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INVASIVE ALIEN SPECIES OF VASCULAR PLANTS IN BULGARIA
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Alien plants – they are all around us. In natural habitats together with our native species. In parks and gardens, on the streets and in yards, near railway and bus stations, border posts, along highways and railways, ports, near buildings, even in the cracks of balconies, walls and roofs, mixed with the ornamentals in containers, landscaped with the good idea to make the atmosphere more beautiful and comfortable. Everywhere! We are so accustomed to their presence that we either ignore them or just do not see them. But we should not!

To them – the “uninvited guests” in our nature, more or less dangerous, the presence of which is a disaster for the native flora, the environment, the economy and our health – is dedicated this book!

AN ALIEN SPECIES WHICH BECOMES ESTABLISHED IN NATURAL OR SEMI-NATURAL ECOSYSTEMS OR HABITAT, IS AN AGENT OF CHANGE, AND THREATENS NATIVE BIOLOGICAL DIVERSITY, IS CALLED INVASIVE (IUCN 2000)
Invasive alien plants – nature and impact on natural biodiversity

At the global level, the invasive alien species are defined as the second cause (after the habitat destruction or loss) for extinction of species of the native biodiversity (Genovesi & Shine 2004). Moreover, many of the invasive species threaten human health or cause damage to national economies, causing irreversible changes in nature.

Over the past 100 years, the number of the recorded alien plant species is increasing with a fast rate in many areas of the world as a result of ever increasing trade, transport, tourism, which break the natural barriers between countries and continents. While some of the plants that naturalize (go wild) do not cause serious problems because they remain limited to man-made habitats or do not enlarge their distribution area, others pose a serious threat. The latter are the invasive alien species. The International Union for Conservation of Nature (IUCN 2000) defines invasive species as:

“An alien species which becomes established in natural or semi-natural ecosystems or habitat, is an agent of change, and threatens native biological diversity”

Thus, the invasive alien plant species are distinguished from the weeds that grow in agroecosystems. In the literature this distinction is rarely made, and the term “invasive” is understood differently (Pyšek 1995; Richardson & al. 2000). The reasons are that it is often difficult to clearly distinguish the natural and semi-natural habitats from the man-made ones, and that these species can be found in all of them. The weeds in the agro-
ecosystems differ in their ecology from the invasive species because the affected ecosystems are different. Agroecosystems are created by humans and represent ordinary habitats of ecological homogeneity, which are species-poor and have a predictable mode of disturbance. In contrast, most natural and semi-natural habitats are species-rich, ecologically heterogeneous and often with unpredictable regime. It is necessary to distinguish the invasive species from the weeds in arable lands. Some authors (e.g. Weber 2003) call the invasive plants "environmental weeds".

These species represent a serious and permanent threat to native biodiversity, and the problem of the biological invasions becomes the central problem for its preservation. Many of them continue to reproduce and spread, even if their cultivation ceased or ecosystems are no longer under the influence of disturbance and pollution. These threats are another addition to the other threats caused by pollution and climate change (Weber 2003).

The wide and rapid spread of the alien species is a result of their biology – they form plenty of seeds with a great viability that is retained for years, have effective mechanisms for distribution, grow rapidly and can adapt to various environmental conditions, etc. In addition, some of them have valuable features for man – they are rich in nutrients, some with very good taste, attractive appearance, etc., which makes them preferable for cultivation as food, for decoration or erosion control, and therefore, they are intentionally transferred from the areas of their natural spread to other parts of the world.

The impact of the invasive alien species is often significant. They are very competitive in the habitats of the native species due to very high tolerance of many of them to different environmental conditions. They cause changes in the soil content due to absorption of nutrients (especially nitrogen) and water from the soil, affect the light regime in the habitat and change its structure, hybridise with closely related native species, cause extinction of rare species, serve as vectors of diseases, have a significant impact on human health – causing allergies, others are poisonous and contacts with them cause serious problems. In addition to the negative impact on biodiversity, the alien species cause high economic costs. They may be a result of direct loss of agricultural and forest crops or of increased costs of production due to application of measures to control the invasive alien species.

In terms of biological invasions the vascular plants are the most inten-
Fallopia ×bohemica

Robinia pseudoacacia
sively studied taxonomic group. Globally, around 395 alien plants have been explored in details, representing 44% of all invasive taxa studied (Pyšek & al. 2009).

Usually it takes some time from the moment in which an alien species is transferred to a new territory and the time when the invasion begins, this time is different for the different species and areas. This delay in time makes the prediction of the invasiveness of a taxon very difficult (Wittenberg 2005). An established species that does not show any threat to the environment, may become invasive in the future. According to the author there are three main categories of factors that determine the ability of a species to become invasive: internal, or its intrinsic characteristics; external, or its interaction with the abiotic and biotic factors; human activities, involving the import of species to meet the various needs of people (Wittenberg 2005).

### Ways and pathways for introduction of the invasive alien plant species

Road, rail, air and water transport reduce or completely remove the barriers for dispersal of plants. This is facilitated also by the intentional activities of people – by cultivating different species of grain, feed, textile, vegetable, medicinal and ornamental plants, etc., some of which are later abandoned. Left without control, they escape and establish in nature, i.e. go wild, some expand their territory and pose a serious threat to the native species and communities.

Depending on the method of entry into an area, the invasive alien species are of two categories:

- **intentionally introduced** – species that have been intentionally transported to be cultivated for ornamental purposes, afforestation, timber production or for other economic use;
- **unintentionally introduced** – species unintentionally transported by man, e.g. as contaminants in uncleaned seeds of vegetables, forest trees, cereals and other cultivated plants, in soil, agricultural products and others.

In both cases, these species create self-sustaining populations outside the area of cultivation or introduction and spread in natural communities.

Among 1780 naturalized plant taxa in Europe with data about the paths of introduction, intentionally introduced are 62.8% and unintentionally introduced – 37.2%. Species that are cultivated for landscaping and gardening and escape in nature represent the largest share –
52.2%. Only 11 species can certainly be attributed to the group of taxa deliberately released into the wild. This group, however, in many cases is difficult to distinguish from the species, planted in semi-natural environment for practical purposes such as landscaping (e.g. Robinia pseudoacacia, commonly used for soil stabilization) (Lambdon & al. 2008).

Contaminated seeds, mineral materials and other commodities are responsible for the introduction of 1091 alien species in Europe, representing 76.6% of the total unintentionally introduced species, and 363 species are directly related to transport, but arriving as stowaways, i.e. independently from the transported objects (Lambdon & al. 2008).

The main pathways for unintentional introduction of alien plant species in Bulgaria are the major rivers, including the Danube and its ports, the Black Sea ports, road and rail networks (Petrova & al. 2012).

International conventions, organizations and documents related to the issue “invasive alien species”

Council of Europe, since the beginning of 1980, has been encouraging its members to prohibit the introduction of non-indigenous species in nature, to take precautions against accidental introductions and to undertake practical recovery measures. This is necessary because the spread of invasive species is a global problem and the unilateral actions of several countries are not effective to prevent them.

In the Convention on the Conservation of European Wildlife and Natural Habitats (Bern Convention 1979), ratified by Bulgaria in 1991, member states are urged “to strictly control the introduction of alien species” (Article 11.2.b).

In response to this global problem, and to promote the aims of the Bern Convention, European Strategy on Invasive Alien Species was elaborated and published (Genovesi & Shine 2004). It aims to facilitate the development and implementation of coordinated measures and efforts to unite Europe on international, cross-border and regional levels, to prevent or minimize the adverse impacts of the invasive alien species on the European biodiversity and its negative consequences for the economy and human health. Attention is paid particularly to the control on the permissions for the introduction of alien species that pose a potential threat to the native biodiversity.

Along with those already mentioned, a number of other international conventions and initiatives,
Ambrosia artemisiifolia

Laburnum anagyroides
to which Bulgaria is a party, have been created, calling for immediate and consistent action:

- **Convention on Biological Diversity (CBD 1993)**, ratified by Bulgaria in 1996, urges the member states to undertake action to “prevent the introduction of, control or eradicate those alien species which threaten ecosystems, habitats or species” (§ 8h).
- **International Plant Protection Convention (IPPC 1997)** – aims to provide a coordinated, effective action to prevent and control the introduction and spread of pests of plants and plant products. The Convention is applied not only to cultivated plants, but also extends to the protection of native flora and plant products. It takes into account both the direct and indirect negative impacts of pests, i.e. it includes weeds too.
- **Directive 92/43/EEC (1992)** on the conservation of natural habitats and of wild fauna and flora obliges member states to “ensure that the deliberate introduction into the wild of any species which is not native to their territory is regulated so as not to prejudice natural habitats within their natural range or the wild native fauna and flora, and if they consider it necessary, prohibit such introduction. The results of the assessment undertaken shall be forwarded to the committee for information” (§ 22b).
- **Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES 1975).**
- **Global Strategy on Invasive Alien Species (McNeely & al. 2001).**
- **DIVERSITAS** – an international research program on biodiversity, established in 1991, aiming to integrate scientific knowledge on biodiversity for the benefit of humanity.
- **Global Invasive Species Programme (GISP),** established in 1997, it aims to conserve biodiversity and maintain the livelihood of mankind by reducing the spread and impact of invasive alien species, enable the governments and other organizations to use the best practices available to control these species, and support the development of additional tools and strategies needed to improve their management worldwide. It was established as part of DIVERSITAS by a consortium of three organisations – IUCN (the International Union for Conservation of Nature), CAB International (CABI) and the Scientific Committee on Problems of the Environment (SCOPE).
- **Invasive Species Specialist Group (ISSG),** founded in 1994 as a global network of experts on invasive species. It is part of the Species Survival Commission (SSC) to the International Union for Conservation of Nature (IUCN). It aims to reduce the threats to
the natural ecosystems and species by raising public awareness of invasive species and of the ways to prevent, control or eradicate these species.

- **IUCN Guidelines for the Prevention of Biodiversity Loss Caused by Alien Invasive Species**, developed by IUCN (2000), through its Invasive Species Specialist Group (ISSG). As a result, a list has been compiled of the “100 of the World’s Worst Invasive Species”.

- **European Environment Agency** (EEA), an agency of the European Union – established in Copenhagen and operating since 1994. It provides sound and independent information on the environment and an assessment of the policies of its main clients – the institutions of the European Union and the member states. In connection with the SEBI 2010 (Streamlining European 2010 Biodiversity Indicators), a Pan-European initiative, was prepared and published “List of ‘Worst invasive alien species threatening biodiversity in Europe” (Annex 1. 2007). It is part of the main indicators of biodiversity change caused by invasive alien species.

- **European and Mediterranean Plant Protection Organisation** (EPPO) – an intergovernmental regional organization established in 1951, headquartered in Paris, and currently involving 50 member countries, including Bulgaria. Responsible for cooperation in plant conservation in Europe and the Mediterranean region. The following lists of plants have been elaborated and are periodically updated: **A1** – includes species that are not yet found in the EPPO region (Europe, Israel, Russia and some countries in North Africa) and **A2** – includes alien species already locally spread in this region, List of invasive alien plants, Observation List of invasive alien plants and EPPO Alert list. EPPO recommends to its member states to treat the taxa from the lists A1 and A2 as quarantine species, since they pose risks and require undertaking of phytosanitary measures.

- **Delivering Alien Invasive Species Inventories for Europe** (DAISIE) – a website developed as part of a project entitled with the same name and funded under the 6th EU’s Framework Programme. It provides information on biological invasions in Europe.

- **Pan-European Biological and Landscape Diversity Strategy (PE-BLDS).**

- **Environment Action Programme** (EAP).

- **Global Register of Invasive Species** (GRIS).

- **Global Invasive Species Database** (GISD).

- **North European and Baltic Network on Invasive Alien Species** (NOBANIS). One of its products
is a database of alien species, identifying the current invasive and potentially invasive species in the region concerned. Besides providing information on the distribution and control of the invasive species, the network aims to provide means to prevent their unintentional dissemination and ensure regional cooperation for eradication and control of these species and minimisation of their environmental impacts.

**East and South European Network for Invasive Alien Species (ESE-NIAS)** is a regional data portal on invasive alien species. It aims to provide data about the scientific names, biology, ecology, invasiveness, pathways of introduction and spread, impact of the invasive species as well as the relevant regulations. It provides references to the major scientific articles on the invasive alien species in the region and serves as an early warning tool for new introductions of aliens.

**Bulgarian national legislation**

The introduction of non-native (alien) species of plants and animals in Bulgaria is regulated by the Biological Diversity Act (BDA 2002, 2007, Art. 2, 4). Control and regulation of non-native species that are or could be introduced intentionally or accidentally in nature and threaten native species are provided for in Art. 35, 6. Chapter III – Section IX, refers specifically to non-native species and states that the introduction of non-native species into the wild is only possible after a positive scientific expertise and a positive decision of the National Council on Biological Diversity (Art. 67, 2).

Based on Art. 69 of the Biological Diversity Act the following documents have been issued:

- **Regulation No. 4** of 8 July 2003 on the conditions and procedures for issuing permits for the introduction of non-native or reintroduction of native plant and animal species in the wild.
- **Regulation No. 14** of 27 October 2005 on the conditions and procedures for issuing permits for the introduction of non-native or reintroduction of native tree, shrub and game species in nature and consideration of the public opinion in the region of the reintroduction.

**Plant Protection Act** (1997) regulates the phytosanitary measures under the International Plant Protection Convention (Art. 1, 1) and the phytosanitary quality and control of plants and plant products intended for the domestic markets as well as for export (Art. 1, 4). Under this law the Bulgarian Food Safety Agency has the authority of the Ministry of Agriculture and Food to
carry out the control, diagnostic, research and the regulatory functions of the Ministry under this Act (Art. 2, 1). Based on the Plant Protection Act Regulation № 1 of 27 May 1998 on phytosanitary control was issued.

**Basic terminology associated with alien species**

The presented terminology is based mainly on the definitions proposed by Richardson & al. (2000), Genovesi & Shine (2004), and Pyšek & al. (2004).

**Alien species**: species, subspecies, or taxa of lower rank, introduced outside their past or present distribution. This includes any part, gametes, seeds or propagules of such species that might survive and give rise to new individuals.

**Invasive alien species**: alien species whose introduction and/or spread threaten local biological diversity.

**Introduction**: any movement of an alien species outside its past or present natural range with the direct or indirect assistance of people.

**Intentional introduction**: the deliberate movement and/or release by humans of an alien species outside its natural range.

**Unintentional introduction**: any movement of an alien species that is not intentional.

**Naturalization**: the establishment of a new species in a new territory, where it successfully reproduces with the likelihood of continued survival.

**Casual alien species** – alien species that can survive and even reproduce occasionally outside cultivation, but do not form self-sustaining populations without human intervention and rely on repeated introductions for their persistence.

**Archaeophytes**: alien plant species introduced to a region since the early Neolithic period until the end of the 15th century (until the discovery of America by Columbus in 1492).

**Neophytes**: alien plant species introduced to a region after the end of the 15th century (after 1492).

**Invasive alien species in Europe**

According to the definition, the invasive alien plant species are not native to the area that they have invaded. In Central Europe, 34% of the introduced species are of Asian origin, 23% are from North America, 22% from South America, and 17% from Africa (Pyšek & al. 2009).

Many alien species in a region of Europe are naturally spread in other parts of the continent, and according to Lambdon & al. (2008) such are 28.6% of the alien species in the European flora.
Paspalum distichum

Catalpa ovata & Ailanthus altissima
After North America, Europe is the second continent where the invasive alien species have been most intensively studied (Pyšek & al. 2008). Despite the considerable amount of information about many of them, the authors draw the attention to its uneven distribution, i.e. many European countries do not have such information in specialized lists.

The invasion of new species in various parts of the continent is a continuous process, and these species are still quite intensively studied. Many countries publish their data and regional lists, and today the number of these countries and lists is significant. Among them are Austria (Essl & Rabitsch 2002), Belgium (Verloove 2006), Czech Republic (Pyšek & al. 2002, 2012b), France (Muller & al. 2004), Germany (Kühn & Klotz 2003), Hungary (Nechay & Kalotás 2003; Balogh & al. 2004; Botta-Dukát & Balogh 2008), Ireland (Reynolds 2002), Italy (Celesti-Grapow & al. 2009), Romania (Anastasiu & Negrean 2009a, b), Switzerland (Wittenberg 2005), UK (Clement & Foster 1994) and others.

Based on the data contained in Flora Europaea (Tutin & al. 1964–1980), a major source of information about the distribution of the naturalized species, Weber (1997) analyzed the alien species in Europe and estimated that they are 1568, including the invasive alien species. As Pyšek (2003) stated, this analysis is irrelevant today and contains many inaccurate data for the individual countries. The author came to this conclusion making an assessment of the reliability of the data, using the Czech Republic as a model country, for which there is solid and complete information for these species. As a result Pyšek (2003) found that 55.5% of the information is incorrect, focusing on the need for urgent investigations, collection of the existing regional data and their inclusion in an integrated European project.

Such a project was Delivering Alien Invasive Species Inventories for Europe – DAISIE (2009), developed under the FP6 program (2004-2008) of EU. A comparison and evaluation of the existing data on the largest group of the European alien species was made. A database was created (http://www.europe-aliens.org/), which is based on the information received from 48 European countries, thus achieving a reliable continental inventory.

The results show that across Europe are distributed 1,780 alien plant species from 213 families, almost twice as much as the families reported by Weber (1997). As expected, the alien flora is dominated by the large families world-
wide, e.g. Asteraceae (692), Poaceae (597), Rosaceae (363), Fabaceae (subfam. Faboideae, 323, Essl & Rabitsch 2002) and Brassicaceae (247). The only additional major tree family is Pinaceae (53 alien species). In some cases the high presence of alien species is due to the frequency of introduction, as some families include valuable for people species (e.g. Rosaceae for fruits, Pinaceae for wood, Lamiaceae as medicinal and ornamental plants). The genera represented by at least one alien species in Europe are 1 567 (Lambdon & al. 2008).

In more than half of the European countries 128 alien plant species are distributed, and the most common among them is Erigeron (Conyza) canadensis, found in 95.9% of the European countries. It is followed, with more than 80%, by Helianthus tuberosus, Robinia pseudoacacia, Amaranthus retroflexus, Datura stramonium, Galinsoga quadriradiata, Galinsoga parviflora, Matricaria discoidea, Oenothera biennis and others. Among the most widespread alien species included in the list of the 100 of the worst alien species are Robinia pseudoacacia (41 countries), Ailanthus altissima (39), Fallopia japonica (39), Ambrosia artemisiifolia (35), Impatiens glandulifera (34) (Lambdon & al. 2008).

The largest number of alien species, regardless of their status, is reported from Belgium – 1969 (Verloove 2006), UK – 1779 (Clement & Foster 1994), Czech Republic – 1454 (Pyšek & al. 2012b), Austria – 1110 (Essl & Rabitsch 2002), and others.

The European Environment Agency (EEA) initiated the development of a set of indicators to monitor progress in Europe to prevent the loss of biodiversity by 2010. The indicators, incl. those for invasive alien species, were published in 2007 (EEA 2007). Member countries are encouraged to use the indicators, which means that solid scientific data on the invasive alien species should be promptly collected.

Following the experience of the expert group who developed a list of the worst invasive alien species in Europe (EEA 2007), a List of “100 of the worst IAS in Europe” has been developed within DAISIE (2009). Among them 18 invasive alien species of vascular plant have been listed. These species have already occupied many European natural and semi-natural habitats, and have caused or have the potential to cause serious problems for the environment, economy and human health (Vilà & al. 2009). According to the authors, this list includes not the one hundred most invasive alien species in Europe, but rather comprises representatives of all major taxonomic groups, selected as representing different threats.
to the environment, human and animal health and having socio-economic importance.

Some of the most intensive studies on the alien plant species in Europe in the recent years have been carried out in the Czech Republic, based on certain historical and present-day research traditions. It is one of the most comprehensively studied countries in terms of alien species for which diverse and complete data has been collected by a large team of researchers in this field. The first comprehensive list of alien species appeared some ten years ago (Pyšek & al. 2002), which included 1 378 species, of which 90 invasive (69 neophytes and 21 archaeophytes). The information from this list became part of the Pan-European database used for analysis of invasive alien species patterns at continental level.

A decade of intensive research followed in this country as a result of increased interest to alien plants and to generate new knowledge. Dozens of new articles with diverse and complete information have been published (e.g. Chytrý & al. 2008, 2009; Pyšek & al. 2009, 2011; Moravcová & al. 2010). This resulted in a second revised and expanded list of the alien plant species (Pyšek & al. 2012b). It includes 1 454 alien species (1104 neophytes and 350 archaeophytes), of which 61 are invasive (50 neophytes and 11 archaeophytes). The authors draw the attention to the importance of regional lists for accumulation of knowledge about these species. The Mediterranean area is the main “donor” of alien species to the country, whereas those from Asia and North America arrived later. Also, it has been noted that the number of the alien species has been consistently increasing over the past two centuries (Pyšek & al. 2012a).

Medvecká & al. (2012) published the first list of alien species of the Slovak Republic, including 634 species, of which 3.3% are invasive. Most of the species are of European and Asian origin, followed by those of African and North American origin.

Results of studies on the alien species from Eastern Europe (Ukraine) were published by Mosyakin & Yavorska (2002) for the urban areas of Kiev. In this list 536 alien plant species are included, of which 37 show invasive traits and expand their range. Sukhorukov (2010) reported about 400 adventive species (archaeophytes and neophytes) for the territory of Tambov Region (Central Russia), which, according to the author, is relatively well studied in this regard as compared to other areas.
Invasive alien species in the Balkans

In the countries of the Balkan Peninsula the studies on the spread of alien plant species began later and lag behind these in the rest of Europe. Most studies are related to recording of new alien species in some areas, and only some of the countries (Greece, Romania, Croatia) have elaborated and published lists.

The most intensive studies are in Romania, where a number of reports have been published for recorded alien species, their distribution and impact on the native flora and vegetation in different areas of the country, including protected territories (Negrean & Karácsonyi 1984; Anastasiu 1994; Costea 1996; Ciocârlan & al. 1998; Dihoru & Sârdu 1998; Negrean & Constantin 1999; Dihoru 2004; Anastasiu & Negrean 2005a, b, 2007, 2009a; Anastasiu & al. 2006; Sirbu 2007; Sirbu & Oprea 2008a, b; Oprea & al. 2011; Sirbu & al. 2011a, b, 2012) and others.

Anastasiu & Negrean (2009b) published a list of neophytes in the flora of Romania, including 365 species, among which 38 are invasive. As noted by the authors, it represents an important step in stimulating actions for mapping and monitoring of these species, and taking measures for prevention and control of their populations. From the Romanian species evaluated as invasive, 37 species occur also in Bulgaria, but not all of them exhibit invasive traits.

Sîrbu & Oprea (2011) published updated information about the distribution of 671 alien species on the territory of Romania, of which 112 are invasive.

In Croatia very intensive research has been conducted and the number of the published articles related to alien species has increased significantly over the past 40 years (Milović & al. 2010). The majority of them are devoted to detection of individual species (Galzina & al. 2010) or studies of whole territories (Vlahović & Mitić 2010; Vuković & al. 2010, etc.). A preliminary list of the neophytes, containing 206 species, representing 3.7% of the entire flora was published by Dobrović & al. (2005). Proposals for national standards, terminology and criteria for determining the invasive status have been recommended (Mitić & al. 2008). Boršić & al. (2008) published a preliminary list of the invasive alien species, including 64 species from 27 families, the majority originating from North America.

Studies on the alien flora of Serbia began in the 19th century, without special attention to its nature and impact on the native biodiver-
Symphyotrichum novi-belgii agg.

Cuscuta campestris
sity, and have intensified since 1995 (Vasić 2003). The author reported 110 alien plants for the territory of Serbia, many of which are of American origin. In the next years a significant proportion of the studies refer to individual species and areas (Randelović & al. 1994; Vrbićanin & al. 2004; Vasić 2006; Stanković-Kalezić & al. 2007; Stevanović & al. 2009; Stavretović & Stevanović 2011, etc.).

In Greece, the studies are also associated with reports of newly recorded individual species or inventories of urban areas (Chronopoulos & Christodoulakis 1996, 2000; Pateli & al. 2002; Krigas & Kokkini 2004, 2005, etc.). Arianoutsou & al. (2010) published a list of the alien plant species in the country, comprising 343 species in total (49 archaeophytes), of which 50 are invasive, mostly originating from North America (29 of these species are found in Bulgaria too).

In Montenegro the studies on the invasive species began in 2000 and are sporadic, as stated by Stešević (2005). In the recent years, more extensive studies related to individual species and areas have been conducted (Stešević & Jovanović 2005, 2008; Stešević & Jovan 2006, 2007; Tomović & Stešević 2007; Stešević & al. 2009, Hadžiablahovic & al. 2012). A list, including 50 invasive species for the territory of Montenegro, was published by Stešević & Petrović (2010). Of these, 34 species are distributed in Bulgaria too, but not all exhibit invasive traits.

In the Republic of Macedonia the information about alien species is limited to reports of the discovery of individual species, e.g. Chenopodium ambrosioides, Sporobolus indicus (Micevski 1962, 1991), Solanum elaeagnifolium, S. cornutum, Ditrichia viscosa, Rudbeckia laciniata (Matevski 2000, 2007), Galinsoga ciliata (Matevski & Kostadinovski 1990) and others (Micevski 1992; Matevski & al. 2001).

In the European part of Turkey the studies on the alien flora are also associated with recording of new species and new localities (Meric & Dane 2005; Dane & Aydin 2011), etc.

Invasive alien species in Bulgaria

A brief history of the floristic studies

Studies into the floristic diversity of Bulgaria have a history of two centuries. More than 200 years ago, in the distant 1794, the Italian diplomat and traveller Domeniko Sestini published his work “Viaggio da Costantinopolì a Bukuresti fatto l’anno 1779 con l’aggiunta di diverse lettere relative a varie produzioni, ed osservazioni asiatiche”, in which was present-
ed the first information about the Bulgarian flora (Stefanoff 1930). In the beginning only foreign botanists explored the Bulgarian flora while travelling across the country in the late 18th and 19th century, e.g. D. Sibthorp, E. Clarcke, J. Pančić, E. Frivaldszky, V. Janka, L. Adamović and others, or while working and residing in the country for a longer period (V. Střibrný, H. Škorpil, J. Kellerer, etc.). Since then, many foreign travellers and Bulgarian researchers have studied the Bulgarian flora. A large number of works have been published, including *Flora Bulgarica* (Velenovský 1891, 1898), four editions of Flora of Bulgaria (Stojanov & Stefanov 1924, 1925, 1933, 1948; Stojanov & al. 1966, 1967), Excursion Flora of Bulgaria (Válev & al. 1960), Flora of Mt Vitosha (Kitanov & Penev 1963), the multi-volume *Flora of People’s Republic of Bulgaria*, vols 1-10 (Jordanov 1963-1979; Velčev 1982, 1989; Kožuharov 1995), Flora of Dobrogea (Kitanov & Penev 1980), Flora of Pirin Mts (Kitanov & Kitanov 1990), field guides, synopses, etc. Although many researchers have for a long time shared the opinion that the Bulgarian vascular flora is already entirely studied and floristic novelties can not be expected, the discovery of new for the country or for science taxa is still an undeniable fact. Over the past 20 years (1991–2011) 47 alien plant species have been recorded for the first time in Bulgaria (Petrova & al. 2012), and in 2012 this number has increased by about 20 species.

### First data about the alien species in the Bulgarian flora

The introduction of alien species in Europe, and particularly in the Balkans, began in antiquity. The first attempts for cultivation of exotic tree and shrub species in Europe began in France in the second half of the 17th century. The species were used as ornaments in the palaces and were imported from Canada, at that time a colony of France (Dimitroff & Stefanoff 1928). In Bulgaria, this activity started after 1878, mainly from the country’s forestry department, and later by private business too. During the period 1905–1910 large quantities of seeds and seedlings of different species were delivered to Bulgaria and planted in the parks of Sofia, parks of the royal palaces in Evksinograd, Vrana, park “Metropolit Metodi Kusev” (Ayazmoto) in Stara Zagora, University Botanical Garden in Sofia, Varna Sea Garden, forest nurseries and forestries, in many places where these species were used for control of landslides and stabilization of soils (Dimitroff 1926). As the author states, of all the disadvantages of those exotics supplied from abroad, the biggest is the uncertain origin and places of introduction and cultivation for many of them. In forest plantations...
they remain virtually “anonymous”. In this period 357 alien woody species and cultivars were introduced for use in forests and parks, including *Pseudotsuga douglasii*, *Fraxinus Americana*, *Quercus rubra*, *Robinia pseudoacacia*, *Acer negundo*, *Amorpha fruticosa*, *Catalpa bignoniiodes*, *C. ovata*, *Gleditsia triacanthos*, *Hibiscus syriacus*, *Paulownia tomentosa*, *Populus canadensis*, etc. The great interest in them results in their cultivation in many private gardens, both in cities and in rural areas of the country.

Efforts have been made for the acclimatization of the imported exotic species and enlarging of the forest-culture areas in Bulgaria, but no mass dispersal and self-sustaining of some of these species in the future was foreseen. Now these exotics pose a serious threat to the native flora, vegetation and habitats.

Bulgaria has no tradition in the study of alien species, unlike many other countries in Europe. For example, a catalogue of alien plants in Italy was published back in 1916 (Celesti-Grapow & al. 2009).

The first reports of established alien plant species in natural habitats in Bulgaria were published by the Serbian botanist Pančić (1883, 1886), who travelled in the country in the period 1880–1883 to explore the Bulgarian flora. He recorded the distribution of aliens such as *Erigeron canadensis*, *Oenothera biennis*, *Xanthium spinosum*, etc. Soon afterwards Bornmüller (1888) reported some other species, mostly from Northeast Bulgaria and the Black Sea Coast, e.g. *Amaranthus retroflexus*, *Broussonetia papyrifera*, *Prunus insititia*, etc. Velenovský (1888, 1891, 1898) reported *Cichorium endivia*, *Datura stramonium*, *Hibiscus syriacus*, *Juglans regia*, *Medicago sativa*, *Peganum harmala*, *Vallesneria spiralis*, *Veronica persica*, *Xanthium italicum* and others.

The most comprehensive analysis of the alien species in the Bulgarian flora is that of Stefanoff & Kitanov (1962), which, as the authors note, is a supplement to *Phytogeographic Elements* of Stefanoff (1943). Relying on the history of the flora of the country, its richness, and the impact of human activities, the authors discuss the spread of the alien species and their use. An overview of the history of entering of these species into the Bulgarian flora has been made. It is worth noting, this work has retained its importance until now as a basis for comparison with the current state of the Bulgarian flora, and for further research.

Afterwards, the research interest in the alien species of the Bulgarian flora has decreased for a long period. The studies were confined only to registering of new al-
ien taxa and their localities in the natural habitats (Ganchev 1950; Kitanov 1950; Vihodzewsky 1965, Panov 1975, 1985, 1987, etc.) in order to add these taxa to the species composition of the Bulgarian flora. The competitive and expansive capabilities of these species, and the threats posed to the native flora and vegetation, remained underestimated and somewhat neglected. Nevertheless, such information is available, although scattered in various publications and editions, and in the herbaria.

Petrov (1970) discusses the role of man for the introduction and dispersal of alien species in the natural habitats of Bulgarian. The author reported localities of some newly established North American species in the country, e.g. *Azolla fuliculoides*, *Oenothera biennis*, *Galinsoga parviflora*, as well as focused on the distribution of already well known species such as *Phytolacca americana*, species of the genus *Amaranthus*, but seen as “invaders” in the natural habitats.

Kuzmanov & Kožuharov (1971), Petrova & Vladimirov (2002) discuss the classification of the antropophytes in Bulgaria, defining and characterizing the different groups of species, and presenting the distribution of some newly established alien taxa.

**Current state of research**


Along with increasing of the research interest in these species at global and European level, and in response to various international documents related to their distribution, impact and control, more focused studies began also in Bulgaria in the past decade. They started mainly within the project “Assessment of the alien for the Bulgarian flora and mycota species and measures for limitation of their impact on the native ecosystems and species” (2004–2006, funded by the Ministry of Environment and Water), carried out entirely by participants in this project.

Of the 29 species reported as the most common and widely distributed alien plants in Europe (Pyšek & al. 2009) 21 occur in Bulgaria, but as the authors note, the wide distri-
bution of an alien species does not guarantee its invasiveness.

The List of “Worst invasive alien species threatening biodiversity in Europe” (Annex I. 2007) includes 39 species of vascular plants. Of these, 21 species are found in Bulgaria, 16 of which are included in this book. It is worth paying attention to the well known fact that an alien species may not be invasive in all territories in which it occurs or it exhibits invasive traits to a different extend in the different areas of its non-native range. For example, *Rhododendron ponticum* is included in this list, and is an invasive species in Britain, where it was introduced during the 17–18 century, whereas it is a native and protected species in Bulgaria – Biological Diversity Act (BDA 2002, 2007), included in the Red List of the Bulgarian vascular plants as “Vulnerable – VU” (Apostolova 2009).

In this sense, this is one of the many reasons for developing regional lists of invasive alien species. In many cases the lists are not complete because the level of research and knowledge in the different countries varies greatly, mainly due to the lack of detailed taxonomic studies of some groups (families, genera), including a large number of alien species. This is the case in our country with the genus *Amaranthus*, all species of which are probably alien to our flora, but taxonomically poorly known. These lists, however, as noted by Wittenberg (2005), reflect the current state of the problem and serve as a guide for carrying research in a particular direction.

Of the 60 invasive and potentially invasive species of vascular plants presented in this book, 44 originate from America, and the remaining are from Asia and other territories (Australia, Africa, the Mediterranean). The past two decades have been marked by very intensive floristic surveys in the country, only for 2009–2012 45 new alien species have been established. Of course, not all of them exhibit invasive traits, even some are with very limited distribution (*Acalypha virginica, Phacelia tanacetifolia, Veronica peregrina*, etc.), others have been found very recently and their characteristics are poorly known. Once recognized, they need to be monitored in terms of their “behaviour” in the wild, although invasive or potentially invasive nature of some of them may be predicted, as they already exhibit such traits in other parts of Europe. This gave us reason to include it in this book such species, with a still limited distribution in the Bulgarian flora, in order to prevent their further spread, to focus the attention of the experts on these taxa and to collect more relevant information (e.g. *Cenchrus*...
incertus, Euphorbia davidii, Grindelia squarrosa, Panicum dichotomiflorum, Parthenocissus inserta, etc.).

**The worst invasive alien species in Bulgaria (“Top 10”)**

Of the invasive alien species spread in Bulgaria, we can separate those which, based on the currently available data, pose the greatest threat and have the greatest negative impact on biodiversity, nature, people, and include them in the “Top 10”. Most of them are widely distributed in Europe and in the neighbouring countries, and they are included in various lists and “rankings” of invasive alien plants:

- Acer negundo
- Ailanthus altissima
- Ambrosia artemisiifolia
- Amorpha fruticosa
- Bidens frondosus
- Fallopia ×bohemica
- Opuntia humifusa
- Paspalum distichum
- Robinia pseudoacacia

**Distribution of the invasive alien species in the country**

Given the fact that over a long period of time this category of plants in Bulgaria has not “enjoyed” the attention they deserve, it is understandable why we do not have adequate information about them now. Moreover, although invasive alien species grow all around us, herbarium material of most of the taxa has not been deposited in the Bulgarian herbaria. Or maybe, just because they are widespread, they have been neglected in collecting and recording of localities. Much of this gap in the knowledge about the distribution of these taxa has been filled with this study, but this is certainly not enough. Just for four years, thanks to targeted survey, many alien species have been found in the country, probably occurring “undisturbed” in their localities for a long time. Also, many new localities of already known in the country alien species have been recorded. The distribution maps of the species presented in this book are not sufficient to reflect the true state of the issue “alien species”. They only reflect the chorological information available up to now, and in a few cases, our assumptions about the distribution of some of the widespread taxa.

**Control of the invasive alien species**

The control or eradication of the invasive alien species is not a goal of their management in itself, but only one way to achieve higher goals, such as biodiversity conservation, protection of human health and prevention of economic losses. Elements of these goals may include habitat restoration, reintroduction
of native species, preservation of relatively undisturbed ecosystems and sustainable use of ecosystems by local people. The awareness of the local population is an important step to control these species. The introduction of new alien species must be preceded by preliminary investigations and risk assessment for their impact on the environment and natural vegetation.

The first important step in prevention is to identify these alien species which have the potential to become invasive, and therefore, require special attention. It is necessary to prevent potentially invasive species to become invasive. While for most invasive alien species that are pests in agricultural crops, forests, or affect human health, well-known control methods exist, the application of these methods for species that threaten natural habitats is still in its initial phase (McNeely & al. 2001). The combined application of such methods is the basis for successful integrated control on the invasive alien species.

Inaction of a country with respect to invasive species can threaten the biodiversity, human health and economy not only in this particular country but also in the neighbouring countries in the region. In order to avoid such situations, a key factor is the development of national capacity in the countries to identify, reduce the impacts and control the invasive alien species, on the basis of up-to-date and accurate scientific information that is easily accessible and convenient for use by the stakeholders.

Of special importance for control of the invasive alien species are:
- early warning and capacity to predict the new territories that are likely to be invaded by certain invasive species;
- knowledge of the international and national rules for prevention and compliance with these rules;
- processing of the imported commodities, including complete fumigation, hot and cold processing, etc.;
- as an ultimate measure for particularly dangerous invasive species – restriction or prohibition of their trading in cooperation with the phytosanitary service.

When an invasive species is already widespread, then specific, biological control may be the only option, but biological control methods are expensive and not always effective, and require long lasting laboratory research and field tests. Usually, however, they remain the only solution in disturbed areas with high biodiversity conservation value, e.g. in national parks.

There are many methods to control invasive species. However, for each
species an individual approach is required, depending on its biological characteristics and abundance in the invaded territories (Wittenberg & Cock 2001).

- **Mechanical control**: removal of plants manually or with appropriate machinery. This method, however, should be followed in many cases by chemical treatment because usually after cutting vigorous vegetative growth is stimulated. For example, *Populus × canadensis* has been widely used for landscaping in the towns and villages in Bulgaria, but now in many places it becomes an undesirable tree and is removed. Just in the next year around the cut trees grow vigorous suckers that form impassable tickets. The mechanical control measures should be consistent and lasting until the species is fully removed from the locality.

- **Chemical control**: use of herbicides to destroy species that are not resistant to them; herbicides which does not accumulate in the food chain must be used.

- **Biological control**: deliberate use of natural enemies of the invasive alien species.

- **Habitat management**: include burning, grazing and other activities.

- **Integrated** use of these methods, as a result of environmental studies, regular monitoring, careful coordination.

### Structure of the book

The book includes 60 invasive and potentially invasive alien plants distributed on the territory of Bulgaria, representatives of 25 families. The selection of the species was based on both the available literature and the experience and expertise of the authors. The following criteria have been considered: 1) Current distribution and abundance; 2) Trend in distribution and abundance; 3) Impact (incl. ecological, economic or on human health), and 4) Listing of the species as invasive or potentially invasive in other parts of Europe with similar climatic conditions. However, the list of the included invasive alien species is somewhat preliminary due to knowledge gaps, e.g. the data about the impact of most of the taxa is very scarce or lacking at all. Therefore, we could not apply a strict criteria-based ranking of the alien species. We believe the book will concentrate the efforts and stimulate gathering of reliable data relevant to the above mentioned criteria, and especially about the impacts. This will provide the opportunity to more objectively rank the taxa in the near future and revise the list if necessary. With the largest number of species – 20, is represented the family *Asteraceae*. The majority of the included species (44) originate from different parts of America, mostly from
North America, followed by those from Asia, the Mediterranean, and one species from Australia (*Chenopodium pumilio*).

Individual species are arranged alphabetically by their Latin names. For each species is presented information about its morphology, biology and ecology, origin and distribution, control, and finally, under “References” are cited the publications that have been used for the elaboration of the accounts.

Each species is illustrated with original photographs of the authors (mainly of Vladimir Vladimirov, and a few of Valeri Georgiev), and distribution map for the species in the country, using the UTM-grid network (10 × 10 km grid squares), and whose technical execution is of Valeri Georgiev. The information on the distribution of each species is based on the field research of the authors, on the available literature data and on the herbarium materials stored in the Bulgarian herbaria (SOM, SO, SOA).

It is necessary to pay attention again to the fact that for widespread alien species, such as *Acer negundo*, *Ailanthus altissima*, *Amaranthus hybridus*, *Datura stramonium*, *Erigeron canadensis*, *Galinsoga parviflora*, *Robinia pseudoacacia*, *Xanthium italicum*, *X. spinosum* and others, almost no material is deposited in the herbaria and very few records with exact localities have been published. In the Bulgarian botanical literature for these species usually the following statement is given “the species is widely distributed throughout the country”. The maps of these taxa are based on both the original observations of the authors in the field (red dot), and on the supposed distribution in the country (blue dot). At the end, the book includes a list of the references and a registry of the Latin names of the species and their synonyms.

We hope the information about the presented alien species will draw the attention of the professionals and many people interested in plants and nature, in conservation of plants and their preservation for the future generations. We believe that the colour photographs will help for the identification of the species.

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SPECIES DESCRIPTIONS
**Acer negundo** L.
Ashleaf Maple

Syn. *Negundo aceroides* Moench
*Aceraceae* – Maple family

- Included in List of “Worst invasive alien species threatening biodiversity in Europe” (Annex 1. 2007).

**Morphological description**
Deciduous tree, 12–15(20) m high, with irregular crown and light gray smooth bark, that cracks and darkens with the age. Young twigs dark green, glabrous; old light gray, with smooth bark. Leaves 15–38 cm long, imparipinnate, opposite; leaflets 3–5(7), serrate or shallowly lobed, bright green above, gray-green beneath, usually glabrous, turning yellow in autumn. Dioecious plant; inflorescences racemose, flowers unisexual, apetalous, yellowish-green. Calyx 4–5-merous, stamens 8. Fruits 2.0–4.5 cm long, of two dry, winged, single-seeded mericarps; wings arcuate, diverging at an angle of 30–70°.

**Biology and ecology**
Pollinated by insects or wind; blooms from March to May, before the formation of leaves; fruiting from August to October, fruits remain during the winter on the tree from where they spread continuously. It reproduces by seeds and vegetatively. It forms many root shoots and a huge amount of seeds that retain their viability for a long time. Seeds are dispersed by wind at a distance of more than 100 m, facilitated by the wings, or by animals (birds and squirrels). After cutting the main trunk one stimulates easy and quick formation of numerous stem and root shoots. Even after death of the tree base numerous root shoots can quickly appear and grow. The species develops both in sunny and shaded areas. Though not-demanding of its soil type, it prefers well-drained, moist soil. Ashleaf maple withstands floods and to some extent droughts as well. Once
naturally, it reproduces successfully and outcompetes the growth of the local shrub and tree species, thus gradually replacing them and impeding their local spread. In its native distribution area it is a rapidly growing tree, inhabiting riparian habitats and floodplains. It grows in a variety of conditions – wide tolerance of soil types and water conditions, sunny and shady areas, disturbed habitats, forests, along roads and railway tracks.

Many ornamental cultivars are known. They can escape and naturalize too. The most common are *A. negundo* f. *variegatum* (with a white stripe along the edge of the leaflets), *A. n. f. auratum* (with pale yellow leaflets) and *A. n. f. aureo-vari-egatum* (leaflets flecked with yellow spots).

**Origin and distribution**

Native to North America and tropical South America.

The species was introduced in Bulgaria for cultivation as a decorative tree in the last two decades of the 19th century, attracted the attention of foresters as a fast-growing plant. In the beginning it was grown in the gardens and parks of the royal palaces in Sofia and Evksinograd, in urban gardens in many cities. Now it is commonly planted for ornament in parks and along roads and railways in many places in the country as well as in forest plantations. Naturalized throughout the country, but no precise data are available when naturalization of the species started.

Found in most floristic regions of Bulgaria, up to about 1000 m a.s.l.
In Europe it was imported along with other American species in the 17th century (in 1688 in a botanical garden in England). Consequently, it was transferred to the Netherlands, Germany and others, occupying a large part of Europe, and in the early 19th century it spread rapidly in parks and gardens. Today it is one of the most common roadside and park trees. Naturalized in disturbed, anthropogenic habitats, along rivers, roads and railways.

**Control**
Chemical control is realized by cutting the trees to the ground and treatment of the rapidly appearing shoots with herbicides. Effective herbicide is 2,4-D. Seedlings and young shoots can be uprooted by hand if not in large number and density.

**References**
**Ailanthus altissima** (Mill.) Swingle
Tree-of-heaven

*Syn. A. glandulosa* Desf.

**Simaroubaceae – Tree-of-heaven family**

- Included in *List of “Worst invasive alien species threatening biodiversity in Europe”* (Annex 1. 2007) and in the list of the invasive species of the European and Mediterranean Plant Protection Organisation (EPPO 2012).

**Morphological description**
Deciduous tree, 5–30 m tall, with a trunk up to 80 cm in diameter. Crown relatively loose. Bark glabrous, smooth, in older trees slightly longitudinally fissured, gray-brown. Young twigs yellowish or blackish, slightly hairy. Leaves imparipinnate, alternate, 45–100 cm long; leaflets 11–25(42), 4–12 cm long, 2.5–4.0 cm broad, ovate-lanceolate, slightly cordate at base, the young hairy, the older almost glabrous, ciliate on the margin, at the base on each side with 2–3 glandular teeth, with strong, ± unpleasant smell when pressed. Flowers 7–8 mm in diameter, greenish-yellow, gathered in loose, 10–20 cm long, terminal panicles. Sepals 5–6, small, connate at the base; petals 5–6, free. Stamens 10. Fruits 3–4 cm long, irregular rhomboid, flat, one-seeded samaras (dry indehiscent fruit with a wing).

**Biology and ecology**
Pollinated by insects; blooms from June to July; fruiting from September to October. Extremely fast-growing species. Propagated by seeds and vegetatively by root suckers which are formed in abundance; underground root branches extend up to 15 m from the main tree. Fruiting abundantly each year. Older trees can produce up to 350 000 seeds per year, easily dispersed by wind, thanks to the winged seeds, or by birds; seeds can penetrate into the smallest cracks and foundations of buildings, and germinate...
quickly even in unfavourable conditions. They retain their viability for a long time, even those that overwinter on the tree and are distributed in the spring. Tree-of-heaven prefers loose, deep soils, but grows also in very unfavourable soil conditions – rocky and poor soils. It likes relatively warm temperatures, but tolerates both very hot and cold climates, fully frost-hardy in Bulgaria. Heliophyte, but it withstands some shade. One of the most drought-resistant tree species of the temperate zone, and one of the most not-demanding in terms of soil type and air humidity, with good wind resistance. Highly resistant to air pollution. Resistant to pests due to the presence of glands on the leaflets, which issue a strong odour. Stems and roots emit secretions that adversely affect the growth of the nearby species (allelopathy). Once established, eradication is very difficult. Cultivated in forest plantations, parks and gardens, boulevards. Used in forestry for afforestation of abandoned places because of its easy propagation, rapid growth and high tolerance to a wide range of habitat conditions, and for stabilisation of eroded areas. It replaces native vegetation due to the extremely rapid growth and the formation of dense monodominant groups.
**Origin and distribution**

Native to East Asia (China and North Vietnam).

It was introduced in Bulgaria for cultivation, which began nearly across the whole country in the period 1888–1900, and in the early 20th century it was already considered the second most widespread alien species after *Robinia pseudoacacia*. Widely naturalized throughout the country, the first reports of which date back to 1928. It has great resistance to unfavourable conditions, and potential for intense and rapid spread in diverse places. One of the worst invasive species threatening the native flora and vegetation.

Recorded in all floristic regions, up to about 1800 m a.s.l.

It was brought to Europe in 1740 for ornamental purposes, and according to some authors erroneously, mis-
identified for *Toxicodendron vernicifluum*, a source of polish needed for the production of polished woodwork. It is spread across all continents except for Antarctica, mostly in the Northern Hemisphere.

**Control**

Control of tree-of-heaven is extremely difficult. Seedlings and suckers can be uprooted but all root fragments must be removed, in order to prevent formation of new shoots. Cutting of old trees stimulates vigorous suckering, so mechanical control must be combined with herbicide treat-
ment. Efficient herbicides are glyphosate, applied on the leaves and cuttings, triclopyr, applied to the bark of young stems, and picloram for the cut trunks. Old trees can be destroyed by girdling – cutting away a 15–20 cm broad ring of the bark and cambium tissue in the basal part of the trunk (most effective during February – March). Drilling of holes at the base of the trunk and injection of glyphosate is effective too. Biological control through infection of the plant by pathogenic fungi of the genera *Verticillium* and *Fusarium* is also recommended.

**References**
**Amaranthus albus** L.
White Pigweed

**Amaranthaceae** – **Amaranth (Pigweed) family**

**Morphological description**
Herbaceous annual. Stems 10–50 cm tall, branched from the base, prostrate, erect or ascending, smooth or striate, sparsely puberulent to glabrous. Leaves obovate-lanceolate, spathulate or cuneate, often with undulate margin, obtuse or slightly emarginate at apex, mucronate, glabrous or sparsely puberulent. Flowers unisexual (monoecious plants), arranged in small axillary cymose clusters that are shorter than the leaves. Bracts twice longer than the perianth. Perianth of 3 unequal segments that are oblong to oblong-lanceolate and nearly equal to the stamens in the male flowers, and linear-lanceolate, mucronate, with a green dorsal stripe, almost equal to the pistil in the female flowers. Fruit dehiscing transversely. Seeds almost rounded, black or blackish, with a narrow rim around the edge.

**Biology and ecology**
Wind pollinated; blooms from May to October; fruiting from July to October. Propagated by seeds, formed abundantly (in millions) and retaining their viability for a long period. It is dispersed by birds and other animals, humans – through the import and/or use of contaminated crop-seeds. Xerophyte; it prefers warm, dry, nutrient-rich, lighter soil types.

White pigweed is a widespread weed in arable fields and vegetable crops, orchards and vineyards, stubble, disturbed areas, along roads, railways, riverbanks. At a young age it is grazed by livestock, mostly by horses and cows.

**Origin and distribution**
Native to North America.

In Bulgaria it was established for the first time in 1912.
Distributed in all floristic regions of the country in man-made habitats, up to about 1000 m a.s.l.

In Europe it has been cultivated since 1778 in England, and it was established in nature in 1872. Widely naturalised weed and ruderal invader in different parts of Europe and the world, with nearly cosmopolitan distribution.

**Control**
Control of white pigweed is usually achieved through application of proper farming practices to reduce propagation and spread (main tillage before sowing the crop; careful cultivation of stubble; regular and timely hoeing, ploughing or cultivating of row-crop fields). Outside crop fields regular low mowing before flowering is recommended.

**References**
Brenan 1961; Kolev 1956; Kovachev 1966; Raus 1997; Rechinger 1933; Tonev 2000; Tutin & Edmondson 1993; Urumov 1923.
Morphological description
Herbaceous annual. Stems 15–100 cm tall, erect, striate, glabrous or pubescent above, green, simple or branched in the upper part. Leaves alternate, 3–8 cm long, 2–4 cm wide, simple, ovate to rhombic-ovate, narrowed at the base, subacute to obtuse at apex, mucronate, glabrous or pubescent on the veins beneath and on the margin; upper leaves triangular to lanceolate, smaller and pubescent; petioles 1.0–2.5 cm long, hairy. Inflorescences dense, often branched, spicate panicles, terminal and axillary, usually bracteate. Bracteoles 3.5–4.0 mm long, lanceolate, acuminate and very long mucronate, up to two times as long as the perianth. Flowers unisexual, 5-merous; perianth-segments free to the middle, 1.5–3.0 mm long, linear-lanceolate, acute, membranous, about as long as the fruit. Fruit 1.5–2.5 mm long capsule, rounded, covered by the membranous perianth, dehiscing transversely. Seeds rounded, somewhat flat, glabrous, shiny, black.

Biology and ecology
Wind pollinated; blooms from July to September; fruiting from August to November. Propagated by seeds, which are produced in abundance and retain their viability for a long period. It is distributed by birds, transport of seeds as contaminants in crop-seeds, disposal of garden waste and soil. It occurs in different soils and habitats, but grows very well on humus-rich soils, in abandoned, ruderal areas, along roads, in warm and sunny places; it withstands high temperatures, fruiting also in dry conditions. Seed germination requires soil temperature between 18°C and 25°C, and the plants grow optimally at air temperature of over 25°C. It ceases to grow at temperatures below 18°C. Wide-spread weed in crop-fields, gardens, orchards and vegetable crops, often in irrigated areas. It is considered one of the most dangerous weeds in the world.
Origin and distribution
Native to tropical and subtropical America.

In Bulgaria established relatively late. Due to its unclear taxonomy and nomenclature, it had not been reported in the Bulgarian botanical literature until 1966, when it was included in the *Amaranthus* account in the Flora of PR Bulgaria. The species is usually neglected by Bulgarian botanists in terms of locating and registering its occurrences in the country because of its wide distribution.

Recorded in all floristic regions, up to about 1000 m a.s.l.

In Europe introduced in the 19th century, naturalized and invasive species in many countries.

Control
Control of green amaranth is usually achieved through application of proper farming practices to reduce propagation and spread (main tillage before sowing the crop; careful cultivation of stubble; regular and timely hoeing, ploughing or cultivating of row-crop fields; use of crop-seeds uncontaminated with amaranth seeds). Outside crop fields regular low mowing before flowering is recommended.

References
**Amaranthus retroflexus** L.
Common Amaranth

Amaranthaceae – Amaranth (Pigweed) family

**Morphological description**
Herbaceous annual. Stems erect, simple or branched, 15–100 cm tall, slightly striate at the base, green or reddish, lanate, especially at the base of the inflorescence. Leaves 3–7 × 2–4 cm, alternate, rhombic-ovate, sometimes undulate, mucronate, green above, purplish on the lower surface, almost glabrous, on the veins and petioles pubescent. Inflorescence somewhat compact, usually with short, thick, pubescent branches. Bracteoles up to twice as long as the perianth. Flowers unisexual, small; perianth simple, 5-merous; perianth-segments of the male flowers oblong, mucronate, membranous, with a green stripe dorsally; perianth-segments of the female flowers oblanceolate-linear, overlapping, longer than the pistil, with a green dorsal stripe, obtuse or truncate at the apex, with a short mucro. Fruit a capsule, equal to or shorter than the perianth, dehiscing transversely, feebly muricate. Seeds round, lenticular, flattened, dark brown to black, shiny.

**Biology and ecology**
Wind pollinated, but pollination by insects may occur too; flowering from June to September (depending on altitude); fruiting from August to October. Propagated by seeds, which are produced in abundance (an individual can form more than 100 000 seeds) and can retain their germination capability for over 10 years. They spread by wind, water, agricultural machinery, manure, birds and other animals, as contaminants of the seeds of various cereals. The seeds can remain in the inflorescence throughout the winter. They germinate best at high temperatures, intense light and soil rich in nutrients. Seedlings are sensitive to low temperatures, and develop a shallow central root. Late spring weed. It is
found in man-made habitats – abandoned, ruderal places, as a weed in spring field and vegetable crops, especially trench ones, orchards and vineyards, stubble fields, along roads and railways, waste places.

Typical of green leaves and stems is the presence of oxalates and high nitrate content, which increases during the bloom. Young plants used in large quantities for feeding livestock can cause poisoning. Seeds are used for feeding domestic birds. Melliferoius plant (gives abundant pollen).

**Origin and distribution**
Native to the temperate and tropical parts of America.

In Bulgaria the taxon was recorded long ago – in 1885 from the vicinity of Varna city as a ruderal and weed species in the crop.

Distributed in all floristic regions of the country, up to about 1000 m a.s.l.

In Europe the species has been known from the gardens since 1759; the oldest record of the taxon in natural habitats is from 1853. A very common weed in most of Europe. Distributed worldwide.

**Control**
Common amaranth is usually controlled by application of proper farming practices, such as: main tillage before sowing the crop; careful
cultivation of stubble; use of manure free of amaranth-seeds; regular and timely hoeing, ploughing or cultivating of row-crop fields; crop rotation; burning of the fields after harvesting. It is sensitive to numerous herbicides, e.g. glyphosate, 2, 4-D, etc. Outside crop fields regular low mowing before flowering is recommended.

References
Bond & al. 2007; Bornmüller 1888; Brenan 1961; Kovachev 1966; Raus 1997; Tonev 2000; Tutin & Edmondosn 1993.
**Ambrosia artemisiifolia** L.

**Ragweed**

Syn. *A. elatior* L.

*Asteraceae* – *Daisy family*

Included in *List of “Worst invasive alien species threatening biodiversity in Europe”* (Annex 1. 2007) and in the list of the invasive species of the European and Mediterranean Plant Protection Organisation (EPPO 2012).

**Morphological description**

Herbaceous annual, not aromatic. Stems erect, branched, 15–120(250) cm tall. Leaves usually opposite, 4–10 cm long, ovate, pinnately divided; primary lobes lanceolate, often divided again. Capitula unisexual, with tubular florets; male capitula with 10–15 florets, hemispherical, about 3 mm in diameter, drooping, in terminal racemose inflorescences, without subtending bracts; female capitula one-flowered, in groups of 2–4 in the axils of the upper leaves or leaf-like bracts. Fruit ovoid, almost glabrous achene, without pappus, with 5–7 short spines and 1.0–1.5 mm long beak; when ripe the achene is enclosed by the nut-like involucre.

**Biology and ecology**

Wind pollinated; blooms from July to September; fruiting from August to October. Propagated by seeds, which are produced in large quantities, usually around 1 000–1 200 by an individual, but there is data in the literature for up to 30 000 – 40 000(100 000), and retain their germination ability in the soil for up to 40 years. The number of seeds in the soil (seed bank) is greatest in the upper 5 cm layer and reaches 2800 seeds/m². Germination is low immediately after seed-ripening, but after dormancy of 5–6 months, it reaches 90% (in soil substrate under glass). The seeds which have not germinated fall in a second period of dormancy that can last up to 5–14(40) years. Due to the spines, the achenes can attach to the fur of animals, clothes of people, and
probably in the tread of the tires of vehicles. The main ways and agents for distribution are: transferring contaminated agricultural products, road and railway transportation, building and repair work along the roads when moving inert materials contaminated with ragweed-seeds, flowing water – rivers and temporary running water along roads after heavy rains, melting snow, food mixtures for ornamental birds, possibly animals (rodents, birds).

In most localities in the country ragweed is represented by populations of a few hundred to a few thousand individuals. In some places the density of plants is very high – up to 200–300(500) individuals/m². When cutting the aerial part of the plants, side branches are formed on top of the remaining stems and plants are still capable of blooming and fruiting; the new branches usually lie close to the substrate and produce mostly female flowers.

It occupies man-made or disturbed semi-natural and natural habitats – along roads and railways, intensively used pastures, riparian habitats, dumpsites, farmland and gardens, spaces between buildings.

Ragweed competes with native species for nutrients, light and space. With massive growth it leads to a rapid exhausting of nutrients and soil depletion. It is a harmful weed in
crops – in Bulgaria it has been registered in plantations of sunflowers, maize, wheat, causing reduction in crop yield and hindering mechanized harvesting. High presence of ragweed in pastures reduces their productivity (as a rule, it is not grazed by livestock). Pollen is a strong allergenic agent and causes a number of diseases such as hay fever, rhinoconjunctivitis, asthma, and sometimes contact dermatitis and urticaria.

**Origin and distribution**
Native to North America.

Ragweed was unintentionally introduced in Bulgaria, probably by importing contaminated seeds of cereals, as well as from neighbouring countries with road and rail transport, and by river Danube. Oldest herbarium materials were collected in 1956 from the Botanical Garden in Sofia, where the species was grown from seeds obtained from the Botanical Garden in Berlin – Dahlem, and in the 70-ties of the 20th century from the territory of the feed mill in Mizia town. For the first time pollen from ragweed was registered in the air of Sofia in 1981, but the species was reported as naturalized in the country only in 2001.

Distributed in the Black Sea Coast, Northeast Bulgaria, Danubian Plain, Forebalkan, Sofia Region, Znepole Region, Valley of River Struma, Rila Mts, Rhodopi Mts (Eastern), Thracian Lowland, up to about 800 m a.s.l.
In Europe it was established in the mid-19th century in Germany and France (1846), where it was introduced from North America as a contaminant to agricultural products. Widely naturalised in many countries in Europe and other parts of the world – Asia, Australia.

**Control**

Prevention requires strict control on imports of seeds and other agricultural products, as well as control on the transfer of soil and sand from contaminated areas in Bulgaria. Small populations should be timely (immediately after their discovery) eradicated, preferably before flowering and fruiting, i.e. until about mid-August. Then for 2–3 years the localities should be consistently monitored because of accumulation of seeds in the soil (seed bank) and new plants should be uprooted before flowering and fruiting.

Promotion among the public about the harmful effect of ragweed on human health would provide support from the people to eradicate the plant.

For chemical control most commonly used are glyphosate and 2,4-D.

The phyllophagous beetle *Zygogramma suturalis* is used as a biological control agent, but with limited success. Where possible, competitive plant species forming dense tufts or groups, e.g. *Lolium perenne* and *Medicago sativa*, can be used successfully for ragweed control.

**References**

**Amorpha fruticosa** L.
*Desert false indigo*

**Fabaceae – Pea family**

- Included in the *List of “Worst invasive alien species threatening biodiversity in Europe”* (Annex 1, 2007) and in the list of the invasive species of the European and Mediterranean Plant Protection Organisation (EPPO 2012).

**Morphological description**
Deciduous, much branched shrub, 2–5 m high; bark smooth, gray-black or brown. Leaves alternate, imparipinnate; rhachis 10–20 cm long, pubescent; leaflets 9–35, 10–50 × 5–30 mm, ovate or elliptical, on short petiolules, broadly cuneate at base, obtuse or slightly emarginate at apex, entire, dark green above, gray-green beneath, pubescent to glabrescent, sparsely red glandular-punctate. Stipules 4–5 mm long, lanceolate-subulate, caducous. Flowers up to 6 mm long, numerous, in terminal, 7–15 cm long ±compact spikes or groups of spikes; pedicels (3)5–6 mm long. Calyx campanulate, 2.0–2.5 mm long, almost actinomorphic to slightly bilabiate. Corolla blue to violet-purple. Standard up to 5 mm long, abruptly narrowed at base, glabrous; wings and keel undeveloped. Fruit a legume, 7–9 × 3 mm, brown, glabrous, red glandular-punctate, usually 1(2)-seeded. Seeds 5.0 × 1.8 mm, oblong-ovoid, smooth, brown.

**Biology and ecology**
Pollinated by insects, mainly bees; blooms from May to July, but flowers can be formed again later in summer; fruiting from August to October; sometimes fruits remain on the bush until next year and can be seen from a distance. It develops extensive root system. Propagated by seeds, which are produced in large quantities and have high germination rate, and vegetatively (through stem shoots and root suckers, green cuttings, layering). Seeds are spread most com-
monly by water currents, but animals are also involved in their distribution. Prefers moist places, but tolerates both prolonged droughts and prolonged flooding, as well as salinity. It grows best in deep, fertile soil, but it is not demanding of its soil type. It develops in acidic, neutral and alkaline soils. Successfully adapted to infertile, dry and sandy soils, withstands extreme conditions. It prefers sunny locations with well-drained sandy soils, but tolerates shade. Thanks to symbiotic relationships with nitrogen-fixing microorganisms it has the ability to fix atmospheric nitrogen, so it can grow on very poor soils. Wind-resistant species. Fully frost-hardy for the climatic conditions of Bulgaria, quickly recovering with stem shoots and root suckers if any damage by frost occurs. It forms dense and very large monodominant groups. In its native distribution area it is found in riparian habitats and sparse floodplain forests.

In Bulgaria it most frequently inhabits riparian and coastal habitats, roadsides, bushes, often as undergrowth in poplar plantations along rivers. It forms monodominant, dense communities along the river Danube, replacing native species and altering the structure of native plant communities, and in forests, where it is assumed as a weed species and outcompetes the other young trees due to its rapid growth. It produces insecticides, which explains the lack of herbivorous insects feeding on the species in the areas outside its native range. Cultivated as an ornamental, melliferous and erosion control plant. All parts contain a substance, the main ingredient of which is amorignon, with repulsive and highly toxic effect on insects, and because of this, desert false indigo is attacked only by several more or less specialized insects. For this reason, in China it is used against forest and agricultural pests.

Origin and distribution
Native to the south-eastern North America (east of the Rocky Mountains and north of Mexico).

In Bulgaria, it was introduced in the early 19th century for ornamental purposes and erosion control. After afforestation with the species in many places, it escaped in the wild, the first evidence of which was reported in 1898 and now it is widespread in the whole country.
Extensive stands of desert false indigo are developed along the Danube, reaching in some places up to 90% of the vegetation cover, where it forms dense, impenetrable communities, with a limited number of species in the undergrowth. Widespread along roads, railway lines, in different parts of the country along rivers and canals. In areas where there are no rivers and wetland areas found in rocky places, scrub, dry grassland, secondary and disturbed habitats, invading also undisturbed protected areas.

Distributed in all floristic regions of the country, up to about 1200 (1500) m a.s.l.

In Europe, it was first introduced in England in 1724 as an ornamental, and then transferred to the rest of the continent. Naturalized in much of Central, Southern and Eastern Europe, and Asia (temperate areas), where it is grown on a large-scale.

Control
No specially developed methods to control desert false indigo. Prevention includes stopping of the use of the species for erosion control of degraded areas and along roads, and as decorative and melliferous plant in riparian and coastal habitats. With the possible establishment of a melliferous crop, the owners to exercise strict control to prevent the spread of the species (including seeds) out-
side the cultivated area, and compulsory destruction of the culture, cleaning and restoring the site upon cessation of use. Seedlings and small suckers can be uprooted. Larger individuals are cut to the ground and the remaining transversal cuttings are treated with herbicide, e.g. glyphosate. Spraying with glyphosate on the green leaves is also very effective.

References
**Asclepias syriaca** L.  
**Common Milkweed**  
**Asclepiadaceae – Milkweed family**

**Morphological description**  
Rhizomatous herbaceous perennial, with sticky milky sap. Stems 1.0–2.0 m high, usually simple, erect, shortly-pubescent. Leaves opposite, 15–20 cm long, 3–10 cm broad, simple, entire, ovate-lanceolate, rounded at the base, acute at apex, with up to 1 cm long stalks, densely pubescent and pale green beneath, sparsely pubescent and dark green above, with prominent veins, the mid-vein reddish. Inflorescences many-flowered, terminal or axillary, umbellate, sub-globose to globose. Flowers with 2–5 cm long, pubescent pedicels, aromatic. Sepals 5, 3–4 mm long, ovate-lanceolate, acute, with short hairs, patent. Petals 5, 6–8 cm long, 3–4 mm wide, oblong-ovate, deflexed at anthesis, pink, purple to white, with curved hairs. Corona with 5 free, to 4 mm long, pink segments, each with a central adaxial, subulate appendage, curved over the anthers. Anthers with short membranaceous appendages at the apex. Fruit of 2 ovate, acuminate, 8–10(12) cm long follicles, narrowed at both ends, curved at the tip, with short, dense, white hairs and short spines. Seeds 6–8 mm long, numerous, flat, ovate, brown, with wrinkled winged edge, and with a tuft of silky white hairs apically.

**Biology and ecology**  
Pollinated by insects, mainly bees, bumble bees, wasps, butterflies, but the effectiveness of pollination is very low (<5%). It blooms from June to July, fruiting from July to August. Propagated vegetatively by adventitious buds on its rhizomes, and by seeds, which retain their germination ability in the soil for years. The seeds are spread by wind, floating in clumps with their silky tufts of hairs like parachutes. The seeds have a period of dormancy only a few weeks and germinate best when they are buried at 0.5 to 1(5) cm depth in the
soil, at temperatures above 15°C. Young plants do not bloom in the first year, but their rhizomes grow intensively.

It inhabits man-made or disturbed habitats – waste places, along roads and railways, canals, at the margin of forests and farmland, with a wide range of soil conditions – damp or dry, sandy, well drained soil. It tolerates drought. Along the Danube it forms large, dense, nearly monodominant communities. In many countries it is a weed in crops.

Common milkweed competes with native species for nutrients, light and space. The significant expansion of the groups hampers the regeneration of the indigenous species. It is more competitive on sandy and loess soils. The populations of common milkweed gradually decrease and disappear in communities with dense grass cover and dense shade from taller plants (when the habitat disturbance is discontinued). Due to the large amount of nectar that is produced in the flowers during the period of massive bloom, it attracts bees in a stronger degree than most crops, including sunflower, and thus leads to lower yields. In some European countries poses serious problems to crops.

It can be used as an ornamental and melliferous plant. Direct contact with the plant can cause skin irritation, due to the poisonous glycosides in the milky sap, and it may cause poisoning if consumed.

Origin and distribution
Native to eastern North America.

It was reported in the Bulgarian botanical literature in 1948. However, it was found escaped in nature earlier, with no accurate data when naturalization started.

Recorded in the Northeast Bulgaria, Danubian Plain, Forebalkan (Eastern), Sofia Region, Mt Belasitsa, Valley of River Mesta, Mt Sredna Gora, Thracian Lowland, Tundzha Hilly Country, up to about 1000 m a.s.l.
It was introduced in Europe in 1629. Naturalization started probably in the Mediterranean countries and now it is distributed in many countries of the continent.

**Control**
Mechanical control is achieved by cutting the aerial and underground parts into small pieces, removing them from the location. This procedure should be repeated several times, otherwise, the vegetative propagation of the species is facilitated and the occupied area enlarges. Mowing at least three times a year also leads to reduction and gradual destruction of the subpopulations. In cultivated areas crop rotation and growing of winter crops can be applied. Ploughing of land is effective only 2–3 weeks after seedling-emergence, when the roots are still underdeveloped and the formation of underground regenerative buds has not started yet. Herbicides, e.g. 2,4-D and glyphosate, can be successfully used for control of common milkweed; treatments should be carried out before seed-ripening.

**References**
**Bidens bipinnatus** L.
Spanish-needles

*Asteraceae – Daisy family*

**Morphological description**
Herbaceous annual. Stems (10)30–100(150) cm tall, single, erect, 4-angular, almost glabrous, green, branched; branches opposite. Leaves 2–3-pinnate; primary leaf lobes 2–4 pairs, ovate to lanceolate in outline, green, sparsely pubescent to glabrous, end-lobules rhombic to rhombic-lanceolate. Capitula 6.0–8.5 × 5.0–6.5 mm, erect, numerous, terminal and on the branches in the axils of the upper leaves. Involucral bracts in two rows; the outer 7–10, linear, usually green, ciliate; the inner 4–6 mm long, linear to lanceolate, dark brown to black-brown, with yellowish membranous margin. Ligules 0–4, 2–3 mm long, yellow; tubular florets yellow, 2–3 mm long. Fruits linear achenes, the outer 8–10(13) mm long, the inner 10–18 mm long (without the bristles), 4-angled, shortly setose, apically with (2)3–4 bristles that are erecto-patent at maturity.

It differs from the other species of the genus *Bidens* in Bulgaria by its 2–3-pinnate leaves and linear, 4-angled achenes.

**Biology and ecology**
Pollinated by insects; blooms from July to October; fruiting from August to November. It forms a large number of achenes that easily attach to the fur of animals and clothes of people with the help of their strong, barbed bristles. The achenes in each capitulum are of two types – 3–8 outer, shorter, dark brown, and 8–15 inner, longer, black. For germination they need a period of dormancy, which is different for the two types of achenes – 3–6 months for the inner and over 7–8 months for the outer.

In the localities in Bulgaria the species is represented by groups of 5–10 to 100–150 individuals, and occasionally by some scattered individual plants. Although its distribution area
is still limited in the country, it is a potentially invasive species, bearing in mind the effective mechanism for attaching of the achenes to human clothing and animal fur, and the relatively extensive distribution area outside its native range.

Spanish-needles grows near railroads, buildings, edge of asphalt grounds, decorative lawns, dumpsites. It prefers sunny to slightly shaded areas with moderately moist, light, often sandy or stony, moderately fertile soils. It competes for nutrients and space with the native plant species.

In some areas of the world it is used as vegetable (leaves and young stems) or spice. In China and North America used in folk medicine to treat rheumatism, diabetes, bronchitis, etc.

**Origin and distribution**
Native to South America.

The species has been unintentionally introduced in our country. The exact pathway and time of introduction are not known. Most likely it was brought by import of commodities at the port of Varna, and from there to the main railway station. The oldest herbarium materials were collected in 2009 from the city of Varna and in the same year the species was reported as new for the flora of Bulgaria.
Distributed in the Black Sea Coast (Northern – Varna), up to about 30 m a.s.l.

First established in Europe in Italy in 1754. It has been introduced in several countries of the continent, including close to Bulgaria countries like Croatia, Hungary, Montenegro, Romania, and Slovenia.

**Control**
The species is still limited in the country and its eradication is possible. Single plants or small groups can be uprooted manually, obligatory before seed ripening. Mowing the plant is not very effective because new shoots are formed at the top of the remaining in the ground parts of the plants which soon afterwards start flowering and fruiting. Herbicides, e.g. glyphosate, can be used for chemical control of the species.

**References**
**Bidens frondosus** L.

**Beggarticks**

Asteraceae – Daisy family

- Included in *List of “Worst invasive alien species threatening biodiversity in Europe”* (Annex 1. 2007).

**Morphological description**

Herbaceous annual. Stems erect, 20–100 (180) cm tall, almost glabrous, often purple in the lower part, branched; branches opposite. Leaves imparipinnate; pinnae 3 or 5, petiolate, oblong-lanceolate to ovate-lanceolate, acute to acuminate, coarsely serrate, dark green, often becoming purple. Capitula 10–15(20) mm in diameter, erect, terminal and at the tips of the branches that are in the axils of the upper leaves. Involucrual bracts in two rows; the outer 5–8 (10), leaf-like, green or purple; the inner ovate-oblong, dark brown to almost black, with membranous, yellow margin. Flowers yellowish-brown, tubular, about 5 mm long; ligules usually absent. Fruits achenes, 5–8(10) × 2.0–3.5 mm (excluding bristles), cuneate, compressed, brown, with 2 straight bristles at the tip.

Similar species is the native *B. tripartitus* L., which differs by the absence of distinct petioles of the leaf-lobes and has smaller, 4.5–6.0 mm long, achenes, usually with three bristles. *B. vulgatus* Greene is another alien species from North America, which differs from *B. frondosus* by having 10–16(21) outer involucral bracts.

**Biology and ecology**

Pollinated by insects; flowering from (June) July to October; fruiting from July to November. It produces a large number of achenes – around 7000 from a plant and they easily attach to the fur of animals and clothes of people with the help of their barbed bristles. The achenes are of two types – outer, wider, adapted for spread at short distances, and inner, more narrow and long, with long-straight bristles.

Included in *List of “Worst invasive alien species threatening biodiversity in Europe”* (Annex 1. 2007).
canals, rivers, ditches, marshy places, dams, railways and roads, margins of irrigated farmlands. Often found together with *B. tripartitus* and *B. vulgaris*, forming mixed groups. It competes for nutrients and space with some native species, especially *B. tripartitus* and *B. cernuus*, from which it grows much faster and reaches twice larger size. Under favourable conditions it rapidly occupies free of vegetation places, e.g. floodplains after the withdrawal of water, burned areas, forming dense groups with a large number of individuals, and thus impedes the establishment of native herbaceous species. Sometimes it grows as a weed in poorly managed vegetable gardens.

**Origin and distribution**
Native to North America.

The species was unintentionally introduced in Bulgaria, but the pathways and the exact time of entry are not known. The oldest herbarium materials were collected in 2001 in the region of Pazardzhik town. The wide distribution of the species in the country, however, suggests that it has penetrated much earlier, but remained undetected because of its similarity to *B. tripartitus*. It was reported as a new species for the flora of Bulgaria in 2004.

Distributed in the Black Sea Coast (Northern), Northeast Bulgaria, Danubian Plain, Forebalkan, Balkan...
Range (Western), Sofia Region, Valley of River Struma, Valley of River Mesta, Thracian Lowland, Tundzha Hilly Country, Mt Strandzha, up to about 1000 m a.s.l.

First established in Europe in the late 18th century (1777), naturalized in many countries of the continent as well as in East Asia, New Zealand.

**Control**
The species is widely distributed throughout the territory of Bulgaria and full eradication is practically impossible. Containment can be achieved to some extent by keeping the roadside areas and railway embankments clear of vegetation. Single plants or small groups can be removed by manual uprooting or cutting, definitely before the seed ripening. Herbicides, e.g. glyphosate, can be used to chemically control the species.

**References**
**Bidens vulgatus** Greene  
Common Beggarticks  
*Asteraceae – Daisy family*

**Morphological description**  
Herbaceous annual. Stems single, erect, 50–200 cm tall, sparsely hispidulous to glabrous, branched; branches opposite. Leaves imparipinnate; pinnae 5, clearly petiolate, oblong-lanceolate to ovate-lanceolate, acute to acuminate, coarsely serrate, dark green, sparsely hispidulous to glabrescent, sometimes the lower two pinnae lobed. Capitula 15–25 mm in diameter, numerous, many-flowered, terminal and on the tops of the branches that are in the axils of the upper leaves. Involucral bracts in two rows; the outer 10–16(21), linear, spathulate or leaf-like, green, hispidulous, on the margins hispid-ciliate; the inner ovate, acute, dark brown, with membranous, yellowish margin, glabrous. Flowers yellow, tubular; ligulate florets usually absent. Fruits achenes, 6–10(12) × 2.5–4.5 mm (excluding bristles), obovate to cuneate, compressed, dark brown, somewhat tuberculate, glabrous or sparsely strigillose, apically with 2 erect or erecto-patent barbed bristles.

A similar species is *Bidens tripartitus*, native to the Bulgarian flora, which, however, has leaf-lobes without distinct petioles and smaller, 4.5–6.0 mm long achenes, usually with three bristles. *Bidens frondosus* is another alien species from North America, which differs from *B. vulgatus* by having 5–8(10) outer involucral bracts of the capitula.

**Biology and ecology**  
Pollinated by insects; flowering from (June) July to October; fruiting from July to November. Propagated by seeds, which are produced in a very large number (several thousand per plant) and can easily attach to the fur of animals and clothes of people (with the help of their barbed bristles). Achenes are of two types – outer, wider, and inner, narrower and long-
er. In the Bulgarian localities it forms subpopulations with a relatively high number of individuals, but more often it is represented by few scattered individuals or small groups, probably when it is in the initial phase of colonization. It withstands some drought and therefore has greater ecological plasticity than the native species *B. tripartitus* and *B. cernuus*.

The species grows in moist areas along rivers, canals, ditches, marshy areas, margins of riverside popular plantations. Often found together with *B. tripartitus* and *B. frondosus*, forming mixed groups. It competes for nutrients and space with native species, especially *Bidens tripartitus* and *B. cernuus*, from which it grows much faster and reaches twice larger size. When growing together with the alien *B. frondosus*, *B. vulgatus* usually reaches a greater size and forms more branched stems. Under favourable conditions it rapidly occupies free of vegetation places, e.g. floodplains after the withdrawal of water, burned areas, and thereby it impedes the establishment of the native herbaceous species.

**Origin and distribution**
Native to North America.

Common beggarticks was unintentionally introduced in Bulgaria but the pathways and the exact time of entry are not known. The oldest herbarium materials were collected in
2009 in the region of Vidin town. However, the fairly wide distribution area of the species in the country suggests that it has penetrated much earlier, but remained undetected because of its similarity to *B. tripartitus* and *B. frondosus*. It was reported as a new species for the flora of Bulgaria in 2009.

Distributed in the Northeast Bulgaria, Danubian Plain, Forebalkan (Eastern), Tundzha Hilly Country, up to about 200 m a.s.l.

First established in Europe in Romania and France in the mid-20th century. Now it is an introduced alien species in many of the European countries – Belgium, France, Germany, Italy, Norway, Romania, Serbia, Slovenia, UK.

**Control**
The species is relatively widespread in the Bulgarian flora and its full eradication would be difficult and very expensive. Single plants or small groups can be removed by manual uprooting or cutting, definitely before the seed-ripening. Herbicides, e.g. glyphosate, can be used for chemical control of the species.

**References**
Morphological description
Deciduous tree, 6–12 m tall. Bark of the young twigs olive-green or gray, of the old – gray-black. Leaves large, serrate, broadly ovate-rhombic or three-lobed (heterophyly), 7–20 × 5–15 cm, grey-tomentose beneath or hairy only on the veins. Flowers unisexual; dioecious species. Male flowers with 4-partite perianth and 4 stamens. Female flowers in dense, globose heads; perianth short, with 4 very small teeth, forming a layer of pulp in fruit. Syncarp orange-red when ripe, comprised of a globular receptacle and numerous drupes, each attached to the receptacle separately.

Biology and ecology
Pollinated by insects; blooms from May to June; fruiting from September to October. Propagated by seeds and vegetatively by root suckers. The seeds are spread by animals over long distances.

Paper mulberry is a fast-growing species that successfully develops in the warmer regions of Bulgaria. It can grow in damp during most of the year soil, and close to waterways. However, it withstands dry periods of 3–4 months. It is not demanding to soil conditions. It grows and develops best on light and moist soil, but grows on poor, sandy or gravelly, medium and heavy clay soils. Not demanding to soil acidity, it occurs on acidic, neutral and alkaline soils. It is assumed that the species cannot withstand soil salinity and strong winds. Sensitive to low winter temperatures, withstands temperatures down to –10°C. Suffering from early autumn and late spring frosts. It prefers sunny places and does not withstand dense shade. It tolerates atmospheric pollution.
The species successfully naturalizes and spreads in the warmer areas of Bulgaria. As a result of the seed and vegetative reproduction it has the potential to form large, dense groups, and thus it may alter the composition and structure of the native plant communities.

It is used as a feedstock for obtaining high-quality paper. The species is often grown as an ornamental plant for landscaping of parks and pathways, mainly in the southern parts of the country (e.g., in the region of Sandanski, Plovdiv, etc.). The fruits are edible. In some countries it is used in folk medicine (fruits – with diuretic, tonic and ophthalmologic effect; leaves – for treatment of dysentery; bark has haemostatic effect).

**Origin and distribution**
Native to East Asia (Japan and Taiwan).

Paper mulberry was introduced in Bulgaria in the early 19th century for landscaping. It was recorded as naturalized plant long ago – in 1885, on sands in the Northern Black Sea Coast.

Distributed in the Black Sea Coast and Valley of River Struma; a trend of enlarging its distribution area in the country is observed.

The species was introduced in Europe around 1750, and now it is naturalized mainly in the south-eastern parts of the continent.

**Control**
Preventive measures include raising public awareness about the potentially invasive abilities of the species (especially in the warmer regions of the country) and prohibition of its use as an ornamental outside settlements and for creating forest plantations. Ensure strict control over the already planted trees in the parks, which includes regular cleaning of the root suckers and careful collecting and disposal of the fruits; disposal of species propagules to dumpsites and waste places should be avoided.

Mature trees can be removed by cutting, with follow-up measures involving regular cutting of the emerging shoots until the whole group is completely destroyed. The species is sensitive to the herbicide triclopyr applied to the bark.

**References**
Bornmüller 1888; Dimitroff 1926; Dimitroff & Stefanoff 1928; Gančev & Prokopiev 1959; Georgiev 1966; Tutin 1993; Vladimirov 2011.
**Morphological description**
Deciduous shrub, 1–5 m high. Twigs bluntly 4-angled, tomentose. Leaves opposite, simple, 10–25 cm, ovate-lanceolate to lanceolate, acuminate, serrate, sparsely pubescent to nearly glabrous and dark green above, tomentose and whitish-gray beneath, shortly petiolate. Inflorescences 10–25 cm long, many-flowered, compact, conical, terminal panicles. Flowers actinomorphic, 4-merous. Calyx campanulate, tomentose. Corolla 8–13 mm long, pale lilac or deep violet, rarely white, with straight cylindrical tube, that is about 4–5 times longer than the calyx, and patent limb with an orange ring at the base inside, outside densely stellate-pubescent and glandular. Stamens inserted about the middle of the tube. Fruit about 10 mm long capsule, many-seeded. Seeds 2–4 mm long, winged.

**Biology and ecology**
Pollinated by insects; blooms from July to August; fruiting from September to October. Propagated by seeds and vegetatively. A bush can form up to 3 million seeds that are spread by wind and running water. When buried with soil substrate, twigs root and quickly produce shoots, thus vegetative propagation is performed. Individuals can live up to 30–35 years. Under favourable conditions, the plants can bloom and produce fruits in the first year. In very cold winters in Bulgaria the aerial part of the bush suffers from frosts but it recovers easily from shoots and starts flowering in the same year.

It prefers fertile, moist, well drained soil, but can grow in poor soil and...
withstands drought. It grows better in sunny places, but tolerates some shading. A pioneer species, colonizing disturbed habitats very quickly. Once established in a new location, the seeds germinate and give rise to new individuals which rapidly form larger groups through vegetative reproduction, reaching densities of over 2000 individuals/ha. If the disturbance of the habitat is discontinued for a long period of time, the butterfly-bush is gradually replaced by native shrub and tree species.

In Bulgaria the butterfly-bush occurs on river banks, riverside sediments, rocky slopes, stone walls, along roads and railway lines, forest margins, stone pits. It forms populations with different size – from a few scattered plants to several hundred individuals, in groups of various size and density. It competes with native plant species for nutrients, light and space. As a pioneer species it settles faster than most native species, causing changes in the composition of the plant communities. On riverside sediments it settles quickly and accelerates the establishment of bush and tree vegetation. Used as an ornamental plant, preferred by many amateur gardeners because of the long period of flowering and beautiful fragrant inflorescences that attract many species of butterflies. There are many cultivars with different colours of the flowers.
Origin and distribution
Native to the temperate parts of Asia (China).

The species was intentionally introduced in Bulgaria as an ornamental plant. Reported as a garden-escape in 1980, based on herbarium material collected in 1978 in the valley of Chepelarska River, Central Rhodopi Mts. It has been frequently imported into the country for landscaping since the mid-20th century.

Distributed in the Black Sea Coast (Northern), Northeast Bulgaria, Sofia Region, Rila Mts, Rhodopi Mts (Western, Central), up to about 1100 m a.s.l.

In Europe first introduced in Great Britain from China in the 90s of the 19th century. Escape from cultivation began in the 30s of the 20th century. Distributed in many parts of the world as an ornamental plant, naturalized in Australia and New Zealand, North America. In Europe it is an invasive species in some countries in the western and southern parts of the continent.
Control
Prevention includes dissemination of information about the invasive nature of the species, especially in riverside and roadside habitats, open habitats or disturbed rocks and slopes. It is necessary to stop the use of the species for landscaping roadsides. Individuals and small groups can be destroyed by logging (prior to seed production), followed by several years of monitoring and eradication or cutting of the emerging shoots.

Sensitive to the herbicides glyphosate and triclopyr which can be used for treatment of the fresh cuts after cutting the stems and for spraying on young shoots after preliminary clearing of the plants.

References
**Cenchrus incertus** M.A. Curtis
Coastal Sandbur
Poaceae – Grass family

Morphological description
Annual. Stems usually several, rarely single, 10–60(90) cm, often geniculate at base, sometimes rooting at the basal nodes, somewhat spreading to almost erect (when vegetation cover is dense). Leaves 6–18 cm × 3–7 mm, glabrous or with sparse hairs on the margin, at the base with up to 1.5 mm long ligule of a fringe of hairs; leaf sheaths hairy on the margin. Inflorescence 4–10 cm long, spike-like panicle. Spikelets in groups of 2–3, enclosed in an involucre; each spikelet with 2 florets – upper fertile and lower sterile or male; involucre 6–10 mm, globose, with 8–40 ± flattened spines, 3.5 to 5.8 mm long, unequal. The whole globular structure (bur) falls off after ripening and serves as a unit of distribution (diaspora). In a spike-like inflorescence 8–20 spiny burs are formed. Fruit a caryopsis; each bur contains 1–3 caryopses, 2.5–4.5 mm long, ovate.

Biology and ecology
Self-pollinated species; blooms from July to August; fruiting from August to September. Propagated by seeds and more rarely vegetatively through rooting of the culms in the lowermost nodes. One plant can form up to 45 culms and 1000–3000 seeds. The spines of the burs are rigid and very easily attach to the fur of animals, clothes and shoes of people. It is believed that the seeds into a bur have different period of dormancy – the upper seeds germinate shortly after maturation, whereas the lower ones are dormant for 2–3 years. Seedlings emerge in April – May, when temper-
atures reach 20°C. The species has C-4 type of photosynthesis. Grazed by animals in the early stages of its development, before the formation of the spiny inflorescences.

It grows in open, sunny, warm places, on sandy or rocky soil. In Bulgaria it occurs along railways and roads, between paving slabs, cracks in the asphalt, in ornamental lawns. It grows in groups of a various size – from a few individuals to hundreds of plants that reach a greater height than the other grass species, forming loose tufts and thus competing with the other plant species in the community for nutrients, light and space. Potentially invasive species in sunny, sandy or rocky habitats, with relatively open vegetation cover. Periodic disturbance of the substrate and vegetation cover stimulates the dispersal of coastal sandbur. Under suitable conditions (sandy or rocky soil, sunny places) it quickly spreads to farmland – in row crops, vineyards, orchards and significantly increases the cost of management. When attaching to sheep wool it hinders its further processing and reduces its quality.

**Origin and distribution**

Native to the tropical areas of America. Because of the unclear species delimitation within the genus and the significant secondary distribution as a result of the human activities, it is difficult to outline the exact native distribution range.

Unintentionally introduced in Bulgaria. The pathways and vectors of penetration are not known, but most likely it occurred at the port of Ruse (terminal “Ruse – East”) by importing contaminated seeds of cereals or attached to clothing of passengers, or using both vectors. The first herbarium materials were collected in 2003. It was published as a new taxon for the Bulgarian flora in 2009. Judging by the wide distribution of the species in the area, as well as from interviews with longtime employees of the port complex, it can be assumed that the species was introduced more than 20 years ago.

Distributed in the Northeast Bulgaria (Ruse – port “Ruse – East” and Railway Station “North”), about 100 m a.s.l.

Due to taxonomic difficulties for distinguishing of the species in the genus, it is difficult to specify the exact time of introduction of *C. incertus* in Europe. Perhaps this happened in the first half of the 20th century (e.g. in Hungary first recorded in 1922). Introduced in many European countries – in East and Southeast Europe it has been registered in Greece, Serbia, Ukraine. Transferred to and naturalized in many parts of the world – Australia, Southeast Asia, South and East Europe, South America, Macaronesia.
Control
Small groups of the species can be destroyed mechanically by manual uprooting, removing the plants before or at the beginning of the flowering period, or repeated mowing to prevent seed formation. Seedlings can be identified by taking out carefully the entire root system, in which the characteristic spiny burs usually remain. For large groups more effective is initial chemical control, followed by monitoring and mechanical eradication of the emerging plants. Herbicides used to control Poaceae-weeds and non-selective herbicides such as glyphosate can be applied to control the species. It is very important and necessary to monitor the treated localities for several years because from the accumulated seeds in the soil new plants develop. To limit the spread of the species, it should be prevented transfer of inert material (soil substrate) from places with populations of species to places lacking such populations.

References
**Chenopodium ambrosioides** L.

**Mexican-tea**

Chenopodiaceae – Goosefoot family

**Morphological description**
Annual to biennial. Stems erect or prostrate, much branched, 40–100 cm long, yellowish, with red longitudinal stripes; the whole plant covered with glandular hairs, strongly aromatic. Leaves alternate, the lower larger, up to 15 cm long and 5 cm wide, elongated-rhombic to lanceolate, unlobed, dentate or rarely laciniate, cuneate at base, acuminate, decreasing in size upward the stem. Flowers hermaphrodite or female, clustered in sessile cymes usually in the axils of the upper leaves that are exceeding the cymes; the whole inflorescence paniculate. Perianth 5-merous, persistent and surrounding fruit, tepals free at least in the upper half, light green. Fruit a nut, one-seeded. Seeds very small, green (when fresh) and black (when dry), slightly flattened laterally.

**Biology and ecology**
Pollinated by wind; blooms from July to October; fruiting from August to October. Propagated by seeds, which have a high germination rate. Often transported by humans as contaminants of crop-seeds. The species contains the toxic essential oil askari-dol, with a strong unpleasant smell, which is used in some countries as an anthelmintic agent for animals. It causes irritation in contact with skin and is dangerous to inhale. It grows in grassy and sandy, disturbed urban habitats, waste places, a weed in crops, near roads.

**Origin and distribution**
Native to South and Central America.

It was first established in Bulgaria in 1890, on the sands near Varna.

Distributed in the Black Sea Coast (Northern), Northeast Bulgaria, Danubian Plain, Forebalkan (Eastern), Sofia Region, Valley of River Struma, Thracian Lowland, up to about 700 m a.s.l.

There is evidence of its introduction to Europe in 1577 as a therapeu-
tic agent. Naturalized in Central and South Europe, Asia and Africa.

Control
To limit the introduction and spread of mexican-tea it is necessary to strictly control the import and sowing of crop-seeds for contamination by seeds of the species. Small groups can be destroyed by manual uprooting of the plants before flowering.

References
Češmedžiev 1988; Delipavlov & Cheshmedzhiev 1997; Grozeva 2008; Markova 1966; Tzonev & Šumberova 2004; Vladimirov 2009a, 2012; Yavashev 1890.
**Morphological description**

Annual. Stems 21–42 cm long, procumbent to ascending, simple or branched, straight, aromatic when pressed, with dense white, multicellular eglandular hairs and sessile glands. Leaves 1–4 cm long, 0.5–2.0 cm wide, alternate, cuneate at base, acute, sinuate with 3–4 lobes on each margin; leaf-lobes rhombic-ovate, often dentate, with eglandular hairs and dense glands, aromatic; petioles up to 5 mm long. Inflorescence paniculate, of sessile axillary clusters of flowers along the ultimate branches; flowers hermaphrodite or female. Perianth with 5 light green, small, lanceolate, entire tepals. Fruit a nut, one-seeded. Seeds reddish-brown, flattened laterally.

**Biology and ecology**

Pollinated by the wind; blooms from July to October; fruiting from August to November. Propagated by seeds, which are formed in abundance and have a period of dormancy because of their hard seed coat; seeds retain their viability for a long time. Many of them remain at the parent plant during the winter and are distributed with variously sized fragments of the plants. Vectors of spread are herbivorous animals, vehicles, agricultural machinery (through adhesion to the tires). The species grows in ruderal and disturbed habitats, waste places, on rocky and sandy soils, near roads, railways, river banks, etc. It competes with some native plant species in these habitats. Toxic to domestic animals; toxins are contained mainly in the leaves and stems.

**Origin and distribution**

Native to Australia and the island of Tasmania.

The species was recently reported for Bulgaria – in 2005, discovered within the Nature Park Sinite Kamani.

Distributed in the Black Sea Coast, Northeast Bulgaria, Balkan Range (Eastern), Valley of River Struma (Southern), Thracian Lowland, Tundzha Hilly Country, up to about 900 m a.s.l. It is expected that more local-
ities of the species in the country will be discovered, since it has been recently reported for the Bulgarian flora and its distribution is still poorly known.

It was introduced to and spread across Europe towards the end of the 18th century, with imported raw wool from Australia. In the beginning it was mis-identified for another morphologically similar Australian species, *Ch. carinatum*. Among the first countries in which it was established were Germany (1889) and the Czech Republic – in Moravia (1890). It is distributed in many European countries, and widely naturalized in Africa, Asia, New Zealand and North America.

**Control**

To limit the distribution of the species throughout the country it is necessary to destroy the plants as soon as they are discovered, obligatory before seed production. Use of herbicides, e.g. glyphosate, is also very effective.

**References**

**Cuscuta campestris** Yunck.

Yellow Dodder

*Cuscutaceae* – Dodder family

**Morphological description**

Herbaceous annual parasitic plant, without roots. Stems twining, moderately stout, glabrous, branched, yellow or orange-yellow, attached to other plants by numerous absorptive pads (haustoria). Leaves scale-like, small. Inflorescence subumbellate to capitulate (especially after flowering), at the base with membranous, acute at apex subtending bract. Flowers in groups of 3–8, 5-merous, 2–3 mm long, with 1–3 mm long pedicels, as thick as the stem. Calyx cup-shaped to semi-globular, with free in the upper half, broadly ovate to suborbicular lobes, obtuse at the apex. Corolla 2.8–3.0 mm long, broadly campanulate, connate from the base to the middle, with patent (often with inflexed apex), triangular, acute lobes, white or cream. Fruit a capsule, depressed-globose, somewhat fleshy, 2.0–2.5 mm long, light brown, enclosed by the calyx and the dry corolla, remaining closed and thus the seeds stay inside for a long time after ripening. Seeds small, almost ovate, brown or pale brown, finely verrucose.

**Biology and ecology**

It blooms from June to October; fruiting from July to November. Propagated by seeds, which are produced in abundance – up to 100 000 from an individual, or vegetatively, by fragments of the stems. Seeds are transported by water, wind, birds and other animals, humans (with agricultural activities), mowing, by agricultural machines, especially by the transportation of agricultural products containing seeds of the parasite. The seeds retain their viability in the soil for about three years, but passed through the digestive system of animals they can survive for up to 10 years. Immature seeds germinate faster than mature. Seeds germinate in the soil at relatively high temperatures, but since the seed-
lings are rootless, they live for only a few days if they do not find the appropriate host. The parasite is twining around the stems or leaves of the host-plants and receives all necessary nutrients through the haustoria. Parasitic on species of different families, including cultivated plants, most often on representatives of Asteraceae. An individual can destroy many square meters of the host-plant, which makes it a dangerous and troublesome weed. It can survive the winter on a perennial host, but it is vulnerable to winter frosts if the snow cover is thin.

**Origin and distribution**
Native to North America.

Established for the first time in Bulgaria in 1928.

It is distributed in all floristic regions of the country up to about 1800 m a.s.l., parasitic on species of different families, including cultivated plants.

It was first reported for Europe in 1883 from the Czech Republic, introduced as a contaminant to crop-seeds. Consequently, it spread to other parts of the continent and now is one of the most dangerous parasitic weeds on a wide range of hosts – representatives of different plant families.

**Control**
Prevention includes control on the yellow dodder before seed-formation which will reduce future problems, and is best to be applied in the invaded area before the massive development of the parasite. Clean crop-seeds must be used in agriculture. Young seedlings can be easily destroyed by shallow tillage before or after the culture emerged. Soil cultivation, crop rotation, and use of cultivated plants resistant to the parasite are good solutions too. As it is easily distributed by human activities, taking preventive measures is essential. Chemical control during the flowering period, but before seed formation, can help to reduce the parasite. Biological control is scarcely used.

**References**
Delipavlov 1982; Feinbrun 1972; Pyšek & al. 2012b.
**Morphological description**
Annual. Stems 30–125(200) cm, erect, simple or bifurcately branched in the upper part, glabrous to puberulent, green to pale yellow. Leaves 7–15 cm long, 3.5–12.5 cm wide, alternate, shortly petiolate, simple, ovate to broadly elliptic, cuneate to subcordate at base, acute, sinuatedentate to sinuate-lobed, lobes unequal. Flowers actinomorphic, hermaphrodite, single, axillary, with unpleasant scent. Calyx 2.5–12.5 cm long, 5–16 mm wide, tubular, slightly swollen at base, somewhat 5-angled, light green, glabrous or sparsely puberulent, with 5 unequal teeth. Corolla 4.5–8.5(10) cm long, infundibuliform, white, rarely purplish, glabrous, with 5 teeth, 4–9 mm long, broadly triangular. Stamens shorter than corolla-tube. Fruit a capsule, 2.5–6.5 cm long, 2–5 cm wide, ovate, erect, densely covered with more or less equal spines, rarely spineless, dehiscing regularly by 4 almost equal valves. Seeds 3.0–3.5 mm long, many in a capsule, black, with reticulated coat with prominent ridges.

Morphologically similar is *Datura innoxia*. There is literature data that it was grown in the park “Vrana” before 1933. It was first registered as an escape from Lokorsko village, Sofia district, in 1979, but reported in literature only in 2005. It differs from *D. stramonium* by its larger flowers (corolla 11–20 cm long), the whole plant is densely pubescent, which gives a greyish colour of the plant, and by its nodding capsules dehiscing irregularly.

**Biology and ecology**
Pollinated by insects, mostly bees; blooms from April to August; fruiting from June to October. Propagated by seeds, which retain their viability for a long period of time in the soil. They are dispersed through trade...
of contaminated crop-seeds, and by birds and mammals (the whole spiny fruit can attach to their fur or wool). All parts of the plant are poisonous to humans and animals. It contains alkaloids, including atropine, hyoscyamine and scopolamine, which are used in medicine.

**Origin and distribution**
Described from America, from where it is believed to originate. However, it is difficult with certainty to outline the native distribution range of this species, as well as of many other widespread weeds.

In Bulgaria it was first discovered in 1885 in the region of Sliven town.

Distributed in all floristic regions of the country. It is a ruderal plant and a weed in crops, grasslands, waste places, disturbed habitats, dumpsites, along roads, up to about 1700 m a.s.l.

In Europe it was cultivated for the first time in England in the late 16th century. It was introduced commercially as a medicinal plant (antispasmodic). The first report for escaped plants there is from 1777. A widespread species worldwide.

**Control**
Manual removal of the plants before flowering and fruit formation. Effective for chemical control is the use of herbicides, e.g. atrazine, 2,4-D or bromoxynil.
References
**Echinocystis lobata** (Michx.) Torr. & Gray

**Wild Cucumber**

**Cucurbitaceae – Cucumber family**

**Morphological description**
Annual, with climbing stems and branched (usually 3-fid) tendrils in the stem nodes. Stems up to 12 m long, soft, fleshy, glabrous, sometimes hairy at the nodes. Leaves alternate, deeply 5-lobed, rounded at the base, petiolate, with entire or finely serrate margin; venation palmate, mid-rib of each lobe exceeds the acuminate apex forming a mucro. Flowers unisexual, with six small petals; male flowers greenish to white, in erect paniculate inflorescences in the axils of the leaves, with 3 stamens, united with their filaments in a column, with yellow anthers; female flowers yellow-green, ovary with soft prickles. Fruits 2.5–5.0 cm long, ovoid, covered with soft prickles, swollen, with much air inside when ripe, green and juicy before ripening, brown and dry when ripe, opening at the apex, resembling a small cucumber. Seeds usually 4 in each fruit (2 in each half), long, flat, blackish to dark brown with darker markings, hard.

It can be confused with *Sicyos angulatus*, which, however, has flowers with 5 petals, in racemose inflorescences, and small, one-seeded fruits, not swollen.

**Biology and ecology**
Pollinated by insects, attracted by the pleasant scent of the flowers, but self-pollination is also possible. It blooms from July to September; fruiting from August to October. Propagated by seeds, which retain their viability in the soil for over a year; seeds are relatively heavy and fall from the fruits that open at the apex after ripening. When floodings occur on the riverbanks, they are spread by the water. Birds and rodents eat the fruits and also take part in the seed dispersal. Seeds require high soil tempera-
ture to germinate in the next spring, when one can see many seedlings under the old plant from the previous year. The species is sensitive to late spring and early autumn frosts. The stems grow and branch very quickly, covering large areas and climbing on the native plants by means of their 3-fid tendrils. Thus, it affects the native flora and vegetation, altering the structure and the succession of the native plant communities. It grows in moist places, marshy soils, along the banks of rivers, streams, forest margins, waste places. It does not tolerate shade, requires sun light, moisture and nutrients, which limits its spread outside the river corridors. The species contains toxic to humans and animals substances (cucurbitacins).

**Origin and distribution**
Native to North America.

Established in Bulgaria for the first time in 1967 in the region of Svishтов town.
Distributed in the Danubian Plain, along the Danube River.

Introduced in Europe in the early 20th century as an ornamental in the botanical gardens. Possibly from the gardens it has spread to almost all parts of the continent.

**Control**

Destruction of the young plants before flowering and fruit formation is important in order to limit the massive spread of the species. Chemical control with herbicides can be applied, especially over large areas of invasion.

**References**

**Eclipta prostrata** (L.) L.
False Daisy

**Asteraceae – Daisy family**

**Morphological description**
Annual. Stems 20–90 cm, erect or decumbent, scabridulous, much branched from the base. Leaves opposite, 4–13 × 0.8–2 cm, oblong to linear-lanceolate, remotely serrate, the lower cuneate at base, narrowed into a short petiole, the upper sessile, all acute, scabridulous. Capitula hemispheric, 3–6(10) mm wide, in loose corymbiform arrays or borne singly. Involucral bracts in 2 rows, 5–6 mm long, herbaceous, scabrid. Receptacle flat or slightly convex, with bracts. Outermost florets ligulate, female, 2–6 mm long, white; the inner florets tubular, shortly 4(5)-lobed, hermaphrodite. Fruit a 2–2.5 mm long achene, gray, brown to almost black, triangular to suberete in section, without pappus or with a crown of few short teeth.

**Biology and ecology**
Pollinated by insects; blooms from July to September; fruiting from August to October. Propagated mainly by seeds, seldom vegetatively by rooting stems and branches in the nodes. Mechanisms of seed dispersal are not well understood, but perhaps this happens by means of running water and animals. Seeds do not need a period of dormancy and germinate at pH 5–8 and temperature above 10°C. Germination rate is higher at higher temperatures of 30–35°C. For germination high soil moisture and light are required. Therefore, the most suitable conditions are at the soil surface; at a depth of more than 2 cm seeds do not germinate.

The species grows in poorly drained, wet, grassy places, near canals, ditches, by river floods, near temporary puddles, on clayey and sandy loam soils. It prefers sunny or slightly shaded places. It withstands salinity in the soil substrate. In the localities in Bulgaria the species is rep...
Reported as a new species for the Bulgarian flora in 2007 on materials collected in 2006 on the banks of the Danube River in Northeast Bulgaria.

Distributed in the Black Sea Coast (Southern), Northeast Bulgaria, Danubian Plain, up to about 50 m a.s.l.

Naturalized in the warmer parts of all continents except Antarctica. From the Balkan countries, besides in Bulgaria, it has been recorded in Greece and Romania.

**Control**
There is no specific methods to control this species. The species is represented in Bulgaria with relatively small populations, and therefore, mechanical control is recommended, by manual uprooting of the plants before flowering. Low mowing might not give good results, because new decumbent branches are formed just above the soil surface and they are difficult to mow.

**Origin and distribution**
Native to the tropical and warmer temperate parts of America.

A potentially invasive species, under observation. The impacts of the species on the local biodiversity are not well understood but possibly it competes with some native species for nutrients and light. From our observations so far, it can be assumed that the species does not pose a serious threat to biodiversity. In some parts of the world, mostly tropical and subtropical, it is a weed in rice fields and other irrigated areas. In some countries it is used in the folk medicine as an antiseptic, ophthalmologic, purgative and tonic agent for the treatment of anemia, diphtheria, hair loss, etc. The leaves can be used for food.

**References**
**Elaeagnus angustifolia** L.
Oleaster, Russian Silverberry

**Elaeagnaceae** – Sea-buckthorn family

**Morphological description**
Deciduous tree or shrub, 2–10 m tall, with deep roots. Stems branched, with red-brown bark, darkening with the age; twigs covered with dense, silvery-white scales, with 7–30 mm long thorns. Leaves 25–80 × 4–25 mm, alternate, simple, narrow-ovate to lanceolate, entire, cuneate at base, obtuse at apex, gray-green above, silvery-white underneath due to dense stellate hairs and silvery scales, petiolate. Flowers hermaphrodite and male on the same plant, 8–15 mm long, single or in groups of 2–3 in the axils of the leaves, appearing together with the leaves; pedicels 2–5 mm long. Hypanthium of the male flowers 5–6 × 2.5–3.0 mm, tubular to tubular-infundibuliform, silvery tomentose; of the bisexual flowers 8–10 × 1–3 mm, tightly enveloping the ovary at the bottom, bell-shaped upward. Fruit a drupe, 7–20 × 5–10 mm, ovate or elliptical, juicy, the immature covered with dense silvery scales, the mature yellow-brown, with fewer scales to almost glabrous. Seeds brown, elliptic-ovate.

Morphologically similar is *Elaeagnus multiflora* Thunb., from Southeast Asia, established as an escape in the Black Sea Coast and the Sofia Region. It differs from *E. angustifolia* by its reddish-brown spineless twigs, glabrous on the upper surface leaves, and the red, white-dotted fruits when ripe.

**Biology and ecology**
Pollinated by insects; blooms from May to June; fruiting from August to September. Propagated by seeds and vegetatively, by root suckers. Fruits and seeds are dispersed by birds and small mammals. It starts fruiting as early as at the age of 5. At the base of the trunk it can form additional roots when covered with sand; it can regenerate well by stem shoots. Fast
growing, especially in the early years. Highly drought resistant, heliophyte, not demanding to the soil type, and tolerant to air pollution. It has the ability to fix the atmospheric nitrogen, and thus, it enriches poor and depleted soils. It grows both on moist and well-drained soils; prefers sandy and moderately fertile soils, successfully develops on poor and dry substrate, but dislikes shallow calcareous soils. It requires sunny exposures. Wind resistant species. It prefers continental climate. It is used for landscaping, for stabilization of dry and eroded areas, and in shelterbelts. As a fast-growing species that forms dense and large groups, it competes with native plant species for water, nutrients, light, and changes the structure and appearance of the habitats.

**Origin and distribution**
Native to Southwest and Central Asia.

Introduced in Bulgaria intentionally, as an ornamental plant, in the late 19th century. It was first reported as an escape in 1891 from the coastal sands and rocks near the Black Sea.

Distributed in the Black Sea Coast, Northeast Bulgaria, Danubian Plain, Forebalkan, Balkan Range (Eastern), Sofia Region, Znepole Region, Valley of River Struma, Rhodopi Mts, Thra-
cian Lowland, Tundzha Hilly Region and Mt Strandzha, up to about 1000 m a.s.l.

In Europe it is grown as an ornamental in parks and gardens, from where it spreads into natural habitats. Preferred species for cultivation in many countries, naturalized in many parts of South and Central Europe, North Africa, North America.

**Control**
The removal of trees must precede the formation of fruits, in order to prevent their spread. Methods for biological control are not known. Preventive measures include dissemination of information about the invasive nature of the species, and limitation of its use as an ornamental, shelterbelt plant and to control soil erosion. Younger plants can be uprooted. Old trees are cut down to the base and immediately afterwards are treated with herbicides. If necessary, the emerging young suckers are also treated with herbicides (glyphosate, 2,4-D or 2,4,5-T, etc.).

**References**
**Elodea canadensis** Michx.
Canadian Waterweed
Hydrocharitaceae – Frogbit family

Morphological description
Herbaceous perennial, entirely submerged aquatic plant with white filiform roots. Stems slender, 30–300 cm long, branched. Leaves sessile, in whorls of 3, 6–15 mm long, 1.5–4.0 mm wide, oblong-ovate to linear-lanceolate, rounded at the apex, flat, minutely denticulate on the margin, dark green. Flowers single, unisexual, the male and female flowers on different individuals (dioecious plant), raised to the water surface on thin, 2–6 cm long pedicels. Perianth of 3 sepals and 3 petals, membranous, sepals and petals equal in size, petals white-violet. Pollen is released directly on the water surface. Fruit to 1 cm long capsule, 1–5-seeded.

Similar in morphology with *Elodea nuttallii*, which has narrower leaves, gradually tapered to the acute apex.

Biology and ecology
Pollinated by insects on the water surface. The flowers are unisexual. The species rarely blooms, in Europe it is always dioecious and on a large part of the continent only female individuals are found. Therefore, reproduction is only vegetative – by fragmentation of the stem. Even a very small part of the stem can form roots at the nodes and start to grow. The vegetative reproduction dominates also in the native populations in North America, where both female and male individuals grow together. The species grows in slowly flowing, usually up to 3 m deep freshwaters, rich in calcium, with pH 6.0–7.5 and tempera-
ture 10–25°C, in swampy and marshy areas, stagnant water, in large irrigation channels, reservoirs of different types with slowly flowing water, shallow lakes, ponds, ditches. It does not withstand drought. It spends the winter under the ice, forming vegetative buds (turions) to survive the winter or other unfavourable conditions. Under favourable conditions the plants root quickly in the nodes of the stems and grow in the water while floating. The species withstands low light, occurs in muddy waters. It spreads very quickly, thanks to the vegetative reproduction. Fragments of the plants and dormant buds (turions) are moved by water currents, and are carried out at long distances by water birds, mainly geese and swans; some human activities also facilitate the distribution of the species.

The species causes changes in the chemical composition of the water by increasing the nutrients and organic substances, which are extracted from the sediments during the growth and released into the water after the death and decomposition of the plants. This leads to strong eutrophication of the lakes and decrease of the oxygen amount, causing massive “blooms” of algae. The rapid development of the species reduces the flowing speed of the water, causes changes in the whole ecosystem and the waterbasin becomes unsuitable for use, hence its popular name pondweeds or waterweeds. By reducing the flow of the water, it may increase the risk of flooding. It is a food and habitat for many zoobenthos species, fishes and birds. Very suitable for bio-accumulation of cadmium and partly of copper. The species is still grown in garden centers as aquarium and ornamental plant. In many places decline of the populations of *E. canadensis* is observed due to its displacement by *E. nuttallii*.

**Origin and distribution**

Native to North America.

In Bulgaria it was first discovered in the wild in 1929 in floods of river Maritsa (herbarium specimens kept in SOA). It is assumed that it was introduced much earlier for educational purposes, grown in aquaria, from where it was transferred to natural habitats; introduction by water birds is also possible.

Distributed in the Black Sea Coast (Southern), Northeast Bulgaria, Danubian Plain, Forebalkan, Balkan Range, Sofia Region, Vitosha Region, Znepole Region, West Frontier Mts, Rhodopi Mts (Western), Thracian Lowland, up to about 1200 m a.s.l.

In Europe it was first reported in 1836 from Ireland, from where it has spread to the countries of North and Central Europe. In some countries deliberately introduced in botanical gardens for decorative purposes, from where it was spread widely by water birds.
and water flows. Cosmopolitan, widely distributed in Asia, Africa, Australia, New Zealand.

**Control**

For control of *Elodea canadensis* very important is the dissemination of information about the risk of increasing of its populations. Since the species is highly invasive and spreads rapidly in aquatic systems, it is essential to stop its distribution on a given territory as soon as it is recorded. Drainage or dewatering of channels can reduce the population size. By reducing the water level in the reservoirs and water pools during the winters, the populations can be controlled; drought, air temperature and presence of snow have a positive effect in this regard.

Mechanical control is inefficient and is not recommended, since the plant fragmentation leads to an even greater increase in the population size or such control can be applied only when there is no risk of spread of parts of the plant by the water currents. It should be performed at the appropriate time – before development of large subpopulations.

Biological control using fishes is possible, but the risk remains, since the fish species do not feed selectively only on the invader.

Chemical control using herbicides is no longer recommended because of the harm they may cause to other aquatic organisms.

**References**

**Morphological description**
Herbaceous perennial, submerged aquatic plant, with thin, filiform roots at the stem nodes. Leaves 6–10 mm long, 1.0–1.5 mm wide, the lower opposite, the upper in whorls of 3(4), linear or linear-lanceolate, gradually tapering towards the acute apex, minutely denticulate on the margin. Dioecious plant; flowers unisexual, perianth of 3 sepals and 3 petals, male flowers breaking free and rising to the surface of the water; female flowers remain connected to the plants, raised to the water surface on thin pedicels. Fruit a capsule, 1–5 seeded.

Similar in morphology with *E. canadensis*, which has broader leaves with obtuse (to subacute) apices.

**Biology and ecology**
Pollinated by insects on the water surface. Flowers are unisexual; rarely blooms, in Europe it is always dioecious plant, on a large part of the continent only female plants are found, and therefore reproduction is only vegetative, as in *E. canadensis* – by fragmentation of the stem. Even small pieces of the stem can form roots in the nodes and begin to grow rapidly. The species grows in still or slow-flowing water, eutrophic reservoirs, often in calcareous water, usually in communities poor of other macrophytes. It does not tolerate drought. It overwinters under the ice with many winter buds (turions), which grow rapidly in spring, at 6–8°C, toward the water surface. It spreads very quickly, thanks to the ability of vegetative reproduction and its tolerance to nutrient rich waters. Fragments of the plants and winter dormant buds are included in List of "Worst invasive alien species threatening biodiversity in Europe" (Annex 1. 2007) and in the list of the invasive species of the European and Mediterranean Plant Protection Organisation (EPPO 2012).
moved by water-currents or are carried over long distances by water birds, mainly geese and swans; some human activities also facilitate the spread of the species.

**Origin and distribution**
Native to North America.

In Bulgaria the species was relatively recently discovered, in 2002, and, as in other parts of Europe, it is more widespread than *E. canadensis*, displacing the latter taxon from its localities.

Distributed in the Black Sea Coast (Southern), Northeast Bulgaria, Danubian Plain (canals along the Danube), Forebalkan, Balkan Range, Sofia Region, Vitosha Region, Znepole Region, Rhodopi Mts (Western), Thracian Lowland, up to about 1200 m a.s.l.

It is assumed that the species was introduced in Europe in the 20th century. The first report is from Belgium in 1959. Most likely it was introduced earlier, but due to its morphological similarity to *E. canadensis*, it was not
recognised. The species is increasingly expanding its range, and since about 1970 it has begun to displace *E. canadensis* from its localities known for a long time.

**Control**

For control of *E. nuttallii* very important is the dissemination of information about the risk of increasing of its populations and its invasive nature. Mechanical control is not recommended as the stems are fragmented very easily and the fragments give rise to new plants; mechanical control can be more effective in small, closed water reservoirs. Chemical control should be used with caution, taking into account the other organisms in the water bodies.

**References**

**Erigeron annuus** (L.) Desf.
Tall Fleabane

*Asteraceae* – Daisy family

**Morphological description**
Herbaceous annual or biennial. Stems 35–100(150) cm tall, erect, simple in the lower part, pubescent, branched in the upper part, pubescent to glabrescent. Basal leaves 5–10(17) × 2.5–4.0(7.0) cm, ovate or elliptical, dentate, with sparse appressed hairs, withering at anthesis; lower cauline leaves 6–10 × 1.5–2.5 cm, ovate-lanceolate or elliptic, dentate, the upper elliptic-lanceolate. Capitula many flowered, few to numerous, forming a loose leafy corymbiform panicle. Involucral bracts 3–5 × 0.3–0.6 mm, linear-lanceolate, nearly equal, green or brown, dorsally with short or long hairs on the midvein. Florets of two types, the outermost female, ligulate, numerous (80–120), white or bluish, ligules to two times longer than the involucral bracts; the inner florets tubular, numerous, 5-lobed at apex, yellow. Fruits 1.2–1.3 mm long, pubescent achenes; pappus of tubular florets of two rows – outer of small scales and inner of 10–15 fragile hairs; pappus of ligulate florets of one row of small scales.

**Biology and ecology**
Facultatively apomictic species in Bulgaria; blooms from June to September; fruiting from July to October. It has a reproductive system, which facilitates quick colonization of new territories, due to formation of apomictic seeds, and retains the possibility of cross-pollination by insects and formation of amphimictic seeds which is a prerequisite for the occurrence of genetic variation and adaptation. A single individual can produce a large number of seeds – about 10 000–12 000 which do not need a period of dormancy to germinate. Under favourable conditions it can have...
more than one generation per year. Some of the seeds germinate in the autumn and give rise to wintering leaf rosettes, whereas the flowering stems are formed in the next year. Seeds retain their viability for a long period of time – over 20 years.

The species grows on a variety of soils, but develops best on fertile, moderately moist, loose soil. It prefers sunny places, but tolerates some shading. A pioneer species that quickly colonizes disturbed habitats and can reach considerable density – over 50–60 plants/m². Maintaining disturbance of the habitat stimulates the spread of the species. With increasing the share of the perennial tufted grasses and thickening of the vegetation cover, the number and density of the individuals of _Erigeron annuus_ gradually decreases.

In Bulgaria the species occurs in sparse woodlands, meadows, pastures, abandoned farmlands, near settlements, roads, railroads, embankments, dikes, river terraces. It forms variously sized populations – from several dozen scattered individuals to tens of thousands of plants occupying several decareas and forming mono-dominant groups (e.g. in abandoned farmlands).

It competes with the local pioneer species for nutrients, light and space. In a massive development in grasslands it decreases their value since it is usually not grazed by livestock. Used as an ornamental plant, more often in the past, now avoided because of its weedy and invasive behaviour in the gardens.

### Origin and distribution
Native of North America (Canada and the northern USA).

Probably unintentionally introduced species in Bulgaria, although deliberate introduction as an ornamental plant cannot be excluded. It was first reported for Bulgaria in 1974, based on material collected in 1971 in a plantation of _Populus ×canadensis_ in Northeast Bulgaria. In the past two decades a very rapid expansion of the distribution range of the species in the country has been observed.

Distributed in the Black Sea Coast, Northeast Bulgaria, Danubian Plain, Forebalkan, Balkan Range, Sofia Region, Znepole Region, Vitosha Re-
region, Valley of River Struma, Mt Belasitsa, Mt Slavyanka, Valley of River Mesta, Mt Sredna Gora (Western), Rhodopi Mts, Thracian Lowland, Tundzha Hilly Country, up to about 1000 m a.s.l.

*Erigeron annuus* was introduced in Europe towards the end of the 17th century, when it was grown as an ornamental plant in some countries. Naturalized in many parts of Australia, Asia, Europe, Central America.

**Control**
The species is widespread in the Bulgarian flora and complete eradication is impossible. On small areas with a small number of individuals manual uprooting of the plants is recommended, obligatory before flowering and seed formation. In arable fields tillage at the stage of leaf-rosettes would also give good results. Where possible, the localities can be treated with herbicides to prevent seed germination or at the phase of leaf-rosettes to kill the plants. In all cases, consistent monitoring and measures for control of the species for several years are needed until depletion of the seed-bank in the soil.

**References**
**Erigeron bonariensis** L.
Argentine Fleabane

Syn. *Conyza bonariensis* (L.) Cronquist
*Asteraceae* – Daisy family

**Morphological description**
Herbaceous annual to biennial. Stems 10–60 cm tall, simple or branched in the upper part, gray-green, densely hairy, with two types of hairs – short, appressed and long, patent. Leaves oblongulate, petiolate, erecto-patent, the lower withering early, the upper smaller, sessile. Capitula cupuliform, numerous, born singly on long peduncles, forming loose panicle; lateral primary branches significantly exceeding the central terminal branch, so the entire synflorescence is obconical in outline. Involucral bracts in 2–3 rows, linear-lanceolate, 4–6 mm long, densely to sparingly hirsute, gray-green, often conspicuously red-tipped. Ligulate florets 50–120, in several rows; ligules up to 0.5 mm long or absent, usually shorter than pappus, whitish, rarely slightly tinged with purple; tubular florets 5, pale yellow. Fruits obvate achenes, flattened, 1.0–1.3 mm long, with scattered hairs and a pappus of whitish hairs.

Morphologically similar to *E. canadensis*, which, however, has glabrous or nearly so involucral bracts and longer ligules (0.5–1 mm) of the ligulate florets, and to *E. sumatrensis*, which has lateral branches of the synflorescence shorter than the central terminal axis (synflorescence rhombic in outline), involucral bracts not red-tipped, and yellow-white to pale brownish pappus.

**Biology and ecology**
Pollinated by insects; blooms from June to October; fruiting from July to November. It produces a large amount of achenes which do not need a period of dormancy. Thanks to the pappus, the achenes are spread by wind. Seeds can germinate in the dark, but
they germinate better in the presence of light. The highest germination rate is observed in neutral or slightly alkaline pH, on the soil surface; buried at 5–6 cm depth the seeds do not germinate. The majority of them germinate in the autumn, giving rise to overwintering leaf rosettes. In the laboratory, the seeds retain their viability for 2–3 years, but it is possible under field conditions to remain viable for a longer period of time.

The species occurs in the warmer parts of the country, mainly in man-made or much disturbed habitats – waste, abandoned and uncultivated areas, near roads, railroads, in settlements, farmland, intensively used grassland, on sandy and stony river-banks, along irrigation canals, etc. It often forms mixed occurrences with *E. canadensis* or *E. sumatrensis*, or with both species together, but in these cases it usually has the smallest size and is represented with fewer individuals.

Under suitable conditions, it forms relatively numerous populations of tens to hundreds of plants. It competes with some native species for nutrients, light and space. It occurs as a weed in row crops, vineyards, orchards, where in a massive development leads to increased cost of crop-fields management.

**Origin and distribution**
Native to tropical America.

Unintentionally introduced species in Bulgaria. The exact pathways of introduction are not known. The oldest herbarium material is from Starchevo village, Petrich municipality, collected in 1976. Reported as a new species for the flora of Bulgaria in 1980.

Distributed in the Black Sea Coast, Valley of River Struma, Mt Belasitsa (above Petrich), Valley of River Mesta, Thracian Lowland, Tundzha Hilly Country, from the sea level up to about 500 m a.s.l.

Introduced in Europe in the past 350 years, but the exact time of penetration is not known. From the Bal-
kan countries except Bulgaria, it has been registered in Albania, Croatia, Greece, Macedonia, Montenegro, Slovenia, Turkey, as well as in many other European countries. Introduced and naturalized in the tropical and warm temperate parts worldwide.

Control
Single plants or small groups can be removed mechanically – by uprooting, hoeing or tillage at the phase of leaf rosettes. Mowing can delay the formation of seeds in the locality thus the leaf rosettes are formed in late autumn and their mortality is higher during winter. It is necessary to monitor the treated field for at least three years, until the seed bank in the soil is depleted, and during this time formation of new seeds should not be allowed. For large groups herbicides are used for chemical control. The treatment is most effective in the autumn or early spring when the rosettes are actively growing and flowering stems are not formed yet. There are glyphosate resistant populations, including in a neighbouring country of Bulgaria (in Greece). Destroying these populations is considerably more difficult and can be achieved by applying a combination of herbicides to which the population is not resistant.

References
**Erigeron canadensis** L.
Canadian Fleabane

Syn. *Conyza canadensis* (L.) Cronquist
*Asteraceae – Daisy family*

**Morphological description**
Herbaceous annual to biennial. Stems (10)30–100(200) cm tall, simple at the lower part, branched in the upper part, densely leafy, sparsely patent-hirsute, green. Leaves narrow, oblanceolate, 1–10 × 0.1–1.0 cm, the lower withering early, on short petioles, the upper smaller, sessile, on both sides nearly glabrous, ciliate on the margin and midvein below. Inflorescence a panicle, with numerous bell-shaped capitula, born singly on long peduncles. Involucral bracts in 2–3 rows, linear-lanceolate, 1.5–3.0(4.0) × 0.20–0.25 mm, glabrous or nearly so. Ligulate florets in a few rows; ligules 0.5–0.8(1.0) mm long, equal or slightly exceeding the pappus, whitish to purplish; tubular florets 5, pale yellow. Fruits obovate achenes, flattened, 1.0–1.25 mm long, sparsely hairy, with a pappus of whitish to brownish hairs.

Morphologically similar to *E. bonariensis* and *E. sumatrensis*, which have densely pubescent involu-
observed in 24/20°C day/night temperature and in neutral to slightly alkaline medium. The seeds germinate at high NaCl-levels in the medium, indicating that the species can grow on saline soils. The highest germination rate was observed on the surface of the soil substrate; at a depth of 0.5–1.0 cm the germination significantly decreases (under 10% germinate), and at a depth of 5–6 cm the seeds do not germinate. The majority of them germinate in the autumn, giving rise to wintering leaf rosettes, and only a small part of the achenes germinate in the spring. It is not exactly known how long the seeds remain viable, but there are some literature data for 10-20 years.

The species occurs mainly in man-made or significantly disturbed habitats – waste, abandoned and uncultivated areas, near roads, railroads, settlements, as a weed in row crops, vineyards, orchards, forage crops, intensively used pastures, sand dunes, floodplains, etc. A pioneer species, one of the earliest colonizers on disturbed or newly created habitats without or with very open vegetation cover. Often it forms mixed communities with Erigeron bonariensis and E. sumatrensis, or with both species together.

Under favourable conditions, it forms populations with tens of thousands of plants. The density can reach to about 1000 plants/m². It competes with native plant species for nutrients, light and space. One of the most common weeds in row crops, vineyards, orchards, where in mass development it significantly reduces the yield of crops. In pastures it lowers their productivity because it is not grazed by livestock.
**Origin and distribution**
Native to North America.

Unintentionally introduced in Bulgaria. The exact time and pathway of introduction are not known. The first literature data for presence of the species in the Bulgarian flora are from 1883, but it arrived much earlier to the country.

Distributed in all floristic regions of Bulgaria, from sea level up to about 1500(2000) m a.s.l.

Introduced to Europe in the 17th century and now it is one of the most widespread alien species. Naturalized in all continents except Antarctica – perhaps the most widespread alien species in the world.

**Control**
Single plants or small groups can be removed mechanically – by uprooting, tillage at the phase of leaf rosettes. Mowing can delay the formation of seeds in the localities, thus the rosettes are formed late in the autumn and during the winter their mortality is higher. For large groups herbicides are used for chemical control. The most effective treatment is during the autumn or early spring when the rosettes actively grow and the flowering stems are not formed yet. In more than 10 countries worldwide, resistant to glyphosate and other herbicides populations have already appeared and spread over large areas. Destroying these populations is considerably more difficult, and is achieved by applying a combination of herbicides to which the population is not resistant.

**References**
**Erigeron sumatrensis** Retz.
Guernsay Fleabane

Syn. *Conyza sumatrensis* (Retz.) E. Walker
*Asteraceae* – Daisy family

**Morphological description**
Herbaceous annual to biennial. Stems (50)100–150(230) cm tall, simple in the lower part, gray-green, branched in the upper part, densely leafy, densely hairy; hairs of two types – dense, appressed, upward pointing, short hairs, and sparse, long, patent hairs. Leaves 4–10 × 0.6–1.0(1.2) cm, elliptic-lanceolate to oblong-ovate, densely appressed-hirsute; the lower remotely serrate, with short petioles, withering early; the upper almost entire, smaller, sessile. Capitula cupuliform, numerous, born singly on long peduncles, forming elongate-rhombic panicle, lateral branches do not exceed the central terminal branch. Involucral bracts in 2–3 rows, 3–5 mm long, linear-lanceolate, densely hirsute, gray-green. Ligulate florets 130–200, in several rows; ligule shorter than 0.5 mm, inconspicuous, whitish; tubular florets about 15, pale yellow. Fruits 1.0–1.5 mm long, obovate, flattened achenes, each with a pappus of pale brown hairs.

Morphologically similar to *E. bonariensis*, which, however, has lateral branches of the inflorescence much exceeding the central terminal one (inflorescence obconical in outline), involucral bracts usually purplish on the apices, and achenes with almost white pappus. *Erigeron canadensis* differs by its glabrous or nearly so involucral bracts and 0.5–1.0 mm long ligules of the ligulate florets.

**Biology and ecology**
Self-compatible and predominantly self-pollinated species, although cross-pollination by insects can also occur; blooms from July to October; fruiting from July to November. It produces large amounts of capitula – to 1 200, and about 200 000 achenes
from a 2 m high plant. Thanks to the pappus, the achenes are spread by wind over long distances. The highest germination rate was observed on the surface of the soil substrate and in the presence of light. The majority of the seeds germinate in autumn, giving rise to overwintering leaf rosettes.

The species occurs in sunny or slightly shaded places, mainly in man-made or significantly disturbed habitats – waste, abandoned and uncultivated lands, along roads, railroads, settlements, weed in row crops, vineyards, orchards, intensively used pastures and secondary grasslands, sand dunes, floodplains, etc. A pioneer species on disturbed or newly created habitats, lacking vegetation cover. It often forms mixed communities with *E. bonariensis* or *E. canadensis*, or with both species together, and in these cases it reaches the largest size.

*Erigeron sumatrensis* is more warm-demanding than *E. canadensis*, but it can grow at slightly lower temperatures than *E. bonariensis*, which corresponds to the distribution patterns of the three species in the country – *E. canadensis* is widespread in all floristic regions up to 1500(2000) m a.s.l., whereas *E. bonariensis* is found only in the warmer parts of the country up to about 500 m a.s.l.

Under favourable conditions, it forms large populations of tens to hundreds of individuals. It competes with the
native plant species for nutrients, light and space. Aqueous extracts of *E. sumatrensis* exhibit allelopathic activity, indicating that allelopathy also contributes to the high invasive potential of the species. A relatively common weed in row crops, vineyards, orchards in the southern and eastern parts of the country where in massive development it leads to reduced yields of crops. In pastures it lowers their productivity because it is not grazed by the livestock.

**Origin and distribution**

Native of South America.

Unintentionally introduced in Bulgaria. The exact time and pathways of introduction are not known. The oldest herbarium material was collected in 2006 in the area of Zhurnalist resort north of Varna city. Published as a new species for the Bulgarian flora in 2009. However, the wide distribution in the country speaks in favour that the species was introduced much earlier, but remained undistinguished from *E. canadensis* and *E. bonariensis*, mainly due to lack of appropriate taxonomic literature.

Distributed in the Black Sea Coast, Northeast Bulgaria, Danubian Plain, Forebalkan (Western), Sofia Region, West Frontier Mts, Valley of River Struma, Mt Belasitsa, Valley of River Mesta, Pirin Mts (Northern), Rila Mts, Thracian Lowland, Tundzha Hilly Country, up to about 1000 m a.s.l.
In Europe it was registered for the first time as a naturalized species in 1875 in France. From the Balkan countries, except in Bulgaria, it has been recorded in Albania, Croatia, Greece, Romania, Serbia, Slovenia, Turkey. Naturalized in the warmer parts of all continents except Antarctica.

Control
Single plants or small groups can be removed mechanically – by uprooting or tillage at the phase of leaf rosettes. Mowing can delay the formation of seeds in the locality, thus the rosettes are formed late in the autumn, and therefore during the winter their mortality is higher. For large groups herbicides (e.g. glyphosate, glufosinate, etc.) can be used for chemical control. The treatment is most effective in the autumn or early spring when the rosettes are actively growing and the flowering stems are not formed yet.

References
**Morphological description**
Annual. Stems 10–50(70) cm tall, single, erect, in the lower part with opposite, arcuately ascending branches, with two layers of hairs: upper of scattered, long, patent hairs, and lower of denser, shorter, downward pointing hairs. Leaves opposite, 10 × 0.5–3.5 cm, lanceolate to broadly elliptic, usually widest in the middle part, narrowed at the base, acuminate at apex, crenate-serrate to serrate on the margin, on both sides with dense short hairs; petioles 7–15(25) mm long. Monoecious plant; flowers unisexual. Inflorescence umbellate, comprised of cyathia. Each cyathium is formed of several male and 1 female flowers, surrounded by a cylindriform involucrum; the female flower with a pedicel of about 3 mm, exceeding the male flowers; involucre 2.5–3.0 × 1.3–1.8 mm, glabrous, green, lobed, each lobe subsequently divided into 5–7 linear lobules; glands 0.9 × 1.3 mm, single, pale yellow. Fruit a capsule, 4.5–5.0 mm wide, broadly ovoid, glabrous. Seeds ovoid to triangular-ovoid, angulate, 2.4–3.0 mm in diameter, irregularly tuberculate on the surface, gray to almost black, with reniform-triangular appendage (caruncle).

**Biology and ecology**
Pollinated by insects; flowering from August to September; fruiting from September to October. Propagated by seeds. A single plant can form 1–100 seeds. The density of adult plants reaches 20–200 individuals/m². The species was described relatively recently – in 1984 and still very little is known about its biology and ecology.

The species grows in waste places, along railroads, embankments, dikes, on a sandy loam or rocky, dry soils. Although with a still limited distribution in Bulgaria, it is included in this
Included in the list of weeds or invasive species in some parts of the world (e.g., Brazil), and in the list of quarantine weeds in Russia and Ukraine.

The species competes with other native plant species for nutrients, light and space. No detailed studies on the species competition with native species in Bulgaria. A weed in crops, which leads to a significant decrease (up to 40%) of yields, e.g. in soybean fields.

**Origin and distribution**

Native to North America (USA, Canada, northern Mexico).

In Bulgaria it was recently established, in 2009, in the area of Razdelna railway station and the harbour complex west of Beloslav town, Varna district. Most likely it has been imported from Ukraine as contaminant in seeds of crops.

Distributed in the Black Sea Coast (Northern), up to about 10–20 m a.s.l.

In Europe, it was first reported in the North Caucasus in 1968, followed by reports from Ukraine (1995), France (1997), Hungary (2011). It is likely that all reported localities of *E. dentata* in Europe, in fact, should be referred to *E. davidii*. Introduced and naturalized in Australia and South America.
**Control**

There is no specific methods to control David’s spurge. Practices that are used to control other species of spurges can be applied. Most effective is the prevention, avoiding sowing of seeds of crops contaminated with seeds of David’s spurge, and transfer of soil substrate from already invaded places to other areas. On small areas, mostly ornamental gardens, mulching can be used to prevent the light to reach the seedlings; manual uprooting or low mowing prior to seed-formation are also effective. The species does not withstand competition with tufted grasses, so thickening the grass cover eliminates spurge.

For chemical control different herbicides can be used, e.g. glyphosate, 2,4-D, triclopyr, etc., applied to green plants, as well as to prevent the germination of seeds.

**References**

Morphological description
Annual. Stems 5–7, 20(30) cm long, branched from the middle part, procumbent, densely pubescent, gray-green to green, later purplish. Leaves opposite, (2)5–7(15) mm long, 1–2(4) mm wide, oblong-elliptic, asymmetric at base, with 0.5–1.0 mm long petioles, obtuse or subacute at apex, on the midrib usually with a long purple blotch. Stipules up to 1 mm long, triangular-subulate. Monoecious plant; flowers unisexual. Male flowers several, grouped with 1 female flower in an inflorescence called cyathium, covered with an involucre of the fused bracts of male flowers; cyathia in the axils of the leaves. Involucre campanulate, pubescent; glands 4, with 2–3-lobed purplish appendages. Fruit a capsule, 1.0–1.5 mm long, with closely appressed hairs. Seeds without an appendage (caruncle), finely reticulate on the surface, with 3–4 transverse furrows on each face, red-brown to brown-black.

Morphologically similar to E. chamaesyce, native to the Bulgarian flora, which has fruit capsules glabrous or covered with evenly spread patent hairs, as well as to E. prostrata, originating from North America, and having patent hairs only along the keels of the fruit capsule, while the walls are glabrous, smooth and shiny.

Biology and ecology
Pollinated by insects attracted by the nectar glands in the inflorescence. It blooms from June to October; fruiting from July to November. Propagated by seeds. A plant can form thousands of seeds, which after dehiscence of the capsules are spread by different animals (ants, birds). The seeds formed in the summer ger-
transition between the higher plants and the bare areas). It does not withstand competition with higher species, especially those forming clumps. Sometimes it forms mixed communities with the native *E. chamaesyce*, in which case *E. maculata* is presented with many more individuals and covers a larger area.

Spotted spurge competes with some native species, e.g. with *E. chamaesyce*, for nutrients, light and space. All parts of the plant contain a milky sap that is poisonous and can cause death of livestock if taken in large amounts in pastures together with the other herbaceous plants. It serves as an intermediate host of fungal diseases in crops.

**Origin and distribution**
Native to North America.

In Bulgaria it has been unintentionally introduced, probably with the import of contaminated seeds of cereals. Established for the first time in 1959 in the region of Varna and Struma Valley. Published as a new species for the Bulgarian flora in 1961.

Distributed in the Black Sea Coast, Northeast Bulgaria, Danubian Plain, Forebalkan, Balkan Range (Central), Sofia Region, Znepole Region, Valley of River Struma, Rhodopi Mts (Eastern), Thracian Lowland, Mt Strandzha, up to about 600 m a.s.l.
In Europe spotted spurge was first reported as an ornamental in the 17th century (before 1660) from a botanical garden in London. Many authors consider that this is probably the center from where it has spread to Central Europe through the tourist flows, rail and road traffic. Naturalized in Central and Southern Europe.

Control
Prevention is the best control. Mechanical control is done by digging or pulling young plants before flowering and seed formation. In lawns, fertilizing and watering leads to thickening of the grass cover and gradual elimination of the spotted spurge. Herbicides are used for chemical control to prevent the germination of seeds (most efficient is the treatment at the end of winter) or seedlings and young plants are treated before flowering. In all cases of control the locality should be monitored in the next few years, because of the availability of viable seeds in the soil.

References
**Morphological description**

Herbaceous perennial, with perennial underground, long and much branched rhizome. Stems annual, 1.5–3 m high, up to 2–3 cm in diameter, erect, smooth, hollow, with clearly visible nodes, in the upper part much branched; young stems and leaves reddish, later green to gray-green. Leaves somewhat coriaceous, in two rows along the stem, petiolate, 10–23(30) cm long, 9–20 cm wide, broadly ovate-triangular, with acuminate apex and subcordate base, the uppermost leaves with subcordate to ±truncate base. Functionally dioecious plants, i.e. functionally male and functionally female flowers on different plants, but on the plants with male flowers some hermaphrodite flowers can be formed. Inflorescences paniculate, in the axils of the upper leaves. Perianth of 5 segments, whitish, the outer three segments keeled, eventually winged; the wings deciduous on the articulated pedicel. Fruit a nut, 3 mm long.

Morphologically similar species are *F. japonica*, which has smaller size (1–2 m) and leaf blade 5–15(18) × 4–10(13) cm, truncate at the base, and *F. sachalinensis*, which has larger size (up to 4 m), larger leaf blades (40 × 28 cm), clearly cordate at base. Both species have not been recorded in the Bulgarian flora so far.

**Biology and ecology**

Pollinated by insects, mostly of the order Diptera (e.g. syrphid flies), beetles, butterflies; blooms from July to September; fruiting from August to October.

**Fallopia ×bohemica** (Chrtek & Chrtková) J.P. Bailey

Bohemian Knotweed

Syn. *Reynoutria ×bohemica* Chrtek & Chrtková

Polygonaceae – Knotweed family

Included in *List of “Worst invasive alien species threatening biodiversity in Europe”* (Annex 1. 2007) and in the list of the invasive species of the European and Mediterranean Plant Protection Organisation (EPPO 2012).
October. Mainly propagated vegetatively, by rhizome shoots, rarely by seeds (in Bulgaria probably only vegetatively). Seeds are spread by running water, wind (due to the winged fruits) and birds. The water in the rivers and canals detaches parts of the rhizomes and transports them to other places on its course. An important way of spreading is moving of soil substrate with living fragments of the rhizomes or disposal of rhizome fragments in the natural habitats together with the garden waste. The rhizomes penetrate up to 1 m in depth and can reach 15–20 m in length. Even small rhizome fragments can give rise to new plants. The species has allelopathic activity.

Bohemian knotweed prefers sunny habitats, but withstands some shade. It grows best on fertile, moist, loose soils, but adapts well to any type of soil. It has very good colonizing ability. In Bulgaria it occurs primarily in man-made habitats – urban environment (in spaces between the buildings, near parks), dumpsites, abandoned gardens, along roads and railways, but also in natural or semi-natural habitats, especially riparian and grassland.

Invasive species, one of the most problematic in the Bulgarian flora. Forming dense groups, thus overshadowing the other plant species. It competes with and eliminates the native plant species due to the extremely fast growth. In mass development it causes changes in the habitats and reduces the capacity of riverbeds to carry water. A large amount of biomass is produced during the vegetative season and in winter it is accumulated on the soil surface, thus altering the soil structure and composition. It is grown as an ornamental landscape plant, impressive due to its fast growth, purplish stems and leaves at the beginning of the growing season, and the high dense groups that it forms.

**Origin and distribution**

Originated from Europe, most likely resulting from spontaneous hybridization between *F. japonica* and *F. sachalinensis*. It was described from the Czech Republic in 1983. Distributed as an ornamental plant in many European countries and subsequently naturalized. The parent species are of East Asian origin.

In Bulgaria first reported as naturalized species in 2002 (as *Reynoutria japonica*), but it has been grown as an ornamental and landscaping plant in the country for more than 50 years.

Distributed in the Danubian Plain, Forebalkan (Western), Balkan Range (Western, Central), Sofia Region, Znepole Region, Vitosha Region, Rhodopi Mts (Central), up to about 1000 m a.s.l.
The parent species were introduced to Europe in the 19th century as ornamental plants – *F. japonica* in 1823 in the Netherlands, and *F. sachalinensis* in 1863 in the UK.

**Control**

It is extremely difficult to eliminate the species due to its vigorous rhizome. Frequent mowing, at least once a month, throughout the growing season results in exhausting of the rhizomes, but can not completely destroy the plants. Small groups can be eradicated with a backhoe, but all rhizome fragments must be collected very carefully. Chemical control involves treatments with glyphosate or 2,4-D amine, but it usually takes three to five years to complete elimination of the species and causes damages to the surrounding vegetation. Where possible, the best results are achieved by initial herbicide application and subsequent covering of the entire group with a thick, opaque fabric for at least 6–12 months; any emerging shoots afterwards must be uprooted mechanically.

It is necessary to increase the public awareness that Bohemian knotweed is one of the worst invasive alien species in Bulgaria and warn that discarding live fragments of the rhizomes and cuttings of the stems in natural habitats can lead to naturalization of the species. The use of the species as ornamental near canals, streams and rivers should be prohibited because of the danger of its large spread.

**References**

**Galinsoga parviflora** Cav.
**Gallant-soldier**
**Asteraceae – Daisy family**

**Morphological description**
Annual. Stems up to 80 cm high, erect, branched, glabrous below, pubescent above. Leaves 5–9 cm long, opposite, ovate, acute to acuminate at the apex, serrate on the margin; petioles shorter than the lamina. Capitula small, subglobose, in dichasial cymes. Peduncles with sparse ereto-patent eglandular hairs and a few short patent glandular hairs. Receptacle conical, with 3-fid scales. Involucral bracts several, in 1–2 lines, broadly ovate. Ligulate florets female, ligules shorter than involucral bracts, about as long as broad, white, with three teeth at the apex; tubular florets hermaphrodite, yellow. Fruits obovate-prismatic achenes, shortly hairy, with a pappus of scales.

**Biology and ecology**
Pollinated by insects; blooms from May to October, or until the cold weather destroys it; fruiting from June to November. It begins to bloom 3–4 weeks after germination. Propagated by seeds, which retain their viability for 2–3 years, and according to some authors even for more. An individual can form thousands of seeds that are spread by wind. People also play a very important role for its spread by transferring contaminated soil in gardens and nurseries. The seeds do not have a period of dormancy and can germinate 11–14 days after ripening. High temperatures stimulate plant growth. Seedlings are sensitive to low temperatures.

The species prefers deep, moist, rich soils. A common weed in some important crops, irrigated ornamental and vegetable gardens, disturbed habitats, uncultivated areas. Some of its traits, such as lack of period of dormancy, rapid growth, early flower-
ing, many generations per growing season, high seed production from an individual, capability of vegetative reproduction under favourable conditions determine the species as a tough weed with expressed invasive behaviour. Highly competitive, especially in low-growing, irrigated fields where it may threaten yield of crops. It spreads easily and rapidly and forms large populations, which makes it difficult to control.

**Origin and distribution**
Native to South America.

There is literature data that the species was recorded for the first time as naturalized species in Bulgaria either in 1943 near Karlovo or in 1934 in nurseries in Sofia.

Distributed in all floristic regions of the country, to about 1300 m a.s.l.

In Europe it was introduced in England as an ornamental in the Royal Botanic Garden Kew in 1796, and in 1860 it was recorded as an escape. Since then it has been spreading rapidly from nurseries and gardens, facilitated by human activities. Widespread, showing an expansion of its distribution area to new territories.

**Control**
Hand weeding, removing of the seedlings by digging while still small, because the plants begin to bloom very quickly, destruction of the fragment-
ed stems since they are capable of rooting and give rise to new plants. Repeated cultivation of the soil, rotation of the crops and use of herbicides are also effective.

References
**Galinsoga quadriradiata** Ruiz & Pav.

**Shaggy-soldier**

Syn. *G. ciliata* (Rafin.) S.F. Blake

*Asteraceae* – *Daisy family*

**Morphological description**

Annual. Stems 10–80 cm high, erect, branched, pubescent. Leaves up to 6 cm long and 4 cm wide, simple, opposite, ovate, widest near the base, acute to acuminate at apex, serrate on the margin, hairy on both surfaces, dark green; petioles shorter than blades. Involucre small, less than 1 cm long and wide, in dichasial cymes. Peduncles with numerous, long, patent glandular hairs. Receptacle conical, with entire scales. Involucral bracts several, in 1–2 rows. Ligu-late florets 4–5, female, white; tubular florets numerous, hermaphrodite, yellow. Fruit an achene, 1.5 cm long, hairy, obovate-prismatic, with a crown of aristate scales.

Morphologically similar to and often confused with *G. parviflora*, which has glabrous in the lower part stems, much fewer and shorter glandular hairs on the peduncles and 3-fid receptacular scales.

**Biology and ecology**

Insect pollinated or self-pollinated; blooming from June to late autumn; fruiting from July until the cold weather destroys the plants in late autumn or early winter. Propagated by seeds. A single plant can produce up to 300 capitula and more than 7500 achenes, which can germinate in moist soil immediately after ripening. Because of the lack of period of seed dormancy the species may have up to 2–3 generations per a growing season. Seeds retain their viability in the soil for several years. The achenes are dispersed by wind, animals, water, transportation of contaminated soil. They are covered with short, sticky hairs, thanks to which the achenes can attach to the fur of animals or clothes of...
humans. The species extracts the nitrogen from the soil.

Shaggy-soldier is adapted to a warmer climate (it is very sensitive to low temperatures), heavy, rich in nitrogen and clayey soils. It grows as a ruderal, weed in crops and gardens, along railways and roadsides, in dumpsites, on river banks. Especially common in irrigated areas where it can become a tough weed in row crops and vegetable fields. In arable fields it has high competitiveness, and may spread quickly and dominate over the other species.

**Origin and distribution**

Native to Central and South America – from Mexico to Chile.

In Bulgaria it was recorded for the first time as a weed in fields around Sofia (Gorublyane village) in 1950, presumably imported from abroad as a contaminant of seeds of cultivated plants.

Distributed in the Black Sea Coast (Northern), Danubian Plain, Forebalkan, Balkan Range (Western), Sofia Region, Znepole Region, Valley of River Struma, Valley of River Mesta, Rila Mts, Mt Sredna Gora, Rhodopi Mts (Western, Central), Thracian Lowland, up to about 1000 m a.s.l.

In Europe, its cultivation started in 1840 in botanical gardens. From there it escaped, like *G. parviflora*, and was
unintentionally spread to other parts of the continent by transport of contaminated soil, grain and other agricultural products, seeds and seedlings of ornamental species for nurseries and gardens, then it settled permanently, although not as rapidly as *G. parviflora*. It is widespread in Africa, Asia and other parts of the world.

**Control**
Most easily controlled before flowering in order to prevent seed formation. The use of herbicides is also effective for controlling its spread. As it occurs mainly as a weed in crops, the use of herbicides must be very careful. Early burial of seeds can be applied since they germinate best at 2–3 cm depth. Rotation of crops, e.g. rotation of tomatoes or other vegetables with cereals, also has a positive effect on reducing the spread of the species.

**References**
Morphological description
Deciduous tree, 15–20(45) m high, much branched in the upper part, forming extended crown. Trunks 0.5–1.0 m in diameter; the bark reddish-brown to black, furrowed, covered with long, branched thorns. Leaves 20–30 cm long, alternate, paripinnate and 2-pinnate; leaflets 10–14 pairs, 25–40 mm long, 7–12 mm wide, widest at the base, rounded at the apex, often with a short mucro, oblong-lanceolate to lanceolate-elliptic, remotely crenate-serrulate, green. Monoecious plant; flowers scarcely zygomorphic, small, unisexual, sub-sessile, usually in axillary racemes, yellow-green; male flowers in ±compact, 7–9 cm long racemes; female flowers in loose, few-flowered racemes or single. Fruits 15–40 cm long legumes, flat, falcate and twisted, brown, leathery, indehiscent to tardily dehiscent, falling down in the winter. Seeds 0.5–1.5 cm long, dark brown, glabrous, smooth, with a hard coat.

Biology and ecology
Pollinated by insects, the flowers are attractive to bees although it is not a significant melliferous plant. It blooms from June to July; fruiting from August to September. It starts fruiting after the third year, the optimum seed production is at the age of 25–70 years, fruiting regularly and in abundance. Ripe legumes fall down since mid-September until late November, but some remain on the tree during the winter. Propagated by seeds, which have high germination rate, retained for a long time, thanks to the hard seed coat. Seeds are spread by birds, mammals, which feed on them; the animal’s digestive system assists in breaking down the hard seed coat, making germination easier. Young seedlings grow rapidly, making it a preferred species for planting in parks, along roads, which in turn is a prerequisite
for its mass dispersal in many places. It forms many shoots near the base of the trunks.

The species grows better than many other trees on poor in nitrogen soils, although unlike most species of *Leguminosae* it is not capable of nitrogen-fixation because it does not form root nodes with symbiotic bacteria. It tolerates dry and saline soils and can grow on poor, gravelly or heavy clay soils, but prefers rich soils in the river valleys. The leaves contain alkaloids – triacanthin and stenocarpin and are therefore very toxic. Fruits are rich in protein and are eaten by animals (birds, mammals). The wood is hard, strong, durable, reddish-brown with attractive appearance. The species tolerates strong winds, strengthens and protects the soil from erosion.

**Origin and distribution**

Native to central and eastern North America.

In Bulgaria honey locust is one of the first deciduous trees introduced for cultivation (along with *Robinia pseudoacacia* and *Ailanthus altissima*) in various places – forests, parks, public and private gardens, boulevards and streets. The naturalization of the species is reported relatively late, and in most cases without reference to specific localities (like for many other exotic tree species).

Distributed in the Black Sea Coast, Northeast Bulgaria, Danubian Plain, Sofia Region, Thracian Lowland, up to about 1000 m a.s.l. It has potential and shows aggressive traits for occupying new territories. Certainly it occurs in more floristic regions.

The species was introduced in Europe in about 1700, and is now naturalized in many West-, Central- and South-European countries.
Control
Seedlings and suckers can be uprooted. Old trees can be destroyed by girdling – cutting away a 15–20 cm broad ring of the bark and cambium tissue in the basal part of the trunk. Cutting of old trees stimulates suckering, so mechanical control must be combined with herbicide treatment. Efficient herbicide is glyphosate, which can be sprayed on the leaves on young trees, shoots and seedlings or can be applied on the fresh transverse cuts of the trunks. Drilling of small holes in the trunks near their base and filling them with glyphosate gives good results too.

References
**Grindelia squarrosa** (Pursh) Dunal
Curly-cup Gumweed, Broad-leaved Gumweed

*Asteraceae – Daisy family*

- Included in *List of “Worst invasive alien species threatening biodiversity in Europe”* (Annex 1. 2007).

**Morphological description**
Annual, biennial or short-lived herbaceous perennial. Stem erect, (10)20–100 cm high, glabrous, usually branched in the upper part. Leaves ovate-oblong, lanceolate to spatulate, alternate, (1)3–7 cm long, the lowermost petiolate, the upper amplexicaul, serrate-crenate to entire, glabrous, strongly resinous-punctate. Capitula several to numerous, 2–3 cm wide, terminating the branches, forming corymbiform arrays. Involucre hemispheric to subglobose. Involucral bracts in 5–6 rows, linear or linear-lanceolate, 3–8 mm long, 0.5–1 mm wide, with a cylindrical, squarrose-reflexed apex, very viscid. Outer florets (12)24–36(40), 7–15 mm long, ligulate, female, yellow, rarely absent; inner florets tubular, hermaphrodite, yellow. Achenes oblong, 2–3(4.5) mm long, glabrous, brown to stramineous or whitish, apically with 2–3(8) awns.

**Biology and ecology**
Pollinated by insects. It blooms from July to October, fruiting from August to October. Seed propagated; an individual can form up to 76 000 achenes. The achenes of the tubular and ligulate florets differ morphologically and by their germination ability – those of the tubular florets germinate earlier.

The species prefers dry, warm, sunny places. It grows mainly on sandy and rocky, well drained soils. A pioneer species which distribution is tolerated by maintaining disturbance of the habitats.
Occurs near railways and roads, invading also dry grasslands in the immediate vicinity.

Potentially invasive species, under observation. It competes with some native species for nutrients, light and space. In some parts of the world it occurs as a weed in arable land. In North America it is used by indigenous people in folk medicine. In some countries (e.g. Poland) the species is cultivated.

**Origin and distribution**
Native to North America.Introduced and naturalized in some parts of Europe and Asia. In the Balkan Peninsula, except in Bulgaria, the species has been recorded in Romania. In Ukraine and Moldova it is considered an invasive species.

Unintentionally introduced in Bulgaria, probably by importing contaminated grain. It was recorded for the
first time as naturalized species in 2009 near a railway line in Varna district.

Distributed in the Black Sea Coast (Northern), Northeast Bulgaria, Sofia Region, up to about 550 m a.s.l.

In Europe, the species was first introduced as a cultivated plant in 1804 in the Royal Gardens in Madrid, Spain. However, the first reports of escaped and naturalised plants are from the mid-20th century (in Ukraine since 1949).

**Control**

Small occurrences can be destroyed by manually uprooting the plants. Mowing is not effective because the underground parts do not die but form pseudo-rosettes on top of the remaining stem, which later extend, bloom and give fruits. Where possible, turfing of soil with tufted grasses and implementing practices to thicken the grass cover leads to a gradual elimination of the species. For chemical control different herbicides can be used, e.g. glyphosate, 2,4-D ester, dicamba, etc. In all cases, monitoring of the treated site is required in the next 2–3 years for destruction of any emerging plant.

**References**


**Helianthus tuberosus** L.
Jerusalem Artichoke, Topinambour

Сем. *Asteraceae* – Сложноцветни

- Included in *List of “Worst invasive alien species threatening biodiversity in Europe”* (Annex 1. 2007) and in the list of the invasive species of the European and Mediterranean Plant Protection Organisation (EPPO 2012).

**Morphological description**
Herbaceous perennial, with tuberous rhizomes. Stems erect, 1–3 m high, scabro-hispid to hirsute, rarely almost glabrous, usually branched in the upper part. Leaves simple, the lower opposite, the upper usually alternate, 10–25 × 7–15 cm, ovate, acuminate, on the margin serrate, scabrous above, whitish puberulent to hirsutulous beneath, narrowed to a winged petiole. Capitula 4–8 cm in diameter, few to numerous, erect. Involucral bracts imbricate, at least as long as the diameter of the disc, ±patent, lanceolate, acuminate, ciliate, dark green. Receptacle convex, with scales, partly enclosing the achenes. Outer florets ligulate, sterile; ligule 30–40 mm long, yellow. Inner florets tubular, shortly 5-lobed, hermaphrodite, yellow. Achenes 5–6 mm long, slightly flattened and angled, glabrous or pubescent.

**Biology and ecology**
Pollinated by insects; flowering from August to October; fruiting from October to November. Propagated mainly vegetatively – by tubers, rarely by seeds (seed propagation occurs more widely in the native range of the species). Stems can also root when covered with soil substrate and give rise to new plants. Young plants growing from tubers initially grow faster and begin to form roots earlier than plants grown from seeds. The seeds need a period of dormancy, and the low temperatures stimulate their germination. Underground stolons are located at 5–20 cm depth in the soil and can reach 1 m in length. The for-
mation of tubers starts in the summer, but they grow more actively during the autumn. A plant can form up to 75 tubers, but under unfavourable conditions it does not form or forms only single tubers. Due to the late flowering of the species in Bulgaria, formation of mature seeds has not been observed, but seed propagation can not be completely excluded. The species falls in natural and semi-natural habitats by throwing out tubers or viable tuber fragments from cultivated plants together with the garden waste. It is also dispersed through shifting of land masses in repair and construction activities, as well as by animals feeding on the tubers (mostly mammals). In rivers and canals the flowing water can facilitate the spread of the tubers. The species has allelopathic activity.

It prefers sunny places, and grows best on fertile, loose, moderately moist soils. It withstands considerable drought, compaction and salinization of soil, light shade. Found in man-made habitats – urban environment (between buildings, in parks and abandoned yards), along roads and railways, abandoned farmland, forest margins, riverside terraces and river banks, ditches, dikes. Periodical disturbance of the soil substrate and vegetation cover tolerates the species and supports its local distribution.

The plants reach very large size and form groups of various size and thickness – from single scattered plants to several hundred or over a thousand individuals in dense mono-dominant groups, almost without accompanying plants. Therefore, it overshadows native species and competes with them for nutrients, water and light. Especially dangerous by rivers and canals where, due to the favourable conditions, it forms groups covering several tens to several hundred square meters. In Bulgaria it is grown in private gardens as an ornamental and food plant, and in some countries it is cultivated as a forage crop.

**Origin and distribution**

Native to North America.
In Bulgaria the species was intentionally introduced as edible and ornamental plant as early as in 18th century. It was reported as a garden escape and established plant in 2003, but the species started naturalizing in the country much earlier.

Distributed in the Northeast Bulgaria, Danubian Plain, Forebalkan (Eastern), Sofia Region, Valley of River Mesta, Rhodopi Mts (Central, Eastern), Thracean Lowland, Tundzha Hilly Country, up to about 1000 m a.s.l.

Introduced in Europe in the early 17th century (1603–1607) in France. The first reports about the naturalization of the species are from the middle of the 19th century. Naturalized in Australia, Asia and South America

Control
It is necessary to raise public awareness about the invasive nature of the species in order to prevent the throwing out of viable tubers and parts of them in suitable habitats, especially riparian.

Small groups can be eradicated by hand or machine, but all tubers and tuber fragments must be carefully gathered. Large groups are difficult to destroy. The application of herbicides (glyphosate, dicamba, 2,4-D) is most effective before flowering, but because of the long and tuberous rhizomes and the accumulation of a significant amount of nutrient reserves it requires long treatment. Discontinuation of habitat disturbance, followed by thickening of the shrub and tree vegetation, inhibits the development of the species and can lead to its gradual elimination.

References
**Impatiens glandulifera** Royle

**Indian Balsam**

**Balsaminaceae – Balsam family**

- Included in *List of “Worst invasive alien species threatening biodiversity in Europe”* (Annex 1, 2007) and in the list of the invasive species of the European and Mediterranean Plant Protection Organisation (EPPO 2012).

**Morphological description**

Annual, with long roots and additional (adventive) roots that are formed at the nodes of the stems. Stems 1–2 m tall, erect, hollow, glabrous, simple or sometimes branched. Leaves opposite or in whorls of 3, 5–18 × 2.5–7.0 cm, 4–5 times longer than wide, lanceolate to elliptic, cuneate and glandular at base, acute at apex, serrate, petiolate. Flowers 2.5–4.0 cm long, with much shorter pedicels, hermaphrodite, zygomorphic, in axillary racemes of (3)5–12 flowers, violet-pink, rarely white. Sepals 5, the lowest longer than wide, saccate, abruptly narrowed into a straight spur; the lateral small, ca. 10 mm long and 7 mm wide, triangular, usually green. Petals 5, the upper is longer, the lower 4 fused in two lateral pairs, with the exception of their apical parts. Fruit a loculicidal capsule, 15–35 × 4–15 mm, glabrous, with 5 valves, slightly 5-angled, which after ripening disperses the seeds by explosive dehiscence.

**Biology and ecology**

Pollinated by insects, most often bees; blooms from June to August, but in shaded areas can continue until September–October; fruiting from August to October. The duration of a blossoming flower is 2–3 days. Propagated by seeds, which are produced in large quantities – one plant can form 700 to 800 seeds that retain their viability for 18 months or more. They have high germination rate and it takes 8–12 days for a seed to germinate, which can happen in water too. Explosive expulsion of seeds from the seed capsule provides dispersal at a distance of several meters (ballochory), which is reflected in its generic.
name and is a typical mechanism of seed dehiscence for the whole family *Balsaminaceae*. Seeds are further dispersed by water currents. Human activities such as processing and cleaning of areas where the species occurs have important role in the species distribution. Plants damaged early in the growing season, can recover and produce seeds in the late autumn. It occurs in a variety of soil conditions, but prefers soils with high humidity, along rivers, around dumpsites and in disturbed habitats. Lack of resistance to very low temperatures (seeds die at −10°C) is a limiting factor for its distribution outside its native range. It dies with the onset of the first frosts. Used as a garden ornamental and one of the melliferous plants in the late growing season.

**Origin and distribution**

Native to Southeast Asia (Western Himalaya, India), where it grows at 1800–4000 m a.s.l., but reaches also up to 4300 m.

In Bulgaria the species was first recorded in 1978.

Distributed in the Forebalkan, Balkan Range (Central), Sofia Region, Vitosha Region, Znepole Region, Valley of River Struma, Valley of River Mesta, Rila Mts, Mt Sredna Gora, Rhodopi Mts, Thracian Lowland, up to about 1500 m a.s.l.
Introduced in Europe for the first time in the Royal Botanical Gardens, Kew (Great Britain) during the first half of the 19th century (in 1839) as an ornamental and melliferous plant. It was recorded as a garden escape as early as in 1848 when it started to invade natural habitats. Later (after 1897) it spread to other parts of Europe. It took a long period of time until the species was declared an invasive plant. During the last 30–40 years the taxon has spread very quickly and is now considered an invasive species in most European countries. It escapes from private and public gardens, where it is grown as an ornamental. In Great Britain it is regarded as one of the “top 20” of the most invasive alien species, especially in moist natural habitats.

Control
Cultivation of the species as an ornamental plant should be done with a great care in order to prevent disposal of viable seeds together with the garden waste in natural habitats, especially in humid areas. Single plants can be destroyed by manual uprooting before flowering. For larger groups mowing to the ground is recommended before flowering. The use of herbicides affects only the young plants, but the treatment is not effective when the plants start to blossom and produce fruits.

References
**Morphological description**

Annual. Stems 10–100 cm tall, erect, simple or branched in the upper part, glabrous, in the lower part usually with few leaves, in the upper part leafy, pale yellow. Leaves 4–20 × 2–9 cm, alternate or only the lowermost two opposite, ovate, elliptic to broadly elliptic, cuneate at base, acute at apex, serrate on the margin, at the base with glands; the uppermost leaves usually the longest, with 20 teeth on each side. Flowers hermaphrodite, zygomorphic, no longer than 1.8 cm together with the spur, in axillary racemes of 3–10 flowers. Sepals 3, the lateral two ca. 3 mm long, green, the lower one saccate, wider than long, gradually narrowed to 1–7 mm long, straight or slightly curved pale yellow spur. Petals 5, the uppermost is the longest (10 mm), the lower 4 fused in two lateral pairs, with the exception of their apical parts, pale yellow. Fruit a loculicidal capsule, with 5 valves, (1)2–3(5)-seeded; seeds 3–5 mm long, brown, longitudinally finely striate.

**Biology and ecology**

Pollinated by insects, but the individuals are self-compatible and can be self-pollinated; they form open or closed flowers and the following pollinating phenomena may occur: chasmogamy and cleistogamy (pollination within the same flower in open and closed flowers respectively), geitonogamy (pollination between different flowers of the same individual) and xenogamy (pollination of flowers of different individuals). It blooms from May to September; fruiting from June to October – flowering and ripening of fruits co-occur for several months. The duration of a blossoming flower is 1–2 days, measured from the opening of the flower to the falling down of the corolla. Propagated by seeds. Although seed capsules

**Impatiens parviflora** DC.
Small Balsam
Balsaminaceae – Balsam family
contain few seeds each, in good conditions and development an individual can produce thousands of seeds that are distributed by antropochory and ballochory (explosive dehiscence of seeds after ripening of the seed capsule). Thanks to the latter mechanism seeds are disposed 3–4 m away from the parent plant. The species tolerates different types of soil, with acidic to alkaline reaction, in sunny to moderately moist wooded areas. Its most preferred habitats are on the river banks.

**Origin and distribution**

Native of Central Asia (Altay Mts, Western Siberia, Mongolia, Tian Shan, Himalayas), where it grows at 2100–3000 m a.s.l.

In Bulgaria the species was first discovered in 1984 near the resort of Borovets (Rila Mts), suggesting a most likely introduction by the tourist flow or from the flower gardens nearby, where it was probably grown as an ornamental.

Distributed in the Sofia Region and Rila Mts, up to about 1400 m a.s.l., but it has the potential for a wider distribution in the country, given its rapid and wide spread in many countries in Europe.

In Europe, it was introduced and spread in almost all countries, probably as a result of horticultural trade. Another possibility is that it escaped
from botanical gardens where it had been grown. The first reports of its discovery as a garden escape in Europe were from 1830-ties, then it quickly spread to Belgium, Germany, Switzerland and other Central European countries. Outside Europe, it is recorded as alien species from Canada and USA.

**Control**
Individual plants and small groups can be uprooted manually before flowering. Low mowing to the ground level can be applied in larger groups before flowering. Herbicides can be used, to damage young plants or to prevent seed germination. However, caution is necessary to avoid affecting the accompanying native plants.

**References**
**Iva xanthiifolia** Nutt.
Marsh-elder

Syn. *Cyclachaena xanthiifolia* (Nutt.) Fresen.

*Asteraceae* – Daisy family

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**Morphological description**
Annuals, with much branched tap-roots. Stems to 250 cm tall, erect, branched, glabrous or sparsely hairy. Leaves more or less opposite, 7–30 cm long, broadly obovate-subcordate to rhombic, sometimes 3- or 5-lobed, serrate on the margin, with petioles as long as lamina or slightly shorter, with 3 main veins, scabrid above, hairy beneath. Capitula numerous, 2–4 mm in diameter, greenish-white, sessile or shortly pedunculate, in axillary and terminal, leafless spikes or panicles. Involucre hairy. Florets unisexual; the functionally male florets 8–20, located in the middle of the capitula; female florets 5, outermost. Achenes about 3 mm long, dark brown to almost black, without pappus.

**Biology and ecology**
Pollinated by wind; blooms from July to September; fruiting from August to October. Propagated by seeds, spread mainly by birds. One plant can form about 35 000–50 000 (105 000) seeds that retain their germination ability in the soil for 5–8 years. Optimal conditions for germination are at a soil depth of 1–3 cm. Human activities play an important role in the dispersal of the species, through the transportation of crop seeds contaminated with seeds of *Iva xanthiifolia*, transportation of soil and manure containing seeds from the species, in construction and repair works, and by fertilization of the land with contaminated organic matter. For the conditions of Bulgaria seedlings start to emerge at the end of March, but most actively during April and May. In the localities in the country up to 240–
270 individuals per 1 m² have been observed. The species has allelopathic activity.

The species grows in abandoned farmland, dumpsites, along railways and roads, in private gardens, as a weed in potato and maize fields, near buildings, on river banks and dikes. Because of its large size and large number of individuals in the occurrences, it competes with the native species for nutrients, light and space. Under the conditions of Bulgaria it depends on maintaining a regime of disturbance of the habitats. A weed in some crops. Pollen and touching the plant can cause allergies. In our country it is not a major threat to biodiversity, but endangers human health.

**Origin and distribution**

Native to North America.

Unintentionally introduced in Bulgaria. It was first established in Sofia Region in 1987 (referred to as “near Sofia”). In 1996 it was established in Kostinbrod town. Our observations show that the area of occupancy of the species in the town has been increasing. In 1997 there were only two localities, whereas in 2006 – more than 15, including the banks of the river Blato.

Distributed in Sofia Region, at about 500–600 m a.s.l.
Introduced in Europe from North America in the mid-19th century, first grown in botanical gardens. The earliest reports of escaped plants were from 1842 near Kiev University botanical garden. Naturalized or casual in several countries of Central and Southern Europe, Asia, Australia. On the Balkan Peninsula except in Bulgaria, the species has been registered in Croatia, Romania, Serbia and Slovenia.

Control
For prevention strict control is required on the imported crop seeds and other agricultural products, as well as on the transportation of soil and sand from the invaded areas in Bulgaria. Small populations should be timely (immediately after their discovery) eradicated, obligatory before flowering and fruiting, i.e. until the mid- to late July (plants should not be touched with bare hands as they may cause allergic reactions!). Mowing before flowering is also efficient, because the plants do not form or scarcely form any shoots. Then, for 2–3 years localities should be monitored because of the presence of seeds in the soil (seed bank) and any emerging new plants should be up-rooted before flowering and fruiting. For chemical control most commonly used are glyphosate and 2,4-D. Where possible control of the species can be achieved by seeding more competitive species, e.g. *Lolium perenne*, *Dactylis glomerata*, *Medicago sativa*. Raising public awareness of the threat to human health would provide support from the public for eradication of the species.

References
Morphological description
Densely caespitose perennial, with slender rhizome. Stems 10–30 cm tall, slender, cylindrical, erect or ascending, unbranched, green. Leaves basal, numerous, 7–30 cm long, 1.0–1.3 mm wide, linear, flat to slightly convolute, glabrous, green when young, becoming brown later, with membranous in the upper part sheets and a pair of membranous, lanceolate auricles. Inflorescences cymose, branched, terminal, at the base with 3 thin bracts, one of them equal to, the other leaf-like, several times longer than the inflorescence. The flowers terminating the branches, at the base with 2 triangular-ovate to lanceolate, membranous, light brown bracts; perianth of 6 segments, in 2 whorls, 3.0–4.5 mm long, lanceolate, long acute at the apex, light green when young, sometimes with a reddish tip, later pale brown, the outer 3 patent in fruit. Fruit a capsule, reddish brown, broadly ovoid, glossy, 2/3 of the length of the perianth or slightly shorter. Seeds oblong, 0.3–0.4 mm long, slightly tapered at both ends, light brown.

Biology and ecology
Pollinated by wind; blooms from June to September; fruiting from July to October. Propagated vegetatively by fragmentation of the rhizomes, by vegetative buds at the base of the stems and by seeds, which are produced in abundance, retaining their viability in the soil for about 20 years. Seeds are spread by wind, in wet conditions they become sticky and stick to shoes, tires of vehicles, birds, which also facilitate their dis-
persal. Thus invasion of new, mostly disturbed habitats is achieved.

The species inhabits a variety of habitats, both semi-natural and man-made ones, disturbed sites, moist low-mountain and mountain meadows. It grows mostly in moist to moderately moist, sandy, rocky or clayey and heavy soils, sunny and shady areas. It withstands drought. Although it invades natural plant communities, it is not considered a dangerous invasive species.

**Origin and distribution**
Native to North and South America.

In Bulgaria the species was first discovered in 1911 in Sofia.

Distributed in the Forebalkan, Sofia Region, Znelpe Region, Vitosha Region, West Frontier Mts, Mt Belasitsa, Valley of River Mesta, Pirin Mts, Rila Mts, Mt Sredna Gora (Western), Rhodopi Mts (Western), Thracian Lowland, Tundzha Hilly Country, Strandzha, up to about 1900 m a.s.l. A wider distribution of the species in the country can be presupposed due to under-recording because of its relatively small size.

In Europe, it was first registered in Belgium (1824–1825), the Netherlands, and has been known on the British Isles since 1795. It is assumed that it has been imported to Europe together with hay from America. A common and widespread alien plant in many European countries.

**Control**
Control is mainly achieved by proper management of pastures and drainage. Cutting before flowering is essential to limit the spread. Grazing by large herds in the pastures is also an effective way of limitation.

**References**
**Koelreuteria paniculata** Laxm.
**Pride-of-India**

**Sapindaceae – Soapberry family**

**Morphological description**
Deciduous tree, up to 10 m tall, with a rounded to ovoid crown. Trunks with gray-brown bark, of the older trees – furrowed. Leaves without stipules, alternate, imparipinnate, with 9–13 leaflets; leaflets ovate, dentate or lobed, sessile or shortly petiolulate, hairy, reddish-yellow in spring, bluish-green in summer, yellow and orange in autumn. Inflorescences paniculate, to 40 cm long, terminating the ultimate branches, often drooping. Flowers hermaphrodite, irregular, sepals 4, petals 4(5), pale yellow, stamens 8. Fruit an inflated, oblong-ovate and acute seedpod, strongly 3-lobed, with 1 seed in each lobe, green when young, becoming yellowish to light brown at maturity. Seeds more or less spherical, black, smooth. They are spread by wind, birds, water, and by cleaning and disposal of the leaves and seedpods falling off under the trees in the autumn.

The species grows rapidly in sunny, open places, in sparse low-growing scrubland and forests, on well-developed soils, but also in poor, calcareous, rocky places. It withstands drought, air pollution, wind, making it a preferred tree for cultivation in villages and towns, parks, shopping centers, near roads. It is sensitive to low temperatures.

A very adaptive species, competing with native plants for water, nutrients and light, and thereby changing the composition and structure of the communities, especially in areas with long, hot summers and short, mild

**Biology and ecology**
Pollinated by insects, mainly by bees; blooms from June to July; fruiting from August to October. Propagated by seeds, which have a high germination rate and retain their viability for a long time. Seeds germinate quickly – for a period of 6–8 days.
winters. It is grown as an ornamental tree in parks and lanes, mainly in the warmer parts of the country. In the climatic conditions of North Bulgaria and Sofia it is sensitive to low temperatures, causing almost every year damages to the young shoots, and sometimes to whole branches. Melliferous plant. In some countries it is used for extraction of yellow dye from the flowers and black dye from the leaves.

**Origin and distribution**
Native to Southeast Asia (Northern China, Japan, Korea).

In Bulgaria the species was introduced in the early 20th century as an ornamental park and lane tree, re-
taining its outstanding appearance throughout the whole growing season. In the Bulgarian botanical literature it was first reported as an escape in 2006, but naturalisation in the country started much earlier.

Distributed in the Black Sea Coast, Danubian Plain, Northeast Bulgaria, Forebalkan, Thracian Lowland, Rhodopi Mts, up to about 1000 m a.s.l. Probably it is naturalized in many other parts of the country, but no herbarium material or literature records for exact locations are available. There is potential for more extensive dispersal in relation to recent climate change (warming and drying, lack of long cold periods and long-lasting snow cover) during the past several years.

In Europe it was introduced from North China in 1747 by a priest, but there is evidence that this happened earlier, in 1560, in England. Naturalized in many parts of Europe, especially in the southern countries.

Control
For prevention of wider spread of the species in the country, its use as an ornamental outside controlled environment should be avoided. Disposal in natural habitats of waste from the parks and lanes, containing viable seeds of the species should be prevented. Individual young trees or small groups can be uprooted manually or by machinery. For chemical control glyphosate can be sprayed on smaller trees, shoots and seedlings or applied on fresh transversal cuts of the trunks near the ground level. Chemical control should be done with caution in order to avoid damaging of accompanying species.

References
Morphological description
Deciduous small tree or large shrub, with a wide crown. Trunks to 9 m tall, with dark gray, smooth bark. Leaves trifoliolate, with 1–5 cm long petiole, appressed-pubescent; leaflets 3–8 cm long, 1.0–2.5 cm wide, elliptic to obovate, cuneate at base, obtuse at apex and usually shortly mucronate, entire, on short petiolules, green and glabrous above, gray and densely appressed-pubescent beneath. Flowers hermaphrodite, zygomorphic, with 5–15 mm long pedicels, in many-flowered, lax, 10–25 cm long, pendulous racemes. Bracts 3-4 mm long, linear, appressed-pubescent, attached to the uppermost part of the pedicels. Calyx 5–6 mm long, campanulate, pubescent, to 1/3 of its length bilabiate, with teeth shorter than calyx-tube. Corolla of 5 petals – a standard, keel of 2 petals, and 2 wings, golden yellow. Fruit a legume, 5–6 cm long, 7–8 mm wide, appressed-pubescent, 3–7-seeded, flat. Seeds lenticular, smooth, with a thick coat, brown.

Biology and ecology
Pollinated by insects, mainly bees, for which it is very attractive with the golden yellow fragrant flowers. It blooms from May to June; fruiting from June to August. Propagated by seeds, which have a thick seed-coat and germinate slowly. Legumes open in the autumn, most remain long on the tree and some of the seeds remain in the fruit until the next spring. Fast-growing species.

It grows almost everywhere, best on well developed, rich in organic matter soil, but also grows on poor, moderately moist, well drained soil. It prefers sunny places, but withstands significant shading and occurs as undergrowth in coniferous and sparse

Laburnum anagyroides Medik.
Laburnum
Syn. L. vulgare J. Presl
Fabaceae – Pea family

Laburnum

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deciduous forests. It is capable of atmospheric nitrogen fixation.

Planted as an ornamental plant in many parts of the country, where it often escapes to natural and semi-natural habitats. It grows in groups of varying size – from a few dozen to several hundred individuals. In some localities up to 40–45 seedlings and annual plants per 1 m² have been registered.

All parts of the plant are poisonous – the roots, bark, wood, flowers and seeds contain the alkaloid cytisine that is similar to nicotine and affects the respiratory center in the medulla oblongata, which makes breathing faster and deeper. Increases blood pressure.

The species competes with native plants for nutrients, light and space. It forms a dense canopy. In the undergrowth of forests it leads to further thickening of the canopy and reduction of the grass cover. During the blooming period it attracts bees and competes with the native plants for pollinators.

The wood is valuable and is used by carpenters for making dichroic objects since the heartwood is very dark (in the past known as artificial ebony) and sapwood is light and smooth. Suitable for hedges, bonsai and ornamental in parks and gardens.

**Origin and distribution**
Native to the mountains of Central Europe. It is cultivated in many countries.

In Bulgaria it is one of the most commonly cultivated ornamental species in parks and gardens throughout the country. In many places it escaped and naturalized, the first report for
which is from 1928. It invades both natural and disturbed habitats.

Distributed as naturalized species in the Northeast Bulgaria, Balkan Range (Western), Sofia Region, Znepole Region, Tundzha Hilly Country, up to about 800–900 m a.s.l. Probably widespread in more floristic regions, but no literature data and herbarium material from exact localities are available.

**Control**

There are no specific methods to control this particular species. To prevent its further distribution in the country it is necessary to discontinue its use as an ornamental plant and for soil stabilisation outside the settlements. Small groups can be destroyed by uprooting when the plants are young, or by cutting and treatment of the fresh cuts with glyphosate. For older trees drilling holes at the base of the trunk (at a height of 30–50 cm from the substrate) and filling them with glyphosate is efficient.

**References**

**Morphological description**
Deciduous shrub, to 2.5 m tall, much branched. Branches slender, arcuate, gray-whitish to yellowish-brown, with few alternate, 6–15 mm long, smooth spines. Leaves simple, entire, 2–10 × 0.6–3.0 cm, narrowly elliptic to narrowly lanceolate, more or less fleshy, green, obtuse to acute at apex, cuneate at base, glabrous, petiolate. Flowers hermaphrodite, actinomorphic, on 5–15(20) mm long, slightly inflated in the upper part pedicels, single or 2–6 on the short and 1–2 on the long branches. Calyx 4–5 mm long, campanulate, bilabiate, with 3–4 teeth, rarely almost actinomorphic, with 5 equal teeth. Corolla infundibuliform, to 10 mm long, purple, becoming brown at the end of flowering. Fruit a berry, 8–18 × 5–10 mm, elliptic to ovate, red or orange-red. Seeds 2.5–3.0 × 2.2–2.5 mm, rounded to reniform, gray-brown or yellowish.

**Biology and ecology**
Pollinated by insects, mainly bees; blooms from June to October; fruiting from July to October. Propagated by seeds and vegetatively (by root suckers). When ripe, the fruits are sweet and juicy, glossy. Flowers are continuously formed until the first frosts. There is no data for Bulgaria, but in other parts of the world the fruits are eaten by some birds and mammals which facilitate the spread of the species. It is not demanding to the soil conditions and grows in dry, calcareous sites, and withstands very poor soils (originates from the harsh slopes of the Himalayas). It grows in grasslands, along roads and railroads, landslides, near settlements. It withstands drought and shade, although it produces more abundantly fruits in sunny places. Young plants become quite cold-resistant after their first year of growing.
The species forms dense thickets, often occupying tens of square meters, thus competing with the native plant species for space, nutrients, water and light. It changes the composition and structure of the plant communities. Cutting of the stems stimulates vigorous formation of new suckers and leads to further thickening of the groups.

It is widely cultivated as an ornamental shrub, for making hedges, and also for stabilization of the soil and landslides. Used as a medical plant for improving eyesight, lowering blood pressure and cholesterol, and for treatment of diabetes and tuberculosis. Fruits are rich in vitamin C. In some countries (e.g. in Chinese traditional medicine) the fruits are used as a tonic and invigorating agent, stimulating the immune system. These effects of the fruits are widely popularised in Bulgaria during the past few years and the species is strongly recommended by some private companies for cultivation (under the name ‘Goji Berry’).

**Origin and distribution**
Native to China.

In Bulgaria it was imported as an ornamental shrub, grown in parks and gardens for hedges. It was first registered as a garden escape in natural environment in 1900 and since then it has spread in many parts of the country.
Distributed in the Black Sea Coast, Northeast Bulgaria, Danubian Plain, Forebalkan, Balkan Range, Sofia Region, Mt Belasitsa, Mt Sredna Gora, Rhodopi Mts (Eastern), Thracian Lowland, Tundzha Hilly Country, up to about 800 m a.s.l.

In Europe it has been introduced as an ornamental plant and for strengthening landslides. The first report of escaped plants was from Belgium in 1857. Now it is widely naturalized, especially in coastal dunes, mainly in southern Europe.

Control
In small fields uprooting or burning of the bushes give positive results. For larger groups cutting of the stems to the ground and subsequent treatment of the fresh cuts with amine-2,4-D or triclopyr prevents the formation of new shoots. Spraying of herbicides containing glyphosate, picloram or a mixture of picloram and triclopyr on the foliage also leads to the destruction of the thickets. A follow-up monitoring is needed in order to eradicate any emerging seedlings.

Preventive measures include raising of public awareness of the potential damages from a wide distribution of the species in natural and semi-natural habitats and discontinuation of the use of the plant for decoration outside the settlements. It is strongly recommended to stop the use of the species for strengthening the soil along roads and railways.

References
Andreev 1989; Kovachev 1900; Petrova 2006; Petrova & al. 2007b, 2012a; Potterat 2010; Stearn 1972.
Morphological description
Annual. Stems (2)8–45 cm tall, erect or ascending, more or less fleshy, branched; branches glabrous, sometimes sparsely pubescent below the capitula. Leaves 2–6 × 1–2 cm, alternate, numerous and relatively crowded, glabrous, 2–3-pinnatisect; segments numerous, flattened, acute and aristate at apex. Peduncles 2–3 cm long. Capitula 5–40(300), 5–9(12) mm in diameter, enlarging with ripening of the achenes; involucral bracts with colourless membranous margin. Florets all tubular, 4-lobed, yellow-greenish. Fruit an achene, pale brown, with 3–4 ribs on the ventral face and a short membranous rim at the apex.

Morphologically similar is Chamomilla recutita (Matricara chamomilla), which differs by the presence of ligulate florets and 5-lobed tubular florets.

Biology and ecology
Pollinated by insects; blooming and fruiting from early spring to late autumn. Propagated only by seeds that are spread by water and together with the soil substrate sticking to the wheels of vehicles; when moistened seeds become sticky and easily attach to animals and shoes which also supports distribution. When pressed the plants smell strongly of pineapple. It prefers disturbed habitats, sandy and rocky slopes, pastures, grasslands with open vegetation cover, roadsides, orchards and cultivated ground. The species has low competitive ability but rapidly colonizes disturbed sandy places without vegetation cover. In the Bulgarian localities it forms variously sized populations – of a few specimens to hundreds and a few thousand of flowering plants. After thickening of the grass cover the species is gradually eliminated by the other native plants.

Origin and distribution
Native to Central and Northeast Asia, from where it has spread to many places in the world.
In Bulgaria first reported in 1950 from Rila Mts (near Borovets resort).

Distributed in the Black Sea Coast, Forebalkan, Balkan Range (Eastern), Sofia Region, Vitosha Region, Mt Slavyanka, Pirin Mts (Northern), Rila Mts, Rhodopi Mts, Tundzha Hilly Country, up to about 1700 m a.s.l.

A widespread species in Europe, but absent from much of the southern parts of the continent.

**Control**
Weeding and herbicide treatment are effective, but the species is resistant to some of the herbicides. There is no biological control method for the species. Proper management of the invaded sites, e.g. thickening of the grass cover gradually eliminates the taxon.

**References**
Oenothera biennis L.
Common Evening-primrose

Onagraceae – Willowherb family

Morphological description
Herbaceous biennial, with deep, yellow, fleshy taproot. In the first year of development a leaf rosette is formed. Flowering stems are formed in the second year and they are 1–2 m tall, simple or branched in the upper part, reddish and often hairy in the lower part. Rosette leaves with a red midvein, lanceolate, acute, often dentate, with long petioles; cauline leaves with a red midvein, alternate, acute, with short petioles or sessile, entire or denticulate; lower cauline leaves often reddish and hairy. Flowers hermaphrodite, actinomorphic, in leafy terminal spikes. Sepals 2–3 mm long, linear-lanceolate, acuminate, deflexed at anthesis, pale green, covered with eglandular and glandular hairs. Petals oblong-obovate, yellow, 15–30 × 18–35 mm, equal to the stamens and sepals, each with a short claw. Fruit an oblong, apically tapering, loculicidal capsule, 20–35 mm long, hairy when young. Seeds numerous, small, irregularly flattened, sharply angulated, reddish-brown to brown, with a rough surface.

Biology and ecology
Pollinated by insects; flowering from June to September; fruiting from July to October (flowering and fruiting simultaneously throughout the growing season). The flowers open in the evening and usually last until the following noon (hence the name “evening primrose”). The flowers are very attractive and visible from a distance, even in the dark. Stems and fruits often remain throughout the winter. Propagated by seeds, which are produced in abundance (a capsule contains over 100 seeds and an individual can produce about 100 capsules in a growing season). The seeds retain

[Map of distribution]
their viability for many years. Young plants develop leaf rosettes which grow also during the whole winter. It prefers sunny places and well drained soil. It occurs on dry, rocky and sandy, poor soils, on river banks, in ruderal areas, near roads, railways, gardens, margins of cultivated ground, usually in small populations of a few dozen of specimens. Rarely forms large populations of several hundreds individuals. It is used as a medicinal plant – as astringent and sedative agent; seeds are used in the cosmetic industry. Flowers and flower buds serve as a reservoir for parasitic insects in the agroecosystems.

**Origin and distribution**
Possibly native to North America, however, some authors consider it of a hybrid origin derived from some American species introduced to Europe, whereas others state it is of unknown origin.

In Bulgaria it was recorded for the first time in 1883 in the region of Samokov resort, Rila Mts.

Distributed in all floristic regions of the country, up to about 1000 m a.s.l.

In Europe it was introduced in 1600, for which there are written records. Widely naturalized in Europe, widespread in East Asia.
Control
Effective is removal of the plants in the early stages of their development – as leaf rosettes or before flowering at the latest (in order to prevent formation of seeds). It is sensitive to some herbicides which can be applied for chemical control.

References
**Opuntia humifusa** (Raf.) Raf.

Eastern Pricklypear


*Cactaceae – Cactus family*

**Morphological description**

Succulent, evergreen shrub. Stems 20–60 cm long, procumbent and spreading or sometimes ascending, jointed; joints 5–17 cm long, 4–12 cm wide, rounded to oblong, flat, fleshy, dark green. Leaves 4–8 mm long, subulate, caducous; areoles numerous, yellow to dark brown. Spines 0–1(2) per alveole, to 5 cm long, brownish or whitish; glochids numerous, yellow to red-brown, up to 4 mm long. Flowers hermaphrodite, 5–9 cm in diameter, bright yellow, sometimes reddish in centre; stamens numerous, with yellow anthers; stigma-lobes white. Fruits 2.5–5.0 cm long, obovate to oblong, succulent, edible, green at first, becoming red when ripe, with areoles and glochidia. Seeds numerous, 4–5 mm wide, with a thick coat.

**Biology and ecology**

Pollinated by insects, primarily bees and bumblebees; blooms from July to August; each flower blooms for only one day; fruiting from August to September. Propagated by seeds and vegetatively. The seeds are spread by birds and other animals that feed on the fruits; the thick coat helps the seeds to retain their viability for a long time if they fall under unfavourable conditions. Any individual, arising from a seed requires about 6–8 years until it starts blooming and fruiting. The species is propagated mainly vegetatively, by stem segments (joints) – the uppermost segments detach, form roots and grow. They are spread by animals, e.g. sheep, attaching to the wool, as well as by flowing water after heavy rains. The joints can survive for a long time until favourable conditions for rooting occur.

The species grows in sunny places – in rocky, sandy and grassy areas, sand dunes, on well-drained soils. It withstands partial shading, e.g. in some
localities in Bulgaria it grows as undergrowth in sparse stands of *Pinus nigra*. Very resistant to drought because of its succulent nature (accumulates water which is evaporated very slowly due to the lack of leaves and thick epidermis of the stem), and can survive after burning, as well as at low temperatures, which makes it very competitive with the surrounding vegetation.

It forms populations with different size and density – from a few scattered groups to hundreds and thousands of groups. The individuals and groups also have different sizes – from a few tens of square centimetres to 5–10 square meters.

Invasion of cacti is a serious problem for the conservation of nature and biodiversity, especially when it is associated with vegetation in rocky and sandy habitats. It threatens some rare and endemic plant species in the Bulgarian localities. It is not grazed by the animals because of the spines. Grown for decorative purposes.

**Origin and distribution**

Native to Central and Eastern America.

In Bulgaria the species was first reported together with other species of the genus for Zmijskiya Island in the Black Sea (opposite of Arkutino). The cacti were introduced in 1933 from the Botanical Garden in Bratislava and planted on the island. The occupied territory gradually enlarged and became impassable. Today the species is rather widespread in many places as a result of human activities (disposal of stem segments while cleaning ornamental gardens and parks), e.g. in the northern Black Sea Coast (Pobitite Kamani Protected Site) the invasion started in 1950-ties and 1960-ties. The plants develop well and produce fruits abundantly, one can find the species in inaccessible rocky places, near settlements, tourist attractions, etc.

Distributed in the Black Sea Coast, Forebalkan (Eastern), Valley of River Struma, Pirin Mts (Southern), Mt Sredna Gora (Western – Mt Lozenska), Thracian Lowland, Tundzha Hilly Country, up to about 700 m a.s.l.

In Europe, it was introduced in the early 19th century in the southern parts, especially in the Mediterranean. In the past decades, the deliberate planting of cacti by plant lovers as ornamentals in natural habitats is the main route of introduction and distribution of the species in many countries. Climate change, drought and higher temperatures will lead to increased invasion of this species in Europe.

**Control**

Prevention is crucial, because once established, the species is very diffi-
cult for eradication or containment. Disposal of stem segments and uncontrolled planting by “nature lovers” must be prevented. Mechanical control is almost impossible because the machines cause stem segmentation and the joints give rise to new individuals. Manual eradication and collecting of all parts of the plant is possible but it is very time consuming, difficult (because of the prickly stems) and expensive. Burning should be used with great caution taking into consideration the possible impact of fire on the surrounding vegetation. Chemical control with herbicides can be effective but the risks for the accompanying plant species need to be assessed in advance.

References
**Morphological description**
Herbaceous perennial. Stems 5–50 cm long, creeping, branched, pubescent, rooting at the nodes, and thus an individual occupies a considerable area. Stipules small, elongated auricles, connate at the base of the leaf petiole, pubescent. Leaves alternate, palmately 3-foliolate, with pubescent or glabrous petioles; leaflets obcordate, deeply emarginate, subsessile, glabrous above, pubescent beneath and on the margin. Flowers actinomorphic, hermaphrodite, in 2–7-flowered umbellate inflorescences; pedicels appressed pubescent, deiliated at fruiting. Sepals 3–5 mm long, twice shorter than petals, lanceolate, obtuse, pubescent. Petals 6–10 mm long, obovate, yellow. Fruit 20–25 mm long, cylindrical capsule, tapering towards the tip, densely appressed pubescent. Seeds ovoid, flat, brown, with transverse ridges.

Morphologically similar is *O. dillenii*, originating from North America. In Bulgaria it was discovered in the vicinity of Balchik town in 1980. It has branched ascending pubescent stems, not rooting at the nodes. Another similar North American species is *O. stricta* [syn. *O. fontana*], established in the country in 1892. It differs from the other two species by the lack of stipules at the base of the petioles.

**Biology and ecology**
Pollinated by insects; blooms from May to October; fruiting from June to November. Propagated by seed and vegetatively, spreading rapidly. Ripe capsules dehiscing and throwing the seeds away at some distance from the mother plant. One plant can form up to 500 seeds that are easily spread by displacement of contaminated soil and machineries for soil cultivation or maintenance of grass cover, as well as by running water. The species prefers sunny, dry, open habitats, but can grow in shady places too. It

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**Oxalis corniculata** L.
Procumbent Yellow-sorrel

Oxalidaceae – Wood-sorrel family
occurs in cultivated and abandoned places, as a weed in gardens, where it competes with the garden and greenhouse plants, in nurseries, settling in the plant containers. A very aggressive invasive species in such types of habitats.

The leaves contain oxalic acid, which gives them a sour taste. It can cause oxalate poisoning of animals if eaten in large amounts. In small amounts, the leaves are the perfect addition to a salad, but in larger quantities they should not be used since the oxalic acid binds with calcium, leading to its shortage. The species is used in folk medicine for treating rheumatic and arthritic diseases, kidney stones and patients with these diseases can include it in their diet in controlled quantities.

**Origin and distribution**
Probably native to Central and South America.

In Bulgaria the species was recorded long ago, in 1899, probably introduced with import of contaminated seeds and containers of ornamental plants.

Distributed in all floristic regions, up to about 1000 m a.s.l.

In Europe it was introduced in 1700 as an antiscorbutic agent. Then the species naturalised widely throughout the continent.

**Control**
The species can be removed mechanically, by tillage and weeding, however, subsequent use of herbicides (glyphosate) is often needed for full elimination. The whole plants should be eradicated, because even small remaining parts can recover and produce new plants. These actions must precede flowering and seed formation. Disinfection of soil used in greenhouses and gardens is necessary in order to reduce the spread of the seeds.

**References**
Hantz & Latowski 1982; Petrova 1979; Roncoroni 2004; Young 1968.
**Morphological description**
Annual herb. Stems 20–80 cm tall, erect or ascending. Leaves 10–30 cm long, 5–15 mm wide, alternate, without auricles, with prominent white midvein, on the upper surface with appressed hairs, patently hairy beneath; sheaths hispid, with a ligule of a row of hairs. Inflorescence a panicle, 8–40 cm long, often occupying the upper half of the entire plant, with a hairy central axis and diffuse, wide spread capillary branches. Each branch ends with a spikelet; spikelets 2.0–2.5 mm long, with 2 florets (the lower sterile), light green, elliptic; lower glume broadly lanceolate, 1/2 as long as the spikelet, acute; upper glume and lower lemma as long as the spikelet, long acute to attenuate, with several veins. Any spikelet bears one seed, about 1.5 mm long, rounded and flat.

Morphologically similar is *P. dichotomiflorum*, which has glabrous sheaths.

**Biology and ecology**
Pollinated by wind; blooming and fruiting in late summer and autumn, the inflorescence and spikelets become yellow-brown with maturity. Propagated by seeds, which retain their viability for a long period; a plant can produce many hundreds of seeds. Some seeds fall from the plant directly on the soil surface, however, most often the whole inflorescence is detached from the plant and carried around by the wind, spreading the seeds. It grows well in dry and damp locations, on different soils, alkaline soil well tolerated. The fertility of the soil and its moisture affect the size of the individual plants. It grows along roads, near ports along the Danube, near grain warehouses, in waste, uncultivated places, and as a weed in crops (mainly corn).

**Origin and distribution**
Native to North America.

In Bulgaria the species was first discovered in 1994 near the grain ware-
houses in Kostinbrod town, apparently introduced with contaminated crop seeds. It spreads along the Danube, probably facilitated by the watercourses, as well as by transportation of contaminated agricultural commodities with the ships.

Distributed in the Northeast Bulgaria, Danubian Plain, Sofia Region, up to about 500 m a.s.l. Obviously increasing its distribution territory within the country, which trend is expected to continue.

In Europe, first introduced with wool, then with cereals as a contaminant. Naturalized in many parts of Southern and Eastern Europe, reaching to Central Russia northeastwards.

**Control**
Small groups can be easily destroyed by manual uprooting or tillage before flowering and fruiting. For larger groups cultivation of the soil and use of herbicides in the early stage of development are effective. In all cases monitoring of the site is required for several years until the seeds in the soils are depleted.

**References**
**Morphological description**
Annual herb, often caespitose. Stems geniculate, ascending, 60–100(150) cm, usually with secondary branches, glabrous. Sheaths glabrous, with ligules ca. 2 mm long, of a row of hairs. Leaves to 50 cm long, 4–12 cm wide. Inflorescence up to 40 cm long, diffuse panicle, more or less ovoid to conical in shape, terminal or sometimes barely exerted from the uppermost sheath, with slender branches. Spikelets 2.5–3.5 mm long, single, stalked, ovoid, laterally flattened, deciduous, with 2 florets, the lower sterile. Lower glume ovoid, ca. ¼ as long as the spikelet, with 5 veins, obtuse; upper glume acute, as long as spikelet, 7-veined. Lower lemma of the lower sterile floret as long as the spikelet, 7-veined, acute, 2.4–3.0 mm long. Each spikelet produces a single grain, glabrous, yellow to brown.

Morphologically similar is *P. capillare*, which has hispid sheaths and leaves and much branched, with capillary branches inflorescence, occupying almost half of the whole plant.

**Biology and ecology**
Pollinated by wind; blooms from July to September; fruiting from August to October. Propagated by seeds, which are produced in abundance – to 500 000 from an individual. This is a prerequisite for their dispersal and development of large populations that defines the invasive behaviour of the species. Seeds are viable for a long time, retaining very high germination rate in the soil even after 10 years. Ripe seeds need a period of dormancy and 3–4 months of cold period before they germinate. Germination begins in April–May and continues during the summer. Culms root at the lower nodes and therefore their basal part is lying on the ground. It is adapted to different habitats and soils, grows on sandy loam soils along the bank of the river Danube, mainly
in open, sunny areas, in moist and dry places, near roads. It does not tolerate shade. In places where the terrain is steep, the species forms small subpopulations, covering an area of 10–50 m², whereas in flat, large areas the subpopulations are large, comprising many hundreds to a few thousand individuals.

It is a competitive species. In crops it causes reduced yields by 15%. In shady areas it is a weak competitor. The seeds provide food for birds, whereas rabbits and other herbivorous mammals feed on its fragile young leaves.

**Origin and distribution**

Native to North America.

In Bulgaria, it was discovered in 2009 on the banks of the Danube, and it was published as a new species for the flora of the country in 2012.

Distributed in the Northeast Bulgaria and Danubian Plain, up to about 50 m a.s.l. The expansion of the range of the species in the country is a matter of time, monitoring and recording.

In Europe, it was first discovered long ago, in 1881 in Belgium, in uncultivated, waste places, probably introduced with imported wool and contaminated seeds of cultivated plants. Currently it is found near ports, warehouses for grain, along roads and railways, and is generally ephemeral in such places. In the recent years its distribution range has been expanding and now it is a naturalized species in more than 20 countries in Europe, in many parts of Asia, New Zealand and South America.

**Control**

The easiest way to control the species is proper soil cultivation. Generally, the species is poorly affected by the applied control technologies due to insufficient knowledge of its biological characteristics. Small populations, with scattered individuals, can be removed by uprooting of the plants when young. For chemical control a combination of atrazine and tridiphane can be applied at the phase of 4–5 leaves.

**References**

Parthenocissus inserta (A. Kern.) Fritsch
False Virginia-creeper
Vitaceae – Grape-vine family

Morphological description
Deciduous climber, attaching by tendrils, opposed to the leaves at the stem nodes. Stems woody, 15–20(30) m long. Leaves alternate, palmate, leaflets (3-)5(-7), to 12 cm long, elliptic or oblong, acutely serrate, dark green above, lighter and shining beneath, becoming reddish in autumn before leaf fall. Tendrils with 3–5 branches, clinging by coiling or by swelling of the apex inside a crevice, but without adhesive discs. Inflorescence a thyrsoid panicle, obviously dichotomously branched, all leaf-opposed. Flowers 5-merous, small, actinomorphic, green; sepals united to the top, petals free, deflexed. Fruit about 8 mm in diameter, blue-black berry, usually pruinose when ripe. Seeds 3–4 in each berry.

It is morphologically similar to P. quinquefolia, from which it differs in the way of clinging – the tendril branches do not end in adhesive discs. It cannot adhere to smooth walls but needs other plants to climb. Therefore, it is not suitable for landscaping buildings and walls.

Biology and ecology
Pollinated by insects, usually bees or wasps; blooms from June to July; fruiting from August to October. Propagated by seeds and vegetatively. The fruits remain on the plants during the winter until about January to February and are dispersed by birds that feed on them. Vegetative propagation is realised by rooting at the nodes when stems are in contact with a suitable substrate or fragments of the stems remaining after mechanical damage. A fast-growing species. With enough sun in summer, the leaves become reddish in autumn, but in shady places they usually remain green.
The species grows in ruderal, waste places, thickets near and in settlements, in deciduous forests, river valleys, along roadsides, climbing and coiling around trees. It occurs in sunny places, but withstands significant shading, growing between the trees near the edge of deciduous forests. Populations are represented by groups of tens to hundreds of individuals occupying several square meters to several acres.

It forms dense coverage of large areas and successfully competes with the native plant species for light and space. Well-developed specimens can outcompete and gradually suffocate the supporting plants. Fruits are poisonous for people, due to presence of oxalic acid, but poisoning is unlikely because of their unpleas-

ant taste. Contact with them can cause skin irritation and dermatitis. The species is used as an ornamental plant.

**Origin and distribution**

Native to North America.

In Bulgaria it was recorded as an escape and reported rather late – in 2012, but the species had spread much earlier, not known exactly when, because it was not distinguished from the closely related species *P. quinquefolia*. It was unintentionally introduced in the country as an ornamental plant, but unintentional introduction from neighbouring countries can not be excluded. A possible invasion corridor is the Danube River, as the species is distributed along the river and some of its tributaries, and the seeds are dispersed by birds and watercourses.

Distributed in the Northeast Bulgaria, Forebalkan (Eastern), Sofia Region, Thracian Lowland, up to about 600 m a.s.l. The species is probably more widespread, but since it was recently reported for the country, still few localities are known.

In Europe, it was introduced in the UK before 1824 as a climbing garden ornamental and was reported as a garden escape in 1948. Now it is spread in many countries – Austria, Belgium, Czech Republic, France, Germany,
Greece, Italy, Poland, Romania, Spain and others.

**Control**
Prevention of the country is too late since the species is already rather widespread in natural and semi-natural habitats. Mechanical control by cutting the stems to the ground may be effective if repeated many times until the plant is depleted and completely destroyed. The deep root system makes the species rather resistant to this procedure because it retains its viability for a long time. Therefore, in addition to mechanical control, subsequent use of herbicides is necessary. Fresh cuts are treated with concentrated herbicides. When there are no other species around that can be damaged, the herbicides can be sprayed during the active growing season. The treatments must be repeated several times until full elimination of the species.

**References**
**Parthenocissus quinquefolia** (L.) Planch.
Virginia-creeper

**Vitaceae – Grape-vine family**

**Morphological description**
Deciduous liana, climbing and trailing, adhering by tendrils, opposed to the leaves at the stem nodes. Stems woody, to 30 m long. Leaves alternate, digitate, leaflets (3-)5(-7), 5–10 cm long, ovate-elliptical, coarsely and obtusely serrate, green, becoming red towards the end of the growing season. Tendrils with 5–12 branches each of which develops a terminal adhesive disc on touching with a solid support. Inflorescences many-flowered, thyrsoid panicles, leaf-opposed, with several lateral branches. Flowers 5-merous, small, actinomorphic, greenish; sepals united to the tips; petals about 3 mm long, free, deflexed. Fruit about 6 mm in diameter, a blue-black berry, pruinose when ripe. Seeds 2–3 in each fruit.

**Biology and ecology**
Pollinated by insects, mainly bees and wasps; blooms from June to July; fruiting from August to October. Propagated vegetatively and by seeds that are produced in abundance and germinate during the first or the second year after falling into the soil. The species is dispersed mainly by birds that eat the fruits. Fruits usually remain on the plants during the winter. The vegetative propagation is realised by rooting of the stems at the nodes when they are in contact with the soil or by stem fragments remaining after mechanical damage. A fast-growing species. With enough sun in the summer, the leaves soon become reddish. The species can grow in shaded areas too.

Morphologically similar to **P. inserta**, from which it differs mainly by the type of adhering to the support – tendrils are more branched and each branch ends with an adhesive disc and therefore the plants can climb on buildings and walls.
The species occurs at forest margins, in abandoned and disturbed habitats, rocky places, on fences, walls and buildings, along roads and railways. Thanks to the terminal adhesive discs of the tendrils the species can climb on smooth surfaces.

It forms populations of different size – from single scattered plants to groups of several dozen to several hundred individuals. In large and relatively dense groups it gives a red colour of the whole vegetation in late summer and autumn. It threatens native plant species competing with them for light, nutrients and space. It can damage the walls and buildings on which it climbs. The fruits are poisonous to people, due to the presence of oxalic acid, but consumption is unlikely because of their unpleasing taste. Contact with the fruits can cause skin irritation and dermatitis. The species is used as an ornamental plant, for erosion control and soil stabilisation on slopes.

**Origin and distribution**
Native to North America.

In Bulgaria it was deliberately introduced as an ornamental plant for landscaping facades of buildings, parks and gardens, from where it escaped to nature. It was registered as a wild-growing species in 2006, but escaping, self-dispersal and naturalisation started long before that.

Distributed in the Black Sea Coast, Northeast Bulgaria, Forebalkan (Eastern), Balkan Range (Eastern), Sofia Region, Rhodopi Mts (Central), up to about 600 m a.s.l. Probably the species is more widespread in the country, but it is under-recorded.

In Europe, it was introduced as an ornamental plant for landscaping, and
consequently it escaped and spread spontaneously in many countries.

Control
Prevention for the country is too late now since the species is already widespread in natural and semi-natural habitats, however activities to limit it further spread are needed. Mechanical control by cutting the stems to the ground, repeated many times to destroy any emerging shoots leads to depletion of the plant and its gradual demise. The deep root system makes the individuals rather independent on this procedure as they retain viability for a long time. To increase the efficiency of the treatment it is necessary to combine the mechanical with chemical control. The stems are first cut to the base and then the fresh cuts are treated with herbicide concentrate, e.g. glyphosate. When there are no other plant species around the herbicide can be sprayed over the virginia-creeper plants during the active growing season. In any case the control measures should be repeated several times until the plants are completely destroyed.

References
**Paspalum distichum** L.

Water Finger-grass


Poaceae – Grass family

- Included in the list of the invasive species of the European and Mediterranean Plant Protection Organisation (EPPO 2012).

**Morphological description**

Herbaceous, rhizomatous perennial, with underground creeping rhizomes and stolons rooting at the nodes. Stems 15–60 cm, smooth, glabrous, the flowering culms erect. Leaves alternate, 4–17 cm long, 2–6 mm wide, linear-lanceolate, somewhat firm, glabrous or with sparse hairs near the base of the midvein; sheaths glabrous, with ciliate margin; ligule membranous, 0.5–1.5 mm long. Inflorescences of 2 (rarely 3–4) racemes; racemes 2–7 cm long, unilateral, arranged digitately, narrow and flat. Spikelets ovate, slightly acute, 2.5–4.0 mm long, usually single, shortly stalked, ±imbricate, pale green, with two florets, the lower sterile, the upper hermaphrodite. Lower glume usually as a small scale or almost absent, the upper 3-veined, as long as the spikelet, glabrous or on both sides of the midrib with sparse, short, appressed hairs; lower lemma membranous, glabrous, elliptical, as long as the spikelet.

**Biology and ecology**

Pollinated by wind; flowering and fruiting throughout the whole year. Mainly propagated vegetatively by stolons; stolon fragments detached from the mother plant can also root and give rise to a new plant. Stolons remain green throughout the year, especially if growing in water. The species has a low seed production; seed viability is low, and therefore, propagation by seeds is more limited than vegetative reproduction. The taxon requires moisture, but it can survive in dry areas during the dry season or in unfavourable conditions. It grows in marshy, brackish, saline soils, with good moisture in summer, near hot springs, pol-
luted waters near settlements, as a weed in rice fields. During the winter the leaves darken and die, but the stolons survive. A fast-growing species. In suitable habitats it makes dense cover and thus prevents the establishment and spread of native plants.

**Origin and distribution**
The species is native to tropical Africa and America, and it is widespread in the tropics.

In Bulgaria the species was first discovered in 1959 near the hot springs in the vicinities of Marikostinovo village, Blagoevgrad district.

Distributed in the Northeast Bulgaria, Danubian Plain, Valley of River Struma, Rhodopi Mts (Eastern), Thracian Lowland and Tundzha Hilly Country, up to 300 m a.s.l.

The time of introduction of the species to Europe is not well documented, but it has been present on the continent for a long time and continues to extend its distribution area. It is widespread in the warmer areas of the whole world.

**Control**
It is very difficult to remove the species by mechanical means from the territories it has occupied. Burning is not recommended because the rhizomes and stolons survive fires. The use of herbicides (e.g. butachlor, glyphosate) twice in a season, gives good results, however the application near water is very difficult and undesirable due to the negative effect the herbicides may have on the other aquatic organisms.

**References**
**Phytolacca americana** L.
American Pokeweed

*Syn. Ph. decandra* L.
Phytolaccaceae – Pokeweed family

**Morphological description**
Herbaceous perennial, with a tap-root growing deep and spreading horizontally. Stems 1–3 m tall, cylindrical, fleshy, hollow, erect, sometimes woody at base, usually subdichotomously branched in the upper part, glabrous, green, often red. Leaves alternate, 10–25 cm long, 3–6(10) cm broad, simple, entire, ovate-lanceolate, lamina cuneate at base, acute at apex, with a prominent midvein, dark green above, pale green beneath, turning red in early autumn, with 1–2(3) cm long, slightly angled and glabrous petiole. Leaves decrease in size upward the stem. Inflorescences 10–15 cm long, racemose, usually opposite the leaves, initially ±erect, drooping down in fruit. Flowers with 3 bracts, hermaphrodite, actinomorphic, with 5-merous perianth; perianth segments *ca.* 2.5 mm, broadly ovate, obtuse, greenish-white, turning reddish in fruit; stamens 10, about a half of the length of the perianth segments. Fruit a berry, fleshy, depressed-globose, green when young, dark red to blackish when ripe, composed of 10 united segments, representing the ten carpels. Seeds 2.5–3.0 mm in diameter, lenticular, shiny, black, glabrous.

Morphologically similar to *Ph. esculenta*, which is distinguished by its broadly ovate leaves, fruit composed of eight free segments (representing the eight carpels) and erect inflorescences, which remain erect even after ripening of the fruits.
Biology and ecology
Pollinated by insects; blooms in May–August (sometimes until September–October); fruiting in parallel with flowering. In spring the horizontally growing taproot of the older individuals gives rise to 6–10 stems which in the next year are not in the same place, but a few meters aside. This gives the impression of “movement” of the plants. Propagated by seeds, each individual forms up to several hundred that retain viability to ten years in the soil.

The fruits, roots and the older parts of the plants are poisonous due to the presence of the alkaloid phytolacca-toxin, triterpene saponins and histamines. When consumed in small amounts it improves mood, however used in larger quantities the fruits are poisonous.

The fruits are not poisonous for the birds which are attracted by their dark red to blackish colour, feed on them, and then disperse the seeds at large distances (zoochory).

The species grows mainly in disturbed habitats, abandoned and ruderal places, margins of forests, along roads, in gardens. It grows equally well in sunny and shady areas. Young leaves are not toxic, and can be used for food. It was used widely in the past for treatments against scurvy, rheumatism, gout, etc., as well as for dyeing wool and silk fabrics. It is a host of many
plant viruses that cause various diseases.

**Origin and distribution**
Native to the eastern parts of North America.

Most likely it was introduced in Bulgaria by the Turks before 1878, judging by its numerous Turkish vernacular names. In the past, it was grown, mostly in Northeast Bulgaria, for its fruits, which were used for staining of wine and increase of its quality. It was first reported as an escape near the vegetable gardens around Lovech.
town and on the hills in Veliko Tarnovo town.

Distributed in the Black Sea Coast, Northeast Bulgaria, Danubian Plain, Forebalkan, Balkan Range (Western, Eastern), Sofia Region, Valley of River Struma, Mt Belasitsa, Rila Mts, Mt Sredna Gora, Rhodopi Mts (Western, Central), Thracian Lowland, Tundzha Hilly Country, up to about 1000 m a.s.l.

In Europe the species was brought in the 17th century, initially in the Mediterranean area (in South Europe but also in North Africa), where it was grown as an ornamental plant and dye for colouring wine, mainly in wine producing regions. Used also as ink. During the wars, soldiers used it for this purpose, hence one of its popular English vernacular names is inkberry. In the beginning it was found as an escape near vineyards in the Mediterranean area, from where it spread throughout Europe (excluding its northern parts). A relatively common alien species in Asia, distributed in Australia and New Zealand too.

Control
An effective way to combat this alien species is the mechanical one, e.g. by plowing and disk ing the soil substrate in order to destroy the underground parts of the plants. The effectiveness of the mechanical control can be increased by subsequent use of herbi-
icides (e.g. glyphosate). One should be aware that the control is difficult and not always successful.

References
Robinia pseudoacacia L.
False-acacia
Fabaceae – Pea family

Morphological description
Deciduous tree, to 15–20(30) m high, with dark brown, furrowed bark. Leaves alternate, imparipinnate, with 5–30 cm long rachis; leaflets 3–10 pairs, elliptic or ovate, entire, sparsely puberulent to subglabrous, shortly petiolulate. Young twigs at the base of the leaves with two big, sharp spines (modified stipules), which later fall out. Inflorescences 15–20 cm long, pendent racemes, hairy, many-flowered, axillary, usually shorter than the leaves. Pedicels 8–10 mm long, densely hairy. Calyx 5–6 mm long, 5-lobed, bilabiate to 1/3 of its length, campanulate, hairy. Corolla 15–20 mm long, zygomorphic (consisting of a standard, wings and a keel), white. Fruit a legume, oblong to linear, strongly compressed, 3–5(10)-seeded, glabrous, dark brown, dehiscent. Seeds 4–5 mm long, reniform, dark brown to blackish, smooth.

Biology and ecology
Pollinated by insects, mostly bees; blooms from May to June; fruiting abundantly in September–October, the fruits ripen in the autumn, remain on the tree and are dispersed during the whole winter. Propagated by seeds and vegetatively – by basal shoots and suckers. Once established on a new territory, the species rapidly spreads and forms dense groups by means of vegetative reproduction. The latter is further stimulated if the aboveground part of the tree is destroyed. Seeds are spread by gravity and by wind over long distances and retain their viability for over 10 years.
The trees begin fruiting at the age of about six years; fruiting is most abundant between 15 and 40 years of age and terminates at the age of about 60 years. Seedlings grow quickly and occupy large territories by root suckers. This leads to the formation of dense, mono-dominant communities, completely inhibiting the development of the natural vegetation. It grows in a wide range of habitats and is one of the most tolerant woody species to any type of soil and climatic conditions. It grows equally well on aerated, deep, light, fresh and fertile soil, rich in minerals and humus, as well as in poor, dry, sandy, stony and rocky places. The species is nitrogen-fixing and can fix the atmospheric nitrogen due to symbiotic relationships with nitrogen-fixing microorganisms, and therefore, it can grow on very poor soils. At the same time it increases the fertility of the colonized habitats that affect their floristic composition, reducing the species preferring poor in nitrogen soils. Often the taxon occupies heavily disturbed habitats. It grows well on protected from strong winds locations. The species is used as an ornamental, as melliferous plant with significant importance for beekeeping, as well as for erosion control and soil stabilization. Wood is used in carpentry. The leaves, seeds and bark are toxic to humans and animals. The species does not tolerate very low temperatures.
This is a dangerous invasive alien species, occupied vast areas of the country, which has led to suppression and destruction of the native flora and vegetation, and to loss of natural habitats.

**Origin and distribution**
Native to North America.

In Bulgaria it was introduced for cultivation in private gardens in mid-19th century, but after 1888 its cultivation increased rapidly throughout the country as an ornamental in parks, gardens, alleys, avenues, and even then it was regarded as one of the most common deciduous tree species. The first report for its escaping from cultivation and penetration in natural habitats is from 1903.

The idea of rapid and widespread afforestation with false-acacia of disturbed and abandoned lands in late 19th and early 20th century, the high technical quality of the wood and the fast growth of the species are
In Europe it was introduced in 1638 and subsequently spread throughout the continent. Outside Europe, it was introduced in Asia, Africa, Australia.

**Control**

Once established on a territory, it is very difficult, if not impossible, to control the species. To limit its spread mechanical and chemical methods can be used. Repeated cutting for several years leads to gradual depletion of the trees. Most effective is chemical control with glyphosate. Trunks are cut close to the ground and the fresh cuts are treated with glyphosate. The newly formed shoots and

the factors that guided the foresters at that time for its wide cultivation. Consequently its cultivation decreased, but the species was already widespread in natural and semi-natural habitats and continued to occupy new territories.

The species is widespread in all floristic regions of the country – along roads, railroads, cemeteries, almost everywhere in the lower forest zone, up to about 1000 m a.s.l. At higher elevations it is often damaged by low temperatures.
suckers should be removed periodically, and the chemical treatment should be repeated at least twice in a growing season. Herbicides have a greater effect if applied in late spring just as the leaves are fully developed.

Burning is not recommended to limit the spread of the species, since it is inefficient – the aboveground parts of the trees burn, but this is followed by rapid and massive growth of basal shoots and root suckers. Moreover, fires stimulate germination of the seeds accumulated in the soil and create conditions for massive growth of seedlings which is also facilitated by the destroyed vegetation cover (no competition).

References
**Senecio inaequidens** DC.
Narrow-leaved Ragwort
Asteraceae – Daisy family

- Included in *List of “Worst invasive alien species threatening biodiversity in Europe”* (Annex 1. 2007) and in the list of the invasive species of the European and Mediterranean Plant Protection Organisation (EPPO 2012).

**Morphological description**
Herbaceous perennial. Stems 50–100 cm tall, erect, often woody at base, usually strongly branched, green, glabrous or with single hairs. Leaves alternate, 3–14 × 0.2–0.7(1) cm, simple, linear, green, remotely denticulate on the margin, acute, sessile, not widened at base or slightly widened and semi-amplexicaul, glabrous. Inflorescences corymbiform or paniculate, terminal and lateral. Capitula numerous, 18–25 mm in diameter. Involucre (5)6–7.5(9) × 3–4.5(5) mm, cylindrical. Supplementary bracts 10–20, linear, up to about 1/3 of the involucre. Involucral bracts 18–20, lanceolate, acute and dark coloured at the tips, usually glabrous. Florets yellow, the ligulate about 13, 8–13 mm long, female, the tubular many, hermaphrodite. Achenes 2.0–2.5 mm long, cylindrical, hairy between the ribs, with a white pappus.

**Biology and ecology**
Pollinated by insects, primarily bees, bumble bees and hoverflies; blooms from July to October; fruiting from August to September. The species is partly self-compatible (at least in some localities) and self-fertilization can occur, albeit in low percentage. Propagated by seeds; a plant can form about 10 000 seeds in one growing season. Seeds are spread mainly by wind, but with the help of the pappus they can attach to the fur of animals. The seeds germinate at different temperatures, but the optimal conditions are in the range 14–30ºC; at temperature above 20ºC the
seeds germinate in 2 days. It can form dense populations – around 300 individuals/m², in which case it accumulates seed bank with over 8 million viable seeds/ha. The seeds retain their viability on the soil surface to 6 months, and slightly buried – over one year (up to 30–40 years). Under optimal conditions, the young plants begin to bloom in the first year of their development.

The species grows primarily on rocky and sandy, well-drained soils, in sunny or slightly shaded places. In nutrient rich soils it develops more vigorously and reaches larger size. It prefers disturbed habitats and has very good colonizing abilities. In Bulgaria it occurs near railways and roads, but in other European countries it was established in dumpsites, villages, rocky habitats (e.g. grasslands), coastal dunes. In its native range it is found on rocky and sandy shores of rivers and rocky grasslands.

It is a potentially invasive alien species, under observation. Currently it does not pose threats to native biodiversity in Bulgaria, however, in other European countries negative impacts have been reported: competition with native pioneer plants, local change in the composition of plant communities, including dominating of the species in rocky habitats in the early stages of vegetation succession. In most localities the presence of the species is dependent on maintaining of disturbance of the habitat. Sometimes it occurs as a weed in vineyards and orchards. It is a poisonous plant that is generally not grazed by the animals. Accidental consumption of the plant by cows and sheep along with other grasses leads to entry of toxic substances in milk, and therefore, there are documented cases of poisoning of people.

**Origin and distribution**

Native to South Africa.

It was unintentionally introduced in Bulgaria, most likely with rail trans-
port. First reported for the country in 2009.

Distributed in Sofia Region, up to about 600 m a.s.l.

In Europe it was unintentionally transported with sheep wool from South Africa. It was registered for the first time in 1889 in Germany. Since the mid-20th century it has been widely spreading in Western, Central and Southern Europe. It is naturalized and often invasive in many areas of Australia, Europe, Central and South America. On the Balkans except in Bulgaria it has been recorded in Montenegro and Slovenia.

Control
Small groups can be destroyed by manually uprooting the plants before seed formation. From the observations near railway stations in Bulgaria it can be assumed that cutting is not effective as shoots are easily formed from the remaining underground parts and the plants recover. It is reported that the species shows considerable resistance to herbicides. Some control of the populations can be achieved by discontinuation of the disturbance of the habitats and implementation of management practices to thicken the vegetation cover of native species.

References
Morphological description
Annual. Stems 4–8 m long, angular, viscid-pubescent, climbing, with branched tendrils that are coiling around the supporting plants in one direction, and then – backward. Leaves alternate, 3–12 cm long, nearly as wide as long, simple, with 4–5 cm long petioles, 5(7)-lobed, the lobes acute, denticulate on the margin, hairy. Monoecious plants. Flowers unisexual; male flowers with pedicels that are several times shorter than the peduncles, in axillary racemes, with 5 stamens; female flowers, in long-pedunculate, 8–20-flowered heads. Calyx green, deeply 5-lobed, lobes narrowly triangular, hairy. Corolla 5-lobed, lobes united at base and free in the upper part, subacute, spreading, yellowish-white, with green stripes. Fruit about 1.5 cm long, fleshy, one-seeded, compressed-ovoid, lanate and covered with long, white bristles, dry and indehiscent when ripe. Seeds long, flat, brown, acute at the apex, remaining enclosed in the fruit.

Somewhat similar in morphology and sometimes confused with *Echinocystis lobata*, which has glabrous leaves, flowers with 6 petals and strongly swollen fruits with 4 seeds each.

Biology and ecology
Pollinated by insects, mainly bees; blooms from July to October; fruiting from July to November. Propagated by seeds, which are formed in thousands from a single plant. Fruits are dispersed by water, small mammals, attaching to their fur with the help of the bristles, birds, agriculture,
al machinery. A fast-growing species. It prefers moist, clayey, nutrients-rich alluvial soils. It does not tolerate drought and is sensitive to early frosts in the autumn. It grows mainly along the rivers, as a weed in agricultural crops, in abandoned, disturbed habitats. In large groups it covers entirely the other native plants, suffocates them, competing with them for nutrients, water, light and space, and thus changes the composition and the structure of the native plant communities.

**Origin and distribution**

Native to North America.

In Bulgaria it was established for the first time in 2004 on the island of Belene. Probably it was transported by the water of the Danube River or by ships carrying grains (especially maize and seeds to feed birds), contaminated with the seeds of the species.

Distributed in the Northeast Bulgaria, Danubian Plain, Forebalkan (Western), up to about 500 m a.s.l., with a tendency to expand its range.

It was introduced to Europe in the 19th century, first in Spain as an ornamental plant. From there it spread to other countries, although it was no longer cultivated as an ornamental. Relatively recently it has emerged as a serious and actively spreading en-
environmental and agricultural weed. Widespread in Asia too.

Control
Control efforts should be focused on the areas that are most threatened by increasing the spread of the species. Uprooting is not considered appropriate. Deep tillage of arable land limits its spread. In Bulgaria it has not been found yet as a weed in crops. The use of herbicides, especially along the river banks, gives a good effect, but the treatment must be repeated and should be done with a great care in order to protect the native species.

Regional cooperation between neighbouring countries, e.g. the exchange of information about the invasive traits and distribution of the species, is very important for successful limitation of its further spread.

References
**Solidago gigantea** Aiton

Early Goldenrod

Asteraceae – Daisy family

- Included in *List of “Worst invasive alien species threatening biodiversity in Europe”* (Annex 1. 2007) and in the list of the invasive species of the European and Mediterranean Plant Protection Organisation (EPPO 2012).

**Morphological description**
Rhizomatous perennial. Stems 50–150(250) cm, erect, unbranched except in the inflorescence, often glaucous, glabrous, only in the inflorescence pubescent. Leaves alternate, numerous (40–110), the middle cauline 6–20 × 1–4 cm, scarcely decreasing in size upwards, lanceolate, usually glabrous, sharply serrate, with 2 prominent lateral veins, the basal usually withering before flowering. Inflorescence paniculate, broadly pyramidal, the branches patent. Capitula strongly secund, 4–8 mm wide at flowering. Involucre 3.5–5.0 mm long. Florets yellow, the ligulate slightly longer than the tubular ones. Achenes 1.0–1.3 mm long, shortly pubescent, with yellowish-white pappus.

Morphologically similar species is *S. canadensis*, which differs by its pubescent stem in the upper half and shorter involucres (2.0–2.8 mm).

**Biology and ecology**
Pollinated by insects; blooms from July to September; fruiting from September to October. Propagated by seeds and vegetatively. The vegetative reproduction is realized by underground stolons, reaching 50 cm in length. Due to the vegetative propagation large and dense groups are easily and rapidly formed. The number of aerial stems can reach 300/m². A single plant produces a large number of seeds that are spread by wind. The seeds need light to germinate (they do not tolerate burial) and do not require a period of dormancy. During the first year the seedlings develop 2–3 stolons, which are 1–10
cm long, and thus give rise to a new group. Through the exchange of nutrients and water between the stems connected with a joint rhizome an equal growth is achieved throughout the whole group and mutual shading is avoided. The species shows allelopathic activity.

The taxon grows on wet soils of a different type (including heavy clayey soils), in sunny and partly shaded areas. It withstands drought in the soil, but then it forms short aerial stems and small inflorescences. Disturbance of the natural habitats facilitates the colonisation of new territories by seed dispersal, but once established, the individuals give rise to large groups by vegetative reproduction and the species becomes independent of maintenance of habitat disturbance. In Bulgaria it grows both in man-made habitats – villages, gardens, canals, roadsides and railways, landfills, and in semi-natural and natural habitats – along streams, rivers, in meadows and mountain pastures, forest margins. It forms dense, monodominant groups that can reach considerable size – from a few dozen to a few hundred square meters. Therefore it competes with the native plant species for space, light, water and nutrients. In large groups it changes the composition and structure of the plant communities and impedes the establishment of the native plants, changing the chemical composition of the soil in the top 10-cm layer. It is grown as an ornamental and meliff erous plant.

**Origin and distribution**

Native to North America.

The species was intentionally introduced to Bulgaria as an ornamental plant. For the first time exact localities for the species were published in 2003, although it was reported for the country much earlier. In most publications *S. gigantea* was not distinguished from the morphologically similar *S. canadensis*, which also occurs in the country (but rather rare) and it is not known for which taxon the reported localities are relevant. The oldest herbarium materials were collected in 1902 from Northeast Bulgaria.

Distributed in the Northeast Bulgaria, Danubian Plain, Forebalkan, Balkan Range (Western, Central), Sofia Region, Znepole Region, Vitosha Region, Valley of River Struma (Southern), Pirin Mts, Valley of River Mesta, Rhodopi Mts (Western, Central), Thracian Lowland, up to about 1500 m a.s.l.

Introduced in Europe in the mid-17th century (1668) as an ornamental plant. The first reports of naturalization of the species are from the mid-19th century. In many European countries it is an invasive species. On the Balkans, except in Bulgaria, it has
been registered in Bosnia and Herzegovina, Croatia, Romania, Serbia, Slovenia. Introduced and naturalized in Asia too.

Control
It is necessary to raise public awareness about the invasive nature of the species in order to limit the disposal of viable rhizomes in favourable habitats (especially along channels, streams and rivers).

After establishment and expansion of the species in a locality, it is very difficult to remove it. Single plants or small groups can be eradicated, and the rhizome fragments should be carefully collected. Mowing once a year, combined with mulching or mowing twice a year, lead to depletion of the plant, prevent its further spread, but the elimination of the species is slow and requires several years of consistent efforts. The application of herbicides (glyphosate, 2,4-D) is effective at the beginning of the growing season, during the active growth of the stems.

References
Morphological description
Herbaceous perennial, with a short, thick, fleshy creeping rhizome. Stems numerous, up to 2 m tall, smooth, glabrous. Leaves alternate, lanceolate, with a wide, prominent mid-vein, glabrous, except on the upper surface near the base; sheaths glabrous, with a membranous, 1–3 mm long ligule, covered with up to 2 mm long hairs. Inflorescence a much branched panicle, conical, 25–45 cm long, reddish, with ±drooping lower branches. Spikelets numerous, ovate-lanceolate, in pairs on the ultimate branches. Florets hermaphrodite or unisexual (male), glumes acute, pubescent, shiny, reddish; lemma and palea membranous, the lemma with a geniculate awn, palea smaller, ciliate. Caryopsis 3–5 mm long, oval, dark reddish-brown.

Biology and ecology
Pollinated by wind and insects or self-pollinated. It blooms from June to September, fruiting from July to November. It propagates rapidly by vegetative means (by rhizomes) and by seeds, which are produced in abundance (thousands). Caryopses retain their viability for over 20 years and are spread over long distances by wind, water, farming activities, animals (seeds retain their viability after passing through the digestive system of birds and mammals).

The species is adapted to a wide range of habitats. It grows in grassy and sandy places, in crops as a weed, along roadsides and railways, in disturbed habitats, dikes, damp places. It thrives best in well-drained soils.

It is considered one of the most dangerous weeds in the world. It spreads aggressively, forming dense populations, displacing natural vegetation.

Origin and distribution
Native to the Mediterranean part of Europe and Asia (Turkey and Syria).
Preventive measures require the use of crop seeds uncontaminated with seeds of Sorghum halepensis and this is the cheapest and least time- and efforts-consuming way of control. In arable land cleaning of the whole field before sowing from the last year’s rhizome fragments is also important to limit the spread of the species.

Manual eradication after rain, when the soil is soft, is possible for small areas, but all rhizome fragments should be carefully collected. For larger areas cropping and tillage of soil is recommended – ploughing, cultivating, disking of soil, with removal of the rhizome fragments. Tillage of soil once a year in early spring, without subsequent repeated processing, only stimulates the growth of the species from the fragmented rhizomes and is ineffective. Rotation of crops, e.g. of winter with summer cereals, has also positive effect for reducing the invasion of a territory by the species.

Chemical control by application of herbicides (e.g. glyphosate) repeatedly within one year, combined with other control methods, is also effective for limitation of the spread of Johnson-grass. It is resistant to many common herbicides, and in some countries (e.g. Argentina, USA) resistance to glyphosate has been recorded.

References
Clayton 1980; Smith 2008; Válev 1963; Vešlenovský 1886.
Symphyotrichum novi-belgii (L.) G.L. Nesom agg.
Confused Michaelmas-daisy

Syn. Aster novi-belgii L.
Asteraceae – Daisy family

Morphological description
Herbaceous rhizomatous perennial. Stems erect, 40–120(150) cm tall, often reddish, glabrous or nearly so. Leaves ovate-lanceolate to linear-lanceolate, the middle 4–20 × 0.4–4.0 cm, 4–10 times longer than wide, ±auriculate at base, remotely denticulate on the margin. Capitula in a symmetrical, sometimes corymbiform, panicle. Involucral bracts in 3–5 rows, oblong-lanceolate to linear-lanceolate, ±acute, the longest 5.5–7.0 mm, erecto-patent or sometimes with a recurved apex. Ligulate florets (6)10–19 × 0.9–2.1 mm, usually violet-blue, rarely white or pale blue; tubular florets yellow. Achenes (1.5)2–4 mm long, obovate, compressed, with a whitish, yellowish to pale brownish pappus.

A species of taxonomically very complex group due to the presence of numerous hybrids and garden cultivars. The species differ mainly in the shape and size of the leaves, the shape of involucral bracts and colours of the ligules. According to Bulgarian botanical literature S. ×salignum (as Aster ×salignus) is most often present, but the whole group is poorly studied and in need of a taxonomic revision.

Biology and ecology
The species in the group are pollinated by insects; blooming from August to October; fruiting from September to November. Propagated by seeds and vegetative means (by underground stolons). One flowering stem can form about 4 500 achenes for a growing season, which are spread by wind, running water and attached to the fur of animals. On 1 m² over 0.5

Included in List of “Worst invasive alien species threatening biodiversity in Europe” (Annex 1. 2007).
million achenes can be formed. Once established in a new location, the individuals reproduce mainly vegetatively. A stem can form up to 10–12 underground stolons, which can reach 1 m in length. The density can reach 50–200 stems/m². It exhibits allelopathic activity.

The species thrive on moist, humus-rich soil, in sunny or slightly shaded places; withstand prolonged flooding. In prolonged droughts and heat waves, their growth is inhibited. They occur along rivers and channels (in grasslands and at the margins of alluvial forests), in gardens, abandoned farmland, along railways and roads. The species form dense, monodominant groups covering an area of several to several tens of square meters and comprising several tens to several thousands of flowering stems. Thus, they compete with the native plant species for nutrients, water and light, replace them and change the composition and structure of the plant communities. Some of the species are grown as ornamental plants. They often suffer from powdery mildew, including the populations in Bulgaria.

**Origin and distribution**

*Symphyotrichum novi-belgii* is native to North America, however, some of the hybrids are a result of horticultural hybridization, cultivation and selection.
It was deliberately introduced to Bulgaria as an ornamental plant. For the first time a naturalized taxon of the group – \( S. \times salignum \) (as \( Aster \times salignum \)) – was reported for the country in 1984 on materials collected in 1979. There is herbarium material collected in 1899 from the towns of Lovech and Klisura, although it is not explicitly stated whether the plants are from naturalized occurrences.

Species from the group are distributed in Northeast Bulgaria, Danubian Plain, Forebalkan (Eastern), Balkan Range (Central), Sofia Region, Znepole Region, Valley of River Struma, Rila Mts, Mt Sredna Gora (Western), Thracian Lowland, up to about 1000 m a.s.l.

In Europe, species of this group were introduced from North America in the first half of the 17th century. The first reports of naturalized populations are from the early 18th century. Introduced and naturalized in most European countries.

**Control**

Prevention includes promoting the invasive nature of the species from the group in order to prevent disposal of rhizomes and flowering stems with mature achenes from the gardens to the natural habitats. Small groups can be destroyed by uprooting, carefully cleaning all stolons and rhizome fragments. The control measures should be consistently applied for several years in order to prevent recovery of the occurrence from rhizome fragments and stolons in the soil. The effect of mowing and applying herbicides to control the species of \( S. novi-belgii \) agg. is not known.

**References**

Assyov & Petrova 2006; Brouillet & al. 2006; Delipavlov & Cheshmejiev 1984; Fehér 2008; Moravcová & al. 2010; Yeo 1976.
**Xanthium italicum** Moretti

**Italian Cocklebur**

*Syn. X. strumarium* subsp. *italicum* (Moretti) D. Löve,
*X. orientale* subsp. *italicum* (Moretti) Greuter

*Asteraceae – Daisy family*

**Morphological description**

Aromatic annual. Stems 20–120(150) cm, often with purple or brownish lines or dots. Leaves alternate, long petiolate. Lamina broadly ovate or triangular, broadly cuneate to cordate at base, usually 3–5-lobed, with coarsely serrate margins and short stiff hairs on both sides. Monoecious plants; capitula unisexual, in axillary clusters or in terminal leafless inflorescences. Male capitula subglobose, situated above the female, with involucral bracts in one row; female capitula ovoid, with involucral bracts in 2 rows, the inner small, free, the outer fused, prickly. Involucre 15–35 × 6–25 mm in fruit, yellow or brown when ripe, covered with hard, hooked spines. Seeds of 2 types, remaining enclosed in the fruit.

Morphologically similar species is *X. strumarium*, which is characterized by the green stems without purplish-brown dots or lines and more slender and soft spines on the fruit.

**Biology and ecology**

Pollinated by wind, self-pollination prevails, but cross-pollination also occurs; flowering from July to October; fruiting from August to November. Monoecious plant, with male and female capitula located on the same individual. Propagated by seeds. There are literature reports of apomixis but the reproductive system of Bulgarian populations has not been studied yet. A well developed plant can form 500–5 400 (7 200) fruits, which are spread by animals and humans, attached by their hooked spines. The fruits overwinter at or below the soil surface, the seeds are not released and germinate inside the fruit. Each fruit contains two types of seeds – a small, located...
and dikes, shores of lakes and dams, coastal dunes, cultivated ground, along roads, in dumpsites and settlements. It forms subpopulations of different size – from single scattered individuals to several thousand plants, densely covering several decares. It competes with native plant species for nutrients, light and space. In disturbed and vegetation-free places it makes large and dense groups, and thus impedes the establishment of the native plants and delays habitat restoration. An important weed in cultivated areas, causing late (secondary) weeding.

Origin and distribution
Native to North and South America.

Unintentionally introduced in Bulgaria. First reported in 1889, but the species had been introduced much earlier.

Distributed in all floristic regions, up to about 1000 m a.s.l.

Introduced to Europe from America, probably in the late 18th century or early 19th century, but there is no evidence of its existence before 1822, when it was described by Moretti as a new to science species. Naturalized on all continents except Antarctica, and in many places it is an invasive species.

at the top of the fruit, with a longer period of dormancy, and a larger, at the bottom of the fruit, which germinates earlier. The seeds remain viable for several years (1–16). Optimal conditions for germination are at a depth of 2.5–5 cm, and at a depth of more than 15 cm the seeds do not germinate.

The species grows on a variety of soils, with pH 5.2–8, in sunny or slightly shaded places. It withstands periodic flooding and salinity. It occurs mainly in man-made and disturbed habitats or habitats with sparse vegetation – river banks
Control
Eradication of single, smaller plants is possible and relatively easy (an annual plant), but it is very laborious and time-consuming to remove large-sized individuals from heavily invaded, large areas. Cutting of the plants to the ground while they are still young and with soft stems gives good results. It is desirable to prevent the formation of large groups on banks and embankments of rivers and lakes, and along roads in order to avoid formation and deposition of large amounts of fruits. To limit the spread of the species in semi-natural habitats it is necessary to timely and carefully cultivate the soil in the invaded arable fields. It is sensitive to many herbicides, such as glyphosate, 2,4-D, diquat, imazapyr, etc. Where possible burning of the groups also gives good results if a high-temperature is reached.

References
**Xanthium spinosum** L.
Spiny Cocklebur

*Asteraceae – Daisy family*

**Morphological description**
Annual. Stems single, 15–100 cm tall, much branched, with 1–2 stout, 3-fid, yellow spines in the leaf-axils. Leaves alternate, lanceolate or elliptic-lanceolate, sessile or shortly petiolate; lamina entire or 3–5-lobed, dark green above, white or grey tomentose beneath. Monoecious plant; florets unisexual. Male capitula in terminal inflorescences; female capitula single or few in the axils of the leaves. Involucre 10–12 × 6–8 mm in fruit, covered with slender spines; involucral bracts in 2 rows, the outer coriaceous, free, the inner fused, with long hooked spines. Fruits ovoid, 10–13 × 4 mm, pale yellow, covered with numerous hooked spines. Seeds 2 in a fruit.

**Biology and ecology**
Pollinated by wind and insects; blooms from July to September; fruiting from August to November. Monoecious plant with male and female flowers located on the same individual. Propagated by seeds, which are distributed together with the whole spiny fruits, that can attach to the fur of animals and people’s clothes and are dispersed over large distances. Running water can also spread them. Each fruit contains two seeds, one of which germinates soon after ripening, while the other remains dormant and germinates in 2–3 years or more. For germination seeds require high soil moisture. They remain viable for up to 8 years. An individual can produce about 150 seeds.

The species grows on different soils, in dry, sunny places. It occurs in intensively used pastures, landfills, waste places, along roads, railways, yards, banks and embankments of canals and rivers. In disturbed habitats, it makes dense monodominant groups and thus slows the recovery of the habitat by native species. It com-
petes with the native plants for nutrients and space. It restricts the movement and changes the paths of animals due to the formation of very spiny, impassable groups. An important weed in cultivated areas (gardens, vineyards, row crops), causing late (secondary) weeding. In large groups in pastures it significantly reduces the effective size of the area grazed by the animals. Fruits are attached to the wool of sheep and hinder its further processing. The plants are toxic to livestock and can cause poisoning.

**Origin and distribution**

The species is native to South America.

Unintentionally introduced in Bulgaria. First reported for the flora of the country in 1891.

It is distributed in all floristic regions, up to about 1000 m a.s.l.

Introduced to Europe from South America in the late 17th century, known for Portugal since 1680 and for Southern France since 1695. It has been naturalized in the warm
and temperate parts of Europe, Asia, North America, Africa and Australia.

**Control**
Cutting (or hoeing when the areas are small) of the plants while they are still young and with soft stems, gives good results. Fruiting of the individuals should be prevented. To limit the spread of the species in semi-natural habitats it is necessary to timely and carefully cultivate the soil in the invaded arable fields. It is sensitive to many herbicides, such as glyphosate, 2,4-D, diquat, imazapyr, etc. Biological methods for control have been developed and tested, of which more promising are those with fungal pathogens (*Puccinia xanthii, Colletotrichum orbiculare*).

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INVASIVE ALIEN SPECIES
OF VASCULAR PLANTS IN BULGARIA

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