East Asian Species in Alien Flora of European Russia

Olga V. Morozova

Olga V. Morozova *
e-mail: olvasmor@mail.ru

Institute of Geography RAS, Moscow, Russia

* corresponding author

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ABSTRACT

Plants of East Asian origin are the important group of species introduced to many regions of the world; three of them are among 100 most widespread invasive species in Europe. Due to geographical location and vast territory of the region of European Russia, which borders with Asia and spreads across a wide range of climatic and vegetation zones, it can be considered as a transitional area between Europe and Asia. One hundred and six East Asian species comprise the second biggest group in the species pool of aliens to whole territory of European Russia and make about 5.8 % of the total number of its alien plants. Invasive status of species was assessed for different regions; it may vary depending of geographical location of the species pool. Summarizing the data by regions alien flora of East Asian origin includes about 60 % of casual species, 30 % of naturalized and 10 % are considered to be the invasive species. The majority of East Asian species (79) were brought to European Russia deliberately; the history of their introduction was similar to that in other European countries. Forty two species of them have naturalized. Twenty three species of East Asian origin were accidentally introduced, and five of them have naturalized. Some East Asian species appeared in European Russia by chance may be transported across the territory of European Russia further to Europe. Of eleven East Asian invasive species in European Russia *Rosa rugosa* occupied preferably the coast of the Baltic Sea, *Reynoutria japonica*, *R. sachalinensis*, *Sorbaria sorbifolia* and *Hordeum jubatum* – the Central regions of Russia, *Ulmus pumila*, *Zizania latifolia*, *Cotoneaster lucidum*, *Hemerocallis fulva*, *Morus alba* and *Monochoria korsakowii* – the southern areas of European Russia.

Keywords

alien plants, biological invasions, East Asia, European Russia, invasive status

РЕЗЮМЕ

Морозова О.В. Восточноазиатские виды в чужеродной флоре Европейской России

Восточноазиатские виды составляют одну из значимых групп растений, заносимых во многие регионы мира; три вида из их числа входят в список 100 наиболее распространенных инвазивных видов Европы. Благодаря географическому положению, значительной по протяженности территории и общей границе с Азией, а также широкому диапазону климатических и растительных зон и историческим связям с Азией, Европейская Россия (ЕР) представляет собой переходную зону между Европой и Азией. 106 видов восточноазиатского происхождения являются второй по численности группой среди видов полностью чужеродных для ЕР и составляют 5.8 % от всего пула чужеродных видов региона. Степень натурализации видов оценена для отдельных областей и меняется в зависимости от их географического положения. Суммируя данные по областям ЕР, среди восточноазиатских видов отмечено около 60 % случайных видов, 30 % натурализовавшихся и 10 % инвазивных. Большинство восточноазиатских видов (79) занесены преднамеренно, и история их интродукции на территории ЕР аналогична их появлению в европейских странах, 42 вида из них натурализовались. 23 восточноазиатских вида – случайно занесенные, 5 из них натурализовались. Некоторые восточноазиатские виды с непреднамеренным способом заноса могут быть «транспортированы» далее в Европу. Из 11 восточноазиатских видов инвазивных на территории ЕР *Reynoutria japonica*, *R. sachalinensis*, *Sorbaria sorbifolia* и *Hordeum jubatum* расселились в основном в областях Средней России, *Ulmus pumila*, *Zizania latifolia*, *Cotoneaster lucidum*, *Hemerocallis fulva*, *Morus alba* и *Monochoria korsakowii* – в южных регионах ЕР, а *Rosa rugosa* – на побережье Балтийского моря.

Ключевые слова

чужеродные растения, биологические инвазии, Восточная Азия, Европейская Россия, степень натурализации

INTRODUCTION

Alien species are one of the major factors of global environmental change and are considered one of the most important threats to biodiversity worldwide (Simberloff 1997, Vitousek et al. 1997, Mack et al. 2000, Pyšek & Richardson 2006). Global species exchange supposed human-mediated immigration of species from various continents by different pathways (Mack 2003, Carlton & Ruiz 2005, Hulme et al. 2008) resulting the biotic homogenization across the globe as one of the consequences (Olden & Poff 2003, Qian & Ricklefs 2006, Stohlgren et al. 2011). All parts of the world except Antarctic proved to be providers of aliens, but America, Asia and Europe have served as important donor areas of alien species to various regions (Prinzing et al. 2002, Fridley 2008, Lambdon et al. 2008, Morozova et al. 2008, Phillips et al. 2010, Jiang et al. 2011).

Species of Asian origin contribute a considerable part in alien floras of many countries and continents. They prevail in alien floras of Europe (Lambdon et al. 2008) and of eastern part of United States (Friedley 2008). Usually, Asia was regarded in the whole in determining an area of species origin and as a donor region (Lambdon et al. 2008, Pyšek et al. 2012), despite the fact that its parts differ by environments and are source areas of different plant groups. East Asia as an Asian part is characterized by great diversity of climate conditions, great species number and by different centers of diversification for various plants' groups (Takhtajan 1978, Qian & Ricklefs 2000, Qian 2002), which may be invasive beyond their native ranges. For instance, the mountains of China and the Himalayas are the origin of most cultivated and naturalizing *Cotoneaster* species (Dickoré & Kasparek 2010). In addition, recent decades are marked by the growth of trade relations and the trade turnover with some East Asian countries, especially with China, which is characterized by the rapid economic development; all this may promote the appearance and the subsequent spread of new alien species from this region (Weber et al. 2008).

According to the recent review based on DAISIE project (Lambdon et al. 2008) several East Asian plant species are successful invaders in many European countries, and three of them (*Reynoutria japonica*, *Rosa rugosa* and *Ailanthus altissima*) are included in the list of 100 of the most invasive alien species in Europe. Presence of the species was recorded in almost all European countries; however, data from the European part of Russia (European Russia) are absent. Nevertheless, these data are required for the proper comparison of the distribution of species, assessing their ability to naturalization, and determining the ways of introduction of alien species. The latter is particularly important in connection with the fact that Russia is the largest country in the world, stretching from Europe to Asia, and its territory includes a part of Asia. Due to its geographical location and vast territory, that covers a wide range of climatic and vegetation zones Russia may represent a corridor between the West and the East, between Europe and Asia. European Russia is located in the East of Europe and has an area of 3.96 million km^2 that is 24 % of whole Russian territory and about 40 % of the Europe's territory. The northern part of East Asia, which refers to the territory of Russia, and European Russia have long-standing historical and cultural ties, as well as direct transport corridor. The transport system is one of the main ways of spread of alien species in the world (Mack 2003, Hulme 2009). Data from the territory of European Russia can elucidate possibilities of plants to spread and are needed both to reveal the peculiarities of establishment of several species and to estimate correct rates of the extent of their invasion.

The present study considers European Russia's alien plant species originated from one of the parts of Asia – East Asia – and aims to examine their number, growth forms, main pathways, invasive status and regional distribution.

MATERIAL AND METHODS

The information on alien species was based on the database (Morozova 2002), in which records data of European Russia's plant alien species from known published works were collected. Studies on flora in European Russia had a long history and provided a solid background for compiling a list of alien species. The first floristic research in the territory of European Russia dated back to the end of the 18th century, and already old floral works contained information on alien plants. Special interest in alien plants dated to the first half of the 20th century (Nazarov 1927), while after the 1960s, studies of alien species became systematic. Usually Russian botanists studied floras according administrative regions, and a good information on aliens was for many of them. The first attempt at producing the regional alien flora was carried out to the Republic of Udmurtia (Tuganaev & Puzyrev 1988) and to the Moscow Region (Ignatov et al. 1990). Afterwards checklists of flora for some European Russia's regions began to appear. However, because of different rate of regional investigations a complete list of alien species in European Russia was absent. Our database represented the first attempt to receive more or less complete information on alien plant species of European Russia.

The database included both spatial and no spatial data (Morozova & Borisov 2010) and consisted of several theme-based blocks: taxonomical, bibliographical and geographical. The taxonomical block contained data on alien plant species, including the taxonomy, description of species morphological, biological and ecological traits, native ranges and species settling in new territories, type of habitats, and mode of introduction into European Russia. The bibliographical block presented information about source of data, and the geographical block included data on species' records (both unpublished and published and if known with references to herbarium specimens) and invasive status of aliens in regions. A taxon was included in the database if it was found as an alien at least in one of the regions of European Russia. To standardize regional reviews and records we used the Cherepanov checklist (Cherepanov 1995) of Russia's vascular plants with additions concerning a treatment of several taxa (Maevsky 2006).

In European Russia, there are 52 administrative regions including a part of the Caucasus territory, but because of lack of data on the Ciscaucasus we analyzed species' records only from 44 ones without the Caucasus.

To describe East Asian geographical element we defined East Asia including China, Korea, Japan and the eastern part of Russia east of Lake Baikal. We also added to analyzed set of species *Sorbaria sorbifolia,* which have the distribution range mainly in East Asia, and some species with native range in various continents, as for example, *Hordeum jubatum* that is native both to north-eastern part of Asia and to North America. We agreed to East Asian origin of *Salix babylonica* according to Skvortzov (1999) and the native range of *Ulmus pumila* according to Grudzinskaya (1977) with distribution of these species mainly in East Asia. Some taxa were excluded from the group of East Asian origin: 1) species with a large native range in Asia, distributed in more than one unit of this part of the world (e.g. *Artemisia sieversiana*), 2) hybrid taxa originated from East Asian species but without specifying an exact region of their direct origin as *Reynoutria x bohemica*. Besides this, the distribution of *Reynoutria x bohemica* in European Russia was poorly documented.

With respect to the residence time, we used the standard approach (Lambdon et al. 2008) and distinguished archaeophytes and neophytes (introduced before and after the beginning of the 16th century).

With respect to invasion status, we determined casual, naturalized and invasive species following the approach proposed by Richardson et al. (2000). The invasive status of alien species was assessed for each of the regions whence a species was recorded.

RESULTS

To date the dataset comprised about 1800 alien species reported from the European Russia territory. We analyzed more than 950 publications (the majority of them contained references to herbarium specimens) and it can hardly be said that this review represented the complete information. Data especially spatial distribution of aliens in regions of European Russia showed some gaps in thorough floristic inventories while such inventories with records fixation are necessary to draw conclusions on the invasion potential and on damages by alien species. However, floras of most regions were well documented, and this fact encouraged us to compile the database of alien species, which was an important instrument for comparative studies of alien floras.

In European Russia's alien flora East Asian plants numbered 106 species, this make 14.6 % of species alien to the whole territory of European Russia and about 5.8 % of the total number of alien species in European Russia. By regions, these species ranged from 5 % to 13 % of the number aliens to European Russia and from 0.4 to 7.5 % of the total alien plants. There is no East Asian species recorded from all regions, and 26 species were found in more than ten regions. Almost one-third part of this species group (34 species) occurred only in one region. The most widespread species found in 20 and more regions were *Hordeum jubatum*, *Rosa rugosa*, *Ulmus pumila*, *Fagopyrum tataricum*, *Panicum milliaceum*, *Sorbaria sorbifolia*, *Reynoutria japonica, Acer ginnala, Malus baccata* and *Thladiantha dubia*; only one of them was accidental, two species have double pathway type and the others were deliberately introduced.

The East Asian alien species of European Russia showed a great diversity in their taxonomy structure and belonged to 43 families and 82 genera. Rosaceae (23 species) and Asteraceae (13 species) contributed most to this alien plant group. These two families occupied the main places in all alien flora of European Russia: Asteraceae is the second and Rosaceae – the third. Despite the fact that Asteraceae is an important source of naturalized species in the world (Pyšek 1998), only three species of this family with East Asian origin have been naturalized at least in one of the regions of European Russia, others were casuals. Fifteen species of Rosaceae were considered as naturalized and three as invasive. Rosaceae was over-represented in many alien floras and highly successful as invader in different areas (Richardson & Pyšek 2006). Six families among the aliens *to* European Russia were represented only by species with East Asian origin: Actinidiaceae, Commelinaceae, Ebenaceae, Menispermaceae, Simaroubaceae and Schisandraceae.

Almost all regarded East Asian alien species were neophytes, and only one species – *Panicum milliaceum* – was archaeophtyte (Grigorievskaya et al. 2004, Notov 2009).

Woody and herb plants among the East Asian alien species had similar proportions in the life form distribution. However, phanerophytes (trees and shrubs) prevailed over annuals among both all East Asian alien species (47 % vs 18 %) and naturalized ones (32 species vs 3 species, Table 1). Perennial herbs amounted to 35 %.

With respect to the mode of introduction, 79 East Asian aliens were introduced deliberately with predominance of ornamental and horticultural purposes and only 23 species accidentally, 4 species have a double pathway of introduction.

Invasive status of alien species changed according to geographical location of regions, and the East Asian species were recorded in almost all regions (42) of European Russia except for the northernmost ones. Many of these species were casuals in some regions, and in other ones were naturalized or invasive. About 46 % of the East Asian species were recorded only as casuals in all regions where species were fixed. Fifty species were classified as naturalized, and 11 species were invasive at least in one of the regions of European Russia (Tables 1, 2).

Naturalized species were presented in more than a half of the European Russia regions. The most widespread species of them (according number of regions where species were naturalized) are *Sorbaria sorbifolia, Spiraea salicifolia, S. media, Reynoutria sachalinensis, R. japonica* and *Ulmus pumila* (Appendix 1). Majority of the naturalized East Asian species was introduced deliberately. Among accidentals species only five species may be named as naturalized at least in one of the regions: *Aconogonon divaricatum, Artemisia argyi, A. umbrosa, Echinochloa caudata* and *Potentilla tergemina*.

DISCUSSION

The considerable extent of European Russia leads to three important points. First, as a result of the large size of the territory, the alien species set of European Russia is heterogeneous. Only 37 % of alien plants found in various parts of European Russia were aliens to this territory in the whole

Table 1. Distribution of East Asian species of European Russian alien flora in terms of invasive status

Characteristics	All Eas (number of species)	Cas	Nat	Inv	Not clear
Number of families	43	42	22	7	10
Introduction mode					
deliberate	79	69/33	42/33	9/19	11/19
accidental	22	23/33	6/12	1/1	2/1
deliberate-accidental	4	4/30	2/10	1/9	1/5
Life forms					
tree	24	20/25	17/28	2/8	5/8
shrub	26	24/26	15/29	3/11	3/7
perennial	37	33/28	15/28	5/15	5/9
annual	18	19/35	3/3	1/1	1/1
Total	106/42	96/38	50/33	11/23	14/21

Invasive status: cas – casual, nat – naturalized (not including invasive), inv – invasive, not clear – unknown invasive status. Numerator of the fraction is the number of species, denominator of the fraction is the number of regions where species with named status were recorded

Table 2. East Asian alien plant species invasive in European Russia (at least in one of the regions)

Species	1st record	Life form	Reg_all	Reg_inv
Cotoneaster lucidus	1935	Shrub	14	2
Hemerocallis fulva		Perennial	12	1
Hordeum jubatum	1914	Perennial	32	9
Monochoria korsakowii	1959	Annual	2	1
Morus alba		Tree	9	2
Reynoutria japonica	1932	Perennial	24	7
Reynoutria sachalinensis	1924	Perennial	19	2
Rosa rugosa		Shrub	28	4
Sorbaria sorbifolia	1857	Shrub	25	8
Ulmus pumila	1965?	Tree	27	7
Zizania latifolia	1955	Perennial	16	6

Reg_all – number of regions whence species was recorded, Reg_inv – number of regions where species was naturalized

(aliens to European Russia), i.e. these species had their native ranges entirely outside the boundaries of European Russia. East Asian species have the second place in this group (14.6 %) after American plants (37 %). Secondly, the variety of natural conditions provides opportunities for establishment here of species from different natural zones. Third, the establishment and, accordingly, the naturalization of alien species differ depending on the regional climate conditions. The reasons for naturalization of aliens can be explained by different factors among which environment plays one of the major roles. Although some sources (Pyšek & Richardson 2006, Lambdon et al. 2008) pointed out to the importance of environments in the process of plant naturalization, there are surprisingly little researches demonstrating the relationship between naturalized species and climate (Thuiller et al. 2006). Alien flora of European Russia's regions exhibited spatial trends due to various climate conditions (Morozova et al. 2008) and distribution of naturalized species showed preference to some parts of territory, thus along latitudinal gradient the same species may by casual in some areas and in other naturalized or invasive. East Asian species, which are invasive in European Russia, demonstrated preferable distribution too.

Rosa rugosa occurred in many regions, but was invasive especially in the shore of the Baltic Sea and in the North-West of Russia (in the Leningrad, Kaliningrad, Tver and Yaroslavl Regions) (Fig. 1). It was introduced in Europe as an ornamental plant at the end of 18th (1796) and during the 19th century, it became very popular. In Russia, it was cultivated in Botanical Gardens since the beginning of the 19th century and as naturalized it was fixed in the second half of the 20th century. In one of regions (Tver), where status of this species was invasive now, the first finding dated from 1971 (Notov 2009). In the native range *Rosa rugosa* grows on sandy or gravely beaches as well as in dune grassland communities. In its secondary (introduced) range, the species was found in similar habitats. First, as invasive *Rosa rugosa* occurred in a variety of seashore habitats where it might form dense thickets: on sandy, gravely or stony shores. It also occupied various human-made habitats: open habitats like road verges, railway slopes, and ruderal habitats such as building sites and field edges.

Four species (*Reynoutria japonica*, *R. sachalinensis*, *Sorbaria sorbifolia*, *Hordeum jubatum*) are invasive mainly in the Central Russia's Regions. *R. japonica* and *R. sachalinensis* were frequently cultivated as an ornamental plants in parks and gardens in many European countries; in Germany, Japanese Knotweed was also used as a forage plant and for erosion control. The history of introduction of these species was related to the 19th: *R. japonica* was introduced

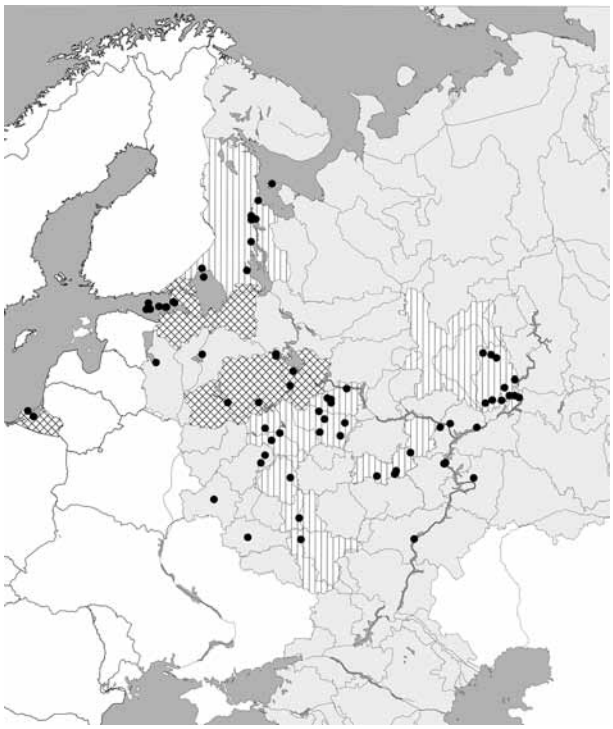

Figure 1 Findings (black circles) and invasive status of *Rosa rugosa* in different regions of European Russia. Invasive status of species: vertically lined area – naturalized, crossed hatching area – invasive

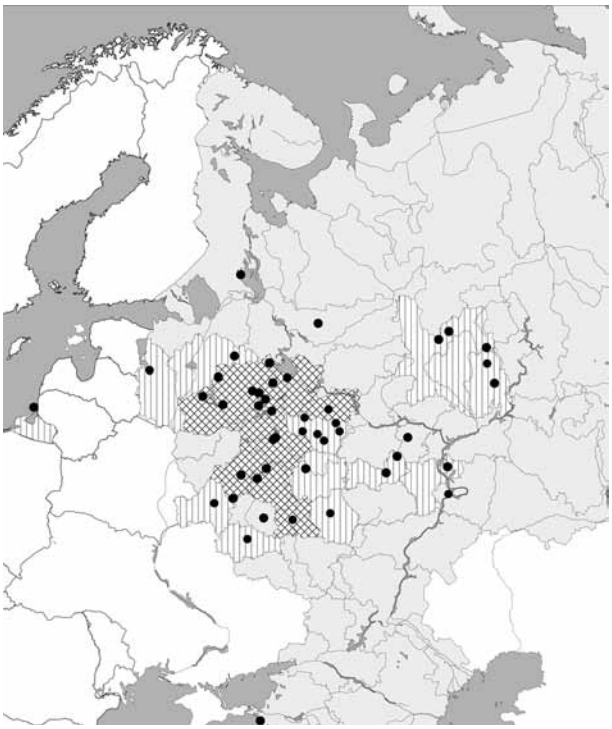

Figure 2 Findings (black circles) and invasive status of *Reynoutria japonica* in different regions of European Russia. For legend see Fig. 1

in Britain from China and *R. sachalinensis* was arrived in Europe perhaps from collection of St. Petersburg Botanical Garden; the first records were known at the middle of the century, and as naturalized, the species were fixed at the end of the one (Mandák et al. 2004). In Russia, distribution of *Reynoutria* species was poorly documented, a first finding of *R. japonica* in the Central Russian regions had been fixed in the first half of the 20th century (Table 2) in the Smolensk Region (Vinogradova et al. 2009). Now *R. japonica* was invasive in 7 regions (Fig. 2) and *R. sachalinensis* in 2 ones. Both species were planted as ornamentals in many cities and villages whence they spread into open disturbed habitats by people, water streams or transported with soil moved during building activities.

Sorbaria sorbifolia was a very popular ornamental plant. It was introduced in Europe at the middle of the 18th century and by now was extended as naturalized in several countries. In European Russia *Sorbaria sorbifolia* had the same history and time of introduction; ones of the first findings dated from 1857 in the Kursk Region (Vinogradova et al. 2009) and from 1868 in the Tver Region, where the species was found at a riverside of a small river (Notov 2009). In European Russia, the species was fixed as invasive in eight regions mainly in the Central Russia (in the Bryansk, Kaluga, Moscow, Ryazan, Tambov, Tver, Voronezh and Yaroslavl Regions). It made dense tickets, but locally and its secondary range was not continuous because little possibility of seed reproduction (Vinogradova et al. 2011).

Hordeum jubatum was introduced by two pathways: escape from cultivation as ornamental plant (at least the first records) and stowaway via transport vectors. The earliest record in European Russia was in 1914, extensive dispersal was fixed after sixties of 20th century and by now *Hordeum jubatum* was invasive in nine regions (the Ivanovo, Lipetzk, Moscow, Ryazan, Voronezh and Saratov Regions, the Republics of Udmurtia, Mordovia, and Bashkortostan).

Six East Asian species are more common and "successful" in the southern part of European Russia. *Ulmus pumila* was used in many regions especially father to the south from Moscow for woodland belts, planting of tree in settlements. The pattern of naturalization (Fig. 3) showed its preference to warm climate conditions. In the introduced range, *Ulmus pumila* grew along railways, in forest edges and sometimes in sparse forests, in its native range the species occupied riparian gravels and sands, stony banks.

Zizania latifolia was introduced in the fifties of the last century in many water reservoirs in various regions of European Russia as a fodder plant in hunter farms. By now, it was naturalized in nine regions and in six ones was invasive. In northern regions, the species did not bear fruits and reproduced by rhizomes, in the south the bearing of *Zizania* was not studied but the species spread successfully along small rivers (Grigorievskaya et al. 2004). In its native range *Zizania latifolia* grew in shallow water of lake margins and swamps.

Cotoneaster lucidus was introduced in 19th century as ornamental plant and by now was widely planted in towns, parks, graveyards and along roadsides. In European Russia it was observed in forest edges in two southern regions (Kursk and Voronezh).

Hemerocallis fulva is very widely grown as an ornamental plant in many countries especially with temperate climate. It was naturalized in six European Russia's regions and invasive in the Voronezh Area.

Figure 3 Findings (black circles) and invasive status of *Ulmus pumila* in different regions of European Russia. For legend see Fig. 1

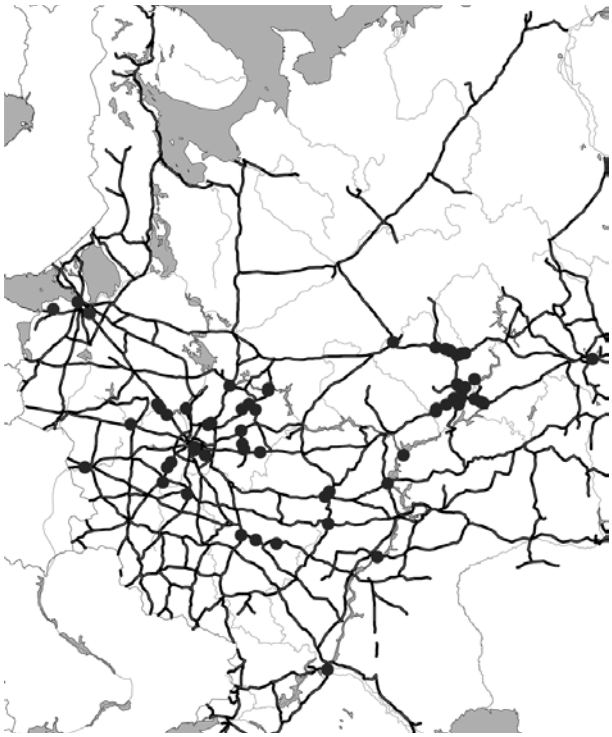

Figure 4 Findings (black circles) of *Artemisia umbrosa* in European Russia along main railways (bold black lines)

Two species *Morus alba* and *Monochoria korsakowii* were spread only in the southernmost regions. *Morus alba* was cultivated in the south of European Russia as popular fruit tree and as ornamental, and now in the Krasnodar and Astrakhan Regions it was invasive. *Monochoria korsakowii* was introduced accidentally with seeds of rice from the Far East, and occurred only in two European Russia's regions (Astrakhan and Krasnodar). The first record was in 1959 in the Krasnodar Region. In recent years, this species was widely spread here and became a harmful weed in rice fields of the Azov-Kuban lowland that was a result of the change in technology of cultivation of rice and the use of a deep water layer for growing rice seedlings (Zelenskaya 2011).

Invasive species of East Asian origin are major or potential invaders in Europe. Three of them (*Rosa rugosa, Reynoutria japonica* and *R. sachalinensis*) are invasive in many European countries (Lambdon et al. 2008). *Sorbaria sorbifolia* suggested to be invasive in Latvia (Laiviņš et al. 2009), Lithuania, Finland and Sweden (NOBANIS www.nobanis.org). *Zizania latifolia* was found in Belgium (Manual of the Alien Plants of Belgium http://alienplantsbelgium.be/) and Estonia (www.nobanis.org) and was fixed in Lithuania where it had potential for further spread (Liatukas & Stukonis 2009). *Ulmus pumila* was established in Austria, Italy, Romania and was potentially invasive in Latvia (www.nobanis.org). *Cotoneaster lucidus* was invasive in Estonia (Ööpik et al. 2008), Latvia (Laiviņš et al. 2009) and potentially invasive in Sweden and Finland (www.nobanis.org).

Fraction of East Asian species on the territory of European Russia is characterized by a high percentage of naturalized species (47 %). Of 50 naturalized (at least in one of the regions of European Russia) East Asian species, the majority were phanerophytes (32 species) and their high proportion is due to several reasons. First, these species were cultivation escapes or deliberate releases and many of them had long history of introduction for ornamental purposes as well as for forestry and for wind or soil protection. In 18th and 19th centuries, numerous noble estates with private parks and gardens were widely represented in European Russia where many exotic species were planted, plantings in many such sites (or parks) have been preserved up to the present time. Ornamental introduction named to be the main pathway for alien species and ornamental plants are among the most important invaders in many parts of the world (Lambdon et al. 2008, Ööpik et al. 2008, Weber et al. 2008). For woody plants, Křivánek et al. (2005) in their study used number of sites in which a species was planted as a surrogate for propagule pressure that is a crucial factor of naturalization process (Lonsdale 1999, Pyšek & Richardson 2006). Thus, long history of cultivation and numerous sources for escaping are responsible for the appearance and establishment of aliens. Second, absolutely predominance of woody and perennial species confirms the assumption that long-lived species have advantages for crossing both the environmental and biotic barriers and for becoming naturalized (Pyšek & Richardson 2007). Third, majority of alien East Asian species originate from temperate regions of East Asia and it is likely that some climatic conditions in new territories are similar to those in their native areas and could facilitate a process of naturalization too.

Of East Asian accidentals, 7 species (*Artemisia desertorum, Corispermum elongatum, Descurainia sophioides, Polygonum sabulosum, Securinega suffruticosa, Sphallerocarpus*

gracilis, Taraxacum sinicum) were recorded only in territory of European Russia compared to the European countries, and 3 species (*Artemisia rubripes, A. selengensis, Potentilla tergemina*) were found also in the adjacent area – in the Ukraine. A majority of them was found near railway stations and along railway tracks, but their findings are rare. Among accidentals, several species showed transit distribution through the European Russia territory father to the west. For example, *Artemisia umbrosa* (Leonova 1994) is so-called "railway" plant; in the European Russia's territory, it was recorded mainly along railway beds and slopes where sometimes it forms dense thickets. Railways are known to be preferential migration corridors for some invasive plants and to promote the rapid spread of non-native plant species (Nazarov 1927, Mack 2003). Despite the low density of railway tracks (0.51 km per 100 km^2), Russia is the second in the world by the length of the railway network, which is about 87,000 km. Information about the importation of plants on the transport routes are known from the very beginning of the operation of railways in Russia (in the second half of 19th century). The substantial increase of the flow of alien plants by railways was noted at the beginning of the 20th century in connection with the movement of troops during the World War I and the Civil war (Nazarov 1927). However, this fact was known mainly for transportation of plants on the territory of European Russia, and an information about the far drift (for example, from the Far East) at this time is absent. Nevertheless, the findings of some species during recent 40 years solely on the railway suggest that this pathway is a just species dispersal mechanism (Fig. 4). The first findings of *Artemisia umbrosa* made in 1970-1980s (Gusev 1980, Maiorov et al. 1993); now the species distribution extended over 18 regions. The railway, connecting the Russian Far East and European Russia, passes through the native area of this species that occupies southern areas of Eastern Siberia and Far East, but direct vector transfer of plant propagules is unknown (it may be ballast, train, people or cargo). Initial contact in the area of influence of the railway may be associated with the ballast for the construction of railway tracks and with humans. As well, railway habitats represented a suitable environment for species with different ecological requirements (Hansen & Clevenger 2005). In European Russia *Artemisia umbrosa* usually was occurred locally and did not occupy the whole territory of any of the regions, but was naturalized in eight regions. Besides European Russia *Artemisia umbrosa* was mentioned in Lithuania (Gudžinskas 1997), Belarus (Identification guide 1999) and in the Ukraine (Mosyakin 1990, Mosyakin & Yavorska 2002, Greuter & Raab-Straube 2005). In 2009, this species was collected in the northeastern Romania (Sírbu & Oprea 2011) where it was accidental, through the rail transport from the east. Another species *Artemisia argyi* had a similar history and was reported from six European Russia's regions (material of database), from the Ukraine (Mosyakin 1990) and recently was found in Romania in close proximity to railway (Sírbu & Oprea 2011).

For European Russia, East Asian species are an example of long-distance drift of species, predominance of escapes among them confirms the importance of deliberate introduction mode in process of plant invasion. With regard to accidental species, European Russia may be considered as one of the corridor for introducing alien species of Asian as well as of East Asian origin father to Europe.

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LITERATURE CITED

Cherepanov, S.K. 1995. *Vascular plants of Russia and adjacent countries*. World and Family-95 Ltd, Saint Petersburg, 992 p. (in Russian). [Черепанов С.К. 1995. Сосудистые растения России и сопредельных государств. Санкт-Петербург: Мир и семья-95. 992 с.]

Dickoré, W. & G. Kasparek 2010. Species of *Cotoneaster (Rosaceae, Maloideae)* indigenous to, naturalising or commonly cultivated in Central Europe. *Willdenowia* 40: 13–45.

Fridley, J.D. 2008. Of Asian Forests and European Fields: Eastern U.S. Plant Invasions in a Global Floristic Context. *PLoS ONE* 3(11): e3630. doi:10.1371/journal.pone.0003630

Greuter, W. & E. von Raab-Straube (eds.). 2005. Euro+Med Notulae, 1. *Willdenowia* 35:223–239.

Grigorievskaya, A.Ya., E.A. Starodubtseva, N.Yu. Khlyzova & V.A. Agafonov 2004. *Adventive flora of the Voronezh Region: historical, biogeographical, ecological aspects*. Voronezh University Press, Voronezh. 320 p. (in Russian). [Григорьевская А.Я., Стародубцева Е.А., Хлызова Н.Ю., Агафонов В.А. 2004. Адвентивная флора Воронежской области: исторический, биогеографический, экологический аспекты. Воронеж: Издательство Воронежского университета. 320 с.]

Grudzinskaya, I.A. 1977. The genus *Ulmus* L. – elm. In: *Ranges of trees and shrubs of the USSR*, vol. 1, pp. 126–132, Nauka, Leningrad (in Russian). [Грудзинская И.А. 1977. Род *Ulmus* L. – вяз, ильм, берест // Ареалы деревьев и кустарников СССР. Т. 1. Л.: Наука. С. 126–132.]

Gudžinskas, Z. 1997. Conspectus of alien plant species of Lithuania. 4. Asteraceae. *Botanica Lithuanica* 3: 335–366.

Gusev, Yu.D. 1980. New information on adventive flora of various taiga zone's regions of European part of Russia. *Botanicheskii Zhurnal* 65(2): 249–255 (in Russian with English summary). [Гусев Ю.Д. 1980. Новые сведения об адвентивной флоре разных областей таежной зоны европейской части России // Ботанический журнал. Т. 65, № 2. С. 249–255.]

Hansen, M.J. & A.P. Clevenger 2005. The influence of disturbance and habitat on the presence of non-native plant species along transport corridors. *Biological Conservation* 125: 249–259.

Hulme, P.E. 2009. Trade, transport and trouble: managing invasive species pathways in an era of globalization. *Journal of Applied Ecology* 46: 10–18.

Hulme, P.E., S. Bacher, M. Kenis, S. Klotz, I. Kühn, D. Minchin, W. Nentwig et al. 2008. Grasping at the routes of biological invasions: A framework for integrating pathways into policy. *Journal of Applied Ecology* 45: 403–414.

Jiang, H., Q. Fan, J.-T. Li, Shi S., S.-P. Li, W.-B. Liao & W.-S. Shu 2011. Naturalization of alien plants in China. *Biodiversity and Conservation* 20: 1545–1556.

Ignatov, M.S., V.V. Makarov & A.V. Chichev 1990. Conspectus of adventive flora of the Moscow Region. In: *Investigations of the flora of the Moscow Region* (A.K. Skvortzov, ed.), pp. 5–105, Nauka, Moscow (in Russian with English summary). [Игнатов М.С., Макаров В.В., Чичев А.В. 1990. Конспект флоры адвентивных растений Московской области // Флорис-

тические исследования в Московской области / Отв. ред. А.К. Скворцов. Москва: Наука. С. 5–105.]

Křivánek, M., P. Pyšek & V. Jarošík 2005. Planting History and Propagule Pressure as Predictors of Invasion by Woody Species in a Temperate Region. *Conservation Biology* 20(5): 1487–1498.

Laiviņš, M., M. Bice, I. Krampis, Dz. Knape, D. Šmite & V. Šulcs 2009. *Latvijas kokaugu atlants*. Latvijas Universitātes Bioloģijas institūts, Apgāds Mantojums [online] http://www.kurtuesi.lv/flora

Lambdon, P.W., P. Pyšek, C. Basnou, M. Hejda, M. Arianoutsou, F. Essl, V. Jarošík et al. 2008. Alien flora of Europe: species diversity, temporal trends, geographical patterns and research needs. *Preslia* 80: 101–149.

Leonova, T.G. 1994. Wormwood – *Atremisia* L. In: *Flora of the European Part of the USSR*, vol. VII (N.N. Tzvelev, ed.), pp. 150–174, Nauka, Leningrad (in Russian). [Леонова Т.Г. 1994. Полынь – *Artemisia* L. // Флора европейской части СССР. Т. VII / Под ред. Н.Н. Цвелева. Ленинград: Наука. С. 150–174.]

Liatukas, Ž. & V. Stukonis 2009. *Zizania latifolia* – a new alien plant in Lithuania. *Botanica Lithuanica* 15(1): 17–24.

Lonsdale, W.M. 1999. Global patterns of plant invasions and the concept of invasibility. *Ecology* 80: 1522–1536.

Mack, R.N. 2003. Global plant dispersal, naturalization and invasion: pathways, modes and circumstances. In: *Invasive Species. Vectors and Management Strategies* (G. Ruiz & J. Carlton, eds.), pp. 3–30, Island Press.

Mack, R.N., D. Simberloff, W.M. Lonsdale, H. Evans, M. Clout & F.A. Bazzaz 2000. Biotic invasions: causes, epidemiology, global consequences, and control. *Ecological Applications* 10(3): 689–710.

Maevsky, P.F. 2006. *Flora of the middle part of European Russia*. 10th edition. KMK Scientific Press, Moscow. 600 p. (in Russian). [Маевский П.Ф. 2006. Флора средней полосы европейской части России. 10-е издание. Москва: Товарищество научных изданий КМК. 600 с.]

Maiorov, S.R., L.F. Volosnova & E.A. Daragan 1993. New floristic records in the Kaluga Region. *Bulletin of Moscow Natural Society, biology department* 98(6): 118–121 (in Russian with English summary). [Майоров С.Р., Волоснова Л.Ф., Дараган Е.А. 1993. Новые флористические находки в Калужской области. Бюллетень МОИП, отд. биолог. Т. 88, вып. 6. С. 118–121.]

Mandák, B., P. Pyšek & K. Bímová 2004. History of the invasion and distribution of *Reynoutria* taxa in the Czech Republic: a hybrid spreading faster than its parents. *Preslia* 76: 15–64.

Manual of the Alien Plants of Belgium. Last modified 18 February 2013 [online] http://alienplantsbelgium.be/

Morozova, O.V. 2002. Database on adventive plant species (Alien plant Species). In: *Proceeding of the Conference on Environmental Safety*. IUCN, Moscow. P. 83–94 (in Russian). [Морозова О.В. 2002. База данных по адвентивным видам растений (Alien plant Species) // Материалы совещания по экологической безопасности России. М.: IUCN. С. 83–94.]

Morozova, O.V. & M.M. Borisov 2010. Web-Oriented Geoinformation System on Alien Plant Species of European Russia. *Russian Journal of Biological Invasions* 2: 47–55.

Morozova, O.V., E.A. Starodubtzeva & N.G. Tzarevskaya 2008. Adventive flora of European Russia: inventory results. *Proceedings of the Russian Academy of Sciences,* series Geography 5: 85–94 (in Russian with English summary). [Морозова О.В., Стародубцева Е.А., Царевская Н.Г. 2008. Адвентивная флора Европейской России: итоги инвентаризации // Известия РАН, серия географическая. № 5. С. 85–94.]

Mosyakin, S.L. 1990. New and noteworthy alien species of *Artemisia* L. (Asteraceae) in the Ukrainian SSR. *Ukrainskii Botanichnii Zhurnal* 47(4): 10–13. [Mosyakin, S.L. 1990. New and noteworthy alien species of *Artemisia* L. (Asteraceae) in the Ukrainian SSR // Український ботанічний журнал. Т. 47, № 4, С. 10–13.]

Mosyakin, S.L. & O.G. Yavorska 2002. The Nonnative Flora of the Kiev (Kyiv) Urban Area, Ukraine: A Checklist and Brief Analysis. *Urban habitats* 1(1): 45–65.

Nazarov, M.I. 1927. Adventive flora of the Central and Northern parts of the RSFSR during a time of war and revolution. *Proceedings of the Main Botanical garden* 26(3): 223–234 (in Russian). [Назаров М.И. 1927. Адвентивная флора средней и северной части РСФСР за время войны и революции // Известия Главного ботанического сада. Т. 26, вып. 3. С. 223–234.]

NOBANIS – North European and Baltic Network on Invasive Alien Species [online] http://www.nobanis.org

Notov, A.A. 2009. *Adventive component of the Tver Region's flora: dynamics of composition and structure*. Tver State University, Tver. 473 p. (in Russian). [Нотов А.А. 2009. Адвентивный компонент флоры Тверской области: динамика состава и структуры. Тверь: Тверской государственный университет. 473 с.]

Olden, J.D. & N.L. Poff 2003. Toward a mechanistic understanding and prediction of biotic homogenization. *American Naturalist* 162(4): 442–460.

Ööpik, M., T. Kukk, K. Kull & T. Kull 2008. The importance of human mediation in species establishment: analysis of the alien flora of Estonia. *Boreal Environment Research* 13: 53–67.

Parfyonov, V.I. (ed.). *Identification guide of vascular plants of Belarus*. 1999. Design PRO, Minsk, 472 p. (in Russian). [Определитель высших растений Беларуси / Под ред. В.И. Парфенова. 1999. Минск: Дизайн ПРО. 472 с.]

Phillips, M.L., B.R. Murray, P. Pyšek, J. Pergl, V. Jarošík, M. Chytrý & I. Kühn 2010. Plant species of the Central European flora as aliens in Australia. *Preslia* 82: 465–482.

Prinzing, A., W. Durka, S. Klotz & R. Brandl 2002. Which species become aliens? *Evolutionary Ecology Research* 4: 385–405.

Pyšek, P. 1998. Is there a taxonomic pattern to plant invasions? *Oikos* 82: 282–294.

Pyšek, P., J. Danihelka, J. Sádlo, J.Jr. Chrtek, M. Chytrý, V. Jarošík, Z. Kaplan et al. 2012. Catalogue of alien plants of the Czech Republic (2nd edition): checklist update, taxonomic diversity and invasion patterns. *Preslia* 84: 155–255.

Pyšek, P. & D.M. Richardson 2006. The biogeography of naturalization in alien plants. *Journal of Biogeography* 33: 2040–2050.

Pyšek, P. & D.M. Richardson 2007. Traits Associated with Invasiveness in Alien Plants: Where Do we Stand? In: *Biological Invasions. Ecological Studies, vol. 193* (W. Nentwig, ed.), pp. 97–125, Springer-Verlag, Berlin, Heidelberg.

Richardson, D.M. & P. Pyšek 2006. Plant invasions: merging the concepts of species invasiveness and community invisibility. *Progress in Physical Geography* 30(3): 409–431.

Richardson, D.M., P. Pyšek, M. Rejmánek, M.G. Barbour, F.D. Panetta & C.J. West 2000. Naturalization and invasion of alien plants: concepts and definitions. *Diversity and Distributions* 6: 93–107.

Qian, H. 2002. A comparison of the taxonomic richness of temperate plants in East Asia and North America. *American Journal of Botany* 89: 1818–1825.

Qian, H. & R.E. Ricklefs 2000. Large-scale processes and the Asian bias in species diversity of temperate plants. *Nature* 407: 180–182.

Qian, H. & R.E. Ricklefs 2006. The role of exotic species in homogenizing the North American flora. *Ecology Letters* 9: 1293–1298.

Simberloff, D. 1997. Nonindigenous species – a global threat to biodiversity and stability. In: *Nature and human society: the quest for a sustainable world*. Proceedings of the 1997 Forum on Biodiversity (P.H. Raven, ed.), pp. 325–334, Academy Press, Washington.

Sîrbu, C. & A. Oprea 2011. New records in the alien flora of Romania (*Artemisia argyi, A. lavandulaefolia*) and Europe (*A. lancea*). *Turkish Journal of Botany* 35: 717–728.

Skvortsov, A.K. 1999. *Willows of Russia and Adjacent Countries. Taxonomical and Geographical Revision*. University of Joensuu, Joensuu. 307 p.

Stohlgren, T.J., P. Pyšek, J. Kartesz, M. Nishino, A. Pauchard, M. Winter, J. Pino et al. 2011. Widespread plant species: natives versus aliens in our changing world. *Biological Invasion*s 13(9): 1931–1944.

Takhtajan, A.L. 1978. *The floristic regions of the world*. Nauka, Leningrad. 248 p. (in Russian). [Тахтаджян А.Л. 1978. Флористические области Земли. Ленинград: Наука. 248 с.]

Thuiller, W., D.M. Richardson, M. Rouget, S. Proches & J.R.U. Wilson 2006. Interactions between environment, species traits and human uses describe patterns of plant invasion. *Ecology* 87(7): 1755–1769.

Tuganaev, V.V. & A.N. Puzyrev 1988. *Hemerophytes of the Volga-Kama interfluve*. Press of Ural University, Sverdlovsk. 128 p. (in Russian). [Туганаев В.В., Пузырев А.Н. 1988. Гемерофиты Волжско-Камского междуречья. Свердловск: Издательство Уральского университета. 128 с.]

Vinogradova, J.K., S.R. Maiorov & L.V. Khorun 2009. *Black book of the Central Russia: alien plant species in ecosystems of the Central Russia*. GEOS, Moscow, 512 p. (in Russian). [Виноградова Ю.К., Майоров С.Р., Хорун Л.В. 2009. Черная книга Средней России: чужеродные виды растений в экосистемах Средней России. Москва: ГЕОС. 512 с.]

Vinogradova, J.K., S.R. Maiorov & A.A. Notov 2011. *Black book of the Tver Area's flora: alien plant species in ecosystems of the Tver Region*. KMK Scientific Press, Moscow, 292 p. (in Russian). [Виноградова Ю.К., Майоров С.Р., Нотов А.А. 2011. Черная книга Тверской области: чужеродные виды растений в экосистемах Тверского региона. Москва: Товарищество научных изданий КМК. 292 с.]

Vitousek, P.M., C.M. D'Antonio, L.L. Loope, M. Rejmánek & R. Westbrooks 1997. Introduced species: a significant component of human-caused global change. *New Zealand Journal of Ecology* 21(1): 1–16.

Weber, E., S-G. Sun & B. Li 2008. Invasive alien plants in China: diversity and ecological insights. *Biological Invasions* 10: 1411–1429.

Zelenskaya, O.V. 2011. Weeds of the Kuban rice fields. In: *Weedy plants in the changing world: topical issues in studying their diversity, origin and evolution*. Proceedings of the I International Scientific Conference, pp. 93-99, VIR, Saint Petersburg (in Russian with English summary). [Зеленская О.В. 2011. Сорные растения рисовых полей Кубани // Сорные растения в изменяющемся мире: актуальные вопросы изучения разнообразия, происхождения, эволюции. Материалы I международной научной конференции. Санкт-Петербург: ВИР. С. 93–99.]

Appendix 1. East Asian species recorded in European Russia

Species are arranged alphabetically. LH – life history: tr – tree, shrub, pr – herbaceous perennial, bn – biennial, an – annual. Path – pathway of introduction into European Russia: D – deliberate planting involved; A – accidental (unintentional) pathway only. Regions: all – number of all regions where species was occurred, nat – number of regions where species was naturalized (not including regions where species was invasive)

Species	Family	Life form		Path	Regions	
		Raunkier	LH		all	nat
Acer ginnala	Aceraceae	phanerophyte	sh	D	21	10
Acer tegmentosum	Aceraceae	phanerophyte	tr	D	1	1
Aconogonon divaricatum	Polygonaceae	hemicryptophyte	pr	A	8	5
Aconogonon savatieri	Polygonaceae	hemicryptophyte	pr	D	3	0
Aconogonon weyrichii	Polygonaceae	hemicryptophyte	pr	D	14	4
Actinidia chinensis	Actinidiaceae	phanerophyte	sh	D	1	0
Adenocaulon adhaerescens	Asteraceae	hemicryptophyte	pr	D	1	0
Agastache rugosa	Lamiaceae	hemicryptophyte	pr	D	2	0
Ailanthus altissima	Simaroubaceae	phanerophyte	tr	D	4	3
Allium tuberosum	Alliaceae	geophyte	pr	D	1	0
Arisaema amurense	Araceae	geophyte	pr	D	1	0
Artemisia argyi	Asteraceae	hemicryptophyte	pr	A	6	1
Artemisia desertorum	Asteraceae	hemicryptophyte	pr	A	1	0
Artemisia feddei	Asteraceae	hemicryptophyte	pr	A	1	0
Artemisia opulenta	Asteraceae	hemicryptophyte	pr	A	1	0
Artemisia rubripes	Asteraceae	hemicryptophyte	pr	A	2	0
Artemisia selengensis	Asteraceae	hemicryptophyte	pr	A	5	0
Artemisia umbrosa	Asteraceae	hemicryptophyte	pr	A	19	8
Astilbe chinensis	Saxifragaceae	hemicryptophyte	pr	D	2	0
Berberis thunbergii	Berberidaceae	phanerophyte	sh	D	3	2
Callistephus chinensis	Asteraceae	therophyte	an	D	14	0
Celastrus orbiculata	Celastraceae	phanerophyte	sh	D	1	0
Cerasus tomentosa	Rosaceae	phanerophyte	sh	D	17	9
Chaenomeles japonica	Rosaceae	phanerophyte	sh	D	6	0
Citrus unshiu	Rutaceae	phanerophyte	tr	D	1	0
Claytonia sibirica	Portulacaceae	therophyte	an	D	1	0
Clematis serratifolia	Ranunculaceae	hemicryptophyte	pr	D	2	1
Commelina communis	Commelinaceae	therophyte	an	A	17	0
Corispermum elongatum	Chenopodiaceae	therophyte	an	A	2	0
Corydalis ochotensis	Fumariaceae	hemicryptophyte, therophyte	an, bn	D	2	0

Appendix 1. Continued						
Cotoneaster lucidus	Rosaceae	phanerophyte	sh	D	14	7
Crataegus chlorosarca	Rosaceae	phanerophyte	tr	D	1	0
Crataegus dahurica	Rosaceae	phanerophyte	sh	D	2	2
Crataegus maximowiczii	Rosaceae	phanerophyte	tr	D	4	0
Crataegus pinnatifida	Rosaceae	phanerophyte	sh	D	3	1
Descurainia sophioides	Brassicaceae	therophyte	an	A	1	0
Dianthus chinensis	Caryophyllaceae	hemicryptophyte	pr	D	1	0
Diospyros kaki	Ebenaceae	phanerophyte	tr	D	1	0
Echinochloa caudata	Poaceae	therophyte	an	A	5	1
Echinochloa utilis	Poaceae	therophyte	an	D	1	0
Eragrostis multicaulis	Poaceae	therophyte	an	A	4	0
Eriochloa villosa	Poaceae	therophyte	an	A	3	0
Fagopyrum tataricum	Polygonaceae	therophyte	an	A	26	2?
Fraxinus mandshurica	Oleaceae	phanerophyte	tr	D	1	1
Fraxinus rhynchophylla	Oleaceae	phanerophyte	tr	D	1	1
Glycine max	Fabaceae	therophyte	an	D, A	11	0
Hemerocallis fulva	Hemerocallidaceae	geophyte	pr	D	12	6
Heteropappus biennis	Astaraceae	hemicryptophyte	pr	D	2	0
Hordeum jubatum	Poaceae	hemicryptophyte	pr	D, A	32	9
Hylomecon vernalis	Papaveraceae	hemicryptophyte	pr	D	1	0
Juglans mandshurica	Juglandaceae	phanerophyte	tr	D	14	7
Lespedeza bicolor	Fabaceae	phanerophyte	sh	D	1	1
Ligularia przewalskii	Asteraceae	hemicryptophyte	pr	D	2	0
Ligustrina amurensis	Oleaceae	phanerophyte	sh	D	1	1
Lilium lancifolium	Liliaceae	geophyte	pr	D	2	0
Lilium maculatum	Liliaceae	geophyte	pr	D	2	0
Lonicera ruprechtiana	Caprifoliaceae	phanerophyte	sh	D	1	0
Lycium barbarum	Solanaceae	phanerophyte	sh	D	7	4
Lycium chinense	Solanaceae	phanerophyte	sh	D	1	0
Malus baccata	Rosaceae	phanerophyte	tr	D	20	10
Malus mandshurica	Rosaceae	phanerophyte	tr	D	1	0
Malus prunifolia	Rosaceae	phanerophyte	tr	D	17	2
Malva verticillata	Malvaceae	therophyte	an	D, A	18	0
Meehania urticifolia	Lamiaceae	hemicryptophyte	pr	D	1	0
Menispermum dauricum	Menispermaceae	chamaephyte	ch	D	2	2
Monochoria korsakowii	Pontederiaceae	therophyte	an	A	2	0
Morus alba	Moraceae	phanerophyte	tr	D	9	3
Padus maackii	Rosaceae	phanerophyte	tr	D	8	3
Panicum milliaceum	Poaceae	therophyte	an	D, A	25	1
Perilla frutescens	Lamiaceae	therophyte	an	D	3	0
Persica vulgaris	Rosaceae	phanerophyte	tr	D	4	0
Phellodendron amurense	Rutaceae	phanerophyte	tr	D	4	1
Pinus koraiensis	Pinaceae	phanerophyte	tr	D	2	0
Polygonum sabulosum	Polygonaceae	therophyte	an	A	4	0
Populus simonii	Salicaceae	phanerophyte	tr	D	3	2
Populus suaveolens	Salicaceae	phanerophyte	tr	D	11	5
Potentilla tergemina	Rosaceae	hemicryptophyte	pr	A	3	1
Pyrus ussuriensis	Rosaceae	phanerophyte	tr	D	6	3
Reynoutria japonica	Polygonaceae	hemicryptophyte	pr	D	24	12
Reynoutria sachalinensis	Polygonaceae	hemicryptophyte	pr	D	19	13
Rheum compactum	Polygonaceae	hemicryptophyte	pr	D	1	0
Rodgersia podophylla	Saxifragaceae	hemicryptophyte	pr	D	1	0
Rosa rugosa	Rosaceae	phanerophyte	sh	D	28	11
Rosa x kamtschatica	Rosaceae	phanerophyte	sh	D	1	0

Appendix 1. Continued						
Salix babylonica	Salicaceae	phanerophyte	tr	D	2	1
Schisandra chinensis	Schisandraceae	phanerophyte	sh	D	6	1
Securinega suffruticosa	Euphorbiaceae	phanerophyte	sh	A	1	0
Senecio argunensis	Asteraceae	hemicryptophyte	pr	D	1	0
Setaria faberi	Poaceae	therophyte	an	A	7	0
Sorbaria sorbifolia	Rosaceae	phanerophyte	sh	D	25	16
Sorbus sambucifolia	Rosaceae	phanerophyte	sh	D	1	0
Sphallerocarpus gracilis	Apiaceae	hemicryptophyte	bn	A	2	0
Spiraea japonica	Rosaceae	phanerophyte	sh	D	7	4
Spiraea media	Rosaceae	phanerophyte	sh	D	15	12
Spiraea nipponica	Rosaceae	phanerophyte	sh	D	2	1
Spiraea salicifolia	Rosaceae	phanerophyte	sh	D	17	14
Swida brachypoda	Cornaceae	phanerophyte	sh	D	1	0
Syringa villosa	Oleaceae	phanerophyte	sh	D	2	0
Taraxacum sinicum	Astaraceae	hemicryptophyte	pr	A	2	0
Thladiantha dubia	Cucurbitaceae	geophyte	pr	D	20	8
Ulmus pumila	Ulmaceae	phanerophyte	tr	D	27	13
Vitis amurensis	Vitaceae	phanerophyte	sh	D	2	1
Waldsteinia ternata	Rosaceae	hemicryptophyte	pr	D	1	0
Weigela praecox	Caprifoliaceae	phanerophyte	sh	D	1	0
Zizania latifolia	Poaceae	helophyte	pr	D	16	9