

Mapping of alien species of *Asclepias syriaca* and *Fallopia japonica* populations in the agricultural landscape

Mapovanie výskytu populácií cudzích druhov *Asclepias syriaca* a *Fallopia japonica* v poľnohospodárskej krajine

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Abstract

In recent years, *Asclepias syriaca*, a invasive neophyte, has spread aggressively in intensively farmed agricultural landscape in the Central Slovakia. In 2011, it had colonized the area of 100 654 m² in abandonment vineyards and permanent grasslands in the district of Veľký Krtíš (South Slovakia). We found the infiltration of these plants into the stands of *Triticum aestivum* and *Helianthus annuus*. No management measures were taken. In contrast, the second studied invasive plant *Fallopia japonica* had occupied area lower by 93 % (7276 m²), but spread across higher number of sites (19) on the banks of the brooks and along the roads. Regulated populations accounted for only 11% of the total area occupied by *F. japonica*. Low correlation dependence was found between the size of the area and population density of *A. syriaca* ($r = 0.50$) and *F. japonica* ($r = 0.56$).

Keywords: agricultural landscape, invasive plant species, management, mapping, *Asclepias syriaca*, *Fallopia japonica*, Slovakia

Abstrakt

V posledných rokoch sa v intenzívne obhospodarovanej poľnohospodárskej krajine na Strednom Slovensku agresívne rozšíril invázny neofyt *Asclepias syriaca*. V roku 2011 kolonizoval hlavne v opustených vinohradoch a na trvalých trávnatých porastoch v okrese Veľký Krtíš plochu o veľkosti 100 654m². Zistili sme prenikanie týchto rastlín do porastov *Triticum aestivum* a *Helianthus annuus*. Manažment nebol realizovaný. Druhý sledovaný invázny druh *Fallopia japonica* naopak zaberá plochu menšiu až o 93 % (7 276m²), ale tvoril väčší počet lokalít (19) na brehoch vôd a pozdĺž cestných komunikácií. Regulované populácie tvorili len 11 % z celkovej plochy pokrytej pohánkovcom japonským. Nízke korelačné závislosti boli

identifikované medzi veľkosťou plochy a hustotou jedincov *A. syriaca* ($r = 0,50$) a *F. japonica* ($r = 0,56$).

Kľúčové slová: poľnohospodárska krajina, invázne druhy rastlín, manažment, mapovanie, *Asclepias syriaca*, *Fallopia japonica*, Slovensko

Detailný abstrakt

K najvýznamnejším nepôvodným a invázne sa šíriacim druhom v intenzívne obhospodarovanej poľnohospodárskej krajine Strednej Európy patria *Asclepias syriaca* a *Fallopia japonica*. Vzhľadom na to, že rozšíreniu týchto rastlín na lokálnej úrovni nebola doposiaľ venovaná dostatočná pozornosť, cieľom našej práce bolo zmapovať výskyt a rozšírenie a zhodnotiť ich manažment vo vybranom okrese na Strednom Slovensku. Základom práce bol terénny výskum, konkrétne metóda mapovania. Všeobecne možno konštatovať, že *A. syriaca* sa úspešne šíri v okrese Veľký Krtíš v katastrálnom území obcí Selešťany, Sklabiná a Olováry. V roku 2011 kolonizoval plochu o veľkosti 100 654 m². Taxón sa rozšíril hlavne v opustených vinohradoch (87,1 % z celkovej plochy obsadenej *A. syriaca*), na trvalých trávnych porastoch (10,7 %), na poliach (1,9 %) a pozdĺž cestných komunikácií (0,32 %), kde tvoril polycenózy. Zistili sme prenikanie týchto rastlín do porastov *Triticum aestivum* a *Helianthus annuus*. Manažmentové opatrenia neboli realizované. Invázny druh *F. japonica* sa vyskytoval v dvoch obciach – Kosihovce a Veľké Straciny – a v mestskej časti Veľký Krtíš. V porovnaní s *A. syriaca* tvoril väčší počet populácií (19), ale kolonizoval oveľa menšiu plochu 7 276m². Šírenie druhu sme zaznamenali pozdĺž cestných komunikácií (59,8 %) a pozdĺž obidvoch brehov potoka Krtíš (40,2 %). Regulované populácie tvorili iba 11 % z celkovej plochy obsadenej pohánkovcom japonským. Nízka korelačná závislosť bola zistená medzi plochou a hustotou jedincov *A. syriaca* ($r = 0,50$) a *F. japonica* ($r = 0,56$). Predpokladáme ďalšie šírenie obidvoch druhov neofytov, najmä prenikanie glejovky americkej do poľných kultúr.

Introduction

Successfully spreading plant species in Slovakia are selected species of genus *Fallopia* (*F. japonica*, *F. x bohemica*, *F. sachalinensis*) and *Asclepias syriaca*. This paper presents the results of spreading of invasive neophyte *A. syriaca* (Common milkweed) and invasive plant species *F. japonica* (Japanese knotweed) in the agricultural landscape in Central Slovakia and performance of the plant management. With this study, we want to help to reconstruct the expansion of selected invasive neophytes on a local level, because there is a lack of detailed studies based on plant-mapping in the chosen location.

Materials and Method

Mapping of alien plant species occurrence have taken place in the administrative area of the following villages in the district of Veľký Krtíš (South Slovakia): Selešťany, Sklabiná, Olováry, Kosihovce, Veľké Straciny and in the urban area of Veľký Krtíš in Banská Bystrica self-governing region in the Central Slovakia. The villages are located in the Ipeľ basin in the wide valley of the streams Krtíš and Plachtinský.

The altitude of the villages is about 160 m.a.s.l. The area belongs to the warm and dry climate zone. The average annual temperature is 9 °C and the annual rainfall is 600 mm. The soils are cambisols, ilimerized, alluvial and meadow soils. The area may be included in the Pannonian flora region and within this region into Matra mountain flora subregion. From the zoo-geographic point of view, the area may be included into Palearctic region (Atlas SR 2002).

Common milkweed (*Asclepias syriaca* L., *Asclepiadaceae*) is native in Canada and USA. The species was introduced to Europe from eastern part of North America as an ornamental plant in the 19th century (Bhowmik, Bandeen 1976 Cramer, Burnside 1982). It is a perennial dicotyledonous weed characterized by erect stem with large leathery leaves and bold pink flowers. Flowering lasts from June to July. Fruits are oblong-ovate shaped vesicles with a white pericarp. Seeds have plumes of white glossy hair and ripen in August and September (Cvachová, et al., 2005). The species is considered as invasive neophyte due to its spread in Slovakia (Gojdičová, et al., 2002 Cvachová, et al., 2005 Medvecká, et al., 2012).

Japanese knotweed [*Fallopia japonica* (Houtt.) Ronse Decraene, *Polygonaceae*] was introduced to Europe from eastern Asia as an ornamental plant in the middle of the 19th century and very quickly began to invade (Barney, et al., 2006). *F. japonica* is a perennial, dioecious plant. The stems are 1.5 m to 3.5 m high, straight, at the top branched, often arcuate, hollow. The base of lower leaves is truncate, apex acuminate, and undersides entirely glabrous. They form an extensive root system, richly branched, reaching up to a width of 15 m to 20 m from the parent plant and a depth of 2 m to 3 m (Cvachová, et al., 2002; Barney, et al., 2006). We recorded invasive plants are defined as non-native species that spontaneously spread and displace native species from their natural biotopes and reduce the biodiversity (the Act No. 543/2002 on Nature and Landscape Protection). The valid list of invasive plant species in Slovakia is presented in the regulation No. 24/2003 and No. 173/2011.

The crux of this paper is the field research performed during the period from May to September 2011, using the mapping method. We recorded taxon, location and type of biotope according to Ružičková, et al. (1996). The nomenclature of species in communities is referred according to Marhold and Hindák (1998). We measured the size of the vegetation area (m²). We found out the average density of shoots (low 1–5 i*m⁻², medium 16–30 i*m⁻², high 31 and more i*m⁻²) using the method of counting individuals, always on a 1x1m square inside the population. We determined the percentage of areas with non-regulated populations, in which the plants have not been removed and also in regulated ones, where the management measures were performed regularly.

Results and discussion

Spread of *Asclepias syriaca* in the district of Veľký Krtíš

In the village Selešťaň, we found three sites with the occurrence of *Asclepias syriaca* located towards Natural reserve Selešťianska stráň hillside on the area of 3,213 m² (table 1). The first location was in abandoned vineyards. In the fields, *A. syriaca* grew in *Triticum aestivum* L. The site no. 3 consists of a narrow and long strip of the population along the cart-road. The major accompanying species in the

A. syriaca stands were *Rubus fruticosus* L., *Sambucus ebulus* L., *Verbascum densiflorum* Bertol. and other species. The occurrence of Common milkweed in the Natural reserve Seleštianska stráň hillside states also Cvachová (2000).

In the village Sklabiná, we found the occurrence of *A. syriaca* at six sites with a total area of 16,041 m² (table 1). Sites 1 and 2 located on permanent grasslands formed polycoenosis with *Achillea millefolium* L., *Centaurea jacea* L., *Cichorium intybus* L., *Cirsium arvense* (L.) Scop., *Convolvulus arvensis* L., *Rubus fruticosus* L. and other species. *A. syriaca* populations penetrated into the stands of *Helianthus annuus* L. Kušík (2011) notes that these sites are neglected due to the unsettled ownership. The major accompanying species in the *A. syriaca* populations in abandoned vineyards were *Agrimonia eupatoria* L., *Aster novi-belgii* agg., *Clematis vitalba* L., *Melilotus officinalis* (L.) Pall. and other species.

In the cadastral area of the village Olováry, we found three sites on the area of 81,400 m² (table 1). At the site 1, which was left fallow between 2010 and 2011 occurred 39 individuals of *A. syriaca*. The site is bordered from three sides by wood (*Quercus* spp.) and from one side by orchard (*Prunus* spp.). A significant degradation of grassland communities is a serious and growing social problem, mainly due to changes in the original species composition. There is increased soil erosion on these sites. The change of the natural grassland community and occurrence of new types of vegetation causes damages to the ecological stability. In phytocenoses, the most frequently occurring species were *Plantago lanceolata* L., *Robinia pseudoacacia* L., *Rosa canina* L., *Sambucus ebulus* L., *Urtica dioica* L., *Verbascum densiflorum* Bertol. and other species in all three sites. Management measures were not implemented. Hartzler (2010) recorded that application of glyphosphate contributed to the decline in common milkweed in agricultural fields.

The field research shows that *Asclepias syriaca* is successfully spreading invasive species in the Veľký Krtíš district in Central Slovakia. In 2011, it had colonized the area of 100,654 m². The taxon has spread mainly in abandoned vineyards (87.1 % of the total sites occupied by Common milkweed), permanent grasslands (10.7 %), fields (1.9 %) and along roads (0.32 %).

The first occurrence of *A. syriaca* in Slovakia was reported in 1917 (Medvecká, et al., 2012). Ružička (1952) observed that this species has an isolated occurrence in warm regions of Bohemia and Slovakia. The population of *A. syriaca* in Záhorská nížina Lowland (West Slovakia) was remainder of old cultures. Valachovič (1987, 1988) reported *A. syriaca* only on roadsides, along railways and at landfills. The infestation of adjacent fields was not recorded. Contrary, in our research this weed infested adjacent fields of *Triticum aestivum* L. and *Helianthus annuus* L. Cramer, Burnside (1982) and Hartzler, Buhler (2000) reported that *A. syriaca* is mainly found in soya, maize, wheat, oat and broomcorn plantations, and often appears also in road-side vegetation in United States and Canada. In the surrounding area of Budapest in Hungary, extent stands of Common milkweed are found on disused agricultural lands, and some smaller stands occur in abandoned vineyards also (Sarkany, et al., 2008; Csontos, et al., 2009).

Table 1 Occurrence, area and population density of *Asclepias syriaca* populations in the Velký Krtíš district

Tabuľka 1 Výskyt, plocha a populačná hustota *Asclepias syriaca* populácií v okrese Velký Krtíš

Number of biotope	Biotope	Area (m ²)	Population density (i*m ⁻²)	Biocoenosis
1.	A122100 Abandoned vineyards	1 260	high	polycoenosis
2.	A110000 Fields	1 870	high	polycoenosis
3.	A521000 Roads	83	medium	polycoenosis
	Total area in the village Selešťany	3 213		
1.	3520000 Permanent grasslands	4 508	medium	polycoenosis
2.	3520000 Permanent grasslands	84	low	polycoenosis
3.	A122100 Abandoned vineyards	391	medium	polycoenosis
4.	A122100 Abandoned vineyards	144	low	polycoenosis
5.	A122100 Abandoned vineyards	4 182	high	polycoenosis
6.	A122100 Abandoned vineyards	6 732	medium	polycoenosis
	Total area in the village Sklabiná	16 041		
1.	3520000 Permanent grasslands	6 160	medium	polycoenosis
2.	A521000 Roads	240	medium	polycoenosis
3.	A122100 Abandoned vineyards	75 000	low	polycoenosis
	Total area in the village Olováry	81 400		

Spread of *Fallopia japonica* in the district Velký Krtíš

In comparison with *A. syriaca*, species *F. japonica* formed bigger number of populations (19), but colonized lower area (7,276 m²). Its spread was observed along roads (59.8 % of total sites occupied by *F. japonica*) and along the banks of the brook Krtíš (40.2 %) (table 2).

Table 2 Occurrence, area and population density of *Fallopia japonica* populations in the Velký Krtíš districtTabuľka 2 Výskyt, plocha a populačná hustota *Fallopia japonica* populácií v okrese Velký Krtíš

Number of sites	Sites	Area (m ²)	Population density (i*m ⁻²)	Biocoenosis
1.	A520000 Roads in village Kosihovce	2 356	high	monocoenosis
2.	A520000 Roads in village Kosihovce	1 560	high	monocoenosis
3.	5210000 Left bank of the brook Krtíš	56	high	monocoenosis
4.	5210000 Left bank of the brook Krtíš	150	high	monocoenosis
5.	5210000 Left bank of the brook Krtíš	132	high	monocoenosis
6.	5210000 Left bank of the brook Krtíš	90	high	monocoenosis
7.	5210000 Right bank of the brook Krtíš	125	high	monocoenosis
8.	5210000 Left bank of the brook Krtíš	87	high	monocoenosis
	Total area in the village Kosihovce	4 556		
1.	A520000 Roads in village Veľké Straciny	170	medium	monocoenosis
2.	A520000 Roads in village Veľké Straciny	444	medium	monocoenosis
3.	5210000 Left bank of the brook Straciny	1 296	medium	monocoenosis
4.	5210000 Left bank of the brook Straciny	450	medium	monocoenosis
5.	5210000 Left bank of the brook Straciny	90	high	monocoenosis
6.	Roads	88	low	monocoenosis
	Total area in the village Veľké Straciny	2 538		
1.	5210000 Left bank of the brook Krtíš	111	low	monocoenosis
2.	5210000 Left bank of the brook Krtíš	18	low	monocoenosis
3.	5210000 Left bank of the brook Krtíš	9	low	monocoenosis
4.	5210000 Left bank of the brook Krtíš	15	low	monocoenosis
5.	5210000 Right bank of the brook Krtíš	29	low	monocoenosis
	Total area in the urban part of town Veľký Krtíš	182		

During the field research, we found that sites 1 and 2 in the village Veľké Straciny were regularly mechanically controlled by mowing. Other sites 3-8 were not controlled and formed bank and cover vegetation with with *Alnus glutinosa* (L.) Gaertn., *Fraxinus excelsior* L., *Salix alba* L., *Sambucus nigra* L., *Robinia pseudoacacia* L., *Quercus cerris* L. and other species. Mechanical and chemical removing of *F. japonica* carried out 2 times a year was done in Veľký Krtíš. We can conclude that management measures are effective, as evidenced by the decreasing area occupied by the species. However, regulated populations occupied 11 % of the

total areas occupied by Japanese knotweed. Each site created monoceneses. Species like *Urtica dioica* L., *Sambucus nigra* L., *Salix alba* L. and other grew in the close vicinity.

Comparison of area and population density shows a decrease in the density of *A. syriaca* individuals with the area increase and increase in the density of *F. japonica* with the area increase (figure 1).

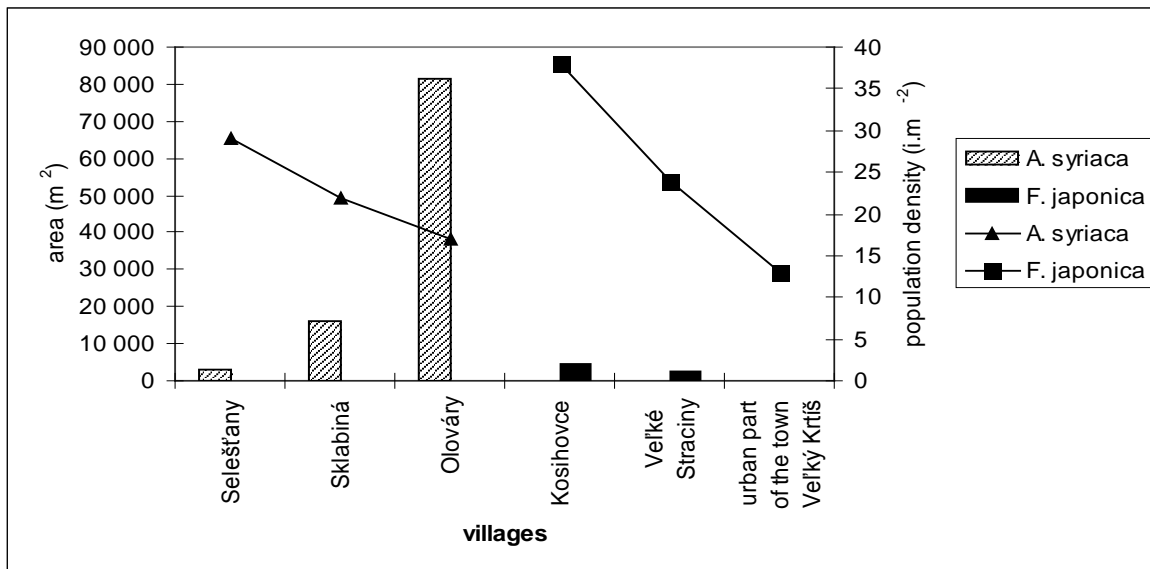


Figure 1 Comparison of area and density of *Asclepias syriaca* and *Fallopia japonica* populations in Central Slovakia

Obrázok 1 Porovnanie plochy a hustoty populácií *Asclepias syriaca* a *Fallopia japonica* na Strednom Slovensku

Statistical analysis of the correlation dependences of the selected characteristics is shown in figure 2 and 3. Low correlation dependences were found between the size of the area and density of *A. syriaca* individuals ($r = 0.50$, exponential model) and *F. japonica* ($r = 0.56$, squares model).

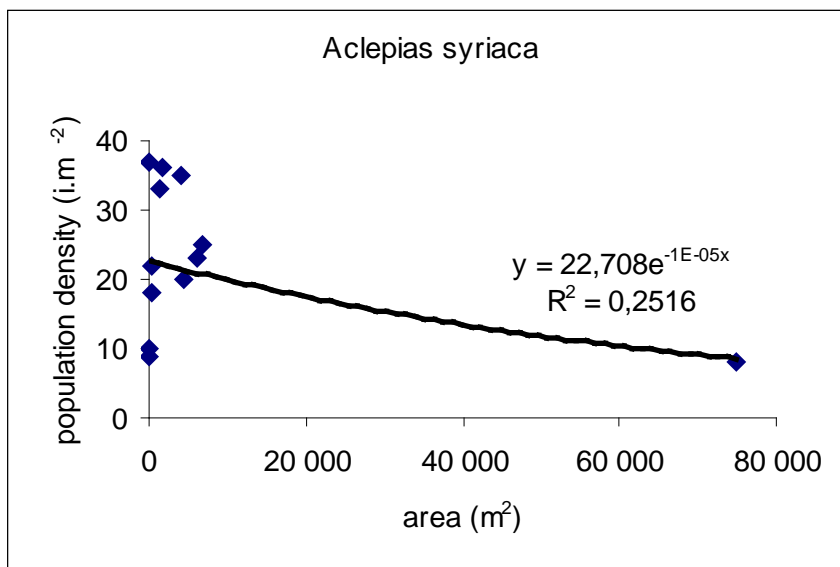


Figure 2 Correlation dependence between area and density of *Asclepias syriaca* in Central Slovakia

Obrázok 2 Korelačná závislosť plochy a hustoty populácií *Asclepias syriaca* na Strednom Slovensku

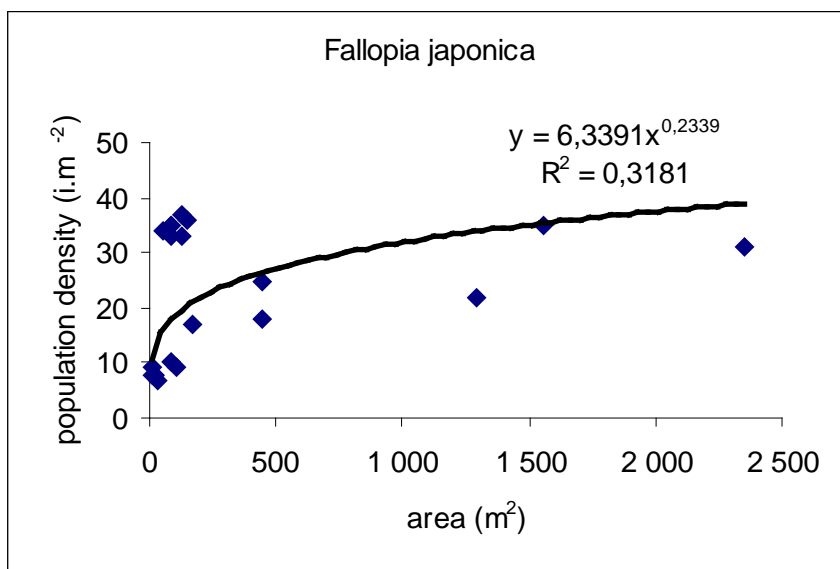


Figure 3 Correlation dependence between area and density of *Fallopia japonica* populations in Central Slovakia

Obrázok 3 Korelačná závislosť plochy a hustoty populácií *Fallopia japonica* na Strednom Slovensku

In Europe, *F. japonica* is considered to be genetically uniform. However, there is an evidence of genetic diversity in its populations in Central Europe (Bzdęga, et al., 2012). The first data about the occurrence of *F. japonica* in Slovakia came from the 1920 (Medvecká, et al., 2012). The occurrence of Japanese knotweed was reported in southern part of Central Slovakia (Hrivnák, Cvachová, 1997), Slovenské Stredohorie and Ipeľsko-rimavská brázda (Cvachová, 2000) and western Slovakia

(Eliáš, Fehér, Končeková, 1998; Fehér, 1998, 2001; Fehér, Končeková, Mooschová, 2000; Pauková, Kršková, 2010; Pauková, 2013a, 2013b).

F. japonica is one of the most aggressive invasive species in Czech Republic (Mandák, Pyšek, Bímová, 2004), Belgium (Tiébré, Saad, Mahy, 2008), Great Britain and represents a serious problem also in Canada (Bourchier, Van Hezewijk, 2010; Gaskin, et al., 2014) and western USA (Gaskin, et al., 2014).

Conclusions

Asclepias syriaca is successfully spreading invasive species in the district of Veľký Krtíš in Central Slovakia. In 2011, it colonized the area of 100,654m². The taxon spread mainly in abandoned vineyards (87 % of total area occupied by Common milkweed) and permanent grasslands (11 %). There were no management measures carried out.

Invasive species *Fallopia japonica* formed a bigger number of populations and colonized the area of 7 276m². Its spread was observed along roads (60 % of total area occupied by Japanese knotweed) and along the brook banks (40 %). Regulated populations occupied only 11 % of the total area occupied by Japanese knotweed. We expect a further spread of the both species.

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