visited in different months to record all vegetation seasons. The data were divided into two sets: historic data obtained mainly by Jehlík between 1964 and 1998 (Dobrá only in 1977–1998 and Maťovce in 1980–1998) and recent data collected by Jehlík, Májeková and Zaliberová in 2012–2013. Čierna nad Tisou kept the most past records, so these were subdivided into groups A (1964–1977) and B (1984–1998). We also utilised herbarium specimen data from 1948 and 1957 stored by S. Hejný in the Herbarium of the National Museum in Prague (PR).

Species abundance was evaluated on a 5-degree scale (cf. JEHLÍK 2013): a – rare, b – occasional, c – scattered, d – frequent, and e – abundant. In some cases only presence/absence was recorded.

Plant taxa nomenclature follows MARHOLD (1998), or is cited with the author's name. IUCN threat categories follow ELIÁŠ jun. et al. (2015), with residence and invasive status and region of origin reported in the inventories of MEDVECKÁ et al. (2012). Alien species not included there are evaluated as casual neophytes. Definitions of alien plants follow PYŠEK et al. (2004). Life form, reproduction type, ecological strategy type and pollen vector are adopted from the BiolFlor database (KLOTZ et al. 2002) and dispersal type from The Leda Traitbase (KLEYER et al. 2008). Where a taxon has more than one category of species traits, the taxon is considered representative of each of these categories. Some categories were also merged for simplification: macrophanerophyte, nanophanerophyte, pseudophanerophyte and hemiphanerophyte were merged into phanerophyte life form and selfing pollen vectors, pseudocleistogamy, cleistogamy and geitonogamy were included in the "selfing" category.

Herbarium specimens are deposited in the herbarium of the Institute of Botany, Slovak Academy of Sciences in Bratislava (SAV) and in the herbarium of the Institute of Botany, Academy of Sciences of the Czech Republic in Průhonice (PRA).

4. Results

We recorded a total of 657 vascular plant taxa in the studied localities (Supplement E1 and examples in Figs. 2b–3). These came from 72 families; the most frequent being *Poaceae*, *Asteraceae* and *Brassicaceae* (Table 1). Of these, 49 were threatened species and one was legally protected (Table 2, Figs. 3b, c, f). Native species prevailed over aliens (52% versus 46%, respectively) (Fig. 4a), and archaeophytes prevailed over neophytes (24% versus 22%, respectively). Most alien taxa were naturalised (67%), while 24% were casual, and only 9% were invasive (Fig. 4b). The alien species mostly originated from Asia and Europe (Fig. 4c). Almost half of the recorded taxa were hemicryptophytes (47%), followed by therophytes (35%), phanerophytes (7%), geophytes (7%), chamaephytes (2%) and hydrophytes (2%) (Fig. 5a). The most frequent reproduction type was by seeds (64%) and by seeds and vegetatively (26%) (Fig. 5b). Pollination by insects dominated with 47%, followed by selfing (37%) and wind-pollination (15%) (Fig. 6a). The most frequent dispersal types were zoochory (27%) and hemerochory (24%) (Fig. 6b) and the most frequent ecological strategy type was competitor with 28% (Fig. 7).

These figures were very similar in both the historic and recent data sets. Native taxa were a little bit more frequent than aliens, and archaeophytes more common than neophytes in the 566 taxa recorded from the past, and ratios were similar in the 431 recently recorded taxa.

Fig. 3. Examples of plant species in the studied localities: **a)** *Vicia grandiflora* in Mať ovce; **b)** Threatened species *Nigella arvensis* (IUCN: NT) in Čierna nad Tisou; **c)** Threatened species *Ceratocephala orthoceras* (IUCN: CR) in Čierna nad Tisou; **d)** Archaeophyte *Portulaca oleracea* in Čierna nad Tisou; **e)** Neophyte *Acosta diffusa* in Čierna nad Tisou; **f)** Threatened species *Eryngium planum* (IUCN: NT) in Veľké Kapušany; **g)** Neophyte *Amaranthus albus* in Čierna nad Tisou; **h)** Invasive neophyte *Ambrosia artemisiifolia* in Čierna nad Tisou (Photos: J. Májeková, 2012–2013).

Table 1. The twenty most frequent families and their representation in the historic and recent data sets.

Tabelle 1. Die zwanzig häufigsten Familien und ihre Häufigkeit im historischen und rezenten Datensatz.

	Total no. of species	Historic data set	Recent data set
Poaceae	70	67	41
Asteraceae	69	65	43
Brassicaceae	49	46	34
Fabaceae	42	37	25
Chenopodiaceae	32	32	14
Lamiaceae	32	29	18
Scrophulariaceae	26	22	17
Cichoriaceae	25	21	22
Rosaceae	25	22	17
Apiaceae	24	18	16
Caryophyllaceae	22	20	17
Polygonaceae	21	18	16
Boraginaceae	13	12	8
Ranunculaceae	13	9	8
Salicaceae	12	11	8
Onagraceae	11	10	7
Solanaceae	10	9	7
Euphorbiaceae	9	8	5
Amaranthaceae	8	7	4
Liliaceae	8	5	3

While naturalised taxa were much more abundant than casual and invasive in both past and recent records, the proportion of casual taxa declined in the recent data set (Figs. 4a–c). The number of threatened species decreased from 38 in the past to 27 in the recent data (Table 2). Plant family representation is similar in both periods (Table 1), but *Asteraceae* has now replaced *Poaceae* as the most frequent family. Comparison of different species traits highlighted that percentage representation remained the same in all data set between past and recent records (cf. Figs. 5–7).

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Abb. 3. Beispiele von Pflanzenarten der Untersuchungsgebiete: **a)** *Vicia grandiflora* in Maťovce; **b)** Die gefährdete Art *Nigella arvensis* (IUCN: NT) in Čierna nad Tisou; **c)** Die gefährdete Art *Ceratocephala orthoceras* (IUCN: CR) in Čierna nad Tisou; **d)** Der Archäophyt *Portulaca oleracea* in Čierna nad Tisou; **e)** Der Neophyt *Acosta diffusa* in Čierna nad Tisou; **f)** Die gefährdete Art *Eryngium planum* (IUCN: NT) in Veľké Kapušany; **g)** Der Neophyt *Amaranthus albus* in Čierna nad Tisou; **h)** Der invasive Neophyt *Ambrosia artemisiifolia* in Čierna nad Tisou (Fotos: J. Májeková, 2012–2013).

Table 2. Threatened plant taxa recorded in the studied localities in both time periods (+: presence of taxa, §: species protected by law).

Tabelle 2. Gefährdete Pflanzentaxa in den untersuchten Lokalitäten im historischen und rezenten Datensatz (+: Taxon vorhanden, §: gesetzlich geschützt).

Taxon	Category of threat	Historic data set	Recent data set
Adonis aestivalis	LC		+
Aegilops cylindrica	VU, §	+	
Allium angulosum	NT	+	
Androsace elongata	NT		+
Artemisia scoparia	NT	+	
Bromus arvensis	LC	+	
Bromus secalinus	EN	+	
Bromus squarrosus	LC	+	+
Butomus umbellatus	LC	+	
Camelina rumelica	CR	+	
Carex stenophylla	NT		+
Centaurium pulchellum	NT	+	
Ceratocephala orthoceras	CR		+
Chenopodium murale	NT	+	
Chenopodium urbicum	VU	+	
Conringia orientalis	CR	+	
Crepis pulchra	NT		+
Cyanus segetum	LC	+	+
Eragrostis pilosa	LC	+	+
Eryngium planum	NT	+	+
Erysimum diffusum	LC	+	+
Erysimum marschallianum	NT	+	+
Erysimum repandum	NT	+	+
Galium tricornutum	CR	+	
Glaucium corniculatum	CR	+	+
Gratiola officinalis	LC	+	
Hibiscus trionum	LC	+	+
Kickxia elatine	LC	+	
Lactuca saligna	VU		+
Lepidium perfoliatum	VU	+	+
Lythrum hyssopifolia	LC	+	
Misopates orontium	NT	+	+
Myosurus minimus	NT		+
Nigella arvensis	NT	+	+
Ononis repens	DD	+	
Ornithogalum boucheanum	LC		+
Ornithogalum divergens	NT	+	
Papaver argemone	EN	+	
Papaver dubium subsp. *austromoravicum*	NT	+	+
Psyllium arenarium	NT	+	
Pulegium vulgare	LC	+	
Senecio erucifolius	NT	+	+
Silaum silaus	NT	+	
Silene dichotoma	LC	+	+
Tithymalus tommasinianus	LC	+	+
Torilis arvensis	NT		+
Tribulus terrestris	NT		+
Veronica triphyllos	NT		+
Xanthium strumarium	DD	+	
Total number	**49**	**38**	**27**

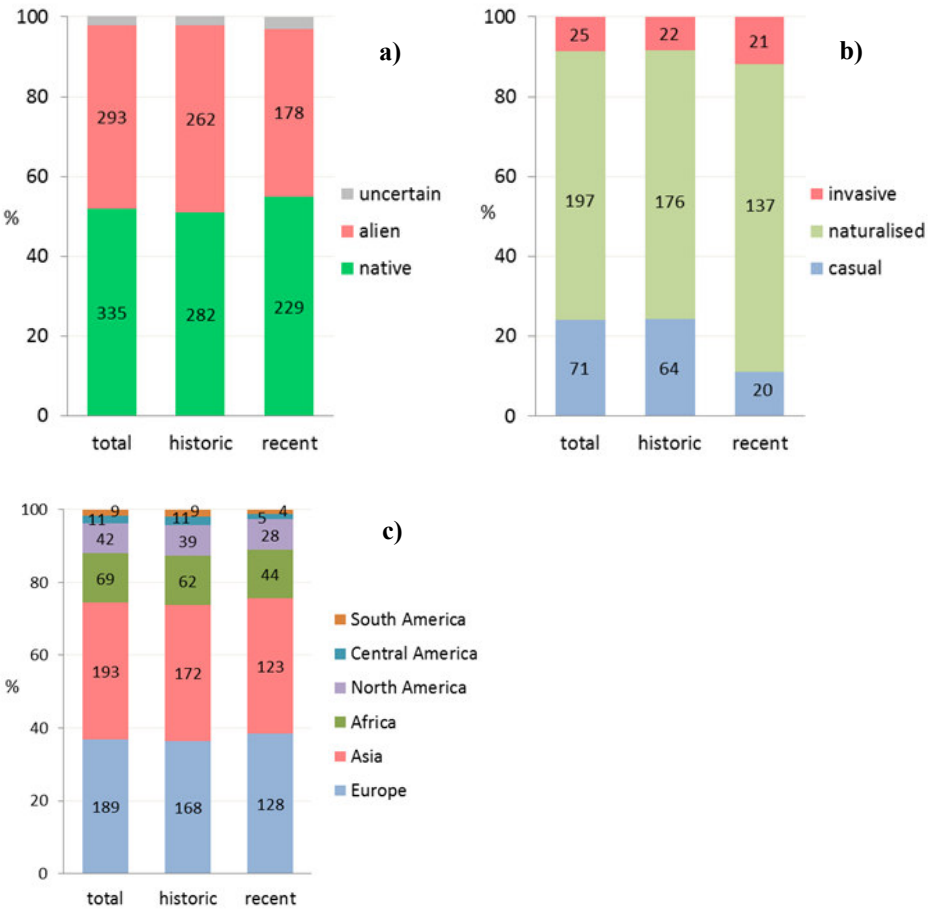

Fig. 4. a) Native and alien taxa presence, **b)** invasive status of the recorded alien taxa, and **c)** region of origin (all according to MEDVECKÁ et al. 2012) in the studied localities in both time periods. Numbers in columns are absolute species numbers.

Abb. 4. a) Anteil der heimischen und fremden Taxa, **b)** Anteil der Invasiven, Eingebürgerten und Unbeständigen unter den fremden Arten und **c)** Herkunftsgebiet der fremden Arten (alle nach MEDVECKÁ et al. 2012) auf den Untersuchungsflächen in beiden Zeitabschnitten. Die Zahlen in den Balken geben die absoluten Artenzahlen an.

We noted 12 taxa not included in the Inventory of alien flora of Slovakia (MEDVECKÁ et al. 2012), thus being new to Slovakia; (A) 10 from the past (*Acroptilon repens*, *Artemisia dniproica*, *Camelina rumelica*, *Chenopodium berlandieri* subsp. *zschackei*, *Coreopsis* cf. *tinctoria*, *Echinochloa colona*, *Ipomoea hederacea* var. *hederacea*, *Lolium persicum*, *Ononis repens* and *Silaus besseri*) and (B) two from the present (*Artemisia verlotiorum* and *Euphorbia davidii*). All are considered neophytes with casual invasion status. The records of the first occurrence of these new taxa and revised dates of the first occurrence of several other alien plants in the Slovak countryside, which differ from the dates published in the MEDVECKÁ et al. (2012), are listed in Table 3.

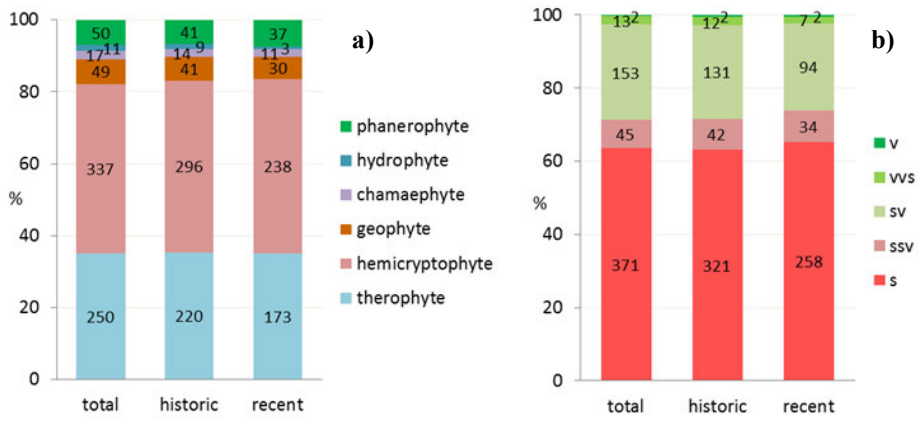

Fig. 5. a) Percentage of species life forms, and **b)** percentage of species reproduction types in the studied localities in both time periods. Abbreviations of reproduction types: s – reproduction by seed; ssv – mostly by seed, rarely vegetatively; sv – by seed and vegetatively; vvs – mostly vegetatively, rarely by seed; v – vegetatively. Numbers in columns are absolute species numbers.

Abb. 5. a) Anteil der Lebensformen und **b)** Anteil der Reproduktionstypen auf den Untersuchungsflächen in beiden Zeitabschnitten. Abkürzungen der Reproduktionstypen: s – ausschließlich über Samen; ssv – meist Samen, selten vegetativ; sv – Samen und vegetativ; vvs – meist vegetativ, selten Samen; v – ausschließlich vegetativ. Die Zahlen in den Balken geben die absoluten Artenzahlen an.

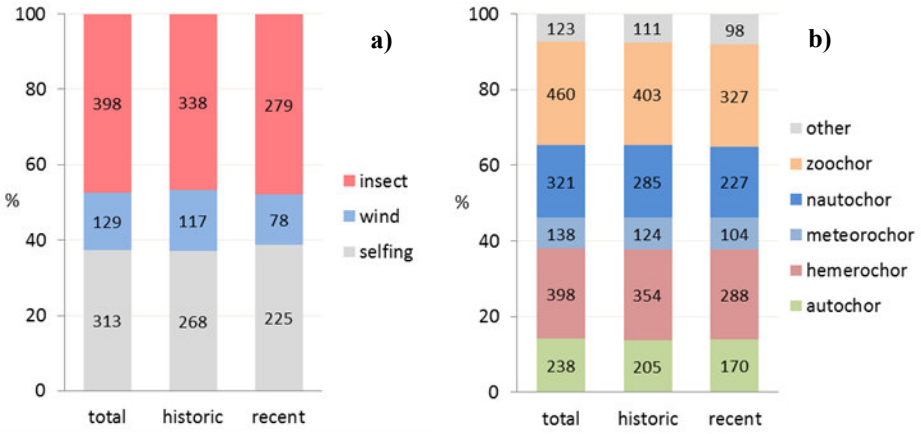

Fig. 6. a) Percentage of species pollen vectors, and **b)** percentage of species dispersal types in the studied localities in both time periods. Numbers in columns are absolute species numbers.

Abb. 6. a) Anteil der Pollenvektoren und **b)** der Ausbreitungstypen auf den Untersuchungsflächen in beiden Zeitabschnitten. Die Zahlen in den Balken geben die absoluten Artenzahlen an.

Fig. 7. Percentage of ecological strategy types in the studied localities in both time periods. c – competitors; cr – competitors/ruderals; cs – competitors/stress-tolerators; csr – competitors/stress-tolerators/ruderals; r – ruderals; s – stress-tolerators; sr – stress-tolerators/ruderals. Numbers in columns are absolute species numbers.

Abb. 7. Anteil der ökologischen Strategietypen auf den Untersuchungsflächen in beiden Zeitabschnitten. c – Konkurrenz-Strategen; cr – Konkurrenz-Ruderal-Strategen; cs – Konkurrenz-Stress-Strategen; csr – Konkurrenz-Stress-Ruderal-Strategen; r – Ruderal-Strategen; s – Stress-Strategen; sr – Stress-Ruderal-Strategen. Die Zahlen in den Balken geben die absoluten Artenzahlen an.

5. Discussion

The number of recorded taxa declined over time in our studied localities due to the decrease in bulk-good imports, mainly Soviet cereal (JEHLÍK 1998, KUBÁČEK et al. 2013). Additional causes could be the increased transport in closed containers and improved weed control.

Human-made (synanthropic) habitats host the highest number of alien species throughout Europe (PYŠEK et al. 2002, TÖRÖK et al. 2003, CHYTRÝ et al. 2005, 2008a, b, RABITSCH & ESSL 2006, ARIANOUTSOU et al. 2010, MEDVECKÁ et al. 2014) and traffic plays an important role in alien species spread (cf. HEJNÝ 1964, JEHLÍK & HEJNÝ 1974, BRANDES 1983, HUBER 1992, JEHLÍK 1998, RABITSCH & ESSL 2006, WRZESIEŃ 2006, HRABOVSKÝ & MIČIETA 2014, KOCIÁN 2014). Our results support the findings of these authors. The number of alien taxa was relatively high in all studied locations in both time periods, although natives were slightly more abundant (Fig. 4a). As in our study, MÁJEKOVÁ & LIMÁNEK (2016) recorded higher representation of native than alien species at the north-eastern Slovak railway stations, and also dominance of archaeophytes over neophytes where naturalised species were the most frequent. Dominance of archaeophytes at railway stations is probably caused by archaeophytes having higher affinity to open vegetation at dry or mesic sites (CHYTRÝ et al. 2008b), and other authors confirm the occurrence of light and dry demanding species at railway habitats (BRANDES 1983, GALERA et al. 2014).

Table 3. Year of first occurrence of some alien taxa in Slovakia. a) Taxa new to the Slovak flora and not included in MEDVECKÁ et al. (2012). b) Taxa included in MEDVECKÁ et al. (2012).

Tabelle 3. Jahr des ersten Auftretens einiger nicht-einheimischer Taxa in der Slowakei. a) Für die Slowakei neue, nicht in MEDVECKÁ et al. (2012) erwähnte Taxa. b) In MEDVECKÁ et al. (2012) enthaltene Taxa.

Taxon	First occurrence in Slovakia according to our data	First occurrence in Slovakia according to MEDVECKÁ et al. (2012)
a)		
Acroptilon repens	1964	-
Artemisia dniproica	1977	-
Artemisia verlotiorum	2013	-
Camelina rumelica	1957	-
Chenopodium berlandieri subsp. *zschackei*	1984	-
Coreopsis cf. *tinctoria*	1980	-
Echinochloa colona	1957	-
Euphorbia davidii	2012	-
Ipomoea hederacea var. *hederacea*	1977	-
Lolium persicum	1957	-
Ononis repens	1980	-
Silaus besseri	1964	-
b)		
Amaranthus palmeri	1977	no year given
Artemisia abrotanum	1984	2008
Atriplex micrantha	1964	1998
Brassica elongata subsp. *integrifolia*	1957	1973
Brassica napus subsp. *napus*	1964	1984
Centaurea adpressa	1977	2008
Chenopodium probstii	1966	1980
Chenopodium striatiforme	1980	1999
Chorispora tenella	1957	1972
Fagopyrum tataricum	1948	1956
Fragaria × *ananassa*	1984	1985
Fraxinus pennsylvanica	1964	1994
Glycine max	1979	1984
Lappula consanguinea	1964	2008
Lepyrodiclis holosteoides	1984	1998
Melilotus wolgicus	1964	1968
Oryza sativa	1977	2008
Panicum dichotomiflorum	1977	1978
Panicum miliaceum subsp. *agricola*	1964	1984
Potentilla intermedia	1964	1978
Salsola collina	1964	1998
Sisymbrium polymorphum	1957	1998
Solanum decipiens	1964	1973
Sorbaria sorbifolia	1984	2005

Hemicryptophytes were the most frequent life form found in our study. This contrasts with GALERA et al. (2014) who report that alien therophytes are the characteristic floral element in operating railway areas. In Poland, hemicryptophytes and therophytes alternate in dominance at railway habitats, dependent on station utilization (PISKORZ & CZARNA 2006, NOWIŃSKA & CZARNA 2008).

In addition, although the number of threatened species declined in our study over the studied period (Tab. 2), the railway habitats provide suitable conditions not only for alien and invasive species but also for the rare and threatened native species (HUBER 1992, HOHLA et al. 2000, 2002, 2005, NOWIŃSKA & CZARNA 2008, MÁJEKOVÁ et al. 2014, MÁJEKOVÁ & LIMÁNEK 2016).

We noted 12 taxa new to Slovakia in accordance to MEDVECKÁ et al. (2012). While the 10 species recorded only in the past were almost certainly introduced accidentally with imported goods and did not establish here, it is most likely that the latter two species will become naturalised in their new localities.

Artemisia verlotiorum is native to East Asia and was secondarily distributed in Europe in 1873. This species was first recorded in the Czech Republic in 1947 and sparsely occupies sites in country areas (JEHLÍK 1998, KOCHÁNKOVÁ et al. 2006). While it is recognised in some Western European countries, and also Slovenia, Croatia, Austria, Ukraine and Poland (JEHLÍK 1998, KIRÁLY et al. 2007), this is the first record of *Artemisia verlotiorum* in Slovakia. We discovered its presence in 2013 at the Čierna nad Tisou trans-shipment yard, thriving as a compact population on banks between the rails. We estimated that it grew there for a minimum of 2 years, because of the large dense population spread over a few square metres.

Euphorbia davidii is a North American species first recorded in Russia in 1968. Since that time it has been recorded at railways and fields throughout Europe. It is in Ukraine, very close to the Slovak border, so we assume it was transported to Slovakia via the Eastern migration route (BARINA et al. 2013). We recorded this species in 2012 and 2013 at the Maťovce trans-shipment yard, where it flourished fruitfully in a full population (JEHLÍK et al. 2013).

There is a relatively large group of taxa recorded only from the past – these 226 taxa amount to 34% of the total recorded taxa, while the 91 recently recorded taxa account for only 14%. The following are examples of species spread in Slovakia:

Until now *Atriplex micrantha* has been considered in Slovakia as temporally introduced species (MEDVECKÁ et al. 2012). Jehlík initially found it in Čierna nad Tisou in 1964, and again in Dobrá in 1998 (Table 3, Supplement E1). The species is native to Kazakhstan and South-Eastern Russia, but is secondarily distributed in other countries, including Ukraine (SUCHORUKOW 2007). Its introduction to Slovakia and Europe was accidental with transported wool from Russia or Ukraine. Although we did not record this species in any studied locality recently, *Atriplex micrantha* has spread along the motorways in Central and Western Europe. Its massive distribution along motorways in the Czech Republic (Moravia and Silesia) was discovered only a few years ago (KOCIÁN 2014). Then its existence was finally established in Western Slovakia along motorway connecting Slovakia and the Czech Republic (HODÁLOVÁ et al. 2016), and it spread viatically in road transport rather than by railway migration with wool (KOCIÁN 2014).

Geranium purpureum is a neophyte species native to Western and Southern Europe, Asia and Africa. It was initially recorded in Slovakia in 2000 and currently distributed at least at the Western, Eastern and Southern Slovak railway stations (ELIÁŠ jun. 2011, JEHLÍK et al.

2013, ZALIBEROVÁ & MÁJEKOVÁ 2014). It is abundantly distributed in European countries; exclusively at railway stations. The first Austrian recording was in 1989 (MELZER 1990), then in the Czech Republic in 2005 (RŮŽIČKA & KOBLÍŽEK 2009). It spread in all our studied Slovak localities and finally to Western Ukraine in 2015 (SHEVERA et al. 2015). This reflects *Geranium purpureum*'s South/North and West/East spread; from Slovakia to the Ukraine.

Senecio vernalis has expanded in warm areas of Slovakia, especially at railway stations, in the latest decades after its initial 1902 recording (MEDVECKÁ et al. 2012). JEHLÍK (1998) reported it "an old species on the Eastern migration route", and we recorded it in all studied localities, with its greatest abundance as a "yellow carpet" over the Maťovce railyard (Fig. 2b). Finally, this species was recorded at railway stations in North-Eastern Slovakia (MÁJEKOVÁ & LIMÁNEK 2016), Austria (MELZER 1995a, b, HOHLA et al. 2000, 2002) and Poland (PISKORZ & CZARNA 2006, NOWIŃSKA & CZARNA 2008) and it is also common in the Czech Republic (PERGL et al. 2016).

Our rediscovery of *Ceratocephala orthoceras* (Fig. 3c) was very serendipitous. Although it is native to Slovakia, it was last recorded in 1969 and thought extinct here (BERTOVÁ 1982, FERÁKOVÁ et al. 2001). We found a small population at the Čierna nad Tisou railway station yard in April 2013 (MÁJEKOVÁ et al. 2013). All historical records of this species are from south-western Slovakia and from Ukraine (DIDUKH et al. 2004); we consider its presence in our study area a secondary migration from Ukraine.

In contrast, some species presence is very similar in both time periods. *Ambrosia artemisiifolia* is a good example. This invasive neophyte species is native to North America (MEDVECKÁ et al. 2012), and commonly found in all our studied localities (Supplement E1, Fig. 3h). It was first recorded in Slovakia in 1949 and is now massively distributed in warm areas. While it is a characteristic species of Pannonian migration route adventives, its arrival and spread in Eastern Slovakia is reminiscent of accompanying Ukrainian cereal on the Eastern migration route (JEHLÍK 1998). *Ambrosia artemisiifolia* is one of the 100 worst alien invasive species in Europe, because its high allergenicity is dangerous to human health (DAISIE 2016). This species is also spreading in other parts of Slovakia (HRABOVSKÝ & MIČIETA 2014) and is common in Hungary (TÖRÖK et al. 2003, PINKE et al. 2011) and Ukraine (PROTOPOPOVA et al. 2006). It is classified among the worst aliens in the Czech Republic (PERGL et al. 2016), and has also been reported in Austria (RABITSCH & ESSL 2006) and at Polish railways (WRZESIEŃ 2006).

JEHLÍK (1998) defined the characteristic adventive species of the Eastern migration route, and we recorded the following species in both time periods: *Acosta diffusa* (Fig. 3e), *Amaranthus albus* (Fig. 3g), *Ambrosia artemisiifolia* (Fig. 3h), *Atriplex tatarica*, *Bassia scoparia*, *Bunias orientalis*, *Camelina microcarpa*, *Cannabis ruderalis*, *Chorispora tenella*, *Erysimum repandum*, *Glaucium corniculatum*, *Grammica campestris*, *Iva xanthiifolia*, *Lactuca tatarica*, *Lepidium densiflorum*, *Panicum capillare*, *P. miliaceum*, *Potentilla intermedia*, *Rumex patientia*, *Silene dichotoma*, *Sisymbrium volgense*, *Stachys annua* and *Stenactis annua*. Only in the past were recorded these species: *Acroptilon repens*, *Amaranthus blitoides*, *Artemisia annua*, *A. sieversiana*, *Brassica elongata* subsp. *integrifolia*, *Camelina rumelica*, *Consolida orientalis*, *Dracocephalum thymiflorum*, *Fagopyrum tataricum*, *Lepidium latifolium*, *Lepyrodiclis holosteoides*, *Melilotus wolgicus*, *Rapistrum perenne*, *Salsola collina*, *Sisymbrium polymorphum*, *Sorghum halepense*, *Xanthium spinosum* and *X. strumarium*. In contrast, *Senecio vernalis* is only recorded recently on the Eastern migration route.

6. Conclusion

The Eastern migration route significantly increases the species number of alien vascular plants in the Slovak flora. In the 1970's, this was considered the most important alien plant migration route in the former Czechoslovakia (JEHLÍK & HEJNÝ 1974). It retains its great contribution and although the Eastern migration route's importance has diminished somewhat by decreased use of our railway trans-shipment yards for Russian and Ukrainian cereal imports, the eastern Slovak trans-shipment yards at Čierna nad Tisou and Maťovce maintain their important role in Slovakia, providing current trans-shipment of over 90% of materials and goods imported to Slovakia by railways from Eastern Europe and Asia. These remain the largest trans-shipment yards providing complex service between broad and standard-gauge railways in Slovakia and therefore they retain their importance as alien plant pathways to Slovakia.

Although railways provide a source of plant introduction and spread, thus helping to enrich country and regional biodiversity, they are also responsible for invading alien species. Here, *Geranium purpureum* or *Senecio vernalis* are good examples of species spread by Slovak railway ferroviatic transport (cf. ELIÁŠ jun. 2011, JEHLÍK et al. 2013, MÁJEKOVÁ et al. 2014, ZALIBEROVÁ & MÁJEKOVÁ 2015). While both ship and ferroviatic migration have been main sources of alien plant introduction to our country (JEHLÍK & HEJNÝ 1974, JEHLÍK 1998) road traffic migration is now supplanting their roles, as road transport so dramatically escalates (KOCIÁN 2014).

While current European Union effort concentrates on displacing heavy road transport (REMÁKOVÁ 2013b), this still leaves railway as an important route of plant species spread. Consequently, the East Slovak Trans-shipment Yards retain their pride of place as the most important gateway to Eastern Central Europe (JANDOŠEK 2013).

While agestochory migration enhances the introduction and spread of species over large distances in a short time, a second important effect is that new species reach biotopes significantly different from surrounding natural biotopes (HEJNÝ 1958). Some species spread very rapidly in a new area, but others lack suitable conditions and consequently disappear. While this is certainly confirmed in our study, all issues concerning the introduction and spread of alien species in these interesting localities will benefit from further studies in this context.

Erweiterte deutsche Zusammenfassung

Einleitung – Viele Pflanzenarten erreichen durch (absichtlichen oder unabsichtlichen) menschlichen Einfluss neue Gebiete und Länder. Agestochorie bezeichnet die anthropogene Ausbreitung von pflanzlichen Diasporen durch Fahrzeuge. In der Slowakei stellt die sogenannte "östliche Route" einen der Haupteinwanderungswege für adventive Pflanzen dar, auf welchem vor allem Getreideunkräuter aus der früheren Sowjetunion per Eisenbahn nach Mitteleuropa gelangen. Die Eintrittspforte sind die Eisenbahn-Umschlagplätze in Čierna nad Tisou und Maťovce. Hejný und insbesondere Jehlík führten in der Vergangenheit umfangreiche botanische Studien an den ost-slowakischen Eisenbahn-Knotenpunkten durch, doch wurden davon bislang nur Teilergebnisse publiziert. Das Ziel der vorliegenden Arbeit ist (1) die zusammenfassende Darstellung der von Jehlík in den Jahren 1964–1998 gesammelten Daten von Čierna nad Tisou, Dobrá, Veľké Kapušany und Maťovce; (2) die Mitteilung neuer floristischer Daten von diesen Lokalitäten; (3) ein Vergleich der beiden Datensätze in Hinblick auf die frühere und rezente Bedeutung der "östlichen Route" für die slowakische Flora, sowie (4) die Bestimmung des Anteils der heimischen, fremden und gefährdeten Arten, der Familienzugehörigkeit und der funktionalen Eigenschaften (Lebensformen, Reproduktionstypen, Ökologische Strategietypen, Pollenvektoren, Ausbreitungstypen) der Arten.

Material und Methoden – Untersucht wurden vier Eisenbahn-Umschlagplätze in der Ost-Slowakei (Abb. 1): Čierna nad Tisou (Abb. 2a), Dobrá, Veľké Kapušany und Maťovce (Abb. 2b). Die Untersuchungen fanden in den Jahren 1964–2013 statt (historische Daten: 1964–1998, rezente Daten: 2012–2013). Es wurden alle Gefäßpflanzenarten (sowohl heimische, als auch fremde) notiert, und ihre Abundanz wurde in einer fünfstufigen Skala geschätzt. Darüberhinaus wurden die im Herbar des Prager Nationalmuseums aufbewahrten Belege von S. Hejný, gesammelt 1948 und 1957 in Čierna nad Tisou, ausgewertet. Die Gefährdungseinstufung folgt ELIÁŠ jun. et al. (2015), der floristische Status MEDVECKÁ et al. (2012). Arten, welche in dieser Liste fehlen, wurden als unbeständige Neophyten eingestuft. Lebensformen, Reproduktionstypen, Ökologische Strategietypen und Pollenvektoren wurden der BiolFlor-Datenbank entnommen (KLOTZ et al. 2002), Ausbreitungstypen der Leda Traitbase (KLEYER et al. 2008).

Ergebnisse – Über den gesamten Untersuchungszeitraum hinweg wurden an den untersuchten Lokalitäten insgesamt 657 Gefäßpflanzenarten gefunden (Anhang E1; für einige Beispiele siehe Abb. 2b–3h). Diese gehörten zu 72 Familien, wovon die *Poaceae*, *Asteraceae* und *Brassicaceae* die häufigsten waren (Tab. 1). Darunter waren 49 gefährdete Arten und eine gesetzlich geschützte Art (Tab. 2). Heimische Arten waren mit 52 % etwas häufiger als fremde Arten (Abb. 4a), und Archäophyten (24 %) waren geringfügig häufiger als Neophyten (22 %). 67 % der fremden Arten waren Eingebürgerte, 24 % Unbeständige und lediglich 9 % Invasive (Abb. 4b; Kategorien nach MEDVECKÁ et al. 2012). Der Großteil der fremden Arten stammte aus Asien und Europa (Abb. 4c). Die häufigste Lebensform stellen die Hemikryptophyten dar (Abb. 5a), es dominieren Reproduktion durch Samen (Abb. 5b), Insektenbestäubung (Abb. 6a) sowie Zoochorie und Hemerochorie (Abb. 6b). Die meisten Arten gehören zu den Konkurrenz-Strategen oder zu deren Mischtypen (Abb. 7). Historische und rezente Daten unterschieden sich in den untersuchten Parametern nur geringfügig, die Verteilung der funktionalen Eigenschaften hat sich zwischen den beiden Perioden kaum verändert.

12 der von uns gefundenen Arten sind in der Liste der "Alien Flora of Slovakia" (MEDVECKÁ et al. 2012) nicht verzeichnet. Diese für die Slowakei neuen Arten sind *Acroptilon repens*, *Artemisia dniproica*, *Camelina rumelica*, *Chenopodium berlandieri* subsp. *zschackei*, *Coreopsis* cf. *tinctoria*, *Echinochloa colona*, *Ipomoea hederacea* var. *hederacea*, *Lolium persicum*, *Ononis repens* und *Silaus besseri* aus dem historischen Datensatz sowie *Artemisia verlotiorum* and *Euphorbia davidii* aus dem rezenten Datensatz (Tab. 3).

Diskussion – Die Zahl der gefundenen Arten nahm mit der Zeit ab, was vermutlich mit dem starken Rückgang der Schüttgut-Importe, vor allem Getreide aus der Sowjetunion, ab 1979 zusammenhängt. Weitere Faktoren könnten der vermehrte Einsatz von geschlossenen Containern und stärkere Unkrautbekämpfung sein.

Die "östliche Route" galt bis 1980 als der wichtigste Einwanderungsweg für nicht-heimische Pflanzenarten in die Slowakei und Tschechien. Aufgrund der Abnahme der Getreideimporte aus Russland und der Ukraine hat die Bedeutung der Route zwar etwas abgenommen, die ost-slowakischen Eisenbahn-Umschlagplätze Čierna nad Tisou und Maťovce spielen aber nach wie vor eine bedeutende Rolle im mitteleuropäischen Verkehr und sind daher weiterhin eine wesentliche Eintrittspforte für fremde Arten.

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Supplements

Additional supporting information may be found in the online version of this article.

Zusätzliche unterstützende Information ist in der Online-Version dieses Artikels zu finden.

Supplement E1. List of recorded plant taxa in the studied localities.

Anhang E1. Liste der gefundenen Pflanzentaxa in den untersuchten Lokalitäten.

References

ARIANOUTSOU, M., BAZOS, I., DELIPETROU, P. & KOKKORIS, Y. (2010): The alien flora of Greece: taxonomy, life traits and habitat preferences. – Biol. Invasions 12: 3525–3549.

BARINA, Z., SHEVERA, M., SÎRBU, C. & PINKE, G. (2013): Current distribution and spreading of *Euphorbia davidii* (*E. dentata* agg.) in Europe. – Cent. Eur. J. Biol. 8: 87–95.

BERTOVÁ, L. (1982): *Ceratocephala* Moench. – In: FUTÁK, J. & BERTOVÁ, L. (Eds.): Flóra Slovenska III (Flora of Slovakia III) [in Slovak]: 141–144. Veda, Bratislava.

BRANDES, D. (1983): Flora und Vegetation der Bahnhöfe Mitteleuropas. – Phytocoenologia 11: 31–115.

CHYTRÝ, M., JAROŠÍK, V., PYŠEK, P., HÁJEK, O., KNOLLOVÁ, I., TICHÝ, L. & DANIHELKA, J. (2008a): Separating habitat invasibility by alien plants from the actual level on invasion. – Ecology 89: 1541–1553.

CHYTRÝ, M., MASKELL, L.C., PINO, J., PYŠEK, P., VILÀ, M., FONT, X. & SMART, S.M. (2008b): Habitat invasions by alien plants: a quantitative comparison among Mediterranean, subcontinental and oceanic regions of Europe. – J. Appl. Ecol. 45: 448–458.

CHYTRÝ, M., PYŠEK, P., TICHÝ, L. & KNOLLOVÁ, I. (2005): Invasions by alien plants in the Czech Republic: a quantitative assessment across habitats. – Preslia 77: 339–354.

DAISIE (European Invasive Alien Species Gateway) (2016): *Ambrosia artemisiifolia*. – URL: http://www.europe-aliens.org/speciesFactsheet.do?speciesId=21692# [accessed 2016-02-04].

DIDUKH, YA., BURDA, R., ZIMAN, S., KOROTCHENKO, I., FEDORONCHUK, M. & FITSAILO, T. (2004): Ecoflora of Ukraine II. – Phytosociocentre, Kyiv: 480 pp.

DOMIN, K. (1947): Pracovní metody soustavné botaniky (Working methods of botany) [in Czech]. – Acta Bot. Bohem. 17: 1–176.

ELIÁŠ jun., P. (2011): *Geranium purpureum* Vill. – new alien species to the Slovak flora. – Thaiszia 21: 21–28.

ELIÁŠ, jun., P., DÍTĚ, D., KLIMENT, J., HRIVNÁK, R. & FERÁKOVÁ, V. (2015): Red list of ferns and flowering plants of Slovakia, 5th ed. – Biologia 70: 218–228.

FERÁKOVÁ, V., MAGLOCKÝ, Š. & MARHOLD, K. (2001): Červený zoznam papraďorastov a semenných rastlín Slovenska (Red list of ferns and flowerings plants of Slovakia) [in Slovak, with English summary]. – In: BALÁŽ, D., MARHOLD, K. & URBAN, P. (Eds.): Červený zoznam rastlín a živočíchov Slovenska (Red list of plants and animals of Slovakia). – Ochr. Prír. 20 (Suppl.): 44–77.

FUTÁK, J. (1980): Fytogeografické členenie (Phytogeographical classification). – In: MAZÚR, E. (Ed.): Atlas Slovenskej socialistickej republiky (Atlas of the Slovak Socialist Republic) [in Slovak]: 88. Slovenská akadémia vied, Slovenský úrad geodézie a kartografie, Bratislava.

GALERA, H., SUDNIK-WÓJCZIKOWSKA, B., WIERZBICKA, M., JARZYNA, I. & WIŁKOMIRSKI, B. (2014): Structure of the flora of railway areas under various kinds of anthropopression. – Pol. Bot. J. 59: 1–10.

HEJNÝ, S. (1958): *Iva xanthifolia* Nutt. v ČSR (*Iva xanthifolia* Nutt. in Czechoslovakia) [in Czech]. – Acta Fac. Rerum Nat. Univ. Comen., Bot. 2: 323–342.

HEJNÝ, S. (1964): *Artemisia sieversiana* Willd., eine neue eingeschleppte Art in der Tschechoslowakei. – Preslia 36: 392–402.

HODÁLOVÁ, I. FERÁKOVÁ, V. ZALIBEROVÁ, M. & MEREĎA, jun., P. (2016): *Atriplex*. – In: GOLIAŠOVÁ, K. & MICHALKOVÁ, E. (Eds.): Flóra Slovenska VI/4 (Flora of Slovakia VI/4) [in Slovak, with English summaries]: 307–350. Veda, Bratislava.

HOHLA, M., KLEESADL, G. & MELZER, H. (2000): Neues zur Flora des oberösterreichischen Bahnanlagen – mit Einbeziehung einiger grenznaher Bahnhöfe Bayerns. – Beitr. Naturk. Oberösterreichs 9: 191–250.

HOHLA, M., KLEESADL, G. & MELZER, H. (2002): Neues zur Flora der oberösterreichischen Bahnanlagen – mit Einbeziehung einiger Bahnhöfe Bayerns – Fortsetzung. – Beitr. Naturk. Oberösterreichs 11: 507–578.

HOHLA, M., KLEESADL, G. & MELZER, H. (2005): Neues zur Flora der oberösterreichischen Bahnanlagen. – Beitr. Naturk. Oberösterreichs 14: 147–199.

HRABOVSKÝ, M. & MIČIETA, K. (2014): The occurrence of an invasive species *Ambrosia artemisiifolia* in Slovakia in the years 2008–2014. – Acta Bot. Univ. Comen. 49: 9–12.

HUBER, W. (1992): Zur Ausbreitung von Blütenpflanzenarten an Sekundärstandorten der Nordschweiz. – Bot. Helv. 102: 93–108.

JANDOŠEK, L. (2013): Čierna nad Tisou and Maťovce report stable 15 million tons. – ZSSK CARGO Business 1/2013: 18–19. (www.zscargo.sk/files/Cargo-business/2013/magazin-vnutro-all.pdf)

JASIČOVÁ, M. & ZAHRADNÍKOVÁ, K. (1976): Organizácia a metodika mapovania rozšírenia rastlinných druhov v západnej tretine Slovenska (Organization and mapping methods in distribution of plant species in west third of Slovakia) [in Slovak] – Biológia 31: 74–80.

JEHLÍK, V. (1971): *Sisymbrium wolgense* M. Bieb. – nová adventivní rostlina v Československu (*Sisymbrium wolgense*: a new adventive plant in Czechoslovakia) [in Czech]. – Zpr. Čs. Bot. Společ. 6: 173–176.

JEHLÍK, V. (1980): Die Verbreitung von *Lactuca tatarica* in der Tschechoslowakei und Bemerkungen zu ihrem Vorkommen. – Preslia 52: 209–216.

JEHLÍK, V. (1981): Chorology and Ecology of *Sisymbrium volgense* in Czechoslovakia. – Folia Geobot. Phytotax. 16: 407–421.

JEHLÍK, V. (2013): Die Vegetation und Flora der Flusshäfen Mitteleuropas. – Academia, Praha: 546 pp.

JEHLÍK, V. (Ed.) (1998): Cizí expanzivní plevele České republiky a Slovenské republiky (Alien expansive weeds of the Czech Republic and the Slovak Republic) [in Czech]. – Academia, Praha: 506 pp.

JEHLÍK, J. & DOSTÁLEK, J. (2008): Influence of railway transport in the South-East of Slovakia on formation of adventive flora in Central Europe. – Biodivers. Res. Conserv. 11–12: 27–32.

JEHLÍK, V. & HEJNÝ, S. (1974): Main migration routes of adventitious plants in Czechoslovakia. – Folia Geobot. Phytotax. 9: 241–248.

JEHLÍK, V., MÁJEKOVÁ, J. & ZALIBEROVÁ, M. (2013): New discovered adventive plants from eastern Slovakia. – Thaiszia 23: 61–66.

JEHLÍK, V. & SLAVÍK, B. (1968): Beitrag zum Erkennen des Verbreitungscharakters der Art *Bunias orientalis* L. in der Tschechoslowakei. – Preslia 40: 274–293.

KIRÁLY, G., MESTERHÁZY, A. & BAKAN, B. (2007): *Elodea nuttalii* (Planch.) H. St. John, *Myosotis laxa* Lehm. and *Pyrus austriaca* Kern., new for Slovenia, as well as other floristic records. – Hladnikia 20: 11–15.

KLEYER, M., BEKKER, R.M., KNEVEL, I.C. et al. (2008): The LEDA Traitbase: a database of life-history traits of the Northwest European flora. – J. Ecol. 96: 1266–1274.

KLOTZ, S., KÜHN, I. & DURKA, W. (Eds.) (2002): BIOLFLOR – Eine Datenbank mit biologisch-ökologischen Merkmalen zur Flora von Deutschland. – Schriftenr. Vegetationskd. 38: 1–334.

KOCHÁNKOVÁ, J., SÁDLO, J. & MANDÁK, B. (2006): *Artemisia verlotiorum* Lamotte 1876. – In: MLÍKOVSKÝ, J. & STÝBLO, P. (Eds.): Nepůvodní druhy fauny a flóry České republiky (Alien species of fauna and flora of the Czech Republic) [in Czech]: 53–54. ČSOP, Praha.

KOCIÁN, P. (2014): Nezpozorované a rychlé šíření lebedy různosemenné (*Atriplex micrantha*) a omanu smradlavého (*Dittrichia graveolens*) na dálnicích Moravy a Slezska (Česká republika) (Unnoticed and rapid spread of Russian Atriplex (*Atriplex micrantha*) and Stinkwort (*Dittrichia graveolens*) on motorways in Moravia and Silesia (Czech Republic)) [in Czech]. – Acta Mus. Beskidensis 6: 27–47.

KRIPPELOVÁ, T. & ŠPÁNIKOVÁ, A. (1963): Nové lokality niektorých zriedkavejšie sa vyskytujúcich rastlín na Slovensku (New localities of some rare plants in Slovakia) [in Slovak]. – Biológia 18: 525–527.

KUBÁČEK, J. (Ed.) (2013): Dejiny železníc na území Slovenska (History of railways in Slovakia) [in Slovak, with English summary]. – Železnice Slovenskej republiky, Bratislava: 280 pp.

LAPIN, M., FAŠKO, P., MELO, M., ŠŤASTNÝ, P. & TOMLAIN, J. (2002): Klimatické oblasti (Climatic regions). – In: MIKLÓS, L. (Ed.): Atlas krajiny Slovenskej republiky (Atlas of Slovak Republic) [in Slovak]: 95. Ministerstvo životného prostredia, Slovenská agentúra životného prostredia, Bratislava, Banská Bystrica.

LEVINA, R.E. (1944): Kvoprosu ob antropochorii (To the anthropochory questions) [in Russian]. – Sov. Bot. 3: 43–46.

LHOTSKÁ, M. (1968): Karpologie und Karpobiologie der tschechoslowakischen Vertreter der Gattung *Bidens*. – Rozpr. Čs. Akad. Věd, Ser. Math.-Natur. 78/10: 1–85.

MÁJEKOVÁ, J., LETZ, D.R., SLEZÁK, M., ZALIBEROVÁ, M. & HRIVNÁK, R. (2014): Rare and threatened vascular plants of the railways in Slovakia. – Biodivers. Res. Conserv. 35: 75–85.

MÁJEKOVÁ, J. & LIMÁNEK, J. (2016): Diverzita flóry železničných staníc na trati Poprad – Plaveč (východné Slovensko) (Diversity of the flora of the railway stations on the Poprad – Plaveč line (Eastern Slovakia)) [in Slovak, with English summary]. – Bull. Slov. Bot. Spoločn. 38: 37–45.

MÁJEKOVÁ, J., ZALIBEROVÁ, M. & JEHLÍK, V. (2013): Extinct species *Ceratocephala testiculata* (Crantz) Besser rediscovered in Slovakia after 44 years. – Thaiszia 23: 141–145.

MARHOLD, K. (1998): Papraďorasty a semenné rastliny (Ferns and flowering plants). – In: MARHOLD, K. & HINDÁK, F. (Eds.): Zoznam nižších a vyšších rastlín Slovenska (Checklist of non-vascular and vascular plants of Slovakia) [in Slovak, with English summaries]: 333–687. Veda, Bratislava.

MEDVECKÁ, J., JAROLÍMEK, I., SENKO, D. & SVITOK, M. (2014): Fifty years of plant invasion dynamics in Slovakia along a 2,500 m altitudinal gradient. – Biol. Invasions 16: 1627–1638.

MEDVECKÁ, J., KLIMENT, J., MÁJEKOVÁ, J., HALADA, Ľ., ZALIBEROVÁ, M., GOJDIČOVÁ, E., FERÁKOVÁ, V. & JAROLÍMEK, I. (2012): Inventory of the alien flora of Slovakia. – Preslia 84: 257–309.

MELZER, H. (1990): *Geranium purpureum* Vill., der Purpur-Storchschnabel – neu für die Flora von Österreich und *Papaver confine* Jord., ein neuer Mohn für die Steiermark. – Verh. Zool.-Bot. Ges. Österreich 127: 161–164.

MELZER, H. (1995a): Neues zur Adventivflora der Steiermark, vor allem der Bahnanlagen. – Linzer Biol. Beitr. 27: 217–234.

MELZER, H. (1995b): *Geranium purpureum* L., der Purpur-Storchschnabel – neu für Kärnten und weiteres Neues zur Flora dieses Bundeslandes. – Carinthia II 185: 585–598.

MICHALKO, J., BERTA, J. & MAGIC, D. (1986): Geobotanical map of C.S.S.R. Slovak Socialist Republic, text and maps. – Veda, Bratislava: 170 pp.

MÜLLER-SCHNEIDER, P. & LHOTSKÁ, M. (1971): Zur Terminologie der Verbreitungsbiologie der Blütenpflanzen. – Folia Geobot. Phytotax. 6: 407–417.

NOWINSKA, R. & CZARNA, A. (2008): Impact of Railway Facility Operation on Floral Growth in Powodowo, the Region of Wielkopolska. – Pol. J. Environ. Stud. 17: 613–622.

PERGL, J., SÁDLO, J., PETRUSEK, A., LAŠTŮVKA, Z., MUSIL, J., PERGLOVÁ, I., ŠANDA, R., ŠEFROVÁ, H., ŠÍMA, J., VOHRALÍK, V. & PYŠEK, P. (2016): Black, Grey and Watch Lists of alien species in the Czech Republic based on environmental impacts and management strategy. – NeoBiota 28: 1–37.

PETROVIČ, Š. (Ed.) (1966): Klimatické a fenologické pomery Východoslovenského kraja (Climatic and phenological conditions of the East Slovakian region) [in Slovak]. – Hydrometeorologický ústav, Praha: 276 pp.

PINKE, G., KARÁCSONY, P., CZÚCZ, B. & BOTTA-DUKÁT, Z. (2011): Environmental and land-use variables determining the abundance of *Ambrosia artemisiifolia* in arable fields in Hungary. – Preslia 83: 219–235.

PISKORZ, R. & CZARNA, A. (2006): Vascular plants on active and closed railway stations in Wolsztyn and its sorroudings. – Rocz. Akad. Rol. Pozn. Bot.-Stec. 10: 137–156.

PROTOPOPOVA, V.V., SHEVERA, M.V. & MOSYAKIN S.L. (2006): Deliberate and unintentional introduction of invasive weeds: A case study of the alien flora of Ukraine. – Euphytica 148: 17–33.

PYŠEK, P., RICHARDSON, D.M., REJMÁNEK, M., WEBSTER, G., WILLIAMSON, M. & KIRSCHNER, J. (2004): Alien plants in checklists and floras: towards better communication between taxonomists and ecologists. – Taxon 53: 131–143.

PYŠEK, P., SÁDLO, J. & MANDÁK, B. (2002): Catalogue of alien plants of the Czech Republic. – Preslia 74: 97–186.

RABITSCH, W. & ESSL, F. (2006): Biological invasions in Austria: patterns and case studies. – Biol. Invasions 8: 295–308.

REMÁKOVÁ, A. (2013a): Intermodal transport terminals and transship terminals in the Slovak republic. – ZSSK CARGO Business 1/2013: 14–15. (www.zscargo.sk/files/Cargo-business/2013/magazin-vnutro-all.pdf).

REMÁKOVÁ, A. (2013b): The future lies in intermodal transport. – ZSSK CARGO Business 1/2013: 17. (www.zscargo.sk/files/Cargo-business/2013/magazin-vnutro-all.pdf).

RŮŽIČKA, V. & KOBLÍŽEK, J. (2009): Kakost nachový (*Geranium purpureum*), nový druh pro květenu České republiky (*Geranium purpureum*, new species to the flora of the Czech Republic) [in Czech, with English summary]. – Zpr. Čes. Bot. Společ. 44: 23–27.

SHEVERA, M.V., MÁJEKOVÁ, J., ZALIBEROVÁ, M., PROTOPOPOVA, V.V. & ANDRIK, E.J. (2015): *Geranium purpureum* (*Geraniaceae*), a new alien species of the flora of Ukrainian plain area [in Ukrainian, with English summary]. – Ukr. Bot. J. 72: 334–339.

SUCHORUKOW, A.P. (2007): Zur Systematik und Chorologie der in Russland und den benachbarten Staaten (in den Grenzen der ehemaligen USSR) vorkommenden *Atriplex*-Arten (*Chenopodiaceae*). – Ann. Naturhist. Mus. Wien 108B: 307–420.

TÖRÖK, K., BOTTA –DUKÁT, Z., DANCZA, I., NÉMETH, I., KISS, J., MIHÁLY, B. & MAGYAR, D. (2003): Invasion gateways and corridors in the Carpathian Basin: biological invasions in Hungary. – Biol. Invasions 5: 349–356.

WRZESIEŃ, M. (2006): Kenophytes chorologically related to the habitats of railway grounds in central eastern Poland. – Biodiver. Res. Conserv. 1–2: 92–94.

ZALIBEROVÁ, M. & MÁJEKOVÁ, J. (2014): Poznámky k prvému nálezu *Geranium purpureum* Vill. na Slovensku a rozšírenie druhu na železničných staniciach Záhoria (západné Slovensko) (Notes on the first finding of *Geranium purpureum* Vill. in Slovakia, and the species distribution in the railway stations of the Záhorie Region (Western Slovakia)) [in Slovak, with English summary]. – Bull. Slov. Bot. Spoločn. 36: 221–230.

Supplement E1. List of recorded plant taxa in the studied localities. Frequency of taxa: a – rare, b – occasional, c – scattered, d – frequent, e – abundant, x – present (without further information on frequency).

Anhang E1. Liste der gefundenen Pflanzentaxa in den untersuchten Lokalitäten. Häufigkeit der Taxa: a – selten, b – gelegentlich, c – zerstreut, d – häufig, e – reichlich vorhanden, x – vorhanden (ohne weitere Information zur Häufigkeit).

Taxon/Locality and time period	Čierna nad Tisou				Dobrá		V. Kapušany		Maťovce	
	Hejný	historic A	historic B	recent	historic	recent	historic	recent	historic	recent
Abutilon theophrasti		a	a		a					
Acer platanoides			a	a		a				
Acer pseudoplatanus				a			a			a
Acetosa pratensis							a			
Acetosa thyrsiflora		b-e	c-d	c-d	b-c	b-c	c	c	x	c-d
Acetosella multifida agg.		a-b					a	a	x	a-b
Acinos arvensis		b-c		b			b	a	x	a
Acosta diffusa		a-c	c	c		a-b	b	a-c	x	a
Acosta rhenana		a-c	b	b	b-c	a-c	b	b	x	b-c
Acroptilon repens		a	a							
Adonis aestivalis						a				
Aegilops cylindrica			a		a					
Aesculus hippocastanum										a
Aethusa cynapium			a		a					
Agrimonia eupatoria		a-c				a	a		x	a
Agrostis capillaris		a-b					a			
Agrostis gigantea			a							
Agrostis stolonifera						a	a	a		
Achillea millefolium agg.		b-c	c	b-c		b-c	b	b	x	a-c
Ailanthus altissima			a	a		b				
Ajuga genevensis									x	
Alisma plantago-aquatica			a							
Alliaria petiolata			a			a				
Allium angulosum		a	a							
Allium schoenoprasum						a				a
Allium vineale			a							
Alopecurus myosuroides								a		
Alopecurus pratensis			a	b		b		a		
Althaea officinalis										a
Alyssum alyssoides			a		a-b				x	b
Amaranthus albus	x	c	b	b	a-b	a-b	a	b	x	b-c
Amaranthus blitoides		a	a		a					
Amaranthus cruentus			a							
Amaranthus lividus			a							
Amaranthus palmeri S. Watson		a			a					
Amaranthus powellii (incl. A. chlorostachys)	x	a-b	a-b	b-c	a-b	b			x	b-c
Amaranthus retroflexus	x	c-d	c-d	d	c	c	c	c-d	x	c-d
Amaranthus × ozanonii Thell. in Asch. et Graebn.										a
Ambrosia artemisiifolia		b-d	d-e	a-e	c-d	d	c	b-d	x	d-e
Ambrosia trifida			a		a					
Anagallis arvensis		a				a	a			
Androsace elongata				a						
Anethum graveolens			a							
Anchusa officinalis		b-c	a-b	b-c	b	b-c	a	a	x	b
Anthemis arvensis		a	a	b	a	a	a			
Anthemis ruthenica		a	a						x	
Anthriscus cerefolium				a						
Anthriscus sylvestris		a		b		a	a	b		
Anthyllis vulneraria		a								
Antirrhinum majus		a								
Apera spica-venti			a	a-b	b	c	a	c		b
Arabidopsis thaliana	x	d	d	d	c	c	c	c	x	a-e
Arctium lappa		b		a-b		a	a			
Arctium minus		a					a			
Arctium sp.				a						
Arctium tomentosum		b-c		a			b			
Arctium × mixtum			a							
Arenaria serpyllifolia			b	a-c	b	c		a-c		c-d
Aristolochia clematitis		a-c	b	a-b	b	a-b				
Armoracia rusticana		a		a			a			
Arrhenatherum elatius		b-d		a-d		c	b	c	x	b-d
Artemisia abrotanum			a	a						
Artemisia absinthium	x	b-c	b-c	a-b	b	a-b	a	a	x	a
Artemisia annua	x	a	a							
Artemisia campestris					a	a				
Artemisia dniproica Klokov		a								
Artemisia dracunculus		a								
Artemisia repens Willd.	x	a-b	a				a		x	
Artemisia scoparia		a								
Artemisia sieversiana		b			a					
Artemisia verlotiorum				b						
Artemisia vulgaris		b-d	c	b-c		b-d	c	c-d	x	a-d
Asclepias syriaca				a		a		a		a
Asparagus officinalis						a				
Asperugo procumbens			b							
Astragalus cicer				a						
Astragalus glycyphyllos		a-b		a-b		a				a
Atriplex micrantha Ledeb.		a			a					
Atriplex oblongifolia × A. patula			a							
Atriplex patula		b-c		a-c		a-b	c	a-b	x	
Atriplex prostrata subsp. latifolia	x			a				a		
Atriplex sagittata	x	a				a			x	
Atriplex tatarica	x	c-d	d-e	c-d		b	b		x	
Avena fatua		b-c		a	a-b					
Avena sativa		a-b					a			
Ballota nigra subsp. nigra		b-c	b	a-c	c	b-c	b	b		b
Barbarea vulgaris			b	a	b-c	c	b	c	x	a
Bassia scoparia		c		b-d		b		b		b
Bassia scoparia subsp. densiflora		a	b		b					
Bassia scoparia subsp. scoparia		c	c-e		c-d		b-c	d	x	
Bassia sedoides (Asch.) Iljin		a								
Batrachium cf. baudotii			a							
Batrachium rhipiphyllum			a							
Bellis perennis		a								
Berteroa incana		b-c	b-c	c	c	b-c	a-b	a	x	b
Beta vulgaris	x									
Beta vulgaris var. altissima Döll		a			a					
Betula pendula			a	a						
Bidens frondosa				b	a	b	b	a-b		b
Bidens tripartita		a-b					a		x	
Brassica elongata subsp. integrifolia	x	a			a					
Brassica napus subsp. napus		a-c	b	b	a-c	a-d	a	b	x	a
Brassica nigra							a			
Bromus arvensis			a							
Bromus hordeaceus		a-c		a-b		b	b			a
Bromus inermis		a-b			b		a			
Bromus japonicus		b-c	c	b-c	c	b	c	c		a-c
Bromus secalinus	x				a					
Bromus squarrosus			a			a		b		
Bromus sterilis			c	b		a		c		b
Bromus tectorum		b-d		c-d	d	c-d		c		c
Bunias orientalis		b-d	d-e	c-d	a	a			x	
Butomus umbellatus			a							
Calamagrostis epigejos		a-c	c	c-d	c	b-c	c	b-c	x	c
Calendula officinalis		a								
Calystegia sepium		c		a-c				a-b	x	b
Camelina microcarpa				a	b	a		a	x	
Camelina microcarpa subsp. microcarpa		b	b	a	b					
Camelina microcarpa subsp. sylvestris						b				
Camelina rumelica	x		b							
Campanula rapunculoides										a
Cannabis ruderalis		a	a		b	a				
Capsella bursa-pastoris		b-c	c	b-d		b-c		b-c		a-c
Cardaminopsis arenosa									x	
Cardaria draba		b-c	c	a-b	b		a-b		x	a
Carduus acanthoides		b-d	a-c	c	b-c	b-c	b	a-b	x	b
Carex acuta		a								
Carex brizoides				b				b		
Carex hirta		b-c		b		a-b	b	a-b	x	a
Carex praecox			a							
Carex spicata			a			a				
Carex stenophylla				a		b		b		
Carex vulpina agg.			a							
Carum carvi		a	a							
Centaurea adpressa Ledeb.		a								
Centaurium pulchellum		a								
Cerastium arvense			a							
Cerastium glutinosum				a		a				
Cerastium holosteoides			b	b	b	a	a	a-b	x	b
Cerastium pumilum			c							
Cerastium semidecandrum				c	c	c		c		b
Cerasus avium						a				
Ceratocephala orthoceras				a						
Cerinthe minor		a							x	
Chaerophyllum bulbosum				a						a
Chaiturus marrubiastrum		a								
Chamerion angustifolium		a-b		a		a		a		
Chamerion dodonaei									x	
Chelidonium majus				a-b		a		a		
Chenopodium album	x	b-c		b		a	b	b		b
Chenopodium album agg.		b				a				
Chenopodium album × C. strictum		a								
Chenopodium berlandieri subsp. zschackei (Murr) Zobel			a							
Chenopodium botrys	x	a								
Chenopodium ficifolium									x	
Chenopodium glaucum			a				a	a-b		
Chenopodium hybridum	x		a							
Chenopodium missouriense			a							
Chenopodium murale		a								
Chenopodium opulifolium		a	a							
Chenopodium pedunculare Bertol.			a	b		a-b		a-b		b
Chenopodium polyspermum	x	a				a				a
Chenopodium probstii		a	a	a	a	b				
Chenopodium striatiforme J. Murr			a		a	a				
Chenopodium strictum	x	b	b-c	b-c	b-c	c	a-c	b-c	x	c
Chenopodium suecicum		b	a							
Chenopodium urbicum	x	a			a					
Chondrilla juncea		b	b-c	a-b	a-b			a	x	a
Chorispora tenella	x	a	a			b				
Cichorium intybus		b-c	b	b		b-c	b	b-c	x	c
Cirsium arvense		c-d		a-c	a-b	a-c	a	b-c	x	a-c
Cirsium canum			a	a			a	a-b	x	
Cirsium vulgare subsp. vulgare		a-b		a-b		a-b	a	a-b	x	a
Clematis vitalba								a		a
Clinopodium vulgare		b	b				a		x	
Colymbada scabiosa		a-b					a			
Commelina communis		a	a							
Conium maculatum		a-c	b	b-c	a	a-c			x	a
Conringia orientalis	x	a-b								
Consolida orientalis		a	a							
Consolida regalis		b-c	b-c	a-b	a-b	a-c	a	b	x	b-c
Convolvulus arvensis		b-c	c	c		b-d	b	b-c		b-c
Conyza canadensis	x	c-d	c-d	c-d	c-d	c-d	b	b-c	x	b-c
Coreopsis cf. tinctoria Nutt.					a					
Cota austriaca										a
Crataegus sp.			a					a		
Crepis biennis			a	b						
Crepis foetida subsp. rhoeadifolia			b	a-c		b		a		b
Crepis pulchra										a
Crepis setosa			a		b	b				a
Crepis tectorum	x	b-c	a-d	a		a			x	
Cuscuta epithymum		a		a			a			
Cyanus segetum		a		a		b				
Cynodon dactylon		b-c	c	a-c	c	b-c				
Cynoglossum officinale		a	a		a	a				
Dactylis glomerata		b-c		b		b	b	a-b		
Dalanum angustifolium		a				a		a-b		
Dalanum ladanum		a			a-b	a				
Datura stramonium	x	b	a	a	a-b	a				
Datura stramonium var. tatula (L.) Torrey					a					
Daucus carota		d		b-c		b-c	b	b-c	x	c
Descurainia sophia		a-b	b	a	b	a-c				
Digitalis lanata									x	
Digitaria ischaemum		b			c		a		x	
Digitaria pectiniformis		a	a							
Digitaria sanguinalis		b-c		c-e		b-d	a	c	x	c-d
Diplotaxis muralis		a								
Diplotaxis tenuifolia (incl. var. integrifolia Guss.)		a	a				a			
Dipsacus fullonum		a		a-b			a-b	a	x	a-b
Dipsacus laciniatus		a								
Dracocephalum thymiflorum	x		a-b		a					
Echinochloa colona (L.) Link	x									
Echinochloa crus-galli		b	c-d	a-c	a-c	a-c	b-c	a-c	x	
Echinops sphaerocephalus				a	a					
Echium vulgare		b-c	b	c-d	c	c	b	b-c	x	c-d
Elytrigia repens		b-d		c		c-d	b	c		c
Epilobium ciliatum		a								
Epilobium collinum		a								
Epilobium hirsutum			b	a				a		a
Epilobium montanum				a						
Epilobium tetragonum (+ E. lamyi)		a		b-c	a	a-b			x	b
Equisetum arvense		b-c	c	c		c-d	b	b-c	x	c-d
Equisetum fluviatile				b						
Eragrostis minor		c-d	c	d	c	c-e	b-c	c-d	x	c-d
Eragrostis pilosa	x	a-b		a			b			
Erodium cicutarium		a		a-b	a	b				a-b
Erophila verna			a	c	a-b	b	c	c	x	c
Eruca sativa Mill.		a-b								
Eryngium campestre		a								
Eryngium planum		a					a	a-b		
Erysimum diffusum			a-b		a-b	b				
Erysimum cheiranthoides		a								
Erysimum marschallianum			a	a				a	x	a-b
Erysimum repandum	x	a			a	a			x	
Erysimum sp.						a				
Euonymus europaeus						a				
Eupatorium cannabinum		a								
Euphorbia davidii Subils										c
Faba bona			a							
Fagopyrum esculentum		a			a					
Fagopyrum tataricum	x	a								
Falcaria vulgaris			c	a						
Fallopia convolvulus		b		b-c		a-b	b	a-c		c
Fallopia dumetorum			b	b				a		a
Fallopia japonica				a						
Festuca brevipila R. Tracey		a			b					
Festuca pratensis		b					b			
Festuca rubra		b-c		a		b	b			
Festuca valesiaca		a	c	a		c				
Fragaria vesca		a					a			
Fragaria viridis		b		a-b						a
Fragaria × ananassa			a							
Frangula alnus						a				
Fraxinus excelsior				a		a				a
Fraxinus pennsylvanica		a	a	b						b
Fraxinus pennsylvanica var. subintegerrima (Vahl) Fern.		a								
Fumaria officinalis						a				
Fumaria schleicheri			a							
Fumaria vaillantii			b	a		a				
Galega officinalis		a					a		x	
Galeopsis bifida			a					a		
Galeopsis pubescens					b	b				
Galeopsis speciosa						a		a		
Galeopsis tetrahit						a				
Galinsoga parviflora		a-b	b-c	a	a-c	a	a		x	a
Galinsoga urticifolia		a	a		a				x	
Galium album		b		b-c		b-c		b-c	x	b-c
Galium aparine			c	b-c	a	c		a-c		c
Galium mollugo		b								
Galium rubioides		a		a						
Galium spurium						a-b				
Galium tricornutum		a								
Galium verum		a-b		b-c		b-c	a-c	b	x	a-b
Geranium columbinum		a		c		a				a-b
Geranium purpureum Vill.				a-b		a		a-b		a-c
Geranium pusillum			a	b		a		a		
Geranium pyrenaicum						a				a
Geranium robertianum			b	a-c		b		b-c	x	b
Geranium sibiricum				a		a-b				
Geum urbanum			a			a	a			
Glaucium corniculatum		a				a				
Glechoma hederacea		b-c	c	a-b	b	a-b	a-b	a	x	b
Glyceria fluitans			a							
Glyceria maxima		a-c								
Glycine max			a		a					
Grammica campestris		a-b	a-b			a				
Gratiola officinalis			a							
Grindelia squarrosa (Pursh) Dunal				b						
Gypsophila muralis		b			a	a	a		x	
Gypsophila perfoliata		a		a				a-c		
Helianthus annuus var. annuus		a			a-c					
Helianthus annuus var. macrocarpus (DC.) Cockerell	x	b-c	a-b			a	a			
Helianthus tuberosus			a-b	b						
Heracleum sphondylium				a		a	a			
Hesiodia montana		a								a
Hibiscus trionum			a	a						
Hieracium sp. div.		a					a			a
Hippochaete ramosissima			b	b						
Hippochaete × moorei		b		b-c		a				a-b
Holosteum umbellatum			a	b		b				b
Hordeum distichon		a-b	a		b		a			
Hordeum murinum		c		c						a
Humulus lupulus		a		a		a		a-b		b
Hylotelephium cf. scherfelii				a						
Hylotelephium maximum agg.		a	a							
Hyoscyamus niger	x	a	a	a	a					
Hypericum perforatum		a-c		a-c		a-c	a	a-b		a-c
Impatiens parviflora						a-d		a		c
Inula britannica		b	b	a-b	b	a	a	a		a-b
Ipomoea hederacea (L.) Jacq. var. hederacea					a					
Iris pseudacorus		a-b	b							
Iva xanthiifolia	x	b-c	a-b		a-b	a				
Jacea macroptilon subsp. oxylepis							a			
Jacea pratensis		b-c	b	a		a	a-b	b	x	b
Juglans regia			a-b	a-b	a	a	a		x	b
Juncus compressus			a							
Juncus effusus		a-b								
Juncus tenuis							b			
Kickxia elatine		a								
Knautia arvensis			a	a-c				a		b
Lactuca saligna				a-b		a		a-c		b
Lactuca serriola		b-c	c	c	b-c	b-c	b-c	c	x	c
Lactuca tatarica		a	a		a	b	a	a		a
Lactuca viminea										a
Lamium album		a-b	b	b		b	b	b		a-b
Lamium amplexicaule		a		b	a	b				b
Lamium purpureum			b	b-c		d		c		b
Lappula consanguinea (Fisch. et C. A. Mey.) Gürke		a								
Lappula squarrosa		a								
Lapsana communis			a	b		a-b				
Lathyrus latifolius			a							
Lathyrus pratensis			b							
Lathyrus sylvestris			a			a-c				
Lathyrus tuberosus		b-c		b	b	a-b	a	a-b	x	b
Lavatera thuringiaca		a	a-c	a-b		a			x	
Leontodon autumnalis		a-b					b		x	
Leontodon hispidus subsp. hispidus		a								
Leopoldia sp.			a							
Lepidium campestre		a-c	a	b	a-c	a	a	a-b	x	a-b
Lepidium densiflorum (incl. L. neglectum)	x	b-d	c	a	b-c	b	a-b	b	x	a-b
Lepidium latifolium		a	a						x	
Lepidium perfoliatum	x	a-c	b-c	a		a			x	
Lepidium ruderale	x	b	c	a-b		a	b	a-b	x	
Lepidium virginicum				a					x	
Lepyrodiclis holosteoides (C. A. Mey.) Fenzl ex Fisch. et C. A. Mey.			a							
Leucanthemum vulgare agg.							a			a
Libanotis pyrenaica			a	a						
Ligustrum vulgare		a								
Linaria vulgaris		b-c		b-c	c	b-c	b	b-c	x	b-c
Linum usitatissimum	x	a-b					a			
Lithospermum arvense			a	b		c		b	x	b
Lolium multiflorum	x	a								
Lolium perenne		b-c	c	c		c	b	b	x	b
Lolium persicum Boiss. et Hoh. ex Boiss.	x									
Lonicera tatarica		a		a						
Lotus corniculatus		a-c		b		b	b	a-b		b
Lotus tenuis				b						
Lycium barbarum		a								
Lycopersicon esculentum		a	a	a	a		a		x	
Lycopsis arvensis		a								
Lycopus europaeus		a								
Lysimachia nummularia		a					a			
Lysimachia vulgaris		a				a				a
Lythrum hyssopifolia		a								
Lythrum salicaria			a	b						
Lythrum virgatum		a	a	a	a	a	a	b	x	a-b
Malus domestica		a-b	a-b		a-b	a	a-b	b	x	a
Malva neglecta			a	a	a	a				
Malva pusilla		a-b			b		b			
Malva sylvestris						a				
Matricaria discoidea		a-b		a		a				
Matricaria recutita			a	a					x	
Medicago falcata		a	a	b		a-c	a			
Medicago lupulina		b-d		b-c		b	a	b	x	b
Medicago sativa		a-b		a-b			a			
Medicago × varia		a-c								
Melica transsilvanica						b				a
Melilotus albus		a-c	a	b-c		b	b	b	x	b
Melilotus officinalis		b-c	c	b-c	c	c	a	b-c	x	b
Melilotus wolgicus		a								
Mentha arvensis		a	a			a				
Mentha longifolia			a				a	a		
Mentha sp.								a		
Microrrhinum minus		a-b		a	b	a	a	a-b	x	b-c
Misopates orontium		a				a				
Morus alba		a		a					x	
Muscari sp.			a							
Myosotis arvensis			a	b		a-c				b
Myosotis stricta			b	c	b	b		b	x	c
Myosoton aquaticum			a	a	b	a				a
Myosurus minimus				a						
Negundo aceroides			b	a-c	b	a-b				
Nepeta cataria				a						
Nigella arvensis		a-c	b	b						
Nonnea lutea				a						
Odontites vulgaris		a	a				a-b		x	
Oenothera biennis		b-c	b	b	b	b	a-b	a	x	b
Oenothera hoelscheri			b				a		x	
Oenothera rubricaulis		b	b	a		b				b
Oenothera sp.										b
Oenothera villosa		b-c	b	b	a-c	a-c	a-b	a	x	b
Onobrychis viciifolia		a					a			
Ononis arvensis			a							
Ononis repens L.									x	
Ononis spinosa							a			
Onopordum acanthium		a-c	a-b	a-b	a	a				
Origanum vulgare subsp. vulgare		a								
Ornithogalum boucheanum				a		a				
Ornithogalum divergens			a							
Oryza sativa					a					
Panicum capillare L. subsp. capillare		b-c	c	a	a					
Panicum capillare subsp. barbipulvinatum (Nash) Tzvel.		c					b-c	c	x	b
Panicum dichotomiflorum Michx.		a	a-b							
Panicum miliaceum		a-c	a-b	a	a-b					
Panicum miliaceum subsp. agricola		a								
Papaver argemone					a					
Papaver dubium						b				a
Papaver dubium subsp. austromoravicum			a	a		a			x	a
Papaver rhoeas		a-b	b	a-c		c		c		b-c
Papaver somniferum		a								
Parthenocisus inserta (A. Kern.) Fritsch				a	a			a		
Pastinaca sativa subsp. sativa		b		b-d		c	a-b	c-d	x	b-d
Persica vulgaris			a		a					
Persicaria amphibia		b	b	a-b		a	a			
Persicaria dubia		a			b	b	b		x	
Persicaria hydropiper						b		a		
Persicaria lapathifolia		a-b					b	a	x	a
Persicaria lapathifolia subsp. brittingeri							a			
Persicaria maculosa		b-c		a-b		c	b	b	x	
Persicaria minor						a				
Petrorhagia prolifera				a		b		a	x	b
Petunia × atkinsiana				a						
Peucedanum alsaticum				b						
Phalaroides arundinacea		a-b								
Phellandrium aquaticum			a							
Phleum pratense			a					a		
Phragmites australis		a		a-b			a-b	a-b		
Picris hieracioides		c	c	b-d	b-c	b-c	b-c	a-c	x	c
Pilosella bauhinii								a		b
Pilosella officinarum		b	a	a		a	a			a-b
Pimpinella major						a				
Pimpinella saxifraga		a-b				c	a			a-b
Plantago lanceolata		c		c-d		c-d	b	b-c		b-c
Plantago major		b-c		a-d		b-d	b	b-c		a-c
Plantago media		a-b					a			
Poa angustifolia			c							
Poa annua		b		a-b		a-b		b		b
Poa bulbosa subsp. vivipara	x	a		b		b		a		b
Poa compressa		c-d	c	a-b		b	a	b	x	b
Poa palustris			c	a			a	a		
Poa pratensis		b-e		d		c		c		b
Poa trivialis			b							
Polygonum aviculare agg.		a-d	c	c-d	c	c-d	d-c	c-d	x	c
Populus alba		a-b	a	a		a-b		b	x	a-b
Populus cf. nigra		a-c	b	a-b	a	a-b	a	b	x	a-b
Populus sp.				b		b		b		
Populus tremula								a		a
Portulaca oleracea		a-b	a-c	d	c	c		c		d
Potentilla arenaria						b				
Potentilla argentea		a-b		b-c		a-c	a	b-c		c
Potentilla intermedia		a	a	a-c						
Potentilla recta										a
Potentilla reptans		b		c		a-c	a	a-b		a-c
Potentilla supina		a-c		b				a		
Prunella vulgaris		a					a			
Prunus domestica		a		b		b	a	a-b		b
Prunus spinosa		a-b	a-b	b		a-b				b-c
Psyllium arenarium		b-c			b					
Puccinellia distans		a-b	c	a			b-c	b-c		
Pulegium vulgare	x	a	a							
Pyrus communis		a	a				a			
Ranunculus acris		a-c					a-b			
Ranunculus polyanthemos			a							
Ranunculus repens		a-b				a	a			a
Ranunculus sardous			a	a	a	a				
Raphanus raphanistrum		a-b		a	a		a		x	
Raphanus sativus				a						
Rapistrum perenne	x	b	a-b							
Reseda lutea		b	b	a-b	b	a	b		x	a
Rhinanthus minor		a								a
Ribes rubrum agg.						a				
Ribes uva-crispa			a							
Robinia pseudoacacia		a-c				a-c	a	a-b	x	a
Rorippa amphibia			a							
Rorippa austriaca		a-b			a		a		x	
Rorippa sylvestris		a		a	a		a			
Rosa canina		c		a-c		b-c	a	a-b		b-c
Rubus armeniacus					a					
Rubus caesius		a	b-d	c	c	c	c	b-c	x	c-d
Rubus sp. div.		b-d		a			a			
Rudbeckia laciniata			a							
Rumex cf. stenophyllus		a	a						x	
Rumex confertus	x	a		a						
Rumex crispus		a-b		a		a-c	a	b	x	a-c
Rumex obtusifolius			a	a		a				
Rumex patientia		a-b	b-c	b	a			a		
Salix alba		a				a		a		
Salix caprea		a				b	a	a-b		a
Salix cinerea			a	a-b		a		b	x	a-c
Salix fragilis						a	a	a		a
Salix purpurea			a					a		a
Salix triandra subsp. amygdalina		a								
Salix viminalis		a								
Salix × rubens		a	a							
Salix × smithiana			a							
Salsola collina		a								
Salsola kali	x	c								
Salvia nemorosa		a-b	a	a			a			
Salvia verticillata		a-c	b		a					
Sambucus ebulus		b-c	b-c	a-c					x	b
Sambucus nigra			a-c	a-c		a-b	b	a		a-b
Sanguisorba minor subsp. minor		a		a		a		b	x	b
Sanguisorba minor subsp. polygama							a			
Saponaria officinalis		b-c	b	b-c	c	a-c	b	a-b	x	b
Saxifraga tridactylites			a	c						c
Scabiosa ochroleuca			a						x	a
Scleranthus annuus							a			c
Scrophularia nodosa		a								
Scrophularia scopolii		a								
Scutellaria galericulata		a								
Secale cereale		a-b	b		b		a		x	
Securigera varia		a-b		a-c		b	a	b	x	b-c
Sedum acre		a		b		a-b		a-b		c
Sedum album										a-c
Sedum rupestre subsp. erectum t´Hart			a	a						
Sedum sexangulare						b				
Senecio erucifolius			a	a			a		x	a
Senecio jacobaea		a								
Senecio vernalis				b-e		b-c		c		b-e
Senecio viscosus		b	b	a-c		b		b	x	a-b
Senecio vulgaris			a	b-c		b		b		b
Serratula tinctoria			a							
Seseli osseum				a						
Setaria faberi F. Herrm.			a		a-b					
Setaria pumila		c	c	a	c	a-c	b	a-b	x	
Setaria verticillata			a-b	a						
Setaria viridis (L.) P. B. subsp. pycnocoma (Steud.) Tzvelev		b	a-b	a-c	a					
Setaria viridis subsp. viridis		b-c	c-d	c-d	a-e	d	d	c	x	c-d
Silaum silaus			a							
Silaus besseri DC.		a								
Silene dichotoma		a	a	a						
Silene latifolia subsp. alba		b-c	b	c		b-c	a	b	x	b-c
Silene noctiflora				a	a					
Silene vulgaris		b		a	a	b	b	a		a-b
Sinapis arvensis		a		a	b	a	a		x	
Sisymbrium altissimum	x	b-c	b-c		b			a	x	
Sisymbrium loeselii	x	a-c	a-c	a-c	c	a-c	a		x	a
Sisymbrium officinale							a			
Sisymbrium orientale	x					b				
Sisymbrium polymorphum	x									
Sisymbrium volgense		a-b	a		a		a	a	x	
Sium latifolium			a							
Solanum dulcamara			b	a						
Solanum nigrum		a	b-c	a-c	b	b		c		b
Solanum nigrum subsp. schultesii		a-b	a-b	b		a		a		
Solanum tuberosum			a				a			
Solidago canadensis				a-c	c	a-c	b	a-c		a-c
Solidago gigantea		a	b	a-b		a	a	a	x	
Sonchus arvensis		a-b		a-b		a	a			a
Sonchus asper		a		b	a-b	a	a		x	a
Sonchus oleraceus		b-c	c	b-c		c	b	b	x	b
Sorbaria sorbifolia			a							
Sorbus aucuparia			a							
Sorghum bicolor		a								
Sorghum halepense		a			a					
Spergula arvensis	x	a								
Spergularia rubra			a							
Stachys annua		b-c	a	b	b	a-b	a		x	a
Stachys palustris		a-c								
Stachys recta			a							
Stellaria graminea				a						
Stellaria media		a	a	a-c	b	b-c		b		a-c
Stenactis annua (mostly subsp. annuus)		a-c	b	b-c	a-c	b-c	a-c	b-c	x	a-b
Swida sanguinea			a	a		a				b
Symphytum officinale		a-b		b	a		a	a	x	
Tanacetum vulgare		b-c	b	b-c		a-c	b-c	b-c	x	a-c
Taraxacum sect. Erythrosperma			a				b			
Taraxacum sect. Ruderalia		d	d	a-d		a-d		b-d	x	b-d
Thlaspi arvense	x	c		a-c	c	a-c		a		a
Thlaspi perfoliatum				a		a		a		b
Thymus serpyllum							a		x	
Thymus × porcii		a					a			
Tilia cordata						a				
Tithymalus cf. esula × T. tommasinianus		a								
Tithymalus cyparissias		a-c	c	b-c	c	b-c	a-b	b	x	b-c
Tithymalus esula subsp. esula		b-c	c	a		b	a-b	a		a
Tithymalus exiguus		a								
Tithymalus helioscopia		a								
Tithymalus palustris			a							
Tithymalus platyphyllos subsp. platyphyllos				b	a	b				
Tithymalus sp.				a		a		a		
Tithymalus tommasinianus		b	b	a-b		a	b	a-c	x	b
Torilis arvensis				b						
Torilis japonica			a			b				
Tragopogon dubius		a-c		a	b				x	a
Tragopogon orientalis		d	b-c	c	c	b-c	a-b	a-c	x	c-d
Tribulus terrestris				b-c						
Trifolium arvense		b-c		b-c		a-b	a			b
Trifolium campestre		a-b				b	a			
Trifolium flexuosum		a								
Trifolium hybridum			b		a					
Trifolium patens				c						
Trifolium pratense		a-c	b	b-c		b	a	c	x	
Trifolium repens		b-c		a-b		b-c	b	a-b		b
Trifolium resupinatum			a							
Tripleurospermum perforatum		b		b-c		b-c	b	b	x	b
Trisetum flavescens		a								
Triticum aestivum		a-b	b-c		b-c		a		x	
Tussilago farfara		b		a		a	a	a	x	
Typha angustifolia				a						
Typha latifolia		a	a				a		x	
Ulmus sp.		a				a				
Urtica dioica		a-d	c	c		b-c	a	b	x	c
Urtica urens		a								
Valeriana officinalis agg.										a
Valerianella locusta			a	c				b	x	c
Verbascum blattaria		a		a	a		a		x	a
Verbascum cf. densiflorum			a		a	b			x	b
Verbascum chaixii subsp. austriacum		a								
Verbascum lychnitis		a		b		a-b		a		a-b
Verbascum nigrum		a-b			b	a			x	
Verbascum phlomoides		c	c	b	c				x	c
Verbascum phoeniceum				b				a		c
Verbascum thapsus									x	
Verbena officinalis							a			
Veronica arvensis			c	d	b-c	c	b	b	x	c
Veronica hederifolia				c		c		b		b
Veronica chamaedrys		a-b	b				a	a		a
Veronica persica			a	b		b				
Veronica polita			a	b		b				
Veronica sublobata				b		b				b
Veronica triphyllos				a						a
Vicia angustifolia							a			
Vicia cracca		b-c		b			a			c
Vicia grandiflora							b	a-d		a-c
Vicia hirsuta			a	b-c		b				a
Vicia lathyroides				b		b				
Vicia sativa			a							
Vicia tenuifolia				a						
Vicia tetrasperma			a	a		a				
Vicia villosa		a	a	b		a-b			x	
Viola arvensis			c	b-c	c	a-c		b		a-c
Viola canina		a								
Viola cf. suavis						b				
Viola reichenbachiana						a				
Viola suavis				a						
Viola tricolor										a
Vitis vinifera		a	a	a		a				
Vulpia myuros				b						
Xanthium albinum		a-b			a-c			a		
Xanthium cf. albinum			a		a		a-b	a	x	
Xanthium spinosum		a			a					
Xanthium strumarium		a					a-b			
Xanthoxalis corniculata (incl. X. repens)			c							
Xanthoxalis dillenii (incl. var. piletorum (Wieg.) Holub)		a-c	b-c	a-b	b	a-b			x	a-b
Xanthoxalis stricta		a-b					a			
Zea mays		a-b	a		b	a	a		x	