



Original article

The current status of the plant invasions in Belarus

Dmitry V. Dubovik¹, Siarhei S. Sauchuk¹, Liudmyla V. Zavalova^{2*}
¹V.F. Kuprevich Institute of Experimental Botany, NAS of Belarus, Minsk, 27 Akademicheskaya Str., 220072, Belarus

²M.G. Kholodny Institute of Botany, National Academy of Science of Ukraine, 2 Tereshchenkivska Str., Kyiv, 01004, Ukraine

E-mail address (*corresponding author): lzavalova7@gmail.com

ORCID iD: Dmitry V. Dubovik: <https://orcid.org/0000-0001-9459-3377>; Siarhei S. Sauchuk: <https://orcid.org/0000-0001-8363-716X>

Liudmyla V. Zavalova: <https://orcid.org/0000-0003-4160-1083>

ABSTRACT

This article provides a review of the current status of plant invasions in Belarus. As a result of this research into the alien flora between 2008 and 2020 a list of 52 invasive plant species that threaten biodiversity, human health, and economic has been compiled. About 300 taxa of non-native plants are currently classified as potentially invasive. The list of invasive plant species has been proposed in this article in accordance with trends in the invasive processes is the basis for the monitoring and management of plant invasions in Belarus. The preliminary data from the previous field seasons showed a significant increase in the population abundance and distribution of *Swida alba*, *Rudbeckia laciniata* and *Artemisia abrotanum*. Enrichment of the flora occurs due to the introduction of aggressive plants. Hybridization between native and alien plant species leads to the appearance of hybrids, which often have an invasive potential, and can invade not only disturbed habitats but also natural plant communities. The invasive properties, expansion, and aggressive behavior of these invasive plants of the alien flora of Belarus has led to significant, often irreversible, changes in the natural vegetation and vegetation cover. Invasive species such as *Solidago canadensis*, *S. gigantea*, *Echinocystis lobata*, *Impatiens glandulifera* are marked by rapid expansion over past decades, and *Heracleum sosnowskyi*, *Solidago canadensis*, *S. gigantea*, *Echinocystis lobata*, *Impatiens parviflora*, *Acer negundo*, *Robinia pseudoacacia*, *Bidens frondosa*, have invaded more recently.

KEY WORDS: invasive alien species, flora, synanthropization, Black Data Book of Belarus, Belarus

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1. Introduction

Much attention has been paid to the problem of biological invasions in Belarus and neighbouring countries in recent years (VINOGRADOVA ET AL., 2010, 2018; BURDA & IGNATYUK, 2011; TOKARSKA-GUZIK ET AL., 2012; ZAVIALOVA, 2017; PROTOPOPOVA & SHEVERA, 2019; ALIEN SPECIES..., 2021). The introduction of alien species into the natural environment of Belarus is taking place at a very rapid pace and these species play an increasing role in the formation and development of the vegetation cover. Their influence on the native species of flora is becoming more and more obvious, and their impact on human economic activity is becoming more and more costly. These species are noxious weeds, which

are very difficult to control, cause chemical burns and allergic reactions, significantly degrade the quality of forage lands, recreational opportunities of natural areas. The entry (or invasion) of alien species into the territory of Belarus is largely due to human economic activity. These invasive processes have accelerated due to global warming, intensification of commerce and other relationships with various countries, and the growth of traffic flow. In addition, the role of Belarus as a transit country has also increased: due to growth in the movement of cargo flows, transport, population migrations, and the entry of new invasive plant species has significantly intensified both directly with transport (road, railway, river) and with the movement of goods.

One of the main types of anthropogenic activity directly contributing to the rapid entry and naturalization of invasive plants in Belarus in recent years is the introduction of agricultural and ornamental species. In connection with the growing popularity of cultivation of new species of ornamental, fruit and other useful plants in recent years, new species of introduced plants have appeared in connection with this cultivation. Some of these have been found in a feral state not only near cultivation sites, but some have been able to successfully enter natural plant communities. Thus, over the past decades, there has been a rapid expansion of such alien species as *Solidago canadensis*, *S. gigantea*, *Echinocystis lobata*, *Impatiens glandulifera*, *Swida alba*, *Rudbeckia laciniata*. These were previously introduced, or escaped from cultivation, and these species now form monodominant communities and currently create serious competition for native flora.

Another important way of entry of invasive species into the country is via passive dispersal by water (hydrochory) and by ornithochory and is very significant for some species such as *Elodea canadensis*, *E. nuttallii*, *Xanthium albinum*, *Bidens connata*, *B. frondosa*, *Phragmites altissimus*. The largest area of the way of entry by water is the migration corridor had formed by rivers Dnieper, Pripyat, Vistula, and Dnieper – Bug Channel. Basically, this is the way of entry of alien species from the Black Sea Basin into the Baltic Sea Basin.

The most aggressive invasive species – which are commonly named "transformers" (RICHARDSON ET AL., 2000; GELTMAN, 2006), have changed the structure of natural plant communities in some places to such an extent that they act as edificators and dominants in them, and often form monodominant communities. Alien invasive species which come into contact with populations of native plant species, transform the structure of biocoenoses and their appearance has not only regional but also global ecological, economic and social consequences. In recent years, the rapid distribution of the most noxious invasive plant species such as *Heracleum sosnowskyi*, *Solidago canadensis*, *S. gigantea*, *Echinocystis lobata*, *Impatiens parviflora*, *Acer negundo*, *Robinia pseudoacacia*, *Bidens frondosa*, and others have been lead to a radical transformation of phytocoenoses.

In the coming years, a similar situation with the consolidation and wide distribution within the country could occur with such species as *Reynoutria xbohemica*, *Geum macrophyllum*, *Bidens connata*, *Padus serotina*. These and other species are characterized by their rapid rates of dispersal and a very short period of transition from the lag

phase (primary appearance) to development in the plant coenoses. The naturalization period under new conditions is very short and does not require the change of many generations, which emphasizes their clearly expressed invasive abilities.

2. Materials and methods

2.1. Study area

An inventory of the alien flora of Belarus was undertaken between 2008–2020 throughout the territory of the country. In our field research we covered almost all administrative regions of Belarus, and visited most of these again in different seasons. The Republic of Belarus is located in the temperate zone of the central part of Europe. The area of the country is 207.6 thousand km², the surface is flat with fluctuations in heights between 80–345 m above sea level. There are some uplands in the central, western and northern parts of the country. The low relief is characterized by Belarusian Polesie. The climate is temperate and continental, the average annual air temperature varies from 4.5 °C in the Northeast to 7.0 °C in the Southwest. The growing season lasts from 185 to 205 days. During the year there is between 600–750 mm of precipitation. The northern and central regions have highest humidity, and the southern and southeastern regions are more arid, and are sometimes characterized by droughts. The rivers belong to the basins of the Black and Baltic Seas. The largest rivers are the Dnieper, Pripyat, Neman, Western Dvina and there are also about 10,000 lakes. There are predominantly sod-podzolic soils, and these are often swampy, usually sandy or clayey, or peat-boggy in texture. The forest cover of the country's territory is about 40 %, two large biomes intersect here – the Eurasian coniferous forest (taiga) and the Palearctic European broadleaf forests (FLORA OF BELARUS ..., 2009).

2.2. Materials and methods

The study of the invasive component of the alien flora of Belarus and the collection of material was carried out by such methods as the reconnaissance survey, the detailed strip survey, and the method of sample plots (FIELD GEOBOTANY, 1964; BURDA & IGNATYUK, 2011). The field description of a specific population began with a description of the location of the research object. Then the geographical coordinates of the locality were determined. Also the administrative-territorial and administrative-economic addresses were determined in accordance with cartographic materials. The date of the relevés

and its authors were indicated. All the materials obtained were recorded into passports (as the description forms) specially developed for these purposes, which reflected the ecological and phytosociological characteristics of the species. The population size, density, projective cover, and the composition of phytocoenoses was described. When identifying invasive and potentially invasive plant species, we took into account the timing of the initial registration of the taxon in the flora of Belarus, their natural range (if possible) and the degree of invasiveness.

In the selection of administrative districts for the study of the invasive component of the alien flora of Belarus, priority was given have been floristic poorly studied and are currently largely anthropogenic developed areas. During the research of the invasive component, landfill sites (urban, township and others), railway stations, parks, American cranberry plantations (large-fruited) were visited, and special attention was paid to highways, wastelands, quarries, and other disturbed habitats. If necessary, herbarium data were collected to clarify the systematic affiliation of the taxon, as well as mapping their locations within Belarus. Herbarium material was collected according to standard methods (SKVOTSOV, 1977).

For the reconstruction of the distribution of the primary point of entry and invasion into semi-natural, or natural, plant communities and realization of a particular species' invasiveness herbarium collections were also studied. Those used were: V.F. Kuprevich Institute of Experimental Botany (MSK), Belarusian State University (MSKU), University of Warsaw (WA), W. Szafer Institute of Botany PAS (KRAM), Lomonosov Moscow State University (MW), Komarov Botanical Institute RAS (LE), Vilnius University (WI), and M.G. Kholodny Institute of Botany NAS of Ukraine (KW).

The data in the literature on various investigations of alien fractions of the flora of Belarus, and neighboring countries, was consulted to establish the periods of their introduction and primary entry. The nature of distribution and frequency of occurrence in Belarus (and abroad) were also studied. Taxonomy of the species is according to Tropicos (<https://www.tropicos.org/home>) with modification.

3. Results and discussion

Our studies from previous years (DUBOVİK ET AL., 2012; AGGRESSIVE PLANTS ..., 2017; DUBOVİK, 2019; THE BLACK DATA BOOK ..., 2020) made it possible to compile a list of invasive, and potentially invasive, species and this included more than 330

taxa. Among these, 52 species (Table 1) are aggressive and are recognized as invasive (THE BLACK DATA BOOK ..., 2020).

All these plant species are widespread, have a large population abundance, and intensively reproduce, mostly forming a seed bank, and causing invasions in disturbed and natural plant biotopes. More than 30 of these species are extremely aggressive and belong to the category of transformer species. In Central Russia, for comparison, 52 species have been recognized as invasive (VINOGRADOVA ET AL., 2010, 2018).

Due to the high invasiveness and rapid dispersal of other alien species this list of phytointvasions in Belarus will undoubtedly be corrected in the future. Such corrections of the invasive species list in the future will occur primarily due to the potentially invasive plants, which are not yet considered to be dangerous as the transformers species but exhibit the ability of active dispersal.

From the category of invasive plants, 8 species were not recorded in Belarus until 1780 (from the first publication and the appearance of herbarium collections from the territory of the country), 5 were documented between 1780 to 1850, 11 – from 1851 to 1900, 14 – from 1901 to 1950 and 14 after 1950. Based on the analysis of these data, the process of synanthropization of the flora of Belarus has intensified and has continued to intensify in recent decades. It has occurred especially actively in the period after 1970 (Fig. 1). This is thought to be due to the development of industry and agriculture, transport infrastructure, and increased interest in the populations of these introduced plant species.

The main role of aggressive weeds in the enrichment of the Belarus flora is played by plants from North America and 26 species of these invasive species originate from here (Fig. 2). Of these, *Galinsoga quadrisulcata* is also found in South America. Nine species of invasive plants originate from Asia and some regions of Europe outside Belarus; 4 species originate from Eurasia (their natural range is remote from the territory of this country); 6 species are hybrid in origin. For three out of nine species of European origin, the place of origin and the primary range is currently not reliably clarified. These are such plants as *Oenothera biennis*, *O. rubricaulis* and *Xanthium albinum*. They probably arose as a result of hybridization and microevolutionary processes in Central and Western Europe and only then began to actively distribute throughout the continent. A similar situation has been observed with *Eragrostis albensis* H. Scholz, which was described from Germany in 1995, but is now noted in almost the entire continent with the exception of the northern regions.

Table 1. List of the invasive alien plant species and the time of their first registration in Belarus

Family	Invasive plant species in Belarus	Years of the first registration in Belarus (The Black Data Book ..., 2020)
Araceae	<i>Acorus calamus</i> L.	There is no data
Hydrocharitaceae	<i>Elodea canadensis</i> Michx.	1901
	<i>Elodea nuttallii</i> (Planch.) H.St. John	1964
Poaceae	<i>Festuca trachyphylla</i> (Hack.) Krajina	1969
	<i>Schedonorus arundinaceus</i> (Schreb.) Dumort= <i>Lolium arundinaceum</i> (Schreb.) Darbysh.	1920–1930
	<i>Phragmites altissimus</i> (Benth.) Mabilie= <i>Phragmites australis</i> subsp. <i>isiacus</i> (Arcang.) ined.	2000
	<i>Zizania latifolia</i> (Griseb.) Hance ex F.Muell.	1966
Aceraceae	<i>Acer negundo</i> L.	1853
Adoxaceae	<i>Sambucus nigra</i> L.	18 th century
	<i>Sambucus racemosa</i> L.	The end of 17 th century
Apiaceae	<i>Archangelica officinalis</i> Hoffm.= <i>Angelica archangelica</i> L.	18 th century
	<i>Heracleum mantegazzianum</i> Sommier et Levier	1960–1970
	<i>Heracleum sosnowskyi</i> Manden.	1960–1970
Asclepiadaceae	<i>Asclepias syriaca</i> L.	The first half 19 th century
Asteraceae	<i>Ambrosia artemisiifolia</i> L.	1973
	<i>Bidens connata</i> Muehl. ex Willd.	1973
	<i>Bidens frondosa</i> L.	1955
	<i>Erechtites hieraciifolius</i> (L.) Raf. ex DC.	2002
	<i>Erigeron annuus</i> (L.) Desf.	1903
	<i>Galinsoga parviflora</i> Cav.	1862
	<i>Galinsoga quadriradiata</i> Ruiz & Pav.	Middle of 20 th century
	<i>Helianthus tuberosus</i> L.	The first half 19 th century
	<i>Cyclachaena xanthiifolia</i> (Nutt.) Fresen.	1946
	<i>Petasites hybridus</i> (L.) Gaertn.	1779
	<i>Solidago canadensis</i> L.	Middle of 20 th century
	<i>Solidago gigantea</i> Aiton	Middle of 20 th century
	<i>Symphyotrichum novi-belgii</i> (L.) G.L.Nesom	The early 20 th century
	<i>Symphyotrichum salignum</i> (Willd.) G.L.Nesom	The early 20 th century
	<i>Symphyotrichum ×versicolor</i> (Willd.) G.L.Nesom	1980–1990
	<i>Xanthium albinum</i> (Widd.) H. Scholz	1964
Balsaminaceae	<i>Impatiens glandulifera</i> Royle.	1920–1930
	<i>Impatiens parviflora</i> DC.	1950
Cucurbitaceae	<i>Echinocystis lobata</i> (Michx.) Torr. & A.Grey	1863
Elaeagnaceae	<i>Hippophaë rhamnoides</i> L.	1940
Fabaceae	<i>Lupinus polyphyllus</i> Lindl.	1960
	<i>Robinia pseudoacacia</i> L.	The early 20 th century
	<i>Sarothamnus scoparius</i> (L.) Koch	The end of 19 th century – the early 20 th century
Fagaceae	<i>Quercus rubra</i> L.	Before the 19 th century
Onagraceae	<i>Epilobium adenocaulon</i> Hausskn. (incl. <i>E. pseudorubescens</i> Skvortz.)	1877–1881
	<i>Oenothera biennis</i> L.	Before the 18 th century
	<i>Oenothera rubricaulis</i> Klebahn	1893
Polygonaceae	<i>Reynoutria ×bohemica</i> Chrtek & Chrtkova	The first half 20 th century
	<i>Reynoutria japonica</i> Houtt.	The early 20 th century
	<i>Reynoutria sachalinensis</i> (F. Schmidt ex Maxim.) Nakai	1926
	<i>Rumex confertus</i> Willd.	1909
Rosaceae	<i>Amelanchier spicata</i> (Lam.) C. Koch	The early 19 th century
	<i>Padus serotina</i> (Ehrh.) Borkh.	1960
	<i>Sorbaria sorbifolia</i> (L.) A.Br.	The end of 19 th century
	× <i>Sorbaronia mitschurinii</i> (A.K. Skvortsov et Maitul.) Sennikov	After 1970
Rubiaceae	<i>Geum macrophyllum</i> Willd.	1991
Salicaceae	<i>Populus alba</i> L. (incl. <i>P. ×canescens</i> (Aiton) Smith)	18 th century
Vitaceae	<i>Parthenocissus inserta</i> (A.Kern.) Fritsch	18 th century

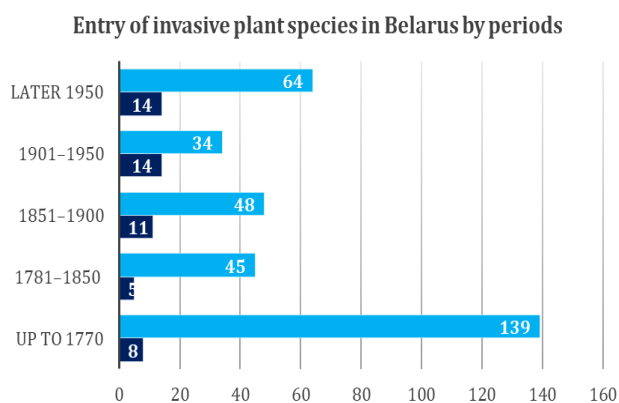


Fig. 1. The invasive and potentially invasive plant species of Belarus by their periods of entry

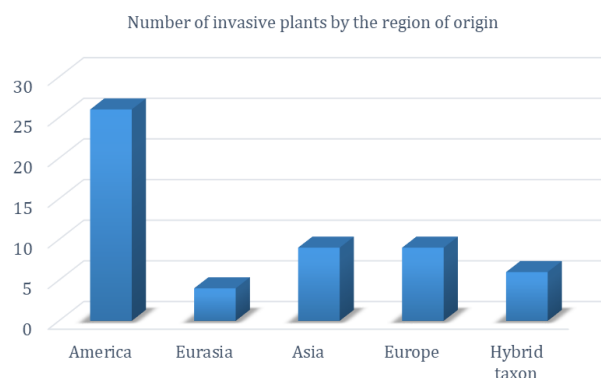


Fig. 2. Natural area (origin) of the invasive plant species of Belarus

Due to the high invasiveness and rapid dispersal of alien species in recent decades, we have selected potentially invasive species, which we call slightly aggressive from this list. Today, there are about 300 such taxa in the flora of the country. They are not as yet considered to be dangerous like, for example, transformer species, which change the structure of plant communities, but show the ability to settle independently. However, different biological features of some invasive species were found in different administrative regions of the country. This is mainly due to differences in natural conditions, and to the historical, cultural and economic development of the territories. Therefore, further monitoring is required and it is also possible to assess the impact of these conditions on the characteristics of plant invasions.

We analyzed the lists of alien plants of Belarus regions and the plant invasion species lists of the neighboring countries (Latvia; Lithuania; Poland; Ukraine; Russian Federation: Bryansk, Smolensk, and Pskov regions) for the determination of the invasive status of an alien species. More distant regions with similar climatic conditions were also taken into account. In the study of invasive plant species, the main focus was paid to the frequency of their occurrence, the degree of invasiveness

towards the aboriginal fraction of the flora, and the area they occupy. The fact of their rapid entry into disturbed and natural phytocoenoses, and the degree of their fixation was also taken into account.

Many species of the alien flora of Belarus are invasive with the highest degrees of naturalization in neighboring countries: Russia (VINOGRADOVA ET AL., 2010, 2018), Poland (TOKARSKA-GUZIŁ ET AL., 2012) and Ukraine (ZAVIALOVA, 2017; PROTOPOPOVA & SHEVERA, 2019). Some of these species also have the highest degrees of naturalization in Belarus, but do not show aggressive properties in the country. For example, such widespread agriophytes in the central regions of the European part of the Russian Federation as *Juncus tenuis* Willd. s.l. and *Lepidotheca suaveolens* (Pursh) Nutt. have not yet shown their invasiveness in Belarus. This is due to the natural conditions of the region, the peculiarities of farming, the competitive relationship of species and others. The appearances of potentially invasive plant species over their years in Belarus were as follows: 139 species before 1770; from 1771–1850 – 45; from 1851–1900 – 48; from 1901 to 1950 – 34; after 1951 – 64 (Fig. 1).

Most of the potentially invasive plant species are archaeophytes (139 species) and are recorded from 1770 (since the first floristic research in Belarus). The degree of their naturalization is different, but some of them have been noxious weeds for a long time (*Melandrium album* (Mill.) Garcke, *Echinochloa crus-galli* (L.) P. Beauv., *Spergula arvensis* L., *Stellaria media* (L.) Vill., *Chenopodium album* L., *Fallopia convolvulus* (L.) A. Love, *Convolvulus arvensis* L., and some others).

Between 1770 and 1950, about 40 aggressive alien plant species appeared (Fig. 1). A sharp surge in the appearance of aggressive alien plants occurred after 1950, when 64 taxa were recorded. This was due to the intensification of the economic development, the forming of the transport network, broader economic relationships between Belarus and other regions of the world, and high rates of plant introduction. The process of introduction of plants intensified especially after 1970.

By the geographical origin (Fig. 3), potentially invasive plant species of the flora of Belarus are natives of Eurasia (some of them entered from North Africa) – 118 taxa; from North America – 57 (of which one species enters South America); Asia – 47; Europe – 38; Mediterranean (including northern Africa) – 35; Europe and North America – 2; North America and Asia – 1. In addition, 32 taxa are interspecific hybrids (Fig. 3).

Number of the potentially invasive plants of Belarus by the region of origin

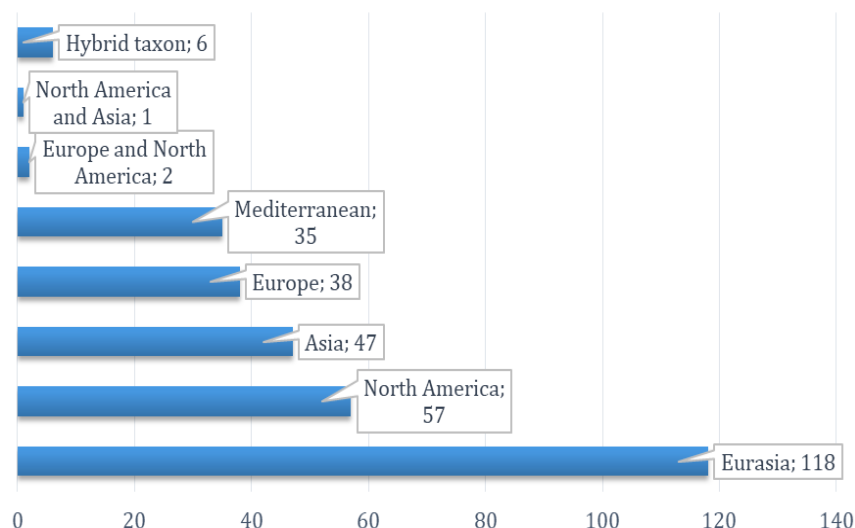


Fig. 3. Natural area (origin) of the potentially invasive plant species of Belarus

Most of the potentially invasive plant species came to Belarus from different regions of Eurasia and North America. Therefore, in the future, special attention should be paid to non-native plants of these regions during the first records of their escape from epy places of cultivation and widespread in the country. The early detection and prediction of the potential distribution of these species are the rapid response and the basis of the management of plant invasions. Special attention should be paid to newly introduced plants that come from the same regions. They must go through a long period of primary introduction in botanical gardens, where they must be closely monitored for their aggressive properties, and only in the absence of such can they be recommended for wider cultivation in the country. Spontaneous introduction of species into local populations is highly undesirable.

We observed the behavior of some invasive plant species in the regions adjacent to Belarus in Poland, Lithuania, Latvia, Ukraine, the Russian Federation (Pskov and Smolensk regions) in order to find out the nature of their aggressiveness in the border areas and the possibilities of their migration into the transboundary region.

The degree of naturalization of invasive plant species is not always the same. Therefore, the control methods and management of phyt invasion should take into account the degree of naturalization of invasive plant species. Out of 52 invasive plants, only about 20 – 30 pose a serious threat to biological diversity and humans.

Strong allergic reactions in humans are caused by *Ambrosia artemisiifolia* and *Cyclachena xantiifolia*. The massive dispersal of the latter species in the south of the country (especially in the Gomel

region) has been caused by an increase in both the growing season there in recent years and a longer alternation of dry periods, although in general both species are not widespread in Belarus. They were included in the list of invasive species due to their allergenic properties and the fact of their recognition as quarantine plants in the country.

According to our studies, several more taxa should be added to the existing list of invasive plants that were not previously assigned to this category. These were able to move from the category of potentially invasive to invasive in a relatively short period of time, and refers to *Swida alba* (L.) Opiz, *Rudbeckia laciniata* L. (its non-double-flowering form), and *Artemisia abrotanum* L. (Fig. 4). Their characteristics are as follows: the rapid growth of the population abundance and distribution, the invasion of various semi-natural and natural types of habitats mostly.

Swida alba has been used as a rapidly growing ornamental shrub for many decades, but this species has been actively distributing into floodplains and along the edges of damp forests over the past 10–15 years very rapidly. Probably, its fruits are actively eaten by birds and thus the plants are dispersed over long distances.

Artemisia abrotanum – is another example of rapid distribution in floodplain biotopes. This species now forms vast thickets, with an area of up to several hectares, in the floodplains of the Sozh and Dnieper rivers in the Gomel Oblast (Fig. 4), and its expansion began in the lower reaches of the River Pripyat. It rapidly displaces the plant communities of grassy vegetation and inhabits biotopes of sand dunes and sand deposits in floodplains. Due to the invasion of *Artemisia*

abrotanum in floodplain habitats become unsuitable for use as hay meadows and pastures, and are of little use for habitation by many bird species, especially rare species of waders.

Rudbeckia laciniata has been actively spreading in recent years near cultivation sites and especially along damp habitats in black alder forests and on their edges, along rivers. It successfully produces seeds that germinate well. In contrast to this form, cultivars with double flowers currently do not show aggressive properties and reproduce only vegetatively and the rate of increase of their populations is rather slow.

One of the typical examples of the very rapid spread of alien plant species in Belarus and Ukraine is of the North American species *Erechtites hieraciifolius* (Fig. 5). Currently, it is known in Eastern Europe only within Ukraine and Belarus and during the period between 2002 and 2011 more than 37 localities of *Erechtites hieraciifolius* were found (TRETAKOV ET. AL., 2011). Our data indicate that after a slow initial entry into the Ukrainian Polissia, an active stage of expansion of *Erechtites hieraciifolius* has already begun both in Ukraine and in Belarus, and its appearance is expected next in Russia. The active expansion of this species continues in northern and eastern directions, and it has already reached the Mogilev Oblast and areas of the Gomel Oblast bordering Russia.



Fig. 4. *Artemisia abrotanum* L. in the floodplain of the River Sozh



Fig. 5. *Erechtites hieraciifolius* (L.) Raf. ex DC. in Gomel Oblast of Belarus

The main contribution in the enrichment of the flora of Belarus, including aggressive invasive plants, is played by the introduction of ornamental and agricultural plants. After an intensive period of summer cottage construction (from the beginning of the 1990s), the emergence of a large number of amateur flower growers, collectors of garden plants, the availability of seed and planting material from Western and Central Europe, and Russia, a lot of new plants spontaneously appeared in a relatively short historical period time. Their diversity has increased many times over several decades, and some of these introduced species have been found in a feral state not only near cultivation sites, but they have also been able to successfully enter natural plant communities. In fact, before our very eyes, irreversible and very rapid changes have taken place in the development of the flora of the country.

The rapid naturalization of some ergasiophytes has occurred over a short period of time. Until recently, these species were only grown domestically, but after only a few years were found in ruderal habitats. Therefore, the problem of such species which have escaped from cultivation has recently attracted more and more attention. The number of ergasiophytes in the alien flora continues to increase. Many of them naturalize, quickly overcoming the phytocoenotic barrier and become invasive. Typical examples of the rapid expansion of ergasiophytes in Belarus are: *Solidago canadensis*, *Echynocystis lobata*, *Impatiens glandulifera*. Most often, we begin to study these species only when they become invasive. We usually let through the period of their adaptation to the new climatic conditions of our territory and naturalization after their frequent "escape" from cultivation, which can continue for decades. Any introduction of new plant species should be accompanied by many years of testing in cultivation by horticulturalists in botanical gardens. The main requirements for the further use of introduced plants outside botanical gardens are the scientific substantiation of their use in the environmental conditions of Belarus and associated recommendations for the quarantine measures in cases of phytointvasions. Such measures must be developed to prevent harm to the environment and human health. With introduced plants, their various associated pests and diseases, are often even more dangerous than the plants themselves, by invading the country, or the plants themselves can be carriers of certain diseases. Subsequently, huge funds are spent on combating these pests and diseases.

The active distribution of alien plant species, for example *Bidens frondosa* and *Lupinus polyphyllus* (Figs. 6–7), requires special attention and control.

Continuous monitoring studies of the behavior and distribution of invasive species, including a thorough analysis of their behavior and the rate of distribution in the territories adjacent to Belarus, are required, which will make it possible to predict their undesirable ways of entry and establishment.



Fig. 6. *Bidens frondosa* L. in the floodplain of the River Dnieper in Belarus



Fig. 7. Monodominant communities of *Lupinus polyphyllus* Lindl. at the forest edge in the Vitebsk Oblast of Belarus

One of the important aspects of the study of invasive plants was the clarification of the taxonomic position of some systematically difficult groups. In particular, we found that part of the populations of giant hogweed, which in the botanical literature of Belarus is usually named the Sosnovsky hogweed (*Heracleum sosnowskyi*), is represented by hybrid individuals between *H. sosnowskyi* and *H. mantegazzianum*. For example, in the vicinity of Vitebsk, along with rather typical specimens of *H. sosnowskyi* (which has relatively blunt and rounded leaf lobes), numerous specimens with leaves with pointed lobes and more strongly dissected leaf blades, which are characteristic of *H. mantegazzianum*, are noted. We classified these plants as hybrids between *H. sosnowskyi* and *H. mantegazzianum*. They are probably more aggressive in Belarus, compared to the parent species, at least more aggressive than *H. mantegazzianum*,

which is typically rare and does not exhibit such aggressive properties as *H. sosnowskyi*. It was noted that hybrids of hogweed behave more aggressively, in comparison with *Heracleum sosnowskyi* and within the National Park "Braslav Lakes", where it is noted not only along roadsides, wastelands, meadows, lake shores, but also it invades forests, and along forest roads, even in mossy pine forests. This hybrid is very aggressive in the vicinity of Vitebsk, where it successfully settles along roads, along river valleys, and often enters the neighbouring forest biotopes.

4. Conclusions

As a result of this research in Belarus, a group of invasive plants with 52 species (including hybrids) has been recognized and about 300 taxa have so far been classified as potentially invasive plants. In the future, it is planned to adjust the lists of invasive and potentially invasive plants, depending on the nature of the species' behaviour over a specific historical period. Not all of the invasive and potentially invasive plants behave with the same degrees of naturalization and invasiveness within Belarus, despite the relatively small territory of the country in terms of its area and natural conditions. It depends on the local ecological and environmental conditions, the degree of anthropogenic development of the territory, the presence of propagules, and the measures used to control invasive plants. Currently, the country is taking active measures to destroy populations of giant hogweed. In addition to two species of giant hogweed at the moment in Belarus, there are 7 species (*Solidago canadensis*, *S. gigantea*, *Acer negundo*, *Cannabis sativa* L., *Papaver somniferum* L., *Robinia pseudoacacia*, *Echinocystis lobata*) which belong to the category of plants that are subject to regulation. In future, it is planned to continue work on the study of invasive and potentially invasive plants in the flora of Belarus. The Law of the Republic of Belarus "on the plant world" contains article 26 "Regulation of the distribution and number of plants of certain species". The regulation of the number of certain species and the measures are determined by the Ministry of Natural Resources and Environmental Protection of the Republic of Belarus in agreement with the National Academy of Sciences of Belarus. According to the resolution of the Council of Ministers of the Republic of Belarus (dated December 7, 2016 No. 1002), 9 species are classified as plants subject to regulation: *Heracleum sosnowskyi*, *H. mantegazzianum*, *Solidago canadensis*, *S. gigantea*, *Acer negundo*, *Cannabis sativa* L., *Papaver somniferum* L., *Robinia pseudoacacia*,

Echinocystis lobata. Of all the invasive species, the most active control measures in Belarus are carried out only with Sosnowski's hogweed.

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