Preliminary report on the grid-based mapping of invasive plants in Hungary

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Summary

1. This paper gives a preliminary report on the mapping of invasive plant species in Hungary done within the framework of the Mapping of the Hungarian Flora Programme.
2. The use of a special "Invasion Data Sheet", showing the occurrence of invasive and other expanding native plant species per grid cell, enables the documentation of further characteristics of these species.
3. Although neither field data collection nor processing of the distribution maps has been finished, both elements are at a high level of completion. All species presented in this study are invasive neophytes in Hungary. The maps show their distribution at a completion rate of data processing of approximately 75%.
4. According to the experience obtained up to now, floristic data collection using the Invasion Data Sheet is less suitable for surveying invasive plants on arable land. It is more convenient for mapping the occurrence of invasive plant species in (semi)natural vegetation, which actually was the main purpose of this work.
5. The results provide data on geographical distribution and will help to determine the dynamics of the spread of invasive plants and their infestation at the landscape level.

Key words: alien plants, *Ailanthus altissima*, *Ambrosia artemisiifolia*, *Asclepias syriaca*, *Fallopia* sect. *Reynoutria*, *Impatiens glandulifera*, Mapping of the Hungarian Flora Programme, *Prunus serotina*, *Robinia pseudacacia*

1. Introduction

The chorological maps of particular countries or parts of continents generally also include the distribution of alien or invasive plant species. It is, however, less frequent that floristic mapping focuses on alien species, e.g. Cvachová (2000), Adamowski et al. (2002), Balogh (2003), Muller (2004) or Tokarska-Guzik (2001, 2005). One of the main parts of the research programme "Survey and Evaluation of the Hungarian Vegetation Heritage" (SEHVH) (Molnár et al. 2007), underway since 2002, is entitled "Mapping of the Hungarian Flora" as part of the project "Mapping of the Central European Flora" (Niklfeld 1971). This paper gives a preliminary report on the mapping of invasive plant species in Hungary done within the framework of this sub-programme. It should be noted that there is another sub-programme of the SEHVH: the MÉTA project, which surveys the distribution of invasive plant species in Hungary based exclusively on habitat types (Botta-Dukát 2006).

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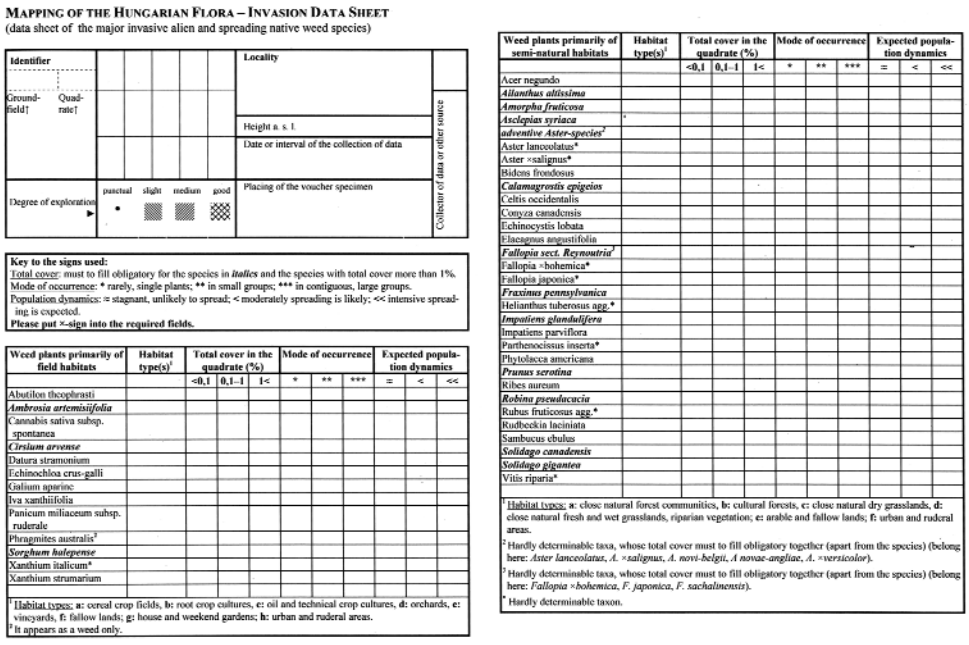
2. Materials and Methods

Floristic mapping is supported by guiding materials (Király et al. 2003). The survey is conducted by grid cells fitting into the grid scheme of the "Mapping of the Central European Flora" (MCEF, Niklfeld 1971). This scheme divides the territory of a given area into basic grid cells (geographical longitude 10' x latitude 6' = approx. 12.5 x 11.1 km), with a further division of these into four quarters (longitude 5' x latitude 3'). These so-called quadrants are the basic units of the floristic mapping in Hungary. In contrast to the MCEF, three types of data sheets are used during mapping: i) Quadrant Data Sheet, which contains all the species observed in the grid cell (to be completed during the field work), ii) Taxon Data Sheet, which makes it possible to collect the floristic data of a certain taxon (this is mainly used for drawing distribution maps on the basis of the available records, and not necessarily during the field works; e.g. Taxon Data Sheet of *Gentianella austriaca*, which includes the distribution of this species only) and iii) Invasion Data Sheet (Fig. 1). While the use of the Taxon Data Sheet is optional, it is always obligatory to fill in the Quadrant and the Invasion Data Sheet for all quadrants. The objective of using the Invasion Data Sheet in addition to both other data sheets is to show the occurrence of invasive and other expanding native plant species per quadrant (cf. Prach & Wade 1992, Pyšek 1995) and to enable the documentation of further characteristics of these species.

The taxa pre-printed on the Invasion Data Sheet were primarily selected from



MAPPING OF THE HUNGARIAN FLORA – INVASION DATA SHEET
(data sheet of the major invasive alien and spreading native weed species)

Identifier						Locality	
Ground-field†	Quad-rate†						
						Height a. s. l.	
						Date or interval of the collection of data	Collector of data or other source
Degree of exploration ►	punctual	slight	medium	good		Placing of the voucher specimen	
	•						

Key to the signs used:
Total cover: must to fill obligatory for the species in ***italics*** and the species with total cover more than 1%.
Mode of occurrence: * rarely, single plants; ** in small groups; *** in contiguous, large groups.
Population dynamics: = stagnant, unlikely to spread; < moderately spreading is likely; << intensive spreading is expected.
Please put ×-sign into the required fields.

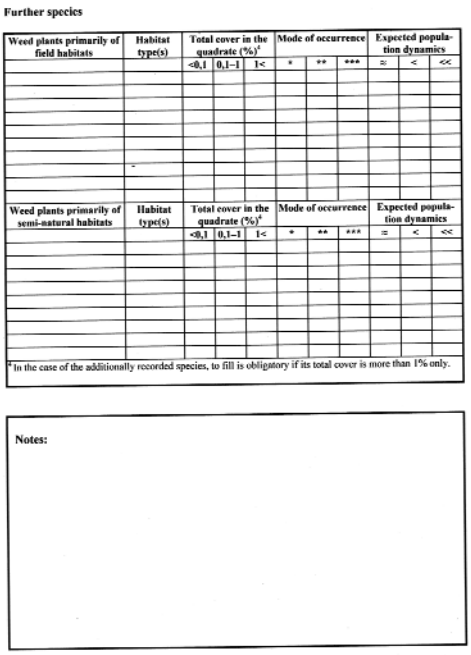
Weed plants primarily of field habitats	Habitat type(s)[1]	Total cover in the quadrate (%)			Mode of occurrence			Expected population dynamics		
		<0,1	0,1–1	1<	*	**	***	=	<	<<
Abutilon theophrasti										
Ambrosia artemisiifolia										
Cannabis sativa subsp. spontanea										
Cirsium arvense										
Datura stramonium										
Echinochloa crus-galli										
Galium aparine										
Iva xanthiifolia										
Panicum miliaceum subsp. ruderale										
Phragmites australis[2]										
Sorghum halepense										
Xanthium italicum*										
Xanthium strumarium										

[1] Habitat types: **a:** cereal crop fields, **b:** root crop cultures, **c:** oil and technical crop cultures, **d:** orchards, **e:** vineyards, **f:** fallow lands; **g:** house and weekend gardens; **h:** urban and ruderal areas.
[2] It appears as a weed only.

Weed plants primarily of semi-natural habitats	Habitat type(s)[1]	Total cover in the quadrate (%)			Mode of occurrence			Expected population dynamics		
		<0,1	0,1–1	1<	*	**	***	=	<	<<
Acer negundo										
Ailanthus altissima										
Amorpha fruticosa										
Asclepias syriaca										
adventive Aster-species[2]										
Aster lanceolatus*										
Aster ×salignus*										
Bidens frondosus										
Calamagrostis epigeios										
Celtis occidentalis										
Conyza canadensis										
Echinocystis lobata										
Elaeagnus angustifolia										
Fallopia sect. Reynoutria[3]										
Fallopia ×bohemica*										
Fallopia japonica*										
Fraxinus pennsylvanica										
Helianthus tuberosus agg.*										
Impatiens glandulifera										
Impatiens parviflora										
Parthenocissus inserta*										
Phytolacca americana										
Prunus serotina										
Ribes aureum										
Robinia pseudacacia										
Rubus fruticosus agg.*										
Rudbeckia laciniata										
Sambucus ebulus										
Solidago canadensis										
Solidago gigantea										
Vitis riparia*										

[1] Habitat types: **a:** close natural forest communities, **b:** cultural forests, **c:** close natural dry grasslands, **d:** close natural fresh and wet grasslands, riparian vegetation; **e:** arable and fallow lands; **f:** urban and ruderal areas.
[2] Hardly determinable taxa, whose total cover must to fill obligatory together (apart from the species) (belong here: *Aster lanceolatus, A. ×salignus, A. novi-belgii, A novae-angliae, A. ×versicolor*).
[3] Hardly determinable taxa, whose total cover must to fill obligatory together (apart from the species) (belong here: *Fallopia ×bohemica, F. japonica, F. sachalinensis*).
† Hardly determinable taxon.

Fig. 1: Invasion Data Sheet belonging to the Mapping of the Hungarian Flora Programme



Further species

Weed plants primarily of field habitats	Habitat type(s)	Total cover in the quadrate (%)*			Mode of occurrence			Expected population dynamics		
		<0,1	0,1–1	1<	*	**	***	=	<	<<
Weed plants primarily of semi-natural habitats	Habitat type(s)	Total cover in the quadrate (%)*			Mode of occurrence			Expected population dynamics		
		<0,1	0,1–1	1<	*	**	***	=	<	<<

*In the case of the additionally recorded species, to fill is obligatory if its total cover is more than 1% only.

Notes:

Fig. 1: continued

"The actual list and attributes of the adventive (incl. invasive) species in the vascular flora of Hungary" (Balogh & Dancza unpubl.), and the agriculturally important weeds of Hungary. These 44 taxa are divided into two groups: 1) weed plants primarily of agricultural habitats (agricultural weeds, 13 taxa), 2) weed plants primarily of semi-natural habitats (ecological weeds, 31 taxa). All species, pre-printed on the Invasion Data Sheet, are invasive neophytes in Hungary, except four invasive archaeophytes (*Cannabis sativa* subsp. *spontanea*, *Echinochloa crus-galli*, *Sambucus ebulus*, *Xanthium strumarium*), one naturalized archaeophyte (*Galium aparine*) and three native species (*Calamagrostis epigeios, Cirsium arvense, Phragmites australis*). The invasion terminology is based on Pyšek et al. (2004).

The main criteria for the species' characterisation per quadrant are: a) invaded habitat type (with pre-defined categories), b) total cover (<0.1 %; 0.1–1 %; >1 %), c) mode of occurrence (rare, single plants; in small groups; in contiguous, large groups), d) expected population dynamics (stagnant, unlikely to spread; moderate spreading is likely; intensive spreading is expected). The latter attribute depends on the collector's experience of the area and the expected changes of land use patterns (e.g. expanding fallow lands, new plantations of an alien tree) regarding the conditions of the habitats in the quadrant.

3. Results and Disussion

Of the 2832 grid cells of Hungary, 2600 have been surveyed, while the maps currently only show the data for 2200 grid cells (Figs 2–8). The survey and processing of the data is incomplete in some regions, such as Zala County (in SW-Hungary), the southern part of Kiskunság (in S-Hungary) and the northern part of Tiszántúl (in NE-Hungary).

Though neither part of the work has been completely finished, both elements as well as the field data and the processing of the maps are at a high level of completion. The maps (Figs 2–8) show the distribution in Hungary at a completion rate of approximately 75 % of the Invasion Data Sheets for the following invasive neophytes: *Prunus serotina*, *Robinia pseudacacia* (tra), *Ailanthus altissima* (tra), *Impatiens glandulifera* (tra), *Asclepias syriaca* (tra), *Ambrosia artemisiifolia* (tra), *Fallopia ×bohemica* (tra), *F. japonica* (tra?), *F. sachalinensis*. Species that essentially change characteristic features of the conquered community or landscape (species composition, physiognomy, succession relations) are indicated as transformer species (tra) (cf. Pyšek et al. 2004, Balogh et al. 2004).

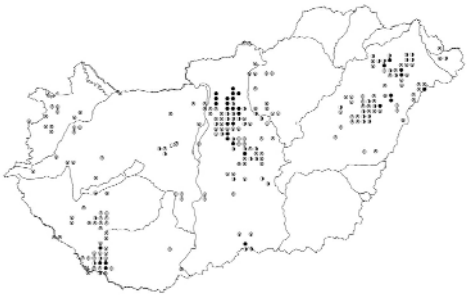


Fig. 2: Distribution and cover of *Prunus serotina* Ehrh. in Hungary.

Fig. 3: Distribution and cover of *Robinia pseudacacia* L. in Hungary.

Prunus serotina Ehrh. (syn.: *Padus serotina* [Ehrh.] Borkh.) (Fig. 2)

The first data on this North American tree in Hungary originate from a garden in Budapest from 1897 (herb. specim.: Hungarian Natural History Museum, Botanical Department, BP). Later it was only used as a subject of forest experiments in some sandy and loess soil regions. The first report on its subspontaneous occurrence is known from the middle of the 20th century (Juhász 2004). It became more important when it was planted together with pine (*Pinus* spp.) and black locust (*Robinia pseudacacia*) in large areas as part of forestry measures. Its rapid spread started in planted woods and it has been present in the neighbouring more natural woods from the 1970s as well. Currently black cherry (*Prunus serotina*) is widely distributed on acidic (Belsõ-Somogy, Nyírség) and limy (Kiskunság, Tengelici-homokvidék) sandy soils and in several loess soil regions (Gödöllõ Hills, Hajdúság). It does not spread on other bedrock; smaller stands can be found in woods on rivers flood plains. Beyond the plantations carried out by forest management, its spread was greatly assisted by over-propagated wildlife (Bartha & Mátyás 1995, Juhász 2004).

Robinia pseudacacia L. (Fig. 3)

This North American species was introduced into Hungary as a planted tree (rows, shelter belts, etc.) in the first half of the 18th century. Subsequently there are records from around 1750 of its utilization in forestry as well. After 1865, mass plantations became widespread mainly in the lowland sandy and loess soil regions exposed to wind and rain erosion. The areas occupied by *Robinia* have continuously increased since then. In 2003 22 % of the wood area (380000 ha) in Hungary consisted of black locust, so this is the species with the largest area of occupancy. Currently, *Robinia* is one of the most widespread species in Hungary; the large empty spots on the map indicate merely the deficiencies of data processing. In some regions this species covers 50-80 % of the woodland area. Except for the dense forests of highlands and for riverine forests on lower river banks it causes severe nature conservation problems, because *Robinia* outcompetes native tree species. The most serious problems are caused in the forest-steppe region of the lowlands (Bartha & Mátyás 1995, Bartha et al. 2006).

Fig. 4: Distribution and cover of *Ailanthus altissima* (Mill.) Swingle in Hungary.

Ailanthus altissima (Mill.) Swingle (Fig. 4)

The first reference to the cultivation of this East Asian tree dates back to the 1840s, when it was utilised in several places as an ornamental or planted as tree of rows. Attempts for forestry application were carried out in the second half of the 20th century. Currently this tree of heaven is present as an invasive species in lower and middle hilly regions and on loess and sandy soil areas in lowlands. It is present more or less within the whole of Hungary, but its frost sensitivity is limiting its spread and therefore it is absent from the higher hilly regions. It has a broad habitat preference and may therefore form large populations everywhere except for the mesophilous forests with closed canopy (Fagetalia communities) and acidophilous forests. *Ailanthus* causes the most serious nature conservation problems by colonizing dry grasslands and lowland oak forests (Udvardy 1998, 2004).

Key to Figures 2–8:

Empty quadrant: the species is not present or no survey has been carried out

Pointed spot: the species covers less than 0.1% (< 35 ha) of the quadrant

Half dark spot: the species covers 0.1–1 % (35–350 ha) of the quadrant

Dark spot: the species covers over 1 % (> 350 ha) of the quadrant

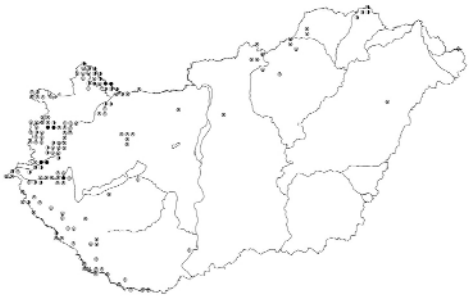


Fig. 5: Distribution and cover of *Impatiens glandulifera* Royle in Hungary.

Impatiens glandulifera Royle (syn.: *Impatiens roylei* Walpers) (Fig. 5)

The first records of this Himalayan annual species, originally introduced as an ornamental plant, date back to the 1940s for the western part of Hungary (Jeanplong 1941, Gondola 1965, Priszter 1965). Its distribution area has increased in Hungary in accordance with the neighbouring countries (e.g. Holzner 1971, Protopopova & Shevera 1998, Drescher & Prots 2003). It dominates mainly alluvial weed associations along rivers, ocurring more rarely along brooks in hill lands. It is frequent for example in West Hungary (e.g. Rába river), South Transdanubia (e.g. Dráva river), along the Danube (Szigetköz), but also grows along some sections of Tisza river and Zemplén Hills (NE-Hungary) (Balogh 2004a).

Asclepias syriaca L. (Fig. 6)

The first occurrence of this North American perennial species is described from

Fig. 6: Distribution and cover of *Asclepias syriaca* L. in Hungary

Fig. 7: Distribution and cover of *Ambrosia artemisiifolia* L. in Hungary

Hungary by Pococke, an English traveller, who during his Hungarian journey in 1736-37 mentioned it from Transdanubia (Rózsa & Nagy 1997, Bagi 2004). The common milkweed was cultivated for different purposes from 1870-80 to the middle of the 20th century. This proved to be unsuccessful, and therefore its cultivation was abandoned, but invasive foci evolved from remaining escaped populations (Bagi 2004). *Asclepias* has recently spread extremely and rapidly on sandy soils. Its distribution is dispersed and it infests arable land, orchards, vineyards, forests, and is frequent along roads and railway embankments (Varga 1998). The common milkweed forms dense stands between the Danube and Tisza (Central-Hungary), the northern Great Hungarian Plain (NS-Hungary) and South-Transdanubia. Its cultivation as an ornamental plant in gardens plays a significant role for its spread. *Asclepias* is an important bee pasture.

Ambrosia artemisiifolia L. (Fig. 7)

This North American annual species has been known in Hungary since 1922; it was observed near some villages in SW-Transdanubia, surroundings of the Lake Balaton, Dráva and Mura rivers (Boros 1924). In 1950, in the first national weed survey carried out on arable lands, common ragweed came only twenty-first in a ranking of weeds based on average cover. During the period of intensive agricultural production (until the 1980s) the infested area increased (Béres & Hunyadi 1991). After the change of the political system in 1989/90 and because of the modification of ownership in agricultural lands, *Ambrosia* became the most important weed all over the country in terms of average cover and speed of spread, causing most important agricultural and human-health effects among weeds. This species is now widespread in Hungary (Szigetvári & Benkõ 2004, Béres et al. 2005, Kiss & Béres 2006). It is omnipresent in the unmarked areas on the map too, except for a few regions in NE-Hungary.

Fallopia ×bohemica (Chrtek & Chrtková) J. Bailey (syn.: *Reynoutria ×bohemica* Chrtek et Chrtková; *F. japonica* × *F. sachalinensis*), *Fallopia japonica* (Houtt.) Ronse Decr. (syn.: *Reynoutria japonica* Houtt.) and *Fallopia sachalinensis* (Frdr. Schm.) Ronse Decr. (syn.: *Reynoutria sachalinensis* (Frdr. Schm.) Nakai (Fig. 8)

According to literature, two geophyte species (*F. japonica* and *F. sachalinensis*) of

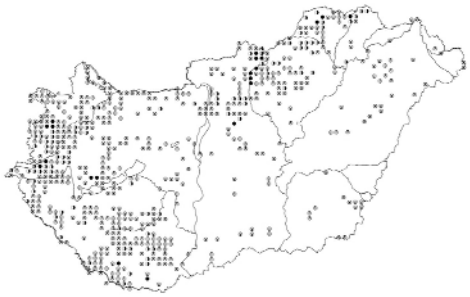


Fig. 8: Distribution and cover of *Fallopia* sectio *Reynoutria* in Hungary

the genus *Fallopia* section *Reynoutria* occur in Hungary, introduced as ornamental plants (*F.* ×*bohemica* is a hybrid of these two species which originated in Europe and is not known from the native ranges of the parent species). The first escaped population of the East Asian species *F. japonica* was observed in Hungary in 1923 (Balogh 2004b). There are a few data from the middle of the 20th century, but the most pronounced increase in floristic data was recorded in the last decade. The only subspontaneous occurrence of *F. sachalinensis* has recently been found in Hungary (Barina 2006). Only a few populations are known up to now in Slovakia and Romania (Fehér 1998, Ciocârlan 2000), while in Austria it has spread considerably recently (Pagitz 2007). The occurrence of the European-born hybrid *F.* ×*bohemica* in Hungary was recently published (Balogh 1998). According to Balogh & Bailey (2003) it is confirmed that most data on *F. japonica* and *F. sachalinensis* in Hungary refer to their hybrid, *F.* ×*bohemica* (see also Balogh 2004b). Because of uncertainties encountered when differentiating the species *Fallopia* sectio *Reynoutria*, the three species are analysed together during the assessment. Although *Fallopia* is established sporadically in the Great Hungarian Plain, it has become dominant first in the Transdanubian hills and riverbanks and in ruderal communities of these areas (Balogh 2004b).

According to the experience obtained up to now, floristic data collection using the Invasion Data Sheet is less suitable for surveying invasive plants in arable habitats because the method of estimating the coverage of invasive plants differs for arable land and (semi)natural habitats. The programme participants mapped their quadrants according to the given method only, resulting in much uncertainty in the assessment of the proportion of invasive plants of arable habitats. The collection of floristic data using the Invasion Data Sheet is more convenient for mapping the occurrence of invasive plant species in semi-natural vegetation, which actually was the main purpose of this work. It is hoped that the information gained from the Invasion Data Sheets will support the nature protection and plant protection authorities to evaluate spatio-temporal invasion patterns and to plan control strategies accordingly at national level. In addition to providing data on geographical distribution, the results will help to determine the dynamics of the spreading of invasive plants and their infestation at landscape level in Hungary.

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