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Conference Overview

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An already annual one-day conference in memory of Alexey K. Skvortsov was held at the Main Botanical Garden in Moscow on his birthday, February 9, 2016. The conference was organized by the Russian Botanical Society, Moscow Branch, and supported by the Main Botanical Garden and Moscow University. Differently from the previous conference which was held in a format that underlined the width of Alexey K. Skvortsov's interests, the scope of the 2016 conference was narrowed to just alien plant species, hence the title *Life within the Secondary Range*. Forty-seven botanists involved in studies in the above-mentioned field contributed oral and poster presentations and participated in discussions. Of those, twenty-four were from the Main Botanical Garden; the others represented diverse botanical and biological institutions from Moscow, St. Petersburg, Volgograd, Belgorod, and Ufa. Twenty-one talks related to various aspects of alien species in their new environments, from geography and ecology to molecular genetics, were presented in five oral sessions. Two contributions were displayed as posters. Translated from Russian by Irina Kadis, abstracts of most of the talks are presented below.

Secondary range of *Ambrosia trifida* L. in the Southern Urals (Bashkortostan Republic and Orenburg Region)

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Studies of invasive species and invasion processes have been gaining momentum abroad and in Russia. A recent advancement has been the development of the *Global Invasive Species Programme* (GISP) and global database of invasive species DAISIE (*Delivering Alien Invasive Species Inventories for Europe*) along with the establishment of specialized working groups investigating the impact of invasive species on ecosystems and elaborating measures for their control (Vinogradova *et al*., 2010). The United States is where this direction of research has been developed the most due to the seriousness and profoundness of the economic and ecological consequences of its plant invasions (Slife *et al*., 1960). At the University of Texas, the Institute for Biological Invasions has been organized along with a magazine *Biological Invasions*. Similarly, a Russian database AliS (*Alien* [plant] *Species*) has been established. It summarizes data and enables generalizations regarding adventive species within concrete territories in Eastern Europe as well as assessments of their impact on ecosystems; it also provides opportunities for developing predictive models forecasting possible future invasions (Morozova, 2002).

Of critical importance are invasive species categorized as quarantine weeds: aggressive and harmful weeds, which, at the same time, inflict serious damage to human health due to the allergenic properties of their pollen. To this category belong representatives of the genus *Ambrosia* L.: giant ragweed *(A. trifida* L.), perennial ragweed *(A. psilostachya* DC.), and common ragweed (*A. artemisiifolia* L.). These species constitute priority targets for invasion control within the territory of European Russia (Dgebuadze, 2014). Despite all the work undertaken in order to prevent their advancement, ragweeds have become ubiquitous weeds and are actively spreading to new regions, especially those that are densely populated.

Ragweeds are native to North and Central America (Slife *et al*., 1960). They are widespread in the United States, especially in the eastern and central states (Srother, 2006) and in Canada, being particularly abundant in the southeastern provinces, Ontario and Quebec

(Basset and Terasmae, 1962; Basset and Crompton, 1975; Lavoie *et al.*, 2007; Simard and Benoit, 2010). They also occur in Mexico, Peru, Argentina, Bolivia, Paraguay, and on the Pacific islands of Cuba, Guadalupe and Martinique. They have been introduced to all continents. In Europe they are known from most countries: Sweden, France, Switzerland, Belgium, Germany, Hungary, Ukraine, Romania, Poland, from the territory of the former Yugoslavia, and more (Maryushkina, 1986; Vasic, 1990; Jurik, 1991; Rybnicek *et al*., 2000; Csontos *et al*., 2010; Galzina *et al.*, 2010; Pyšek *et al*., 2012; Ančkov *et al.*, 2013; Smith *et al.*, 2013; Qin *et al*., 2014).

The range of ragweed species in Russia is also wide, so that they have been studied within numerous inventories of the flora (Fisyunov, 1984; Dmitriev, 1995; Popov, 1997; Abramova, 1997, Abramova *et al*., 2013; Ryabinina, 1998; Matveyev *et al*., 2000; Anufriyev, 2008; Yesina, 2009; Pikalova, 2015). Ragweeds have been conquering the Cis-Ural area at an ever increasing rate. Among ragweeds, *A. trifida* appears to be the most successful, having become the most widespread in the region and invading a wide range of plant communities (Abramova, 2011, 2014; Pikalova and Abramova, 2014).

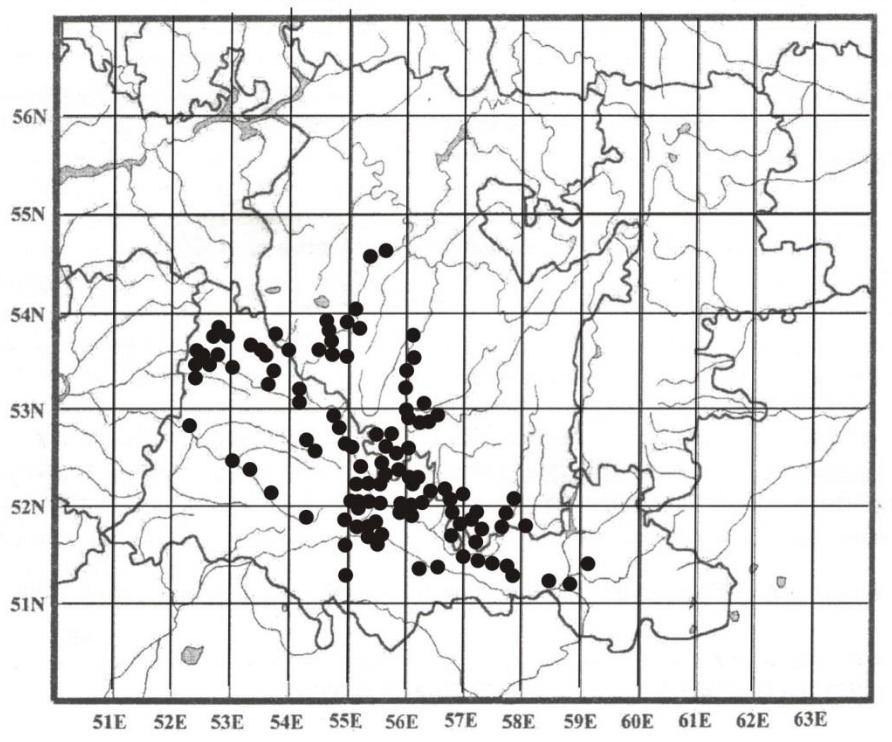

Figure 1. Secondary range of *Ambrosia trifida* L. in the Southern Urals

We have been engaged in a study of the secondary range of *Ambrosia trifida* since 1995. The survey includes the territories of Bashkortostan and Orenburg Region, where areas of infestation with this quarantine weed are the largest (comparable only to the areas infested by ragweed in Samara Region). During the many years of the study, we have identified more than 150 localities (hotbeds) of the species invasion, which are shown in Fig. 1. One can see that initial points of giant ragweed invasion are concentrated in southern Cis-Ural, while they are infrequent in Trans-Ural and the montane forest belt. These hotbeds are mostly associated with areas of human habitation within floodplains of the largest rivers, such as the Sakmara, Dema, Belaya, Greater Ik, or else with the largest expressways.

We have studied the biological characteristics of giant ragweed within its secondary range, including its ontogenesis, seasonal and year-to-year population dynamics, variability of morphometrical parameters, etc. Our prediction is that in the absence of measures for controlling the magnitude of the populations and liquidating the existing hotbeds of invasion, giant ragweed will continue spreading across the entire Southern Urals, which will produce a negative impact on the biodiversity and overall ecology in the region.

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On ontogenesis of *Ribes aureum* Pursh in its secondary range

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Despite the fact that the expansion of golden currant *Ribes aureum* Pursh in Europe has been observed since the mid-20th century, data on individual organism development in a natural setting are not available. In the Central Federal District in Russia, plants undergo the full cycle of individual development, the stages of which are briefly described below.

Latent Period.

Ontogenetic stage. Dormant seed. Seed small, of irregular shape, ovoid, of dark reddish-brown color, dull, wrinkled, sized up to 3×2 mm. Stratification occurs naturally when seed are sown outside in the fall or due to self-seeding. Most seed (75%) germinate the next spring; not more than 10% germinate during the second and third year. The germination is of epigeal phanerocotylar type.

Pre-Generative Period.

In a natural setting, most seedlings (p) emerge in late May to early June. Depending on the weather conditions, cotyledon separation starts the same or next day. From this moment on, one can also observe the development of the terminal bud. Cotyledons mostly two, elliptic, somewhat cuneate at base, sized 5×3 mm (a species-specific character), hairy. The first true leaf three-lobed, with a larger central lobe, toothed at margin, hairy, 3×2 mm. The second leaf three-lobed, without pronounced difference in size between central and lateral lobes, up to 5×4 mm. Hypocotyl 2–6 mm long and 1.5 mm in diameter. By mid-summer, seedlings attain a height of 1–4 cm.

Juvenile Stage (j) starts with wilting of cotyledons, the beginning of shoot growth, and its lignification. The transfer to the juvenile stage occurs with the expansion of the 6–7th leaf. Leaves 3–5-lobed, 5–6×4–5 mm. During the second season, leaves develop on the current-year increment of the shoot. Buds situated on the first-year segment of the shoot do not open, becoming dormant. A stooling zone containing up to 15 approximated nodes is formed.

Immature Stage (im) starts on the 2–3rd year if no abiotic or biotic factors impede the growth. Leaves 3–5 lobed, of the mature type, typically smaller than during the previous stage, though larger than the first leaves. The periderm attains gray color. The branching of the main axis begins: elongated shoots are formed both acro- and basipetally, reaching the length of up to 16 cm and consisting of 7–16 metameres with internodes shortened to 3 cm. During this stage, the main axis typically branches up to the second order. The plant height is 40–100 (to 150) cm. The immature stage usually lasts for 2–3 years.

Virginile Stage (v) is characterized by monopodial growth of the main axis, developing of shoots from axillary buds, formation of hypogeogenic shoots in the stooling zone, and entire systems of crown-forming shoots. This stage begins from the age of 3–5 and lasts for 2–3 years. However, one sometimes may encounter virginile plants that are 12–15 years old.

Young Reproductive Stage (g1). Formation of reproductive organs in *Ribes aureum* begins during the year prior to flowering: initiation of the flowering shoot starts in mid-June. By October, the bud containing the flowering shoots is completely preformed. The presence of mixed buds is characteristic of golden currant. A mixed bud is broader than a vegetative on average by 0.2 mm. Saplings attain the young reproductive stage on the 4–8th year, while clonal plants formed in the situation of windshield plantings—on their 7–8th year. While depending on the age of the plant, the annual increments of the crown-forming shoots may be as large as 1.5 m. The longevity of this stage is about 1–2 years.

Mid-Age Reproductive Stage (g2) begins after 5–9 years. Both vegetative and reproductive organs are maximally developed. The system of crown-forming shoots develops up to the fourth order. Shrubs 1.7–2.8 m tall. Diameter of crown-forming shoots at their origin 2–7 cm. The periderm changes its color to gray-black and acquires cracks. Flowering and fruiting is abundant, inflorescences borne on abbreviated perennial foliated shoots. The number of crown-forming systems is 1 to 15–20, each containing from 1 to 10 crown-forming shoots. This stage is the longest in the life cycle, supposedly lasting for about 15–20 years.

Old-Age Reproductive Stage (g3) starts approximately at the age of 25–30, and in single-axis plants at 15-18 years old. The reproductive function declines, and particulation process starts. The number of vegetative/fruiting shoots diminishes; their perennial parts branching to the second order in 10% of shoots. The root system mostly remains intact, although some die-back of skeletal roots may occur. This stage lasts for 3–5 years.

Post-Reproductive Period or Sub-Senescent stage (ss) is represented by shrubs that don’t produce fruit anymore. Their system(s) of crown-forming shoots have mostly died off, and those remaining lack fruiting shoots. At the same time, the branching shoots die back en masse.

Specimens in Senescent Stage (s) are rare.

Biodiversity of pea (*Pisum sativum* L.) outside the center of its origin

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Peas are widespread as a valuable nutrition plant. The species *Pisum sativum* L. currently has a wide range. Vavilov considered mountainous areas of West and Middle Asia to be the primary centers of *P. sativum* biodiversity, while assigning the status of the secondary locus to the Mediterranean. As a result of contemporary studies, our understanding of the primary center has been somewhat shifted, now including all the countries of West Asia, while Ethiopia is believed to be the secondary center. Yet the understanding of the species' taxonomic limits remains vague: some tend to include *Pisum transcaucasicum* (Govorov) Stankov, *P. abyssinicum* A.Braun, *P. sativum* subsp. *asiaticum* Govorov within *P. sativum;* others prefer to treat them as distinct species.

The goal of this work was a study of the biodiversity and limits of *Pisum sativum.*

Eighty three samples chosen for the study were of various eco-geographic origin. They represented populations within the primary locus of biodiversity along with populations from various parts of the contemporary species range. Samples of questionable taxonomic status (*Pisum transcaucasicum*, *P. abyssinicum,* and *P. sativum* subsp. *asiaticum*) were also included.

For the first time the genetic diversity of *Pisum sativum* was assessed with the help of multilocus markers applied to the entire nuclear genome (AFLP) and to the analysis of the resistance gene family (RGA profiling). The multiloci marker analysis revealed a significant difference between ranges of genetic distances produced as a result of RGA profiling (0.15–0.75) and those produced during AFLP analysis (0.04–0.38).

The obtained values of genetic distances were further subjected to cluster analysis, principle component analysis (PCA) and population structure analysis. For both AFLP and RGA, clustering on the dendrogram was no different from that on the PCA graph. On the dendrogram as well as on the PCA graph, samples of tentatively distinct taxa (*Pisum transcaucasicum*, *P. abyssinicum*, *P. sativum* subsp. *asiaticum*) were well mixed in, forming a continuous group with other *P. sativum* samples, which proves their intraspecific status. According to the results of cluster analysis, the samples of *P. sativum* of various origin formed a continuous polymorphic cluster, inside which the samples of mostly East Asian origin formed a more distal subgroup. The principal component analysis showed a continuum of genotypes with two extremes: one predominantly formed by the samples from Asia, the other by those from Europe. Most of the analyzed samples, including those originating from the primary centers, occupied an intermediate position between the two extreme groups.

The study also included an assessment of the intraspecific polymorphism of the sequence within the gene of sucrose synthase (*SUS1*), the enzyme which provides for sucrose metabolism and also participates in symbiotic nitrogen fixation in legumes. Such an assessment was conducted for the first time. Samples with varying levels of symbiotic nitrogen fixation participated in the analysis.

The work was conducted with partial support from *The Living Nature*, the RAN Program for Fundamental Research and also from the Russian Foundation for Fundamental Research Grant 16–34–00981.

Genome variability in garlic *Allium sativum* L. within populations from the historic center of origin and from the contemporary species area

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Garlic (*Allium sativum* L.) has been in cultivation for more than 7000 years and still remains an important crop. While Central Asia is believed to be the primary center of its origin, the contemporary cultigenic area embraces all the continents except for Antarctica. The simplicity of cultivation, ready availability of vegetative propagules, resistance to various biotic and abiotic environmental factors, and long-term storage capacity have contributed to the plant's popularity and resulted in its wide range.

Despite its importance, the genetic diversity of garlic is poorly known, as compared to other cultivated plants, which must be due to the enormous size of its genome. (Ricroch *et al.*, 2005). The major feature of garlic is a complete absence of seed production. As a result of that, garlic can be propagated only vegetatively, while its genetic diversity is due to the accumulation of somatic mutations. Fertile forms of garlic have been recently discovered in the high-altitude Tien Shan; however, their seed have very low germination rate (Kamenetsky *et al.*, 2005).

Previous studies of intraspecific variability in *Allium sativum* have embraced mostly local populations and certain cultivars; therefore, the author found it interesting to assess the level of genome variability in contemporary populations within the primary center of origin and compare these to populations within the cultigenic area, employing the methods of multiloci AFLP analysis and NBS profiling.

The RAPD and ISSR analysis that had been conducted earlier did not reveal intra-population variability in *A. sativum.* Taking these results into account, I chose only a single sample to represent each of 80 garlic populations featured in the collection of Vavilov Institute of Plant Genetic Resources, 12 of which represent populations from the primary center of origin and 68 having been taken from the contemporary cultigenic area. Three combinations of primers differing in the number of selective nucleotides were chosen for the AFLP analysis and four primer pairs for NBS profiling.

Specific for each sample, DNA spectra were obtained as a result of the conducted AFLP analysis and NBS profiling. Calculated in accordance with the results of the AFLP analysis, genetic distances between the samples turned out to be quite low, fluctuating from 0.007 to 0.15. The comparatively low genome polymorphism, apparently, must be attributed to the vegetative reproduction in garlic. Based on NBS profiling of the disease resistance gene family, the level of intraspecific variability appeared quite significant, varying from 0.005 to 0.12. This result may serve as the key for explaining the high ecological plasticity and resistance to a wide range of pathogens in garlic.

Both the results of the AFLP analysis and those of resistance gene family NBS profiling were further subjected to cluster analysis. Neither of the two techniques resulted in formation of any groups in accordance with the samples' geographic origin. Individual groups included samples from the primary area of origin along with those from the secondary, cultigenic area. This may be explained by the fact that the active spreading of garlic occurred along trade routes.

The population analysis allowed for the division of the studied samples into eight groups, according to their genome type; however, the majority of samples exhibited a combination of a few genome types. Just as it had been with the cluster analysis, groups of samples showed no correlation with their geographic origin. This may be connected with the fact that *A. sativum* is currently represented by a number of morpho-genetic forms due to millenia of mostly vegetative reproduction, accumulation of somatic mutations and intensive selection.

Seed production by sticky ragwort *Senecio viscosus* L. (Asteraceae) in its secondary range

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Senecio viscosus L. (Asteraceae) is a beach plant, an annual psammophyte 15–35 cm tall, its leaves alternate, sessile, mostly pinnately lobed to pinnately irregularly divided; involucre oblong-ovoid; rays yellow, short; plant sticky, glandular-hairy in all parts. Cypselae fusiform, dark brown, longitudinally ribbed, pappus composed of long white simple trichomes.

This European species is widespread in Scandinavia, Central and Atlantic Europe, the Mediterranean Region, and the Caucasus; introduced to the Far East and North America (Tzvelev, 1994); it presumably occurs in all regions within the temperate belt of the European Russia (Mayevsky, 2014).

Within its natural area, the species occurs on maritime sands, on river banks and lake shores, and also in areas of habitation (Tzvelev, 2000). Within its secondary range, sticky ragwort advances along railroads. From there it reaches into natural habitats (Vinogradova *et al*., 2010). The species is listed as invasive in Central European Russia (Vinogradova *et al*., 2010); however, in Tver Region it has been categorized so far as potentially invasive.

Studies of ecological and biological traits in invasive plants have been undertaken in conjunction with the publication of the Black Book (Vinogradova *et al*., 2011). The current work is a study of the reproductive biology of *Senecio viscosus* within its secondary range.

The survey took place in 2012–2014 within three different areas in which the species is adventive: in Tver Region (Andreapol), Moscow Region (Zelenograd and the vicinity of Senezh Railroad Station), and Kaluga Region (the vicinity of Sadovaya Railroad Station). For comparison, we also studied plants within the primary range: on the Gulf of Finland coast in Leningrad Region (Lebyazhiy National Reserve, in Scots pine forest on sand).

Ripe fruit were collected and kept in paper bags for two weeks at 24ºC; thereafter in refrigerator at 4ºC. In model plants, the total number of heads was recorded along with the number of initiated fruit; the length and width of ripe cypselas were measured. The cypselar surface was observed under a scanning electron microscope. Data were processed with an analytical software package *Statistica* 6.0 and *Microsoft Excel* 2007.

According to our observations, seed germinates in spring, while flowering in European Russia starts at the end of June and goes on until the start of November. Fruit start to form in mid-July and ripen early in August. The fruiting period lasts for 65–90 days. Sticky ragwort regenerates exclusively from seed. Average density fluctuates widely from population to population and from year to year: from 1 to 15 plants m^{-1}. The average number of heads per plant in *Senecio viscosus* in Leningrad Region (2014) was 8.7, while in other surveyed areas plants produced more heads. For example, in Zelenograd the average number of heads was twice as many as within the primary range (17.97). Seeds produced by plants within the secondary range were somewhat longer than those produced in the population within the primary range, on the Gulf of Finland shore. The number of fruit per involucre varied from 18 to 79. While in the studied population within the primary range a certain part of cypselas (7 to 43%) were damaged by herbivores, no damage to cypselas was observed in the populations within the secondary range.

In the population within the primary range (Leningrad Region), one plant produced on average 470.3 cypselas, while within the secondary range the number of cypselas per plant was significantly higher: 637.9 (Andreapol, 2014) and 902.8 (Zelenograd, 2014). The latter crop was twice as high as the one observed within the primary range. The population at Sadovaya R/R Station was characterized by the lowest productivity: 404.6 cypselas per plant. These results generally match data obtained in a study of the same plant in Scotland, where the crop fluctuated from 30 to 900 cypselas per plant (Harvie, 2004).

While studying cypselas under scanning electon microscope, I observed trichomes between ribs. The trichomes forming pappus were antrorsely barbed.

On the whole, the observations allow us to conclude that seed productivity in the secondary range was higher than that within the primary range (with the exception of the population at Sadovaya R/R Station). However, this characteristic, as well as the population density, varies from year to year.

The species may soon colonize pine forests and woodland on sand all along the banks of the Zapadnaya Dvina in Andreapol and its surroundings (Tver Region). Despite the quick advance, the impact on natural ecosystems presumably will remain minimal, since during the natural succession at any concrete area the species is gradually displaced by the developing native vegetation till it finally is eliminated, migrating into other open areas.

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Implications of hybridization in cottonwood and balsam poplars in natural and disturbed habitats

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As it has been noted multiple times, hybridization plays an important role in the evolution of cottonwood and balsam poplars (*Populus* sect. *Aigeiros* Duby and *Populus* sect. *Tacamahaca* Spach), and the evolutionary process is of a reticulate nature (Eckenwalder, 1984, 1996; Smith and Symata, 1990; Nasimovich and Kostina, 2015). The presence of hybridogeneous zones within areas of overlap of the natural ranges of species has been confirmed by herbarium data and interpreted in the literature as a direct consequence of this type of evolutionary process (Eckenwalder, 1984; Gom and Rood, 1999; Broeck *et al*., 2005; Bakulin, 2004). Remarkably, hybrids with characters intermediate between those of parent species occur within hybridogeneous zones much more seldom than those deviating morphologically toward one of the parents (Likhovid, 1994). We speculate that hybrids with intermediate characters are eliminated in a natural setting, as they cannot find an appropriate ecological niche, so the results of hybridization are not as much dictated by the genomic or physiological incompatibility as by the habitat restrictions.

In cases where there are both native and introduced poplar species in a certain region, hybridization between them takes place en masse. In minimally altered habitats, native species and those hybrids that morphologically are close to the natives receive an advantage, while in disturbed habitats, the advantaged ones are hybrids with intermediate characters. This has been confirmed for *Populus nigra* L. and its hybrids both outside Russia (according to foreign colleagues in West Europe) and in this country (own observations near Izhevsk).

The situation is different within territories where neither native cottonwoods nor balsam poplars are present, while introduced species frequently occur in cultivation—common circumstances in much of East Europe, for example, in Moscow. Here one can find highly ornamental cultivars represented exclusively by plants with staminate flowers, so that no "cotton" is produced. However, these constitute only some 5–7%, while the overwhelming majority of cultivated poplars (grown in nurseries and installed on a large scale) are various spontaneous intersectional hybrids that tend to form a complex hybrid swarm, the so-called urban poplar. These copiously fruiting (i.e., cotton-producing) plants are prone to multiple diseases, short-lived, tend to produce volunteer seedlings and naturalize, thus provoking discontent of the urban population.

Apparently, the evolution of poplars in the urban environment (both spontaneous and man-induced) exhibits a trend toward the prevalence of R-strategy: plant lifespan tends to become shorter, while seed productivity goes up, which contradicts the general philosophy of the green industry. Often botanic gardens trigger the formation of new invasive species, then the green industry facilitates the spread of new introductions in cities, from where these newcomers later expand to disturbed suburbs, thus receiving a jumpstart for their next leap from cities into natural habitats. Current candidates among poplars for the future invasive status in temperate European Russia are *Populu*s ×*sibirica* G.V.Krylov & G.V.Grig. ex A.K.Skvortsov, *P.* ×*nevensis* Bogdanov, and their hybrids.

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Formation of the apricot's cultigeneous range

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The primary range of the genus *Armeniaca* Scopoli must have been restricted to northern and eastern China. This concept can be justified by the presence in northeastern China of three apricot species whose areas partially overlap: *A. sibirica* (L.) Lam., *A. mandschurica*

(Maxim.) Skvortzov, and *A. vulgaris* Lam. Yet another species, *A. mume* Siebold is found south of this area, in southeastern China. One can observe a whole array of varieties and forms of *A. vulgaris* and *A. sibirica* in these regions of China. Chinese researchers have counted some 2000 varieties and forms of *A. vulgaris* including 500 forms in the northeastern provinces of Shandong and Hebei and 300 forms in the northwestern Province of Xinjiang (W.Liu and N. Liu *et al*., 2010).

There supposedly exists one other primary center of *A. vulgaris* within Middle Asia: in the Western Tien Shan, that is, within the territory of Kyrgyzstan (whereas the Eastern Tien Shan is within China). A record number of varieties and forms of *A. vulgaris*—more than anywhere else in the world—can be found in this mountainous country including the piedmont and surrounding plain.

Of all apricots, *A. vulgaris* is the most widespread in the world. This plant overran its natural geographic limits since time immemorial; it is now cultivated over large territories across the globe, in both hemispheres, except for the arctic and equatorial zones. The beginnings of apricot cultivation are lost in the distance of centuries and millennia. Apricot stones found at archaeological sites are evidence of an extremely long cultivation time. The current richness and variability within the loci of its cultivation could have been formed only during a prolonged period of time. Among the four known loci, the Middle Asiatic, Chinese, Iranian-Caucasian, and European, it is the European one that is the youngest. This youngest locus is about two millennia old. During the epoch of Alexander the Great and the subsequent Hellenic Period, apricots, supposedly, migrated from the Iranian-Caucasian locus to Asia Minor and Greece, and from there later on reached the Roman Empire under the name “Malus Armeniaca” (Armenian apple). According to other data, apricots could have moved into southern Europe via Egypt.

During the Middle Ages, horticulture in Europe was developing only very slowly. Apricots appeared in Germany and northern France around the year 800, but reached England only in the 14th century. The rate of its advancement accelerated during the Renaissance. Apricots were introduced to North America, South Africa, and Russia in the 17th to early 18th century.

Russia owes the introduction of apricots to the Russian tzar Alexey Mikhailovich. The monarch had a curious mind; thoroughly educated, well-rounded, he had a fine aesthetic taste and used to go into much detail as far as running his Moscow estates and keeping gardens. It was during his reign, in 1654, that four trees of «peach plums» and two of «Armenian apples» were delivered to Moscow via Arkhangelsk. By the 18th century, apricots became quite popular and were grown in monasteries, hothouses belonging to nobility, and in the open in southern Russia. With the addition of new territories, Crimea, the Caucasus, and Turkestan, cultivation of apricots was spreading further south (Bakhteyev, 1970).

Attempts to grow the apricot north of its traditional cultivation range were undertaken in the 20th century. The first such cultivars were selected from *Armeniaca mandshurica* by I.V.Michurin in Kozlov (now Michurinsk), Tambov Region. Michurin's work was then continued in Voronezh Region by his pupils K.K.Yenikeyev, M.M.Ulyanishchev, and M.N.Venyaminov, who crossed Michurin's varieties with those from Middle Asia and Europe (Vavilov, 1987).

In the Far East, the most significant accomplishments belong to G.T.Kazmin. He crossed selections from the indigenous *Armeniaca mandshurica* with European cultivars, which resulted in an entire assortment of apricot varieties adapted to the climate of Khabarovsk.

World symposia dedicated to the cultivation of apricots have been held on a regular basis starting from the mid-20th century. The most recent, 16th Symposium took place in 2015 in Shenyang (Liaoning Province, China). From the 1980's, apricot production rate has been accelerating in China—both for fresh fruit consumption and for the use of apricot kernels for various purposes. Scientific selection work has been undertaken on a large scale. Interesting cultivars have been produced as a result of crossings between local Chinese and European varieties. Apricots also have a long cultivation history in China as ornamentals (W.Liu and N. Liu *et al*., 2010).

The First All-Russia Symposium on Apricots took place in December, 2013. Areas of intensive selection work with apricots are currently located in Southern Siberia and the Southern Urals (work with *Armeniaca mandshurica*); Orenburg, Saratov, and Samara (*A. vulgaris*); and also in Moscow.

A cultivated population of *A. vulgaris* with some added *A. mandshurica* was created in Moscow by professor A.K.Skvortsov, whose work on the project started in the 1950's. Today it is carried on by L.A.Kramarenko. The apricot population has been expanding, new gardens started in 27 monasteries in the Moscow Region and surrounding areas. Attempts have been undertaken to promote apricot cultivation farther north, to northern Vladimir and northern Tver Region (Skvortsov and Kramarenko, 2007).

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Arboretum Mlyňany in Slovakia

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A trip to the Arboretum Mlyňany took place within the agenda of the Second International Conference *Agrobiodiversity for Improving Nutrition, Health and Quality of Life* (August 2015, Nitra, Slovakia). Dr. Štefan Ambrózy-Migazzi (1869–1933) founded his "Park of Evergreen Cultivated Plants" in the late 19th century according to his own design. Nowadays, the Arboretum is one of the largest in Central Europe and belongs to the Slovak Academy of Sciences. It occupies an area of 67 hectares, and its dendrological collection includes more than two thousand taxa. When taking the major 4.5 km-long path, one can observe exotic plants belonging to various floras.

Representatives of the North American Flora occupy an area of 7.5 hectares. A major attraction in the collection and a subject of pride is a gigantic specimen of the relict *Sequoiadendron giganteum* (Lindl.) J.Buchholz towering at 35 meters, with a columnar trunk more than 1.5 meters in diameter. One can also observe *Sequoia sempervirens* (D.Don) Endl., the tallest tree species on the planet. Fastigiate junipers (*Juniperus virginiana* L., *J. scopulorum* Sarg., *J. rigida* Siebold & Zucc.) are planted in rows up to 4 meters tall. The Arboretum also boasts the intergeneric hybrid ×*Cupressocyparis leylandii* (A.B.Jacks. & Dallim.) Dallim., which you cannot find in Moscow or St. Petersburg. *Torreya californica* Torr. features ripening megastrobiles on female trees. Within Russia this species has been cultivated only on the Black Sea Coast. There is also an exceptionally large specimen of *Chimonanthus praecox* (L.) Link, an evergreen shrub that can grow up to 5 meters and flowers at the end of January, the flowers borne on leafless shoots. *Hydrangea quercifolia* W.Bartram, a very ornamental and robust plant, is a rarity in Moscow. On the contrary, *Hamamelis virginiana* L., which produces good flowers and fruit in Slovakia, also has been successfully grown in Moscow.

Four hectares are devoted to representatives of the European flora. *Castanea sativa* Mill., *Pyracantha coccinea* M.Roem., and others were observed in fruit.

In order to enhance the collection of woody plants, the arboretum organized a number of collection trips to China, Korea, and other countries. In the 1980's collection trips were undertaken on a regular basis. Currently, about a thousand taxa from East Asia are grown within the area of 14 hectares. The Japanese *Cryptomeria japonica* (L.f.) D.Don and its ornamental forms are useful street plants wherever the climate is mild enough. In the collection there is also *Metasequoia glyptostroboides* Hu & W.C.Cheng, a Chinese endemic. An attempt to grow this tree in Moscow (Main BG RAS) failed, as this species could not survive the cold winter (Svjazeva, 2005). However, in St. Petersburg Botanical Garden RAS, a few trees of *M.glyptostroboides* have been successfully growing since 1952, while *Cryptomeria japonica, Sequoiadendron giganteum*, and *Sequoia sempervirens* all failed during the very first winter they were planted outdoors (Svjazeva, 2005). *Ginkgo biloba* L. grows in Slovakia much more robustly and taller than it does in Moscow or St. Petersburg (where at the age of 30 it was not more than 4 meters tall).

The Carpathian piedmont, where the Arboretum Mlyňany is situated, is rather picturesque. In August one can observe the flowering of such nectariferous plants as *Euodia daniellii* (Benn.) Hemsl. (Rutaceae) producing its white inflorescences at a height of more than 5 meters and *Koelreuteria paniculata* Laxm. (Sapindaceae) with lush yellow inflorescences. Plants from East Asia surround a pond with bridges, stone street lights, and a Japanese-style gazebo. The eastern atmosphere is enhanced by the low-growing *Viburnum farreri* Stearn 'Nanum', *Cynoxylon kousa* Nakai with its characteristic edible fruit, and more. Here you can observe the fruiting *Decaisnea fargesii* Franch. (Lardizabalaceae), a shrub about 2.5 meters tall, with large, pinnate leaves. *Paulownia tomentosa* (Thunb.) Steud., another Chinese plant, is also abundantly fruiting. In Russia, this tree is cultivated only in the south; all attempts to grow it in Moscow and St. Petersburg have been unsuccessful (Svjazeva, 2005). Edible dark-blue fruits were ripening on the evergreen Chinese shrub *Berberis julianae* C.K.Schneid. In Moscow it produces fruit extremely rarely, as the shoots become frost-bitten.

Dendrologists have been looking for ways to restrict the invasive spread of the Chinese *Ailanthus altissima* (Mill.) Swingle and the North American *Robinia pseudoacacia* L. and *Amorpha fruticosa* Thunb. These plants have proved to be invasive in southern Russia.

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A collecting trip targeting Mexican weeds

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During recent years, an effort has been made to augment the Carpological Collection at the All-Russian Center for Plant Quarantine with samples of quarantine plants collected within their primary ranges. A field collection trip to the United Mexican States was undertaken from 18^{th} October to 9^{th} November, 2015 with the goal of collecting samples from those Mexican species that have a quarantine status in the Russian Federation. Samples of quarantine plants from the North American Continent are extremely under-represented in the Collection housed at the Center, and the goal of the trip was to mend that gap.

The trip was conducted in an exploratory mode, with the goal of general familiarization with Mexican plants especially those of importance as quarantine alien species within the territory of the Russian Federation. The trip included a 7300-kilometer expedition to the agricultural production area in northern Mexico, densely settled with orchards, nurseries, cornfields, and plantations of sugar cane, soybeans, asparagus, and cotton.

Extensive collections included carpological and herbarium samples of quarantine weeds along with samples of species morphologically similar to the quarantined species in the genera *Cenchrus* L., *Bidens* L., *Ambrosia* L., *Solanum* L., *Cuscuta* L., and *Ipomoea* L.

Of particular significance is the acquisition of fruit and herbarium samples of Texas blueweed (*Helianthus ciliaris* DC.), which previously had not been represented in the Collection. Along with quarantine weeds, the participants collected a number of other weeds commonly found in corn and soy plantings.

All the collected specimens will be included in reference carpological collections at the Center, used for standardized samples and control samples for inter-laboratory comparison trials, and also provide molecular data for the database of quarantine and noxious organisms and material for introductory trials in the restricted environment at the Center's Greenhouse. Data on the ranges of Mexican weeds will be taken into account when evaluating phytosanitary risks.

The trip has also yielded representative images of quarantine weeds in their natural habitats, which are going to be used for publications, such as management recommendations and scientific articles and also as teaching material at the Center.

The participants of the field trip were the head of the Trial and Expertize Center V.G.Kulakov and Senior Scientist at the Experimental Department, J.Y.Kulakova.

Consequences of the introduction of American ash species to the territory of the Volga-Akhtuba floodplain

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From the start of the 20th century, a large-scale installation of windbreak plantings was undertaken within areas of natural vegetation in the Volga-Akhtuba floodplain. A large number of exotic species, hybrids, and forms were introduced with the goal of enhancing the local flora Today the extent of the negative impact that these introductions produced on the biodiversity and natural complexes of the floodplain is only comparable to the impact of water flow regulation.

Introduced species that have been particularly aggressively spreading can be categorized as species-transformers—plants whose presence leads to transformation of entire ecological systems. These are *Fraxinus pennsylvanica* Marshal, *F. lanceolata* Borkh., *Amorpha fruticosa* L., and *Elaeagnus angustifoilia* L. Special attention should be paid to the North American ash species, particularly *F. pennsylvanica*. Due to high adaptation capacity and outstanding resistance to long-term flooding, Pennsylvania ash was intensively used in windbreak plantings and also as a companion tree in oak and other economically important tree plantings over the entire territory of the Volga-Akhtuba floodplain.

Ashes (*Fraxinus pennsylvanica* and *F. lanceolata*) have been advancing due to the capability of their seed to spread with the wind and water, especially during the flood periods. Due to the presence of waterways, floodplain ecosystems are especially vulnerable when it comes to invasions of alien species. Ash seed have high germination rates and produce dense seedling populations in disturbed habitats as well as within intact herbaceous and woody plant communities. Seedling survival rate is also exceptionally high, which results in the eventual complete displacement of all herbaceous and woody plants and the formation of pure ash stands.

Ashes, especially *Fraxinus pennsylvanica*, are equally comfortable in disturbed and pristine habitats and drastically modify the structure and functions of natural ecosystems. We have found Pennsylvania ash ubiquitous in riparian willow, poplar, and oak stands, wet sedge meadows, brome meadows at intermediate levels, and other plant communities on the entire territory of the floodplain. Riparian vegetation of floodplain and river delta waterways (arms and channels) is most susceptible to invasions.

Observations of alien ash populations allow us to arrive at preliminary conclusions about the lack of factors restricting their aggressive intrusion in local communities and the high probability of complete destruction of riparian complexes. In addition to constant monitoring, actions restricting further advancement of invasive populations are needed, as their expansion results in reduction of biodiversity at all levels of biota organization.

Due to the scale and rate of North American ash expansion, a program has to be promptly developed providing methods and techniques that would prevent further invasions, especially on conservation land. A country that has signed and ratified the Convention on Biological Diversity is accountable for any such invasions. The Federal Law *On Protection of the Environment* also requires undertaking measures preventing plant invasions.

Some directions of introduction work with representatives of the genus *Iris* L. and related genera: pro and contra

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One of the oldest collections in the Main Botanical Garden of the Russian Academy of Sciences is the Iris Collection. Major directions and priority objects for research work with this collection have been identified over a long time of the Collection existence. Bearded irises (genus *Iris* L., subgenus *Iris*, section *Iris*), predominantly varieties of *Iris ×hybrida* hort., historically formed the core of the Collection and have remained its centerpiece until now. As per the 2015 inventory, the collection of the Department of Ornamental Plants includes 10 species of *Iris*, another 3 species belonging to related genera (*Iridodictyum* Rodion. and *Juno* Tratt.), and 209 horticultural varieties and forms including 190 varieties of *Iris ×hybrida*.

The worldwide diversity of iris horticultural varieties has been recently growing at a high rate: according to a number of assessments, there are now 70–80 thousand of iris cultivars in the world. At the same time, the assortment of cultivated plants has been significantly shifting. As a result of these changes, the range of perspective research directions has been also modified: some that were not previously prioritized have now been developing more actively.

The introduction of aril and arilbred irises

The core of this class is formed by hybrids involving an *Iris ×hybrida* cultivar as one of the parents and a species from the section *Oncocyclus* (subg. *Arilosa*), *Regelia*, *Hexapogon*, or *Psammiris* as the other. The assortment of aril and arilbred irises in the world is now large enough to provide copious material for successful selection of cultivars best adapted to the soils and climate of temperate European Russia, so that it is possible to assemble a large collection representing just this group. Two cultivars were evaluated in the Department of Ornamental Plants over the 2011–2015 period: 'Kalifa's Horn' and 'Afrosiab.' Further introduction work with aril and arilbred irises may turn out to be more productive if conducted in climate-controlled test chambers.

The introduction of re-blooming *Iris ×hybrida* cultivars

Within the context of the contemporary selection work, the ability of bearded irises to flower repeatedly over a single season is generally considered a desired trait. This is certainly true in climatic conditions that are optimal for *Iris ×hybrida* varieties. However, when dealing with a less-than-optimal climatic situation in the area of introduction, the attitude toward the re-blooming ability may become a subject of discussion. In non-optimal conditions, the second flowering becomes irregular, likely producing a negative effect on the coefficient of vegetative reproduction, triggering shifts in timing of physiological processes meant to prepare the plant for overwintering, sometimes reducing the potential of the first flowering, and so on. Of 1507 cultivars evaluated in the Department of Ornamental Plants, 16.8% had been introduced by hybridizers as re-blooming; however, this character appeared to be stable only in three: *Iris* 'Cry Baby,' *Iris* 'Champagne Elegance,' and *Iris*'Tennison Ridge.'

The introduction of *Iris ×hybrida* cultivars with non-standard beard morphology (space age irises)

This trend is one of the newest in the world selection of bearded irises. Beard modifications are extremely unreliable traits prone to frequent phenotypical irregularities and dependent on a combination of environmental factors. There is currently one cultivar in the Collection featuring non-standard beard morphology, three more varieties are at the primary evaluation stage, and five more are to be included in the trials in 2016. Introductory work with spaceagers may be considered a component of more general *Iris ×hybrida* studies devoted to cultivars with uncommon characters.

The introduction of *Iris ×hybrida* varieties featuring some undesirable characteristics along with a number of useful characters

There are groups of cultivars in the Collection with three major limiting characteristics. 1. A low coefficient of vegetative reproduction is typical for ca. 10% of the overall number of dwarf and intermediate bearded cultivars in the Collection. 2. High susceptibility to bacterial infections has been reported in about 25% of the cultivars suffering from these diseases on a regular basis. 3. Insufficient winter hardiness (varieties that constantly sustain winter damage constitute about 5–7% of the total number of taxa in the Collection). It is important to note that, despite high variability among available bearded iris cultivars, it appears impossible to sustain a representative collection in the conditions of temperate European Russia without including at least some of those genotypes that have proved to possess undesirable characters.

The introduction of some representatives of related genera: *Iridodictyum*, *Juno*, *Belamcanda chinensis* (L.) Redouté

Two *Iridodictyum* species have been included in the collection (or are at the propagation stage): *I. reticulatum* (Bieb.) Rodion. and *I. kolpakowskianum* (Regel) Rodion. ≡

Alatavia kolpakowskiana (Regel) Rodion. There are also two species of *Juno*: *J. orchioides* (Carr.) Vved. and *J. kuschakeviczii* (B.Fedtsch.) P.Poliakov. Outdoor cultivation of *Belamcanda chinensis*, without special agrotechnical methods, has proved to be unproductive.

Molecular-phylogenetic data testify to the polyphyleticity of annual ruderal bluegrasses

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The section *Ochlopoa* of the genus bluegrass (*Poa* L.) is a small group of mostly annual grasses, occasionally short-lived perennials with soft foliage and decumbent culms, lacking underground shoots, and completely lacking epidermal unicellular prickles in all parts of the plants. Due to peculiarities of their habit, the species of this group are easily disseminated all across the globe. Growing in places of human habitation, they mostly take over ruderal habitats, frequenting roadsides, edges of fields and meadows, or eroded shores and banks. The Ancient Mediterranean Region has been named the center of diversity for this section (Tikhomirov, 2013). Depending on the interpretation of the taxa rank, 3–7 species of this section occur within Russia.

A number of intraspecific taxa have been lately segregated within the large aggregate *Poa* aggr. *annua* (*Ochlopoa* aggr. *annua*). These taxa differ from each other in both their vegetative and reproductive organs as well as in geographic distribution. Along with the nearly cosmopolitan type subspecies, this complex includes *P. annua* subsp. *pilantha* (Ronninger) H.Scholz (≡ *Ochlopoa annua* subsp. *pilantha* (Ronninger) H.Scholz), which is characterized by pubescence present not only along, but also between veins; *P. annua* subsp. *notabilis* Chrtek & V.Jirásek (≡ *O. annua* subsp. *notabilis* (Chrtek & V. Jirásek) H. Scholz & Valdés), a perennial plant; and *P. annua* var. *raniglumis* S.E. Fröhner (*O. annua* subsp. *raniglumis* (S.E. Fröhner) Chrtek) with glabrous lemmas. *P. annua* subsp. *pilantha* is less frequent than the type subspecies. It must have originated in southern Europe (Tikhomirov, 2013), now occurring around St. Petersburg, in the area around the Black Sea, and in the Northern Caucasus. *P. annua* subsp. *notabilis* originates from moderate-elevation mountains of Central Europe and is likely to be of hybrid origin, with the participation of *P. supina* Schrad. (Tikhomirov, 2013). It has been spreading in the same Russian regions as *P*. *annua* subsp. *pilantha*. Originating from North America, *P*. *annua* var. *raniglumis* is believed to be the rarest of all: it has been encountered only in a few places in Europe (including St. Petersburg). Many researchers now treat the sect. *Ochlopoa* as a namesake genus. (Scholz, 2003; Scholz and Valdes, 2006; Tikhomirov, 2013). Up until recently, a number of East Asian species were included in the sect. *Ochlopoa: P*. *nipponica* Koidz., *P*. *hisauchii* Honda, *P*. *acroleuca* Steud., and others. They are annuals or short-lived perennials, just as *Ochlopoa* s.str.; similarly to *P*. *annua*, they have short anthers, yet at the same time they also have a crown of long trichomes within the lemma callus. Very occasionally these adventive plants can be found in pastures and abandoned fields of the Russian Far East.

The goal of our study was to clarify the phylogenetic relations among these groups and find out how distinct the taxa within *Poa* aggr. *annua* are. To this end, we conducted molecular-phylogenetic analysis of the sequences trnL-trnF of the chloroplast genome and ITS1 gene of 5.8S rRNA-ITS2 of the nuclear genome. The sequencing was conducted following the standard protocol on a ABI PRIZM 3100 Genetic Analyzer (*Applied Biosystems*, United States) in the Communal Center for Scientific Appliances of the Botanical Institute, RAN. Phylogenetic trees were produced employing Bayesian and Maximum Likelihood methods.

The molecular-phylogenetic data obtained do not justify the segregation of the genus *Ochlopoa* on the basis of the sect. *Ochlopoa* s.str. (*P*. *annua* s.l., *P*. *supina*, *P*. *infirma* Kunth). According to both chloroplast and nuclear sequences, this section groups with the clade sect. *Alpinae*+sect. *Bolbophorum*, forming a general large clade of the so-called basal *Poa*, a sister-clade to the rest of *Poa* s.str. Inside this large clade, sect. *Ochlopoa* s.str. is monophyletic, although there are some differences within the clade as far as different genes are concerned. According to chloroplast genes trnL-trnF, the species of *Ochlopoa* are sisters to the endemic New Zealand sections, *Parodiochloa* and *Tzvelevia*, while, according to ITS, *Ochlopoa* form an independent clade among the basal *Poa*, and the sections *Parodiochloa* and *Tzvelevia* occupy an indeterminate position. Our data confirm the speciation of the tetraploid *P*. *annua* via hybridization of diploids *P*. *supina* and *P*. *infirma: P*. *annua* inherited its chloroplast genome from *P*. *infirma* (within trnL-trnF, *P*. *annua* has only 3 nucleotide differences), while the nuclear genome of *P.annua* originates from *P.supina* (no differences found between *P*. *supina* and any of the *P*. *annua* s.l. in ITS1 gene of 5.8S rRNA-ITS2 of the nuclear genome).

We did not detect any differences in nuclear or chloroplast genes between the subspecies and varieties from the complex *Poa* aggr. *annua*. All of them appear to be no different from those of *P*. *annua* s.str. At the same time, the East Asian species, which have been considered closely related to sect. *Ochlopoa*, are actually very far away from any of the basal *Poa*. Both *P*. *hisauchii* and *P*. *burmanica* Bor have ITS sequences very similar to those in the sect. *Stenopoa* and related sections, while ITS in *P*. *sikkimensis* (Stapf) Bor and *P*. *acroleuca* fall in the clade of Arctic and North Pacific bluegrasses and are akin to those in the sect. *Malacanthae*. According to their trnL-trnF, the short-lived perennial and annual bluegrasses from East Asia are monophyletic with the species of sections *Homalopoa* and *Macropoa*. The group of East Asian short-lived perennial and annual bluegrasses must have originated from triple intersectional hybridization. Their habit must have recently developed convergently to that in the sect. *Ochlopoa*, as both groups are of hybridogeneous origin. In contemporary treatments, the East Asian bluegrasses have been placed in the sect. *Acroleucae*.

The phylogenetic data obtained, concerning mostly ruderal, annual and short-lived perennial bluegrasses, testify against any close relations between the two sections in question. Both sections must have evolved fairly recently: during the late glacial or post-glacial time. The sect. *Ochlopoa*, a group originating from the Ancient Mediterranean, may have had a slightly longer evolutionary time, as its species are distributed more widely. At the same time, they have preserved a larger number of primitive morphological characters.

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Alien and native plants of the Southern Hemisphere

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The South African Department of Environmental Affairs (DEA) published the National Environmental Laws Amendment Act concerning invasive and noxious species in 2014. In that document, a total of 198 species of invasive plants and noxious weeds are sorted into three categories:

Category One: plants that have to be immediately eradicated;
Category Two: plants that may be grown under certain controlled conditions;
Category Three: plants that may no longer be planted.

Five species of Australian phyllode acacia may serve as examples of plants from Category One. The most common of these are *Acacia pycnantha* Benth. and *A. longifolia* (Andrews) Willd. These are characterized by extremely high growth rate, so that they can attain 7–10-meter height in five-six years. They are widely used in subtropical areas across the world for erosion prevention, as food plants (having edible flowers and beans), as well as for timber. They have been thus introduced to South Africa. As compared to the native Fabaceae, such as *Acacia tortilis* Hayne, *Burkea africana* Hook., *Cassia abbreviata* Oliv., Australian acacia have the advantages of faster growth, adaptability to nearly every kind of soil, and frost tolerance. The money spent yearly in South Africa in order to combat the Australian acacia on agricultural land amounts to $60 million.

Common yellow elder, *Tecoma stans* (L.) Juss. ex Kunth, a highly ornamental Bignoniaceae tree/shrub from Central and South America, is another category-one plant. It used to be cultivated for its large, spectacular, bright golden-yellow flowers. The plant easily escapes to rocky or sandy disturbed habitats. Even suckering shoots at the base of the trunk can produce a large number of seed.

Yet the most troublesome of all weeds despite all eradication efforts is by far the Mexican opuntia, nine species of which were introduced into South Africa for their edible fruit. Opuntia fruit are of high nutritional value, containing more than 50% fiber, multiple amino acids (eight of which are essential), as well as a vast array of vitamins and minerals. Prickly opuntia are well armed against herbivores, which makes them highly competitive, capable of gradual displacement of the native vegetation in pastures. Opuntia is widespread across the entire country; however, dry and rocky savanna and karoo areas are the ones that suffer the most damage. Here opuntia outcompetes succulent representatives of the local flora from Asclepiadaceae and Asphodelaceae. Two types of chemicals have been registered as herbicides for opuntia extermination in South Africa; however, biological control is the most economical and ecologically clean method. Cactus moth and certain weevils were introduced to the country, which has resulted in reducing the territory under opuntia.

Examples of plants belonging to Category Two are seven species of Australian eucalyptus, the plants whose count in South Africa is already over 16 million. Eucalyptus plantations occupy about 40% of all forested land. The attempt to grow eucalyptus under control for the purpose of producing wood for furniture, paper, and oil extraction has resulted in a troublesome situation. Eucalyptus species are characterized by a high growth rate, while requiring colossal amounts of water: up to 400 liters per plant per day. Covered with cultivated and spontaneous eucalyptus groves, South Africa has become one large drought area. The governments of Namibia, Botswana, and Zimbabwe have appealed to the United Nations demanding a halt to South African "eucalyptus expansion," as the aggressive trees now break into these countries.

Of eight alien pine species, two have penetrated natural habitats. *Pinus elliottii* Engelm., a tree from the southeastern United States that can attain 30 meters in height, has become widespread at forest margins in Mpumalanga Province (it also occurs in moist lowlands of Zimbabwe). *P. pinaster* Aiton, a pine originating from the western Mediterranean, which arrived here with the Europeans, now threatens local species on Table Mountain. The government currently offers annual grants to authors of innovative approaches to extermination of this pine and substituting it with other species. A native conifer *Widdringtonia schwarzii* Masters, whose wood is also rot-resistant and featuring good mechanical properties, grows very slowly and remains rather uncommon.

Every year at the end of summer, roadsides in Mpumalanga turn into colorful carpets due to the expansion of an ornamental *Cosmos* Cav. from Mexico, whose seed were inadvertently introduced with bags of forage for the horses of the English during the Anglo-Boer War. *Senna* Mill., *Bauhinia* L., and *Metrosideros* Banks ex Gaertn. are Category Three plants. These were introduced to South Africa as ornamentals. The situation with invasive alien plants appears to be not as dire in South America (Argentina) as it is in South Africa. Castorbean *Ricinus communis* from Euphorbiaceae, a plant originating from Ethiopia, has become naturalized in tropical and subtropical regions of both hemispheres, the major centers of its cultivation having been Brazil, Argentina, some African countries (including South Africa), China, and India. In the Southern Hemisphere, castorbean grows as an evergreen shrub up to 10 meters tall. It now occurs in both uplands and lowlands.

Two species of Mexican *Argemone* L. have become widely naturalized in many parts of the world. These are tough pioneer plants, drought-tolerant and well adapted to poor roadside soil. Their seed resembles and thus often mixes with that of mustard, which makes prepared mustard poisonous. A few cases of mustard poisoning have been registered in South Africa and other countries.

Rumex acetosella L. (Polygonaceae) was once introduced from Great Britain to Argentina. As this plant is capable of spreading by rhizome fragments and is also fire-tolerant, it presents a great challenge for management. Due to its exceptionally wide ecological amplitude, it may invade disturbed as well as pristine habitats. It has been reported from high-elevation steppe habitats in the Torres del Paine National Park, Patagonia, Chile, occurring there together with the endemic *Senecio patagonicus* Hook. & Arn. And *Mulinum spinosum* Pers.

Invasion of *Cenchrus longispinus* (Hack.) Fernald in East Europe: historical data and assessment of risk

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Cenchrus longispinus (Hack.) Fernald is a noxious weed listed as a quarantine species in many regions of the world including Ukraine and Russia. The plant features extremely sharp spiny burs, a kind of involucres surrounding the spikelets, formed by modified panicle branches. A native of North America, it made its first appearance in Europe before World War II, then more successfully in the early 50's. It continued its expansion, advancing to South Europe, Ukraine, and Russia starting from the late 80's–early 90's, probably after a short lag phase. We sampled *C. longispinus* from more than twenty localities in Ukraine, southern Russia, Hungary, and northern Italy. Analysis of AFLP markers revealed an unusually low degree of variability among the sampled populations with nearly no variability within. However, cluster analyses (UPGMA and Ward's Method) enabled division of the samples into two major clusters, probably corresponding to two different phases of invasion. The first one took place, according to available herbarium records, in 1951 in southern Ukraine, from where later, in the 90's the plants spread throughout Kherson Province of Ukraine, then to Kiev and Volgograd via long-distance dispersals. The second invasion occurred later, in the early 90's, plants suddenly appearing in several localities: Crimea, Rostov, Krasnodar, and later on also in Kiev and Volgograd. Remarkably, in Kiev, the plants originating from the first invasion are still confined to the railroad, while those from the second one occur only on the Dnieper River bank in the vicinity of the river port. The second wave may have reached Russia through Europe, since plants from Italy and Hungary all congregate at the base of the second cluster. This subdivision coincides with the distribution of the two revealed nuclear haplotypes of chalcone synthase intron (*CHSi*), the only variable region we managed to sequence among 8 sampled chloroplast introns, spacers, and nuclear ITS. The low level of genetic variability in *C. longispinus* may be due to predominate selfing and facultative apomixis, since SCAR markers associated with the apomixis-control region developed for *C. ciliaris* L. were also mostly amplified from the specimens of *C. longispinus*. The analysis of geographical distribution of *C. longispinus* in DIVA-GIS showed that all but two localities lay within the area of mean annual temperature 7.6–19.8°C. The two outliers were the records from Moscow (1987) and Belgorod (2012), neither of which was later confirmed, apparently, due to extinction of both populations. Hence the available data indicate that *C. longispinus* has already reached the limits of its distribution in East Europe under current climatic conditions, yet may expand farther in the northern and eastern direction if the climate becomes warmer.

Chemical composition of oil in the seed of *Echinocystis lobata* (Mich.) Torr. & A.Gray

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The subject of the study was the seed of wild cucumber *Echinocystis lobata* (Mich.) Torr. & A.Gray, a species with a primary range in North America deemed invasive in Russia. Within the former USSR territory, the plant became established practically simultaneously in the European and Asiatic parts of the country, forming a wide secondary range. Two isolated loci of expansion can be currently discerned within this territory: one in Central Europe, the other in the Maritime Province. Invasive populations have been very stable: wild cucumber actively displaces native riparian species from their habitats, producing deep shade, which makes it impossible for native herbaceous plants to survive underneath (Klotz, 2007; Vinogradova *et al.*, 2010). The above-ground parts, roots, and seed of *E. lobata* contain steroidal saponins including tetracyclic triterpene glycosides (cucurbitacins) as well as flavonoids, phenolics and medium- and long-chain fatty acids (Krauze-Baranowska and Cisowski, 1996; Budantsev and Lesnovskaya, 2001). Within its country of origin, wild cucumber has been known in folk medicine as a remedy for headache (taken as tea): bitters extracted from its root contain analgesics. Medicinal qualities of *E. lobata* within the secondary-range populations so far remain unknown.

The scientific interest in practical applications of lipophilic substances (fatty oils) of natural origin has significantly grown during recent years, which has to be attributed to the wide range of their pharmacological qualities. Such unsaturated acids as linoleic and linolenic, which belong to the group of omega-3 and omega-6 essential fatty acids, along with other essential phospholipids, are produced only by plants (Kretovich, 1980). Studies of lipophilic substances are of priority, as they lead to the identification of chemicals responsible for therapeutic qualities in plants. Data on the composition of lipophilic substances in *E. lobata* could not be found in the available literature.

The goal of this study was the identification of chemical components in the vegetable oil obtained from the seed of *E. lobata* in populations of central European Russia. Material for the study was collected in 2015 from two populations: one near the Town of Zvenigorod (Moscow Reg.), the other near Redkino (Tver Reg.). After the seed was ground, oil was extracted following a standard method (Folch Extraction Procedure). The chemical composition of the oil was identified at the Center for Collective Research, Institute of Biochemistry, RAN (Identification Number RFMEFI62114X0002). For analysis of the methyl esters of the fatty acids obtained, a *Shimadzu GS 2010* gas chromatograph equipped with a mass spectrometer *GCMS-QP 2010* was used (GOST [National Standard] Method 30418–96).

Results

Ripe seed contained more than 20% of fatty oil, whose composition in both studied populations was variable only quantitatively and insignificantly. Fatty acids were mostly represented by the following six: palmitic, stearic, oleic, linoleic, linolenic, and hexanedioic acid. Arachidonic and behenic acids were detected in negligible amounts (less than 1%). The oil is characterized by the low content of oleic acid (ca. 12%), though it is rich in the polyunsaturated linoleic and linolenic acids.

The major component of the oil in *E. lobata* seed is linoleic acid (up to 61%). Linolenic acid content was found to be up to 2%, while the percentage of saturated fatty acids (palmitic and stearic acids, ca. 18%) appeared to be relatively low, as compared to respective percentages in other fatty oils of vegetable origin, such as cotton, sea buckthorn, pumpkin, or soy oil. The study has thus revealed a high potential of the fatty oil contained in the seed of *E. lobata* growing around Moscow and Tver. It presents interest for a further study with the goal of possible utilization of this plant as a source of valuable biologically active compounds.

The work has been undertaken within the framework of the following topic included in the Research Plan at the Main Botanic Garden RAN: *The study and conservation of biological diversity of the native and cultivated flora: fundamental and applied problems*; also, partially supported by the following Program for the Fundamental Research, Division of Biological Sciences RAN: *Rational Utilization of biological resources in Russia: fundamental basics of management*; as well as by the grant 15–29–02556 from the Russian Foundation for Basic Research.

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Selection of peonies: employment of the natural gene pool

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The current trend in selection is utilization of natural resources. Unfortunately, peonies have been over-collected due to their high ornamental potential. They are cut for bouquets, dug out and transplanted to private gardens, which has resulted in decimation of native populations. In most regions of this country, peonies are protected species, some of them listed in the Red Book. Many peonies are narrow endemics. Despite the restriction of species to certain areas, the range of the genus on the whole stretches over a large territory. Analysis of taxa distribution has revealed centers of high species concentration and enabled a study of genetic relations between sections. Two centers of diversity have been traditionally recognized for *Paeonia* L.: the western (Mediterranean Region/Asia Minor) and eastern (southwestern China).

Results of our long-term introduction trials demonstrate that areas of some rare and protected species may be readily extended to temperate European Russia. Such species as, for example, *Paeonia anomala* L., *P. lactiflora* Pall., or *P. tenuifolia* L. have been doing well not only in botanical garden collections, but also in spontaneous populations, demonstrating high seed productivity and viability. The ability of these species to reproduce is the most important trait ensuring their high stability in new settings. In addition to seed reproduction, these species successfully reproduce vegetatively in new situations. Therefore, they can be widely used in the green industry.

For the contemporary selection, it is important to employ native species as primary material and also obtain separate genes from wild populations in order to considerably improve horticultural varieties, for example, obtain seedlings that will produce brightly colored, abundant, early flowers, while demonstrating elevated resistance to diseases. One such useful introduction has been the Chinese peony (*Paeonia lactiflora*)—many-flowered, frost-hardy, drought-tolerant, and pathogen-resistant. Another one, *P. peregrina* Mill., brought from Buzhory, Moldova, has scarlet flowers, producing a single flower per stem, flowering early; however, it is susceptible to *Botrytis* blight. By means of interspecific hybridization, we formed a hybrid peony population, selections from which have proved to be highly ornamental and promising. A few of them were approved by the state commisssion as cultivars *Paeonia* 'Ivan Gorozhankin,' *Paeonia* 'Ogonyok' ['Twinkler'], *Paeonia* 'Zvezdochka' ['Little Star'], *Paeonia* 'Kitaiskiy fonarik' ['Chinese Lantern'].

Plants intended for a street environment should be shade tolerant or at least capable of growing in half-shade, retaining their ornamental traits in urban situations. *Paeonia anomala* is a species with one of the largest ranges, native in Siberia, on the Kola Peninsula, in Middle Asia, and in China. The species has been introduced to cultivation on a large scale in Yakutia, where plants have to adapt to the permafrost, steep drops in night-time temperatures, and relatively warm and short summers. Taking into consideration these qualities of *P. anomala*, we used it for interspecific hybridization. The obtained hybrid population consisted of plants variable in their habit, flower color, height, and phenology. They have proved to be frost tolerant, possess a good reproductive ability, and grow well in neutral soil. The two most promising seedlings have been registered as cultivars and named *Paeonia* 'Zarnitsa' ['Heat Lightning'] and *Paeonia* 'Alexandra.'

In the Moscow University Botanic Garden, research is conducted on enhancing genetic variability by exposing herbaceous and woody peonies to ionizing radiation and chemical mutagens. The goal is to obtain highly ornamental forms that are resistant to diseases and other adversities. Seed of woody *Paeonia suffruticosa* Andrews and herbaceous *P. mlokosewitschii* Lomak. were subjected to mutagens. This seed produced populations, from which some interesting forms were then segregated. Among the first-generation plants of woody peony, there were forms characterized by elevated frost hardiness, fungus resistance, differences in height or growth structure. The most promising of these were then hybridized with the best cultivars among woody peonies. As a result, new cultivars were obtained, which are suitable for the conditions of temperate European Russia.

Of wild herbaceous peonies, the most interesting one appears to be *Paeonia mlokosewitschii*, a species with yellow flowers. Upon being subjected to ionizing radiation, seed of this species demonstrated a spike of genetic variability, producing plants with a different color of petals and stamen filaments and also unusual habits. A plant with a delicate flower color has been segregated and registered as a cultivar, which was named *Paeonia* 'Nezhnost' ['Tenderness'].

Since natural populations of peonies have been rapidly declining, conservation of their genetic diversity is now more important than ever. The gene bank can be conserved not only within the natural populations, but also ex situ, in botanic gardens, including the production of new ornamental varieties.

Invasive and native *Bidens* L. taxa in Eastern Europe

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The taxonomy of the genus *Bidens* L. remains quite confusing. The species native to temperate European Russia are polymorphic and include a number of forms and varieties. Attribution of alien plants to species varies by the author; the rank of plants exhibiting intermediate characters is unclear. Therefore, we launched an experimental study of variability and heritability of morphological characters in a number of beggarticks taxa.

In 2014, we surveyed the vicinity of Tasinskiy near Vladimir and discovered there six taxa belonging to the genus in question: *Bidens cernua* L., *B. frondosa* L., two forms of *B. tripartita* L.—typical and *B. tripartita* f. *minima* (Lej.) Larss., and also two morphotypes of '*B. connata* Muhl. ex Willd.', which differed in the shape of their proximal leaves: either three times divided (morphotype A, wet habitats) or entire (morphotype B, moderately moist habitats). These leaves are typically absent on herbarium specimens, as they are shed early. They are apparently missing in the isotypes of *B.connata* [PH] and in the type specimen of *B.decipiens* Warnst. [PRC]. (The majority of the European '*B. connata*', which significantly differ from plants found within the native North American range, were earlier attributed to the latter taxon.) European samples do not have ray florets; their first normal leaves are wider and with more pronounced petioles; leaf denticles are fewer, more irregular, and usually larger than those in the North American *B. connata*; outer series of involucral bracts are clearly herbaceous, well developed, 3–6 cm long (Sherff, 1937).

Seed were collected from plants belonging to each taxon and sown in a uniform setting at an experimental plot (located in the vicinity of Zvenigorod, not far from Moscow). In 2015, a number of their morphological characteristics were assessed and phenological data collected for F_1 progeny.

Diagnostic morphological characters were fully inherited in all of the studied taxa of the genus *Bidens* with the only exception being *B. tripartita* f. *minima* whose progeny did not inherit the miniature dimensions of the parent plants. The two morphotypes of '*B. connata*' inherited, respectively, either entire or divided proximal leaves.

In the F_1 generation, we observed remarkable uniformity of growth dynamics and timing for entering certain pheno-phases. The observed sequence of reaching a similar phenological stage was as follows: *Bidens tripartita* → '*B. connata*' → *B. cernua* → *B. frondosa,* with a one- to two-week time lapse between the taxa adjacent in the series. The vegetative period lasted ca. 100 days in *B. tripartita*, while in *B. frondosa* it was prolonged to about 160 days. Having quite a wide ecological amplitude, *B. tripartita*, *B. frondosa*, and *B. connata* successfully grow in hygrophytic as well as mesophytic situations. By the end of the vegetation period, it was *B. frondosa* that produced the tallest plants (95.6±5.9 cm). The latter species enjoys a vegetative period that is a whole month longer than that of *B. tripartita* (which reached the height of just 49.5±2.3 cm). The average height of '*B. connata*' was 67.0±3.1 cm for morphotype A and 59.2±3.5 cm for morphotype B. The plants that grew the least by the end of the season belonged to *B. cernua*: they only reached a height of 28–46 (37.3±1.9) cm, even though the parent plants in a natural setting had been twice as tall. This allowed us to conclude that *B. cernua* is a stenotopic species whose development depends on availability of a wet habitat.

The largest number of flowering heads (more than 100 per plant) was observed in *Bidens frondosa,* while the smallest amount (not more than 8 per plant) was produced by *B.cernua*. The average number of heads in *B. connata* was dependent on the morphotype: 62.6±20.4 for morphotype A and 82.6±27.6 for morphotype B. *B. tripartita* on average formed 39.9±10.0 heads.

Pollen grains isopolar, either spheroidal or wide ellipsoidal, tricolporate; surface sculpture echinate, spine size diminishing in the series *Bidens frondosa → B. connata → B. tripartita→ B. cernua.* Pollen grains in *B. frondosa* (37.6±0.4×31.3±0.3 µm; V=ca. 19000 μm^3) were twice as large as in *B. cernua* (31.2±0.8×25.0±0.3 µm; V=ca. 10000 μm^3). Pollen fertility was high in all of the examined taxa: 70-90%.

Potential seed productivity was found to be the largest in *Bidens tripartita* f. *minima* (more than 8000 cypselas per plant), followed by *B. frondosa* (more than 5000 cypselas), then by the typical form of *B. tripartita* (3500), *B. connata* (2500–3500), giant form of *B. tripartita* (2500), and finally *B. cernua* (just less than 1000 cypselas per plant).

Cypselas in '*Bidens connata*' are 4-angled, with 4 awns (just like those in the European *B. cernua*), their surface papillose (like cypcelar surface in the North American *B. frondosa*). In addition to papillae, cypselas of *B. connata* are covered with trichomes of two types: duplex (as in *B. frondosa*) and unbranched multicellular simple trichomes (as in *B. cernua* and *B. tripartita*). This gave us grounds to assume that the so-called *B. connata* was a putative hybrid *B. cernua* × *B. frondosa.*

However, the leaf morphology allows for another assumption: plants attributed to '*Bidens connata*' (and particularly morphotype A) are actually hybrids *B. cernua* × *B. tripartita,* since their distal and mid-stem leaf blades are entire, linear-lanceolate (as in *B. cernua*), while proximal ones are more or less three-parted (as they are in *B. tripartita*).

To test the hypothesis regarding the hybrid origin and possible parent species of '*B. connata*', we resorted to molecular analyses. DNA was extracted employing the standard STAB Method from leaves collected from 28 individual plants of beggarticks, which included the parent plants from Tasinskiy along with their F_1 progeny and also samples collected in 2015 in Belovezhskaya Pushcha National Park, Belarus. Evaluation of putative hybridogeneous nature of '*B. connata*' was performed employing Inter-Simple Sequence

Repeat (ISSR) method, that is, polymerase chain reaction (PCR) conducted with ISSR primers (GA)8 YG, (AG)8YA, (CAG)5, DBD(AC)7, and CCC-TCC-CTC-CCT-CCC-T. *Cross Checker*, PAST 2.0, and *New Hybrids* programs were used for data analysis. According to the results of the cluster analysis, differences between populations within '*B. connata*' were more significant than interspecific differences between '*B. connata*' and *B. cernua.* These results do not contradict our hypothesis initially based on morphological analysis regarding the hybrid nature of the taxon that has been known in various contexts as *B. connata*.

Posterior probability for each plant's attribution to either one or the other parent species, their first-generation hybrid, or else to a back-cross was calculated using the *New Hybrids* Program. The hypothesis stating that '*Bidens connata*' originated as a cross between *B. tripartita* and *B. cernua* was not confirmed. There is a high probability that the so-called '*B. connata*' constitutes a back-cross, that is, a result of hybridization between the hybrid *B. cernua* × *B. frondosa* and the parent species *B. cernua* (posterior probability higher than 50% for the majority of samples). Plants of '*B. connata*' from Tasinskiy vicinity are back-crosses with a posterior probability from 2.6 to 60%. At the same time, they were attributed to the parent species *B. cernua* by the *New Hybrids* Program with a probability from 40 to 97.3%— evidence of great similarity between their genomes. This confirms our assumption regarding a probable hybridization process that takes place in areas of co-habitation. As to the vicinity of Tasinskiy, this is, apparently, one of such areas. The progeny of plants from this area as well as individuals from Belovezhskaya Pushcha were identified as hybrids with a posterior probability of 100%. The probability that these are first-generation hybrids is significantly lower than that of their back-cross nature: while the former is only 15.6–26.8%, the latter is 70.6–76.3%. F_1 progeny of these plants could constitute a cross (back-cross×pure species *B. frondosa),* since both were found in the same habitat. According to our data, this progeny may theoretically represent recovered *B. cernua* (that is, one emerged as a result of at least four consecutive crosses of the hybrid *B. cernua* × *B. frondosa* with the parent species *B. cernua*). However, despite the lower probability, we would rather attribute these samples to back-crosses, as they exhibit morphological characters of the so-called '*B. connata*'. The most probable scenario is that in the habitats shared by *B. cernua* and *B. frondosa,* one can find their hybrids along with back-crosses, recovered *B. cernua*, and probably also recovered *B. frondosa*.

Apparently, in Eastern Europe, the native *Bidens cernua* has crossed with the alien *B. frondosa*, and this process resulted in formation of a complex of hybrids and back-crosses, which for decades have been erroneously attributed by botanists to the North American species *B. connata*. Two different groups of individuals can be distinguished within the European populations of *B. connata*. These two groups differ by their inherited morphological characters and also by ecological requirements. We treat these groups in the rank of varieties in accordance with the International Code of Botanical Nomenclature.

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