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RIPARIAN INVASIVE ALIEN PLANT SPECIES IN SOUTHERN TRANSYLVANIA (ROMANIA): HISTORY OF INTRODUCTION, CHOROLOGY AND ECOLOGY

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DOI: 10.2478/trser-2023-0001

KEYWORDS: invasive alien plant species, riparian habitats, history, introduction, paths, Southern Transylvania.

ABSTRACT

The establishment and spread of invasive alien plant species (IAPS) outside their natural habitats have irreversibly affected native biodiversity in almost every habitat type.

For Southern Transylvania, we recognise that there are about 200 adventive plants. From those, we selected 18 IAPS that occupy riparian habitats, the most common, abundant, frequent or with higher impact on habitats and human health. We studied the history of their introduction in the study area, their distribution paths and means of spreading in the wild, their chorology and ecology.

ZUSAMMENFASSUNG: Riparian invasive Pflanzenarten im südlichen Transsilvanien (Rumänien): Geschichte ihren Einbürgerung, Chorologie und Ökologie.

Die Ansiedlung und Verbreitung invasiver, fremdländischer Pflanzenarten außerhalb ihrer natürlichen Lebensräume hat die heimische Bioversität in beinahe jedem ihrer Habitattypen unwiederbringlich gestört.

Für den Süden Transsilvanien/Siebenbürgens wird eine Zahl von etwa 200 adventiver Arten geschätzt. Unter diesen wurden 18 fremde, in Uferhabitaten häufige und in beachtlicher Menge vorkommende, invasive Arten ausgewählt, die eine beachtliche Beeinträchtigung der Habitate oder eine Bedrohung für die Gesundheit der Menschendarstellen. Dabei wird auch auf die Geschichte ihrer Einbürgerung im Untersuchungsgebiet hingewiesen, ihre Verbreitungswege und Ansiedlungsweise im Gebiet dargestellt sowie ihre Chorologie und ökologische Anforderungen besprochen.

REZUMAT: Specii de plante invazive ripariene în sudul Transilvaniei (România): istoricul introducerii, corologia și ecologia.

Instalarea și răspândirea speciilor de plante alohtone invazive, în afara habitatelor lor naturale, au afectat ireversibil biodiversitatea nativă în aproape fiecare tip de habitat.

Pentru Transilvania de Sud, apreciem că există aproximativ 200 de plante adventive. Dintre acestea, am selectat 18 specii de plante alohtone invazive care ocupă habitate riverane, cele mai comune, abundente, frecvente sau cu impact mai mare asupra habitatelor și sănătății umane, din sudul Transilvaniei și am studiat istoricul introducerii lor în zona de studiu, căile de distribuție ale acestora și modalități de răspândire în natură, corologie și ecologie.

INTRODUCTION

The rate at which humans translocate species beyond their native ranges has substantially increased during recent centuries (Seebens et al., 2017). A wide range of motivations underlie the introduction of alien species and the relative importance of these vary considerably in space and time; for example, many alien species of taxa such as mammals, plants or birds were released by European explorers and settlers all over the world during 1500-1800 (Seebens et al., 2017). In the nineteenth century, numerous plants were brought to Europe for ornamental purposes (Fry, 2013).

The establishment and spread of invasive alien plant species (IAPS) outside their natural habitats have forever affected native biodiversity in almost every habitat type and are a global major threat to biodiversity, as well as in Southern Transylvania. IAPS pose severe threats to ecosystem services, environmental quality, human health, and local biodiversity (Prots and Simpson, 2011; Goia et al., 2014; Kumar Rai and Singh, 2020), including changes in floristic composition of phytocoenosis.

Due to the changes that IAPS produce at the global level, the Convention on Biological Diversity (CBD, 1992), Article 8 (h) states that "Each contracting party shall, as far as possible and as appropriate, prevent the introduction of, control or eradicate those alien species which threaten ecosystems, habitats or species". Recognizing that IAPS represent one of the main risks to biodiversity, the CBD adopted guidance on their prevention, introduction and mitigation of impacts that threaten ecosystems, habitats or species (COP, 2002, Decision VI 23). The CBD creates the pathways classification framework used in the implementation of European Union Regulation 1143/2014 on invasive alien species (IAS Regulation) (EC, 2014).

In order to facilitate information on alien species and support the implementation of the IAS Regulation, the European Alien Species Information Network (EASIN) was created. The EASIN Catalogue currently includes information on about 6,000 alien plant taxa.

For better understanding, there is a need to define the terms that we use in this paper. We agree that alien plants are plant taxa in a given area whose presence there is due to intentional or unintentional human involvement, or which have arrived there without the help of people from an area in which they are alien (Pyšek et al, 2004), and invasive plants are a subset of naturalized plants that produce reproductive offspring, often in very large numbers, at considerable distances from the parent plants, and thus have the potential to spread over a large area (> 100 m in < 50 years for taxa spreading by seeds and other propagules; > six m in three years for taxa spreading vegetatively) (Pyšek et al, 2004).

The Romanian list of adventive plants in 2011 included 671 species, of which 112 may be considered invasive (Sîrbu and Oprea, 2011). In 2019, the list of invasive and potentially invasive alien plants in Romania included 130 taxa (Anastasiu et al., 2019). Of these, 36 are subject to different European laws, being species of concern for the European Union, but there are reports for only eight of them from Romania (Anastasiu et al., 2017, 2019).

In Romania, 435 allochthone plant species were identified (384 neophytes and 51 archaeophytes) (Anastasiu and Negrean, 2007). Anastasiu and Negrean (2009) list 365 neophytes, of which 38 are invasive, specifying for each the origin, bioform, the Romanian provinces where they were reported, the introduction method (accidental or deliberate), abundance, status (occasional, naturalized, invasive), impact on ecosystems (potentially invasive, invasive, unknown), and economic impact (non-harmful, potentially harmful, or harmful). 83% of neophytes come from America 38.63% (141 taxa), around the Mediterranean Sea 18.90% (69), from Asia 16.71% (61 species) and Europe 8.49% (31 taxa). 82.73% (195 taxa) of the neophytes were introduced deliberately (as ornamental, food, medicinal, nectar plants, fodder species, etc.) and 46.58% (170 taxa) were brought accidentally.

For Southern Transylvania area, we recognize that there are about 200 adventive plants; the list of alien plant species includes 69 species only for Sibiu County (Drăgulescu, 2009b).

From Southern Transylvania, we selected 18 invasive alien plant species that occupy riparian habitats, the most common, abundant, frequent or with higher impact on habitats and human health. We studied the history of their introduction in the study area, their distribution paths and means of spreading in the wild, their chorology and ecology. When defining the territory of Southern Transylvania, we considered Alba County, Brașov County, Hunedoara County, and Sibiu County areas of Romania.

The threat to biodiversity and related ecosystem services that invasive alien species pose takes different forms, including severe impacts on native species and the structure and functioning of ecosystems, through the alteration of habitats, predation, competition, the transmission of diseases, the replacement of native species throughout a significant proportion of range, and through genetic effects by hybridization. Furthermore, invasive alien species can also have a significant adverse impact on human health and the economy (European Union Regulation 1143/2014).

MATERIAL AND METHODS

The following study is based on an analysis of the bibliography regarding invasive alien plant species (IAPS) in Southern Transylvania as well as on the authors' data field information. For this research we selected a total of 18 riparian IAPS from Southern Transylvania – the most common, abundant, and frequent or with higher impact on habitats and human health. These plant species are: *Acer negundo* L., *Ailanthus altissima* (Miller) Swingle, *Amaranthus retroflexus* L., *Ambrosia artemisiifolia* L., *Amorpha fruticosa* L., *Asclepias syriaca* L., *Datura stramonium* L., *Echinocystis lobate* (Michx.) Torr. et Gray, *Erigeron canadensis* L., *Helianthus tuberosus* L., *Impatiens glandulifera* Royle, *Impatiens parviflora* D. C., *Parthenocissus inserta* (A. Kerner) K. Fritsch, *Phytolacca americana* L., *Reynoutria japonica* Houtt., *Rudbeckia laciniata* L., *Solidago canadensis* L., and *Solidago gigantea* Ait.

For each these plant species, we wrote the name, bioform, geographical origin, ecological and cenological preferences, regional-zoological category, and distribution in Southern Transylvania. The chorological information also specifies the year in order to know the time when the first specimens (populations) entered or were reported and the directions of spread.

For each of the IAPS we also elaborate a GIS distribution map; we should mention the fact that the number of points in the species distribution maps reflects the distribution of their populations, but because some territories and taxonomic units have been studied more, others less, the chorological information does not faithfully reproduce the situations in the field, for example: *Amaranthus retroflexus* grows in all localities located below 600 m above sea level (asl), i.e. in approximately 700 villages and towns in the four counties in the research area. We have marked on the map only the coronims in which the species was observed by authors or cited. For the GIS maps we used different colors to represent the period in decades of the first record in the wild of every selected riparian IAPS.

The paper is designed in two main parts; the first focuses on the distribution maps, the second part includes the coronims.

RESULTS AND DISCUSSION

In order to create a summary regarding the introduction of the invasive alien plant species (IAPS) selected by us for this research, we analyzed the year of introduction of those taxa into wild in Europe, in Romania, versus the year of introduction in Southern Transylvania using the existing data in the scientific literature. The information is synthesized in table 1.

Table 1: Comparative analyze regarding the first record in wild in Europe *, Romania, Southern Transylvania, of studied invasive alien plant species.

Alien plant taxa	Date of first record in the wild of Europe	Country of first record in the wild of Europe	Date of first record in the wild in Romania (Sîrbu, Oprea, 2011)	References	Date of first record in the wild of Southern Transylvania	References
Acer negundo	1688	UK	1871	Fătu	1882	In the Herbar of Botanical Garden in Cluj Napoca there is material collected from Ilia (Hunedoara County) D. L. Simonkai registered the species fromTransylvania (ap. P. Anastasiu, G. Negrean, 2009) in 1887.
Ailanthus altissima	1931	FR	1866	Fronius	1858	The species is reported for the first time by F. Fronius (1858) from Sighişoara, but in HF** there is material from Sibiu from 1854.
Amaranthus retroflexus	1700	AT	1816	Baum-garten	1816	Baumgarten mentioned the plant as common in Transylvania, in gardens, agricultural lands and ruderal fields.
Ambrosia artemisiifolia	1613	PL	1908	Javorka	1946	Negrean, 1972 mention that Wallfishch collected it in Călan, HD**.
Amorpha fruticosa	1724	DE	1871	Fătu	1885	In Transylvania is recorded as a cultivated plant (Porcius 1885, Simonkai 1886).

Table 1 (continued): Comparative analyze regarding the first record in wild in Europe *, Romania, Southern Transylvania, of studied invasive alien plant species.

Alien plant taxa	Date of first record in the wild of Europe	Country of first record in the wild of Europe	Date of first record in the wild in Romania (Sîrbu, Oprea, 2011)	References	Date of first record in the wild of Southern Transylvania	References
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Amorpha fruticosa	1724	DE	1871	Fătu	1885	In Transylvania is recorded as a cultivated plant (Porcius 1885, Simonkai 1886).
Asclepias syriaca	1825 1736-1737	FR HU	1836	Czihak	1793	In the list of ornamental species cultivated at Samuel von Brukenthal's castle in Avrig (ap. J. C. Eder's manuscript diary in M. I. Doltu, E. Schneider-Binder, 1973) in 1793 *Asclepias* was also noted, probably A. syriaca. In HF** there is material of *A. syriaca* collected from gardens in Sibiu and Bradu from 1843 and 1861 respectively.
Datura stramonium	1583	AT	1778	Benkö	1778	Benkö, cited by Pop (1930), in XIX century is considered a common weed in the whole country (Baumgarten, 1816; Heuffel 1858; Schur 1866).
Echinocystis lobata	1800	AT	1904	Moesz	1904	Recorded as a subspontanoeus plant by Moesz close to Dârste, BV**.

Table 1 (continued): Comparative analyze regarding the first record in wild in Europe *, Romania, Southern Transylvania, of studied invasive alien plant species.

Alien plant taxa	Date of first record in the wild of Europe	Country of first record in the wild of Europe	Date of first record in the wild in Romania (Sîrbu, Oprea, 2011)	References	Date of first record in the wild of Southern Transylvania	References
Erigeron canadensis	1674	IT	1814	Nyárády	1816	Cited by Baumgarten in Transylvania from meadows, orchards, ruderal and sandy areas.
Datura stramonium	1583	AT	1778	Benkö	1778	Benkö, cited by Pop (1930), in XIX century is considered a common weed in the whole country (Baumgarten, 1816; Heuffel 1858; Schur 1866).
Echinocystis lobata	1800	AT	1904	Moesz	1904	Recorded as a subspontanoeus plant by Moesz close to Dârste, BV**.
Erigeron canadensis	1674	IT	1814	Nyárády	1816	Cited by Baumgarten in Transylvania from meadows, orchards, ruderal and sandy areas.
Helianthus tuberosus	1607	FR	1778	Benkö	1778	First record is in Transylvania, in a plant list made by Benkö, cited by Pop (1930).
Impatiens glandulifera	1839	UK	1882	Balogh	1882	First recorded in Sibiu.
Impatiens parviflora	1831	CH	1939	Prodan	1950	Recorded from different localities from Transylvania (Bechet et al., 1962, cited by Drăgulescu 2003, and Ciocârlan 2006).

Table 1 (continued): Comparative analyze regarding the first record in wild in Europe *, Romania, Southern Transylvania, of studied invasive alien plant species.

Alien plant taxa	Date of first record in the wild of Europe	Country of first record in the wild of Europe	Date of first record in the wild in Romania (Sîrbu, Oprea, 2011)	References	Date of first record in the wild of Southern Transylvania	References
Parthenocissus inserta	1959	NO	1958	Săvu-lescu	1858	The material from the HS** from Sibiu from the mid-19th century is the oldest record in Romania. It was noted for the first time in 1858 from Sighișoara by B. Fronius (under *Ampelopsis hederacea* DC**.
Phytolacca americana	1601	DE	1780	Sestini	1866	Mentioned by Schur from Tălmaciu, Turnișor and Gușterița, SB**.
Reynoutria japonica	1844	DK	1940	Paucă	1959	Mentioned by Borza 1959 from Sebeș, Șugag (AB**) and other localities from Transylvania.
Rudbeckia laciniata	1787	PL	1855	Fronius	1855	First recorded in Avrig (SB**) by Frobius 1855, cited by Fuss (1866) and Simonkai (1886).
Solidago canadensis	1648	FR	1866	Schur	1866	Cited by Schur in Transylvania, where during 100 years it invaded the riverbanks of the main rivers in the whole country.
Solidago gigantea	1830	AT	1866	Borbas	1941	Mentioned by Borza, from Transylvania and Cibului Gorges (AB**). In the Höhr Herbarium there is material from Sighișoara, from Dealul Turcului, from 1914 (Gross et al., 2022)

Regarding introduction pathways, we analyzed information provided by CBD; we observed that most of the plants were introduced for ornamental purpose, followed by horticulture, and aesthetic release, then as contaminant on animals (Fig. 1).

The presence of IAPS in the local flora leads to the false conclusion that the flora is not impoverished, the number of species being constant, maybe even higher than in the past, but that is due to the installation of many adventive plants that mask the disappearance of many autochthonous phytotaxa.

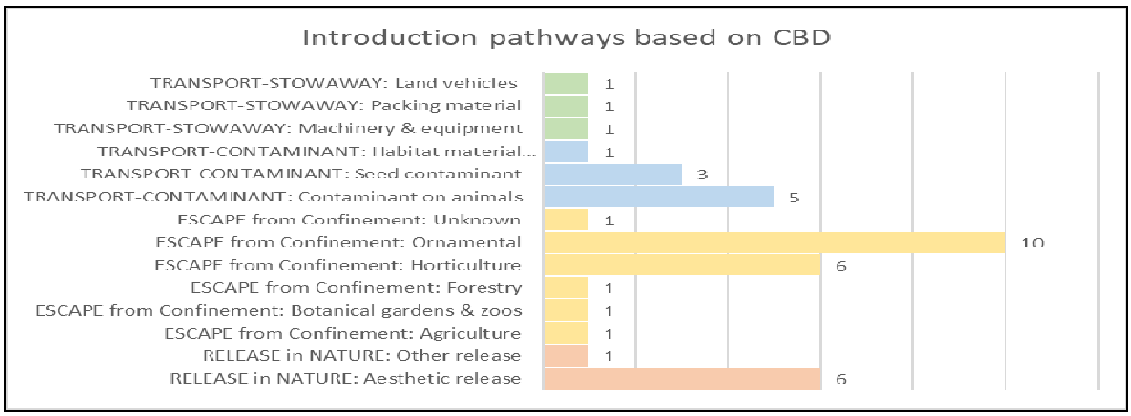


Figure 1: Introduction pathways of selected taxa, based on CBD.

Acer negundo L.: mPh-MPh, Adv (North America); $U_{3,5}T_3R_4$, Salicetea purpureae.

J. Baumgarten collected material from culture (Herbar Liceu G. Lazăr-Muzeul Brukenthal Sibiu) around 1810, without indicating the locality and date. In the Herbar Grădina Botanică Cluj-Napoca there is material from Ilia (Hunedoara County) from 1882. It is the first record of the species in Transylvania and Romania. In the south of Transylvania it is wild in hundreds of localities between 200 m and 650 m a.s.l., especially on the banks of rivers, as presented in figure 2.

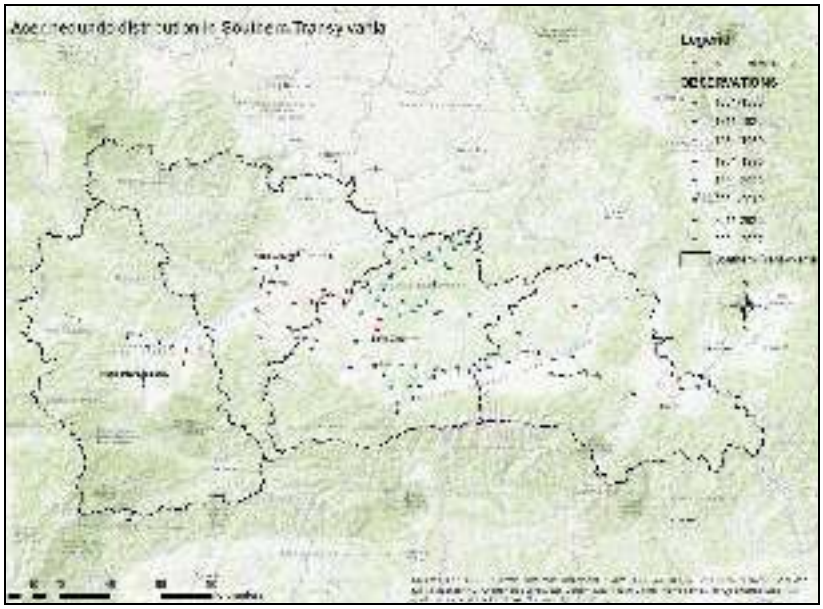


Figure 2: *Acer negundo* distribution in Southern Transylvania.

Ailanthus altissima (Miller) Swingle: MPh, Adv (Asia-North China); $U_0T_0R_0$, Ailanthetum altissimae. The species is reported for the first time by Fronius F. (1858) from Sighişoara, but in HF** there is material from Sibiu from 1854. Species is increasingly widespread, growing wild from plantations. In the south of Transylvania it rises up to 700 m asl. Distribution of the species in Southern Transylvania is presented in figure 3.

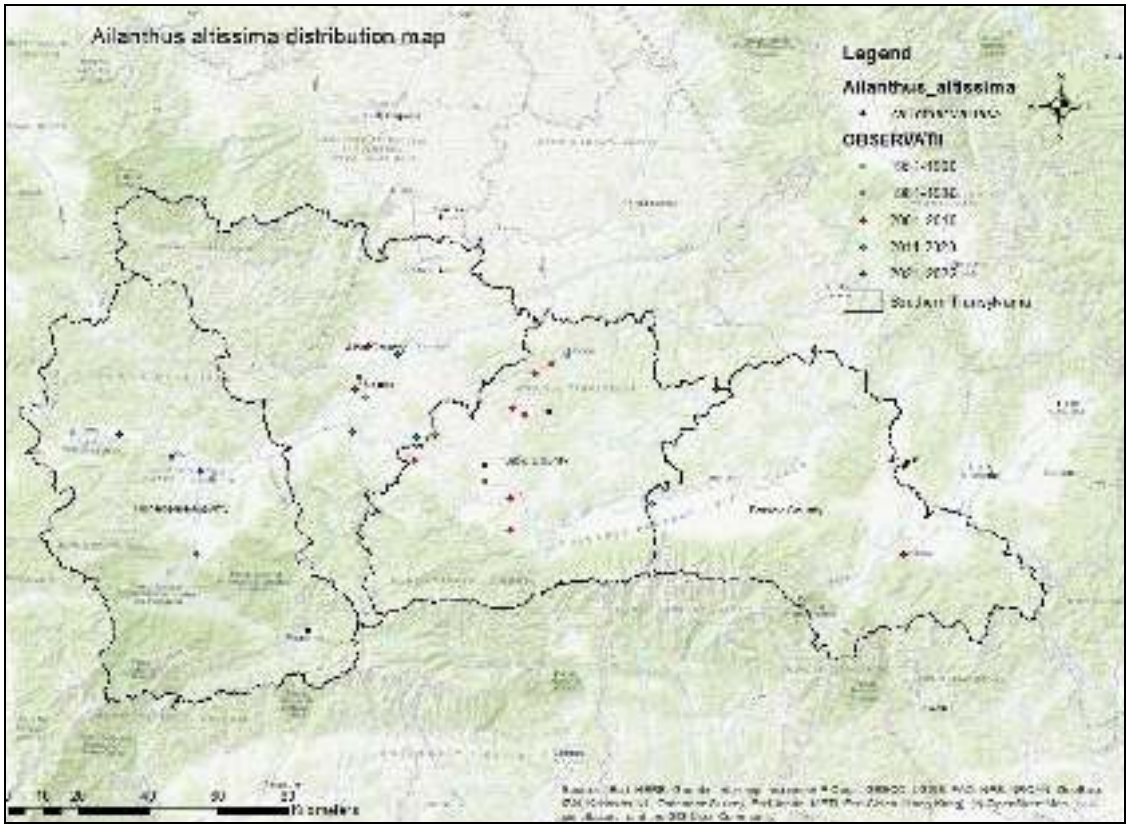


Figure 3: *Ailanthus altissima* distribution in Southern Transylvania.

Amaranthus retroflexus L.: Th, Adv (America); $U_3T_3R_0$, Chenopodietea, Panico-Setarion. Common species widespread in all localities between 200 m 700 m asl. In HS** there is material from the Transylvania leg. Kladni in 1839. But J. Baumgarten mentions it wild in Transylvania as early as 1816. The distribution of *Amaranthus retroflexus* is presented in figure 4.

Ambrosia artemisiifolia L.: Th, Adv (North America); $U_2T_0R_0$, Sisymbryon.

The first record in Southern Transylvania was in 1946, in Călan (Hunedoara County). We saw the first specimens in 1994 in western Romania, in the interflow of the Criș Rivers. In the in 2001 we noticed it east of Arad, in 2003 in Simeria, in 2005 in Ocna Sibiului railway station, in 2006 in Sibiu, which leads us to say that the plant reached the south of Transylvania coming from the west, preferring the edges of the Arad-Sibiu road and the embankment of the railway. Between 2005 and 2020, it spread to at least 60 localities in Southern Transylvania, climbing up to 700 m asl. The distribution of *Ambrosia artemisiifolia* in Southern Transylvania is presented in figure 5.

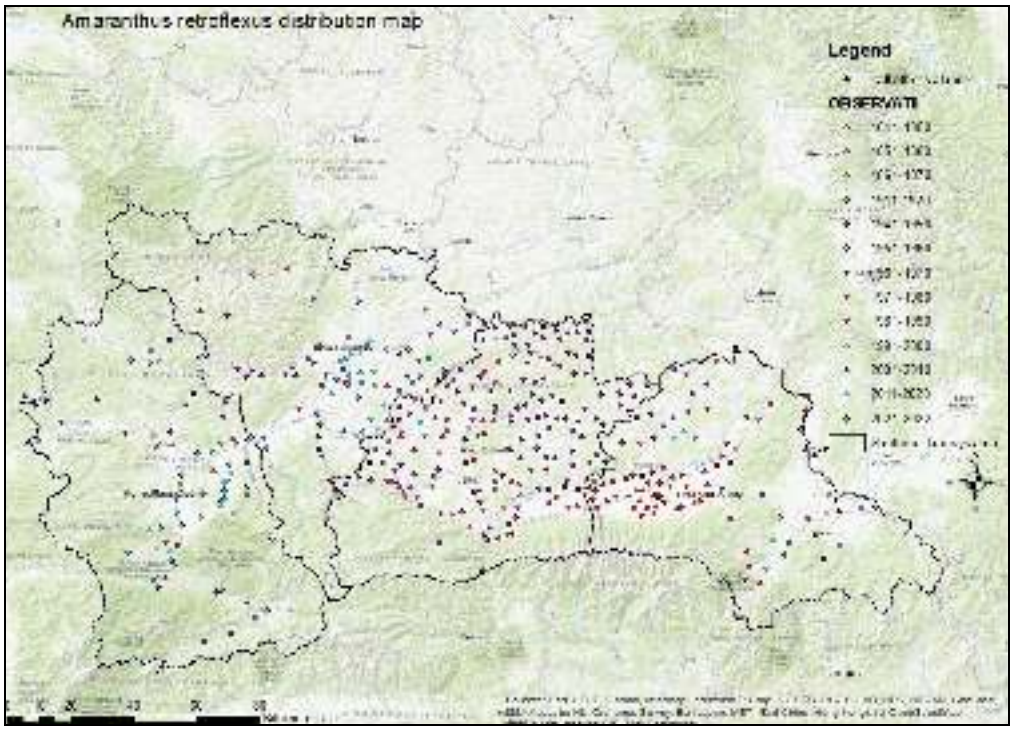


Figure 4: *Amaranthus retroflexus* distribution in Southern Transylvania.

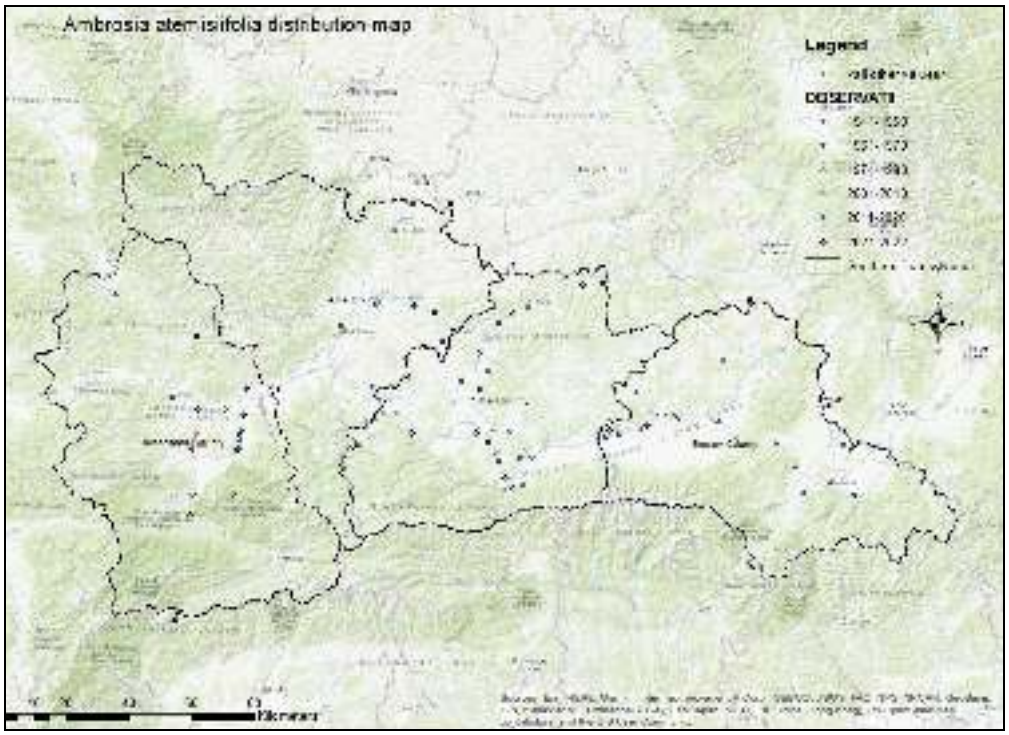


Figure 5: *Ambrosia artemisiifolia* distribution in Southern Transylvania.

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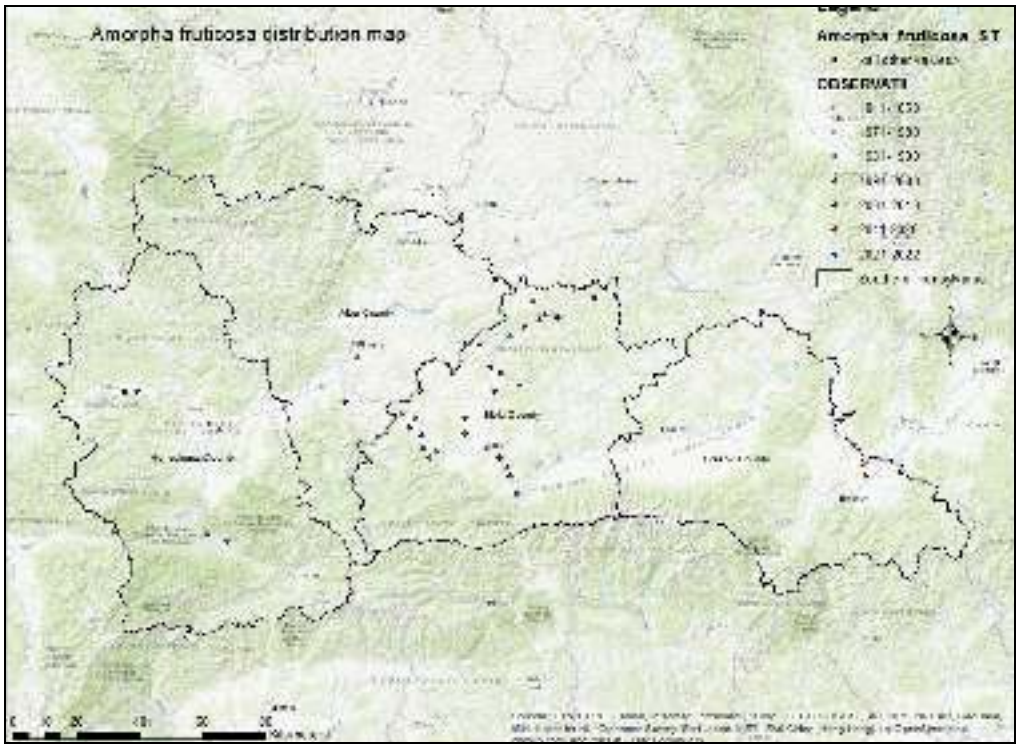


Figure 6: Distribution of *Amorpha fruticosa* in Southern Tansylvania.

Asclepias syriaca L.: H, Adv (North America); $U_3T_3R_4$, Artemisiatea.

In the list of ornamental species cultivated at Samuel von Brukenthal's castle in Avrig (Sibiu County) (ap. J. C. Eder's manuscript diary in M. I. Doltu, E. Schneider-Binder, 1973) in 1793, *Asclepias* was also noted, probably *A. syriaca*.

In HF** there is material of *A. syriaca* collected from gardens in Sibiu and Bradu from 1843 and 1861, respectively. F. Schur notes it, in 1866, from gardens in Sibiu and its surroundings, stating that over time it becomes troublesome and difficult to eradicate.

I. Prodan in 1923 indicates that it is only cultivated, but in 1939 he specified the fact that it is rarely also wild. A. Borza notes it in 1949 as both a cultivated and subspontaneous species in Romania.

It has been spreading more and more in recent years, especially in river meadows and in creeper crops. In the last two decades, it has been observed in over 50 localities in Southern Transylvania. Reaching about 650 m asl. The distribution of *Asclepias syriaca* in Southern Transylvania is presented in figure 7.

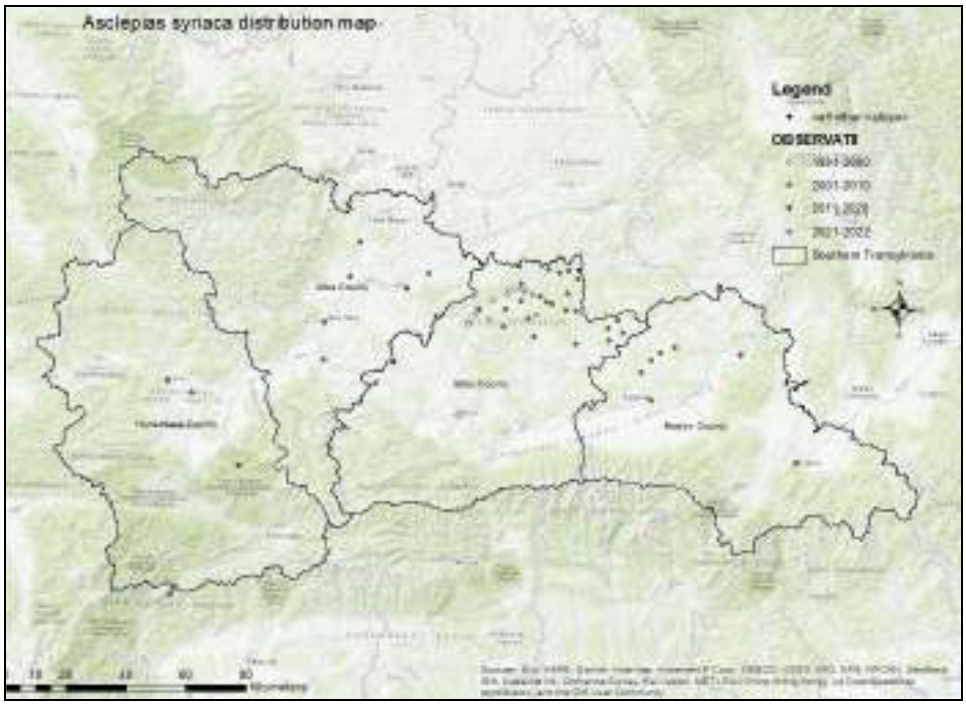


Figure 7: Distribution of *Asclepias syriaca* in Southern Tansylvania.

Datura stramonium L.: Th, Adv (→Cosm); $U_3T_4R_4$, Chenopodietea.

Common weed observed in most localities below 1000 m asl. Distribution of *Datura stramonium* in Southern Transylvania is presented in figure 8.

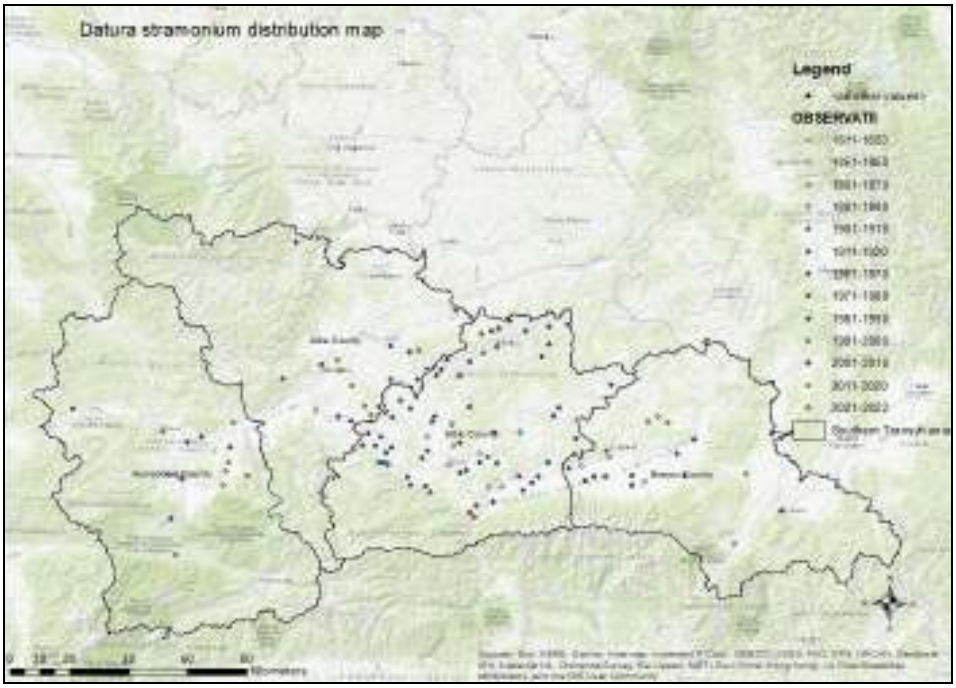


Figure 8: Distribution of *Datura stramonium* in Southern Transylvania.

Echinocystis lobata (Michx.) Torr. et Gray: Th, Adv (NE America); $U_4T_0R_4$, Calystegion, Senecion fluviatilis.

The records of the plant since 1907 (in Zlatna, Alba County) and 1912 (from Săliște, Sibiu County) could be not only Romanian but also Eastern and Central European firsts.

In recent decades it has invaded the riparian areas of bigger rivers reaching, in the south of Transylvania, up to 700 m asl. The distribution of *Echinocystis lobata* in Southern Transylvania is presented in figure 9.

Erigeron canadensis L. (Conyza canadensis (L. Cronq.): Th-TH, Adv (North America); $U_{2,5}T_0R_0$, Chenopodietea, Festucion vaginatae, Sisymbrion officinalis.

Wild species in Southern Transylvania at the beginning of the 19th century, mentioned by J. Baumgarten (1816) and existing in his herbarium in Sibiu. It climbs up to 1,300 m asl. The distribution of *Erigeron canadensis* in Southern Transylvania is presented in figure 10.

Helianthus tuberosus L.: H(G), Adv (North America); $U_{3,5}T_3R_4$, Calystegion.

J. Benkö (1783) notes it from Transylvania with Hungarian and Romanian names. Mentioned by J. Baumgarten (1816) in the flora of Transylvania. In the herbarium of J. Baumgarten from Sibiu (HLGL**) there is material without locality or date. In HF**, the material from Noul dates from 1845. M. Fuss (1866) did not mention its existence in the spontaneous flora of Transylvania, which leads us to believe that the material from his herbarium from 1845 was from culture (garden). From cultivation it went wild and spread rapidly. Transylvanian peasants, until two or three decades ago, planted tubers at the bottom of the garden, next to the fences, from where the plant spread through vegetative propagation. In the south of Transylvania it rises up to 650 m asl. The distribution of *Helianthus tuberosus* in Southern Transylvania is presented in figure 11.

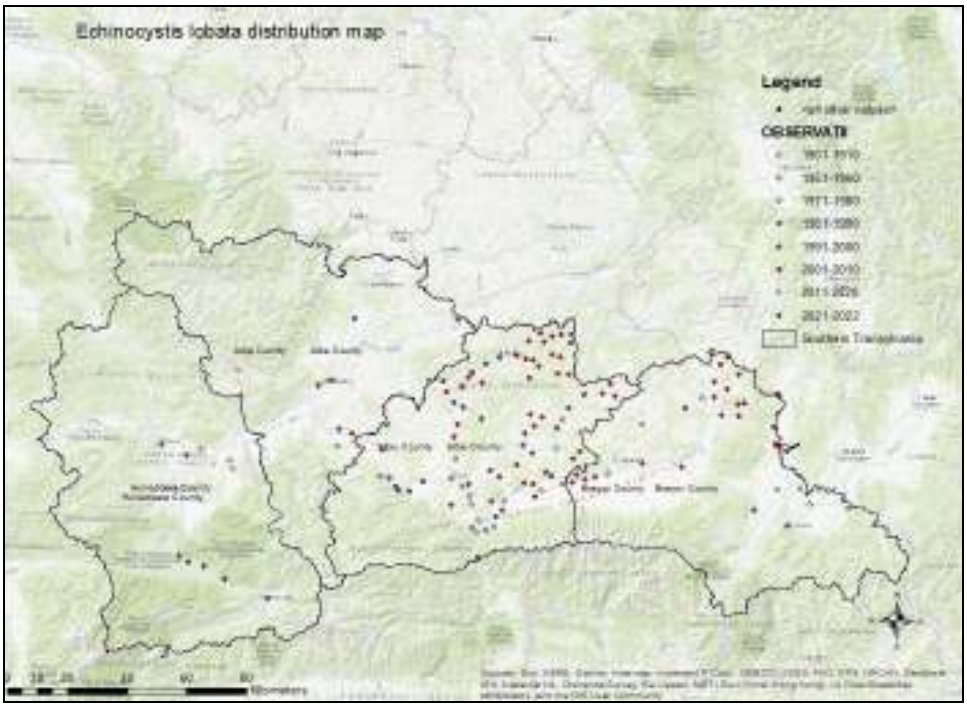


Figure 9: Distribution of *Echinocystis lobata* in Southern Transylvania.

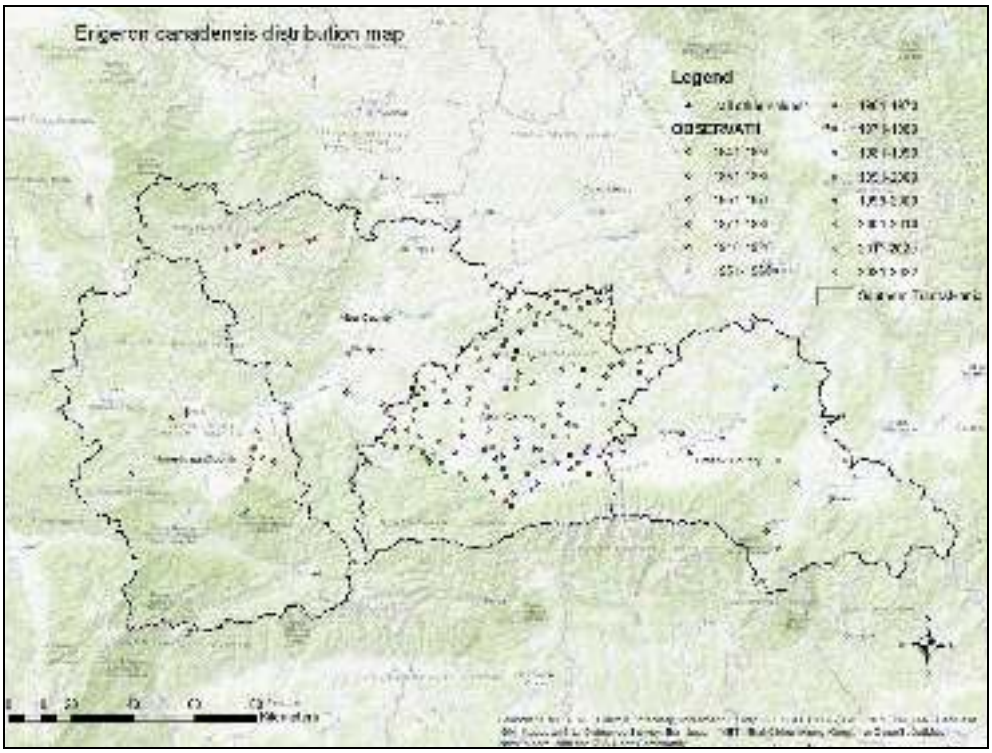


Figure 10: Distribution of *Erigeron canadensis* in Southern Transylvania.

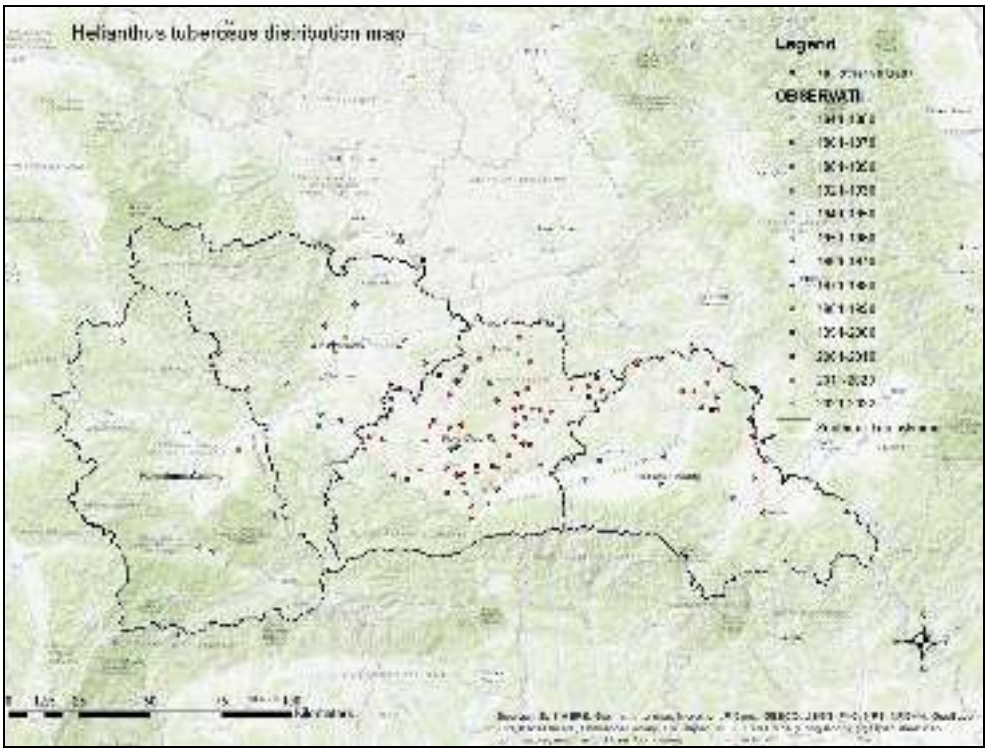


Figure 11: Distribution of *Helianthus tuberosus* in Southern Transylvania.

Impatiens glandulifera Royle (I. roylei Walp.): Th, Adv (India-Himalaya); $U_4T_{3,5}R_4$, Calystegion, Salicion albae.

In Herbar Liceu G. Lazăr-Muzeul Brukenthal Sibiu there is material (not sure if from culture) from Sibiu, Aleea Filozofilor collected by Ormay in 1882, which leads L. Balogh (2008) to argue that it was identified in Sibiu in a subspontaneous state as early as 1882.

In the Herbar Botanical Garden Cluj-Napoca there is material from 1922 from Cluj. A. Borza (1925) mentions it in the gardens of Porumbacu de Jos (Sibiu County), as a "novelty".

I. Morariu (1938) records it from Poienile Zagrei/Zăgrii locality (Bistrița Năsăud), as an ornamental plant. In 1939 I. Prodan also reports it only from gardens (Geoagiu, Năsăud, Valea Mureșului, Sinaia). R. Soo cites the species, in 1943, from the Mureș Gorge between Răstolița and Lunca Bradului, and from Tușnad.

A. Borza notes it in 1949 also as subspontaneous in Transylvania. In the last half century it has had a rapid expansion in river meadows. It climbs up to 900 m asl. The distribution of *Impatiens glandulifera* in Southern Transylvania is presented in figure 12.

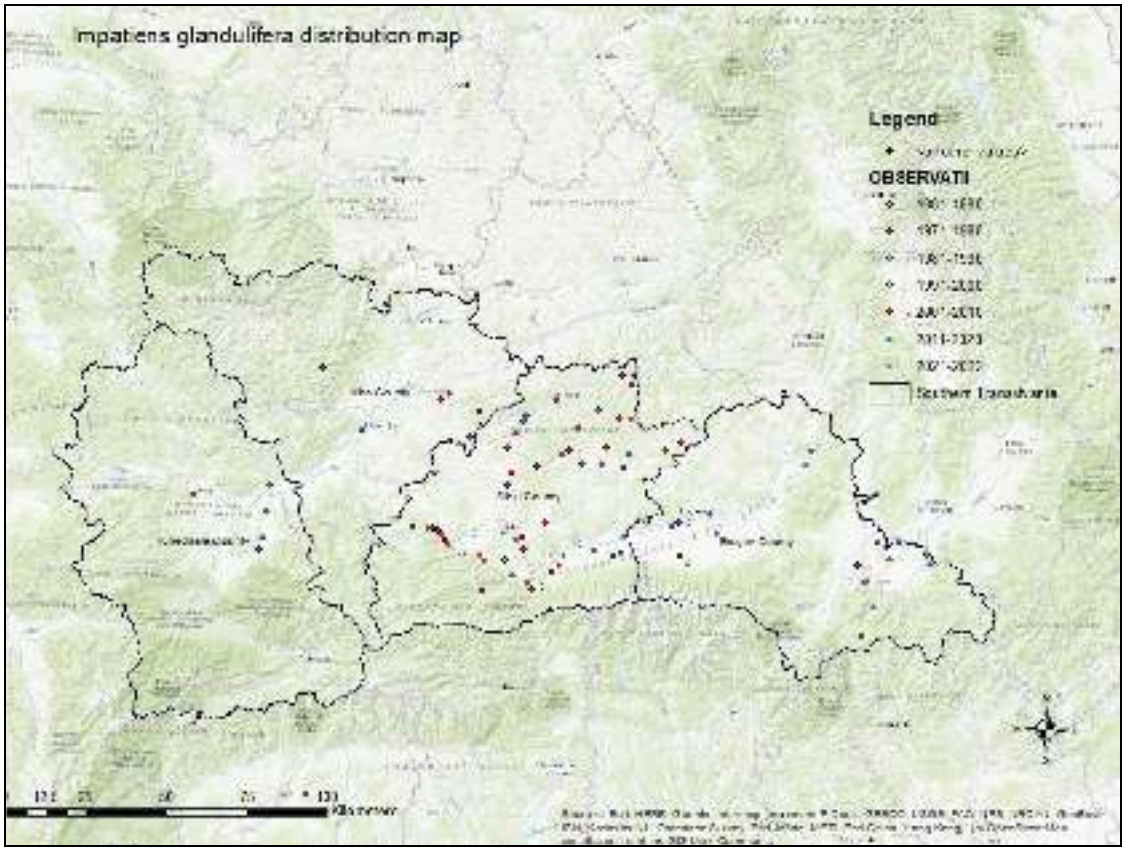


Figure 12: Distribution of *Impatiens glandulifera* in Southern Transylvania.

Impatiens parviflora D.C.: Th, Adv (Central Asia); $U_3T_{3,5}$ R_0, Alliarion petiolatae, Arction lappae.

More and more widespread in Southern Transylvania climbing up to 1,200 m asl. From Romania it is recorded by I. Prodan in 1939, without locality, as an ornamental plant, sometimes escaped from crops. It is reported for the first time from Southern Transylvania by Bechet et al. in 1962 from Bâlea Waterfall. The distribution of *Impatiens parviflora* in Southern Transylvania is presented in figure 13.

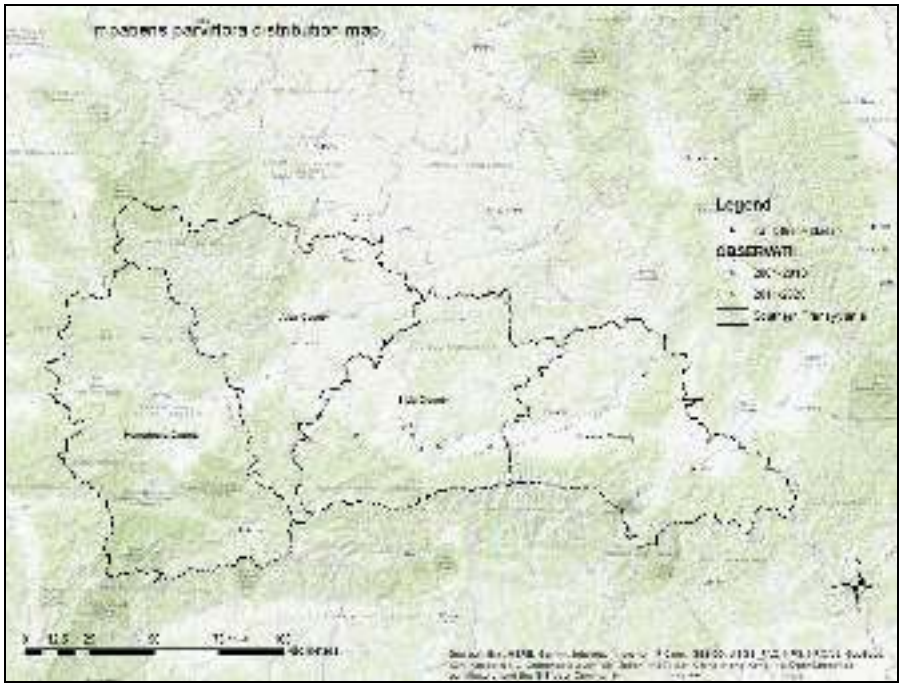


Figure 13: Distribution of *Impatiens parviflora* in Southern Transylvania.

Parthenocissus inserta (A. Kerner) K. Fritsch: mPh-L, Adv (North America); $U_{3,5}$ $T_{3,5}R_4$, Alno-Padion, Salicion albae.

The material from HS** from Sibiu from the middle of the 19th century is the oldest record in Romania. It was noted for the first time in 1858 from Sighișoara by Br. Fronius (under *Ampelopsis hederacea* D.C. In the south of Transylvania it reaches 650 m asl; distribution of the species is presented in figure 14.

Phytolacca americana L. (Ph. decandra L.): H, Adv (North America); $U_3T_0R_0$, Alliarion petiolatae, Carpinion betuli.

In Southern Transylvania it is not widespread, growing in less than 20 localities. In the south of Romania it is much more frequently, found in yards, next to fences, and walls. In a single county (Teleorman) we observed the plant in more localities than in the four southern Transylvanian counties combined (e.g. Alexandria, Beiu, Cernetu, Conțești, Dragănești-Vlașca, Mârzănești, Nanov, Peretu, Plosca, Poroschia, Roșiori de Vede, Smârdioasa, Știorobăneasa, Teleormanu, Turnu Măgurele, Valea Părului, and Zimnicea).

Cultivated and wild around the town of Copșa Mică, the species being resistant to pollution existing in the area in the new decade of the 20th century.

In the south of Transylvania it rises up to 600 m asl, the distribution map of *Phytolacca americana* is presented in figure 15.

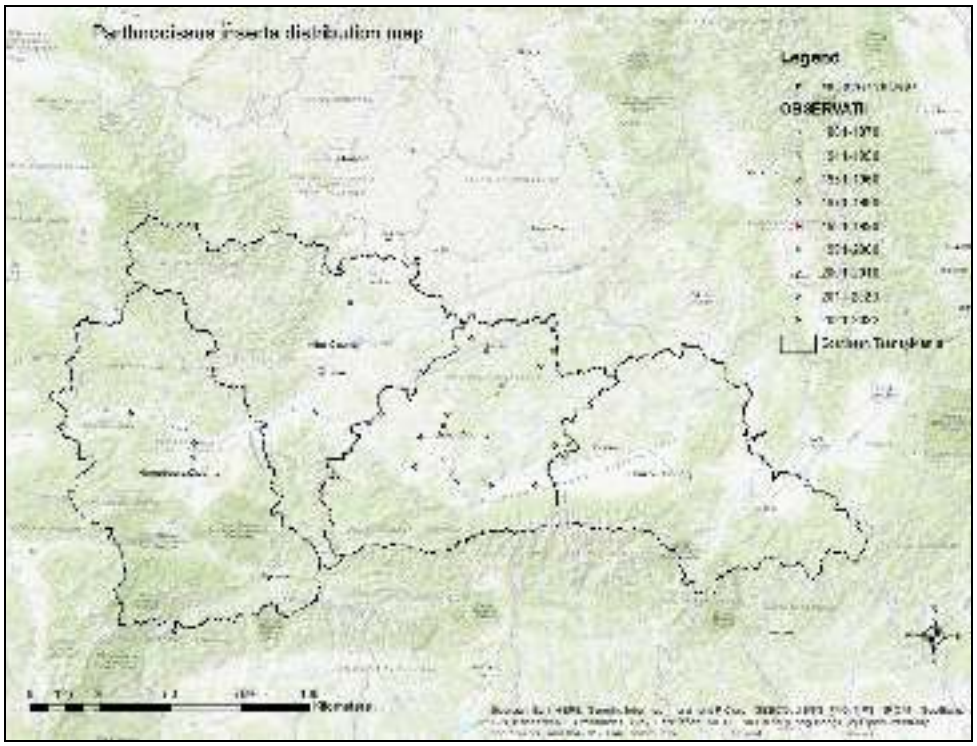


Figure 14: Distribution of *Parthenocissus inserta* in Southern Transylvania.

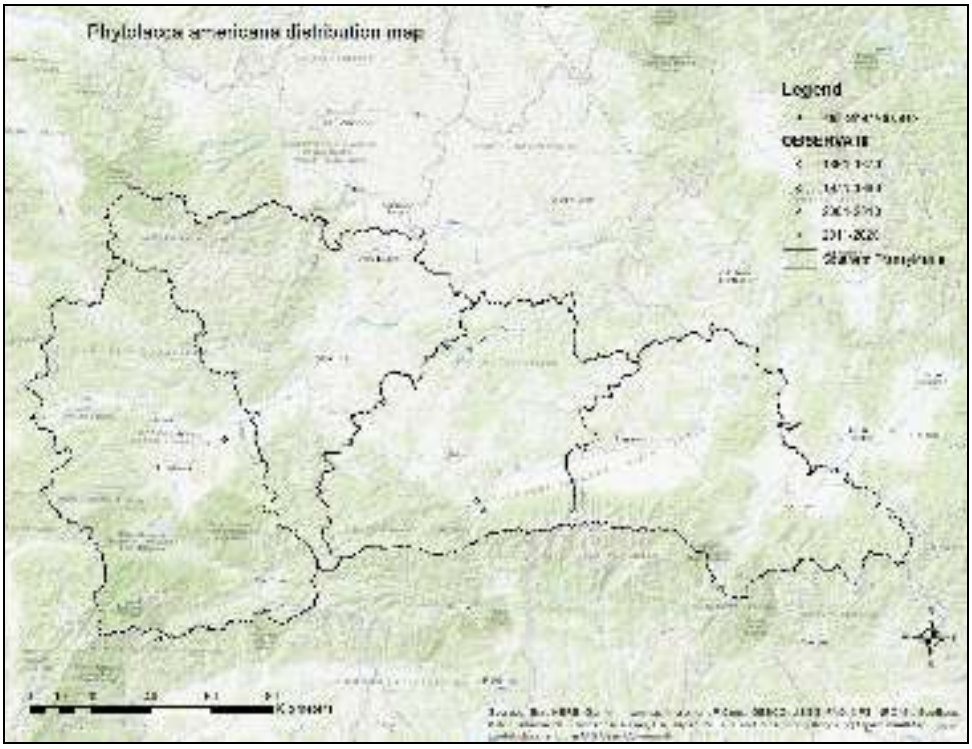


Figure 15: Distribution of *Phytolacca americana* in Southern Transylvania.

Reynoutria japonica Houtt. (Polygonum cuspidatum Sieb. et Zucc.): H(G), Adv (East Asia); $U_{3,5}$ T_3R_4, Alno-Padion, Calystegion, Salicion albae.

In the last five decades it has spread alarmingly far into river meadows. In Southern Transylvania it climbs up to 700 m asl; the distribution of *Reynoutria japonica* in the study area is presented in figure 16.

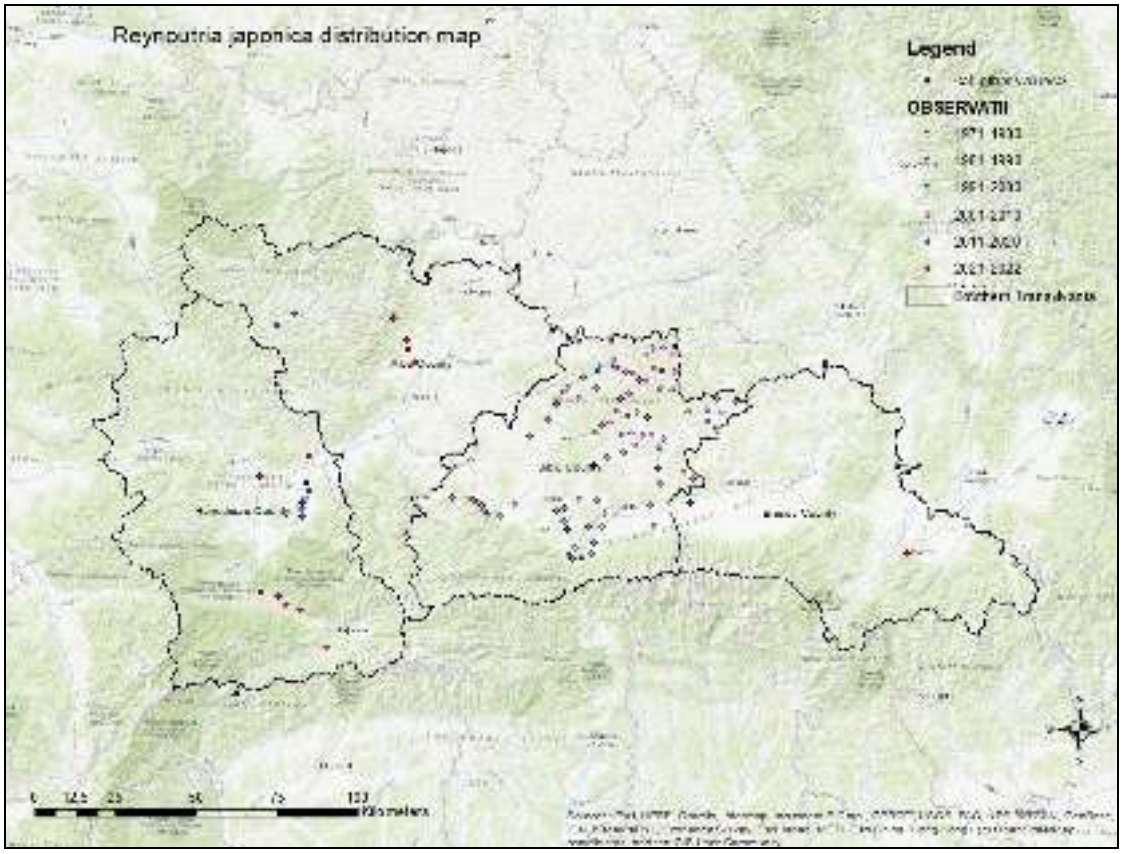


Figure 16: Distribution of *Reynoutria japonica* in Southern Transylvania.

Rudbeckia laciniata L.: H, Adv (NE America); $U_{4,5}$ $T_{3,5}$ R_4, Calystegion, Senecion fluviatilis.

Due to the number of specimens and the vast areas occupied by them between Avrig and Bradu (F. Schur, 1866), we believe that the plant became wild in the area, at the beginning of the 19th century, from the Avrig park of Baron Samuel von Brukenthal. The first record from the current territory of Romania is made by F. Fronius, 1856 from Avrig. A century later it was widespread throughout the Făgăraș Depression (T. Săvulescu, 1964).

A. Borza (1925) notes it from gardens in Sâncel, Tiur, Teiuș, Sălciua (Alba County) and Biertan (Sibiu County).

Currently, it is one of the most expansive adventive species, occupying thousands of hectares in meadows and river terraces. It climbs up to 850 m asl. The distribution of *Rudbeckia laciniata* in the study area is presented in figure 17.

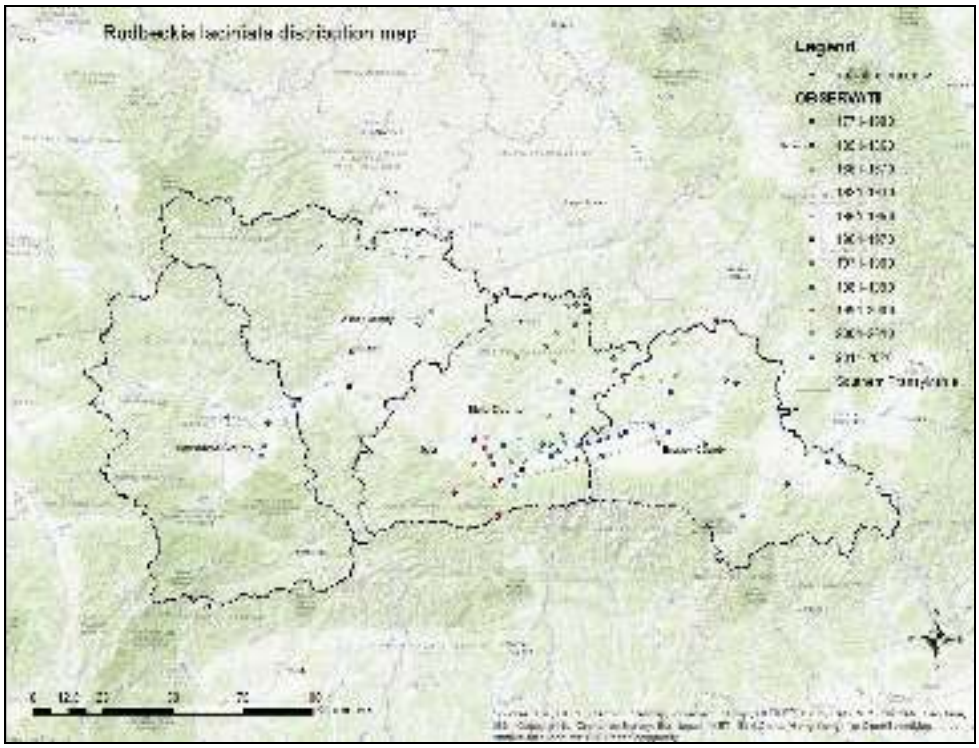


Figure 17: Distribution of *Rudbeckia laciniata* in Southern Transylvania.

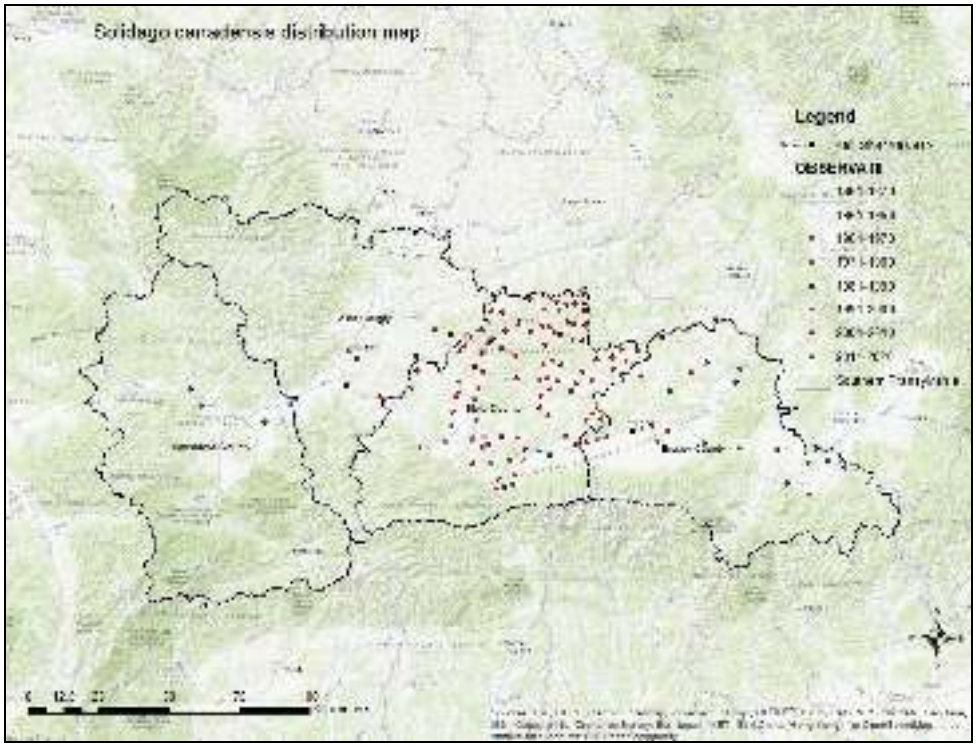


Figure 18: Distribution of *Solidago canadensis* in Southern Transylvania.

Solidago gigantea Ait. ssp serotina (Ait.) Mc Neil: H, Adv (North America); $U_{3,5}T_3R_3$, Alno-Padion, Calystegion, Salicetea purpureae.

In HGBC** there is material from Gurghiu (Mureş County) collected in 1857 by F. Porcius. The first citation from Transylvania is that of V. Borbas (1886), because the statement of I. Morariu and E. I. Nyarady (in T. Săvulescu 1964) that the first indication is that of F. Schur (1866) between Avrig and Bradu is not correct as F. Schur provides this information for the species *S. canadensis*.

The plant was, however, cultivated in the Haller Garden in Albeşti (Mureş County) where J. Baumgarten collected material in 1818 (HLGL**).

In the south of Transylvania it is less widespread than the previous species, being observed up to 650 m asl; the distribution of the species is presented in figure 19.



Figure 19: Distribution of *Solidago gigantea* in Southern Transylvania.

The 18 adventive species presented in this paper are invasive to varying degrees, reflected both by the number of crowns and by the occupied surfaces and speed with which they occupied them. Sorted according to this criterion, we get the following order from the least invasive to the most invasive: *Impatiens parviflora-Phytolacca americana – Amorpha fruticose – Parthenocisus inserta – Ailanthus altissima – Datura stramonium – Asclepias syriaca – Solidago gigantea – Impatiens glandulifera – Acer negundo – Helianthus tuberosus – Echinocystis lobata – Reynoutria japonica – Ambrosia artemisiifolia – Rudbeckia laciniata – Solidago canadensis – Erigeron canadensis – Amaranthus retroflexus.*

Some of these species have invaded river meadows changing not only their floristic structure but also the physiognomy of the phytocenoses. This is especially the case for *Solidago canadensis* and *Rudbeckia laciniata*, and fens were transformed by the infiltration of the species *Echinocystis lobata* and *Reynoutria japonica*.

CONCLUSIONS

All the studied species, which were introduced into Europe between XIV century and XIX century, are found in all of the four counties in Southern Transylvania. The rate at which humans translocate species beyond their native ranges has substantially increased during recent centuries. A wide range of motivations underlie the introduction of alien species; in the study area, the introduction pathways which predominate are escape from confinement – ornamental and horticulture – and aesthetic release into the wild.

The development of the activities of human communities, especially the exchange of products (food, floriculture, etc.), tourism, and transport also resulted in a series of changes in flora and vegetation through the appearance and spread of adventive species. The evolution of their chorology in Southern Transylvania is easier to reconstruct as a consequence of the fact that a number of botanists have been active here since the 18th (J. Baumgarten, J. Lerchenfeld, P. Sigerus, J. Eder) and 19th centuries (F. Fronius, F. Schur, M. Fuss, J. Barth, J. Römer, etc.). They provided the first information about the penetration into the flora of the region of some new, adventive species such as *Acer negundo, Ailanthus altissima, Amaranthus retroflexus, Asclepias syriaca, Erigeron canadensis, Helianthus tuberosus, Rudbeckia laciniata*, and *Solidago canadensis.*

Currently, the adventive species noted above occupy thousands of hectares in Southern Transylvania, mainly in fields and fallows (*Amaranthus retroflexus, Erigeron canadensis, Helianthus tuberosus*), in river meadows and valleys (*Solidago canadensis, Rudbeckia laciniata, Impatiens glandulifera*), abandoned vineyard terraces (*Solidago canadensis*), parks and cemeteries (*Reynoutria japonica*), even nature reserves (e.g. Șuvara Sașilior nature reserve from Tălmaciu, Sibiu County).

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