

Rapid Communication**A new record of *Prunus virginiana* L. (Rosaceae) in Poland**Artur Pliszko^{1,*} and Edyta Jermakowicz²¹*Institute of Botany, Faculty of Biology, Jagiellonian University, Gronostajowa 3, 30-387 Kraków, Poland*²*Department of Plant Biology and Ecology, Faculty of Biology, University of Białystok, Konstantego Ciołkowskiego 1J, 15-245 Białystok, Poland*

*Corresponding author

E-mail: artur.pliszko@uj.edu.pl**Citation:** Pliszko A, Jermakowicz E (2022)A new record of *Prunus virginiana* L. (Rosaceae) in Poland. *BioInvasions Records* 11(3): 609–619, <https://doi.org/10.3391/bir.2022.11.3.03>**Received:** 28 October 2021**Accepted:** 14 March 2022**Published:** 17 May 2022**Handling editor:** Carla Lambertini**Thematic editor:** Giuseppe Brundu**Copyright:** © Pliszko and Jermakowicz

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OPEN ACCESS**Abstract**

Invasion by alien trees and shrubs has been well documented in many regions of the world, and horticulture and forestry are the main pathways of their introduction. A lack of proper management and control of cultivated alien trees and shrubs can lead to their establishment and invasion in new areas. The early detection of alien woody species outside cultivation is crucial for their control and protection of native habitats. *Prunus virginiana* is a North American shrub or small tree cultivated and established in a few countries in Europe. It is considered invasive in the state of Alaska in the United States, as well as in Sweden and Central European Russia. It forms dense thickets that can outcompete native vegetation, impair visibility and limit access to recreational areas. In this paper, we present a new record of *P. virginiana* in north-eastern Poland, with a new range extension of about 300 km in the east from known spontaneous localities in Central Europe. The status of the species in Polish flora is discussed.

Key words: biological records, distribution, invasive alien species, ornamental shrubs and trees**Introduction**

Alien trees and shrubs are commonly cultivated due to their wide use as ornamental and medicinal plants, as well as a source of edible fruits and wood. Moreover, they can be used as hedges, windbreaks and against soil erosion. On the other hand, a lack of proper management and control of cultivated alien trees and shrubs can lead to their establishment and invasion in new areas (Richardson 1998; Brundu and Richardson 2016). They are usually intentionally introduced for horticulture and forestry, and their invasion has been well documented all over the world (Richardson 1998; Richardson and Rejmánek 2011; Rejmánek and Richardson 2013; Rejmánek 2014). Invasive alien trees and shrubs have a huge impact on the structure and functioning of ecosystems. They can cause loss of biodiversity (Linders et al. 2019), hinder the regeneration process of native tree species in forests (Langmaier and Lapin 2020), enhance fire intensity and reduce water quality (Chamier et al. 2012). The early detection of invasive alien species may help to protect native species and valuable habitats by allowing

for their quick and effective removal as long as they do not form numerous populations and occupy large areas. In addition, the cost of removing alien species in the early stages of invasion is significantly lower than in later stages (McConnachie et al. 2012). In Europe, many alien trees and shrubs are black-listed and controlled, such as *Acer negundo* L., *Acacia* spp., *Ailanthus altissima* (Mill.) Swingle, *Pinus* spp., *Prunus serotina* (Ehrh.) Borkh., *Quercus rubra* L. and *Robinia pseudoacacia* L. (Brundu and Richardson 2016), and their spread is observed in various habitats, including temperate forests (Brundu and Richardson 2016; Langmaier and Lapin 2020). According to Wagner et al. (2017), European forests are prone to alien plant invasions, particularly when exposed to disturbance, fragmentation, alien propagule pressure and high soil nutrient levels. In European forests, phanerophytes are the most alien species-rich (148 species) life form, and the most common invasive alien trees are *P. serotina*, *R. pseudoacacia* and *Q. rubra* (Wagner et al. 2017). In Poland, 100 alien trees and shrubs occur in forests and 68 of them are established in forest communities. Moreover, 10 species of trees and shrubs established in forests have the most negative (recomposing) impact on forest communities (Danielewicz et al. 2020). The most common invasive woody plants in Poland are *A. negundo*, *P. serotina*, *Q. rubra* and *R. pseudoacacia*. *Acer negundo* spreads mostly in riparian forests, whereas the other species are usually found in pine and mixed forests, as well as on the fringes of forests (Tokarska-Guzik et al. 2012; Danielewicz et al. 2020).

Prunus virginiana L. is a large shrub or small tree (up to 10 m high) in the family Rosaceae native to North America. It is commonly distributed in the northern and central United States and southern Canada. The native geographical range of *P. virginiana* extends from Texas in the United States to about 62° north latitude in the Northwest Territories in Canada (Mulligan and Munro 1981). It can be found in various types of habitats such as forest edges, riverbanks, sandy dunes, rocky hills, frost pockets, abandoned fields, fence lines and roadsides. However, it grows best in places with rich, well drained, moist soil and abundant sunlight, but it is also found in the shade on poor dry soils. The optimal soil pH for this species is 6.0 to 8.0 (Vilkitis 1974; Mulligan and Munro 1981; Rohrer 2014). *Prunus virginiana* was introduced to other parts of North America, Europe, Asia and South America as a plant that can be used for horticulture, forestry, and revegetation of wildlife habitats and mine spoils, as well as for soil stabilization (Johnson 2000; Danielewicz and Wiatrowska 2013; Randall 2017; ACFP 2021; Plants of the World Online 2021). The earliest introduction of *P. virginiana* to Europe took place in 1665 (Chrtek 1992). Currently, it is a casual alien species in Austria, Belgium, Czechia and Slovakia, as well as an established alien species in France, Germany, Poland, Norway, Sweden, Finland, Ukraine and Russia (Medvecká et al. 2012; Pyšek et al. 2012; Danielewicz and Wiatrowska 2013; Randall 2017

and references therein). Moreover, it is considered as an invasive species in the state of Alaska in the United States (ACFP 2021), as well as in Sweden (Tyler et al. 2015) and Central European Russia (Vinogradova et al. 2010). It is also treated as a potentially invasive species in Ukraine (Burda and Koniakin 2019). *Prunus virginiana* reproduces sexually and vegetatively by its extensive root system with suckers. It produces from 300 to 6000 fruits (drupes) per plant, and seeds can be dispersed over long distances by frugivorous birds and mammals (Mulligan and Munro 1981; Johnson 2000; Parciak 2002). The invasiveness of *P. virginiana* is mainly due to its ability to form dense thickets that can outcompete native vegetation, impair visibility and limit access to recreational areas (ACFP 2021). Moreover, it contains a cyanogenic glycoside and can be toxic to mammals with segmented stomachs. Livestock (i.e. sheep, goats and cattle) and wild animals (i.e. moose and deer) can be poisoned by eating fresh, wilted or dried leaves, and the leaves are most toxic during the spring and summer. The poisoning is caused by the formation of hydrocyanic acid in animal stomachs. There have also been cases of poisoning in humans after eating the seeds or chewing young twigs of the species (Mulligan and Munro 1981). Furthermore, *P. virginiana* harbours viruses and fungal pathogens which are of economic importance for domestic plums and cherries (Mulligan and Munro 1981).

Prunus virginiana was introduced to Poland in 1813. It is rarely cultivated in gardens and parks, and rarely established in forests, or semi-natural and anthropogenic habitats (Danielewicz and Wiatrowska 2013). The number of records of *P. virginiana* in Poland is low, and they have been registered only in the western part of the country so far (Danielewicz and Wiatrowska 2013; Zając and Zając 2019). In this paper, we present the first record of *P. virginiana* in north-eastern Poland, indicating a new range extension of the species in Central Europe.

Materials and methods

Identification of *P. virginiana* was based on morphological features provided by Mulligan and Munro (1981), and Danielewicz and Wiatrowska (2013). *Prunus virginiana* belongs to the *Prunus* subgenus *Padus* (Mill.) Peterm. which is characterized by having a raceme (as an inflorescence) and usually deciduous leaves (Liu et al. 2013). It flowers after leaf emergence. The leaves of *P. virginiana* are alternate, petiolate (petioles 4–22(–27) mm long, usually glabrous, sometimes hairy, glandular distally with two glands), obovate or elliptic to ovate or oblanceolate, 2.5–9(–11) × 1.2–5(–6.6) cm, glabrous or hairy (especially along midribs) abaxially and glabrous adaxially, with base cuneate to rounded or subcordate, serrulate to serrate margins (teeth ascending to spreading, usually sharp and eglandular), lateral veins 6–13 per side, and acuminate, acute, or obtuse apex. The racemes are 18–64-flowered with central axes (18–)40–110(–130) mm long and pedicels 2–

8(–16) mm long, usually glabrous, rarely hairy. The hypanthium is cupulate, 1.5–3 mm and glabrous externally; the sepals are erect-spreading to reflexed, semicircular, 0.7–1.4 mm, with erose, usually glandular-toothed, sometimes nearly eglandular margins and glabrous surfaces; the petals are white, obovate to suborbiculate, 2–5(–7) mm long. The fruits (drupes) are red, purple, dark purple, or black, globose, 6–14 mm, glabrous with fleshy mesocarps and stones subglobose to ellipsoid, not flattened and smooth (Rohrer 2014). In Europe, *P. virginiana* is often confused with Eurasian *P. padus* L. and North American *P. serotina* (Ehrh.) Borkh., which are commonly distributed in many European countries and belong to the same subgenus (Danielewicz and Wiatrowska 2013). However, it differs from both species by lower growth, production of numerous vertical root suckers, and the lack of calyx remnants on the developing fruit. In *P. virginiana*, the buds are widest in the middle of their length, with acuminate apex, whereas in *P. padus* they are widest below the middle of their length, with acute apex, and in *P. serotina* they are widest at the base, with weakly acute apex. In *P. virginiana*, *P. padus* and *P. serotina*, the mean number of flowers per raceme is 40, 26 and 45, respectively, and the mean flower diameter is 0.9 cm, 1.5 cm and 1.1 cm, respectively. In *P. virginiana* and *P. serotina*, the surface of the endocarp is smooth, whereas in *P. padus* it is furrowed. Moreover, *P. virginiana* can be distinguished from *P. padus* by finer serrulation on the edge of leaves, as well as the smoother and less glossy top of the leaf. It differs from *P. serotina* by having glands on the margins of the flowering calyx, lower leaf surface lacking thick brown mats of appressed hairs towards midribs, copious minor leaf veins, and smaller and squarish enclosures (Mulligan and Munro 1981; Danielewicz and Wiatrowska 2013).

Floristic surveys were conducted in the south-central part of the city of Białystok (Podlaskie province, north-east Poland) in August and September 2021. The study area included partly opened areas subjected to secondary succession and located between Letniska Street and Zwierzyniecki Park (about 5 ha), as well as forested areas of Zwierzyniecki Park (about 9 ha), which is one of the most valuable green areas in Białystok (Wołkowycki 2019). It includes the Zwierzyniecki Forest Nature Reserve, which protects a moist deciduous oak-lime-hornbeam forest for the purposes of education and recreation, and is a place of ecological monitoring informing about the state of the natural environment of the city (Kwiatkowski and Gajko 2011). Białystok lies in the Białystok Heights in the Northern Podlasie Plain (Solon et al. 2018) and covers 102.13 km² (GUS 2021). It is situated in the temperate climate zone with an average annual air temperature of about 7 °C and annual precipitation of about 600 mm (Lorenc 2005; Puczko and Jekatierynczuk-Rudczyk 2020). Herbarium specimens of *P. virginiana* collected during the study are deposited at the Herbarium of the Institute of Botany of the Jagiellonian University in Kraków (KRA0591986, 0591987).

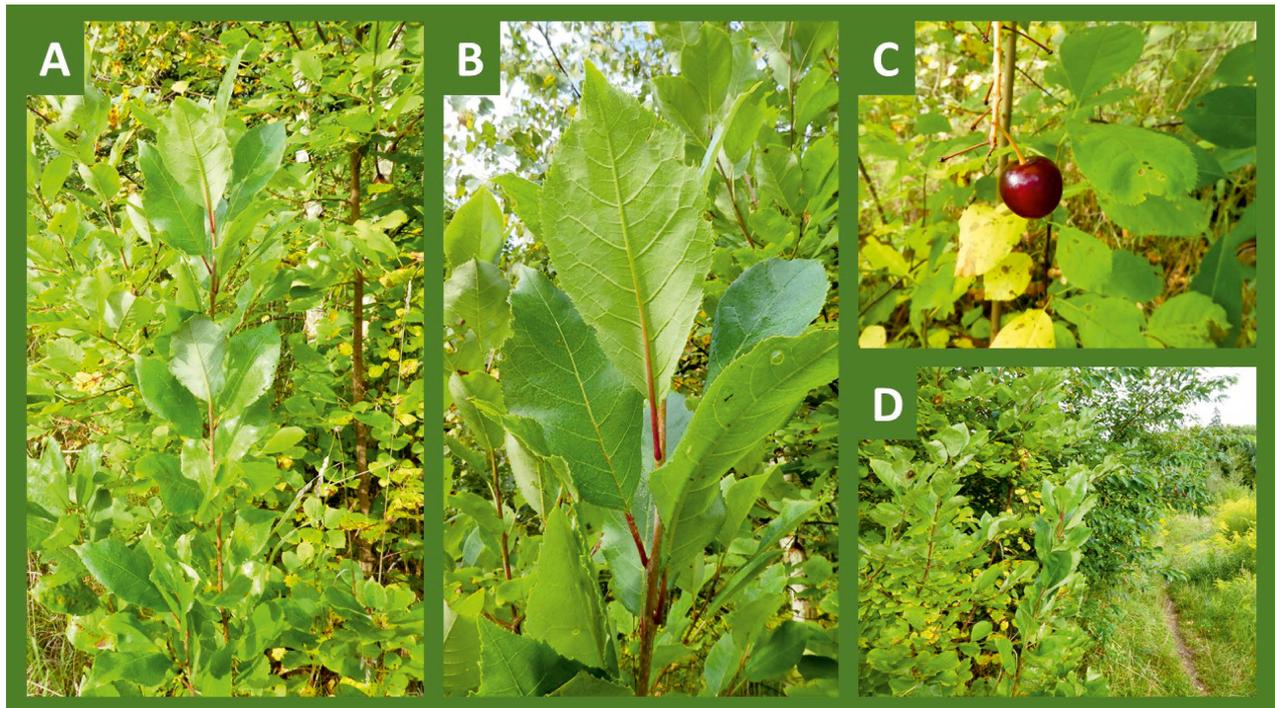


Figure 1. *Prunus virginiana* in Białystok, north-eastern Poland: A, B – leafy twigs, C – fruit, D – habitat (Photographed by E. Jermakowicz, 03 September 2021).

A map of the distribution of *P. virginiana* in Poland was prepared using the ATPOL cartogram method (Zajac 1978) and published data (Danielewicz and Wiatrowska 2013; Zajac and Zajac 2019). The geographical-historical status of the species in the Polish flora (on national and local scale) was verified using the criteria proposed by Pyšek et al. (2004).

Results and discussion

A new locality of *P. virginiana* was discovered between Zwierzyniecki Park and Letniska Street in Białystok, north-east Poland (53°06.657'N; 23°09.476'E, 143 m a.s.l.), on August 16, 2021. The species was found growing on abandoned land which was excluded from agricultural use over 30 years ago. Two generative and thirteen vegetative individuals of *P. virginiana* were recorded along an informal waking path (Figure 1). The generative individuals grew at a distance of 2 m from each other, and they were about 3.5 m and 2.0 m high. The vegetative individuals (most likely originated from root suckers) were small (ranging from 0.5 to 0.8 m in height) and grew at a distance of 0.5 m from the larger generative individual. *Prunus virginiana* was accompanied by trees (*Betula pendula* Roth, *Prunus serotina* (Ehrh.) Borkh. and *Quercus robur* L.) and perennial herbs (*Achillea millefolium* L., *Artemisia vulgaris* L., *Carex hirta* L., *Cichorium intybus* L., *Dactylis glomerata* L., *Equisetum arvense* L., *Plantago lanceolata* L., *Solidago canadensis* L., *Trifolium repens* L. and *Vicia sepium* L.).

Prunus virginiana is a rare established alien species in Poland with a total of 33 localities in the western part of the country (Danielewicz and

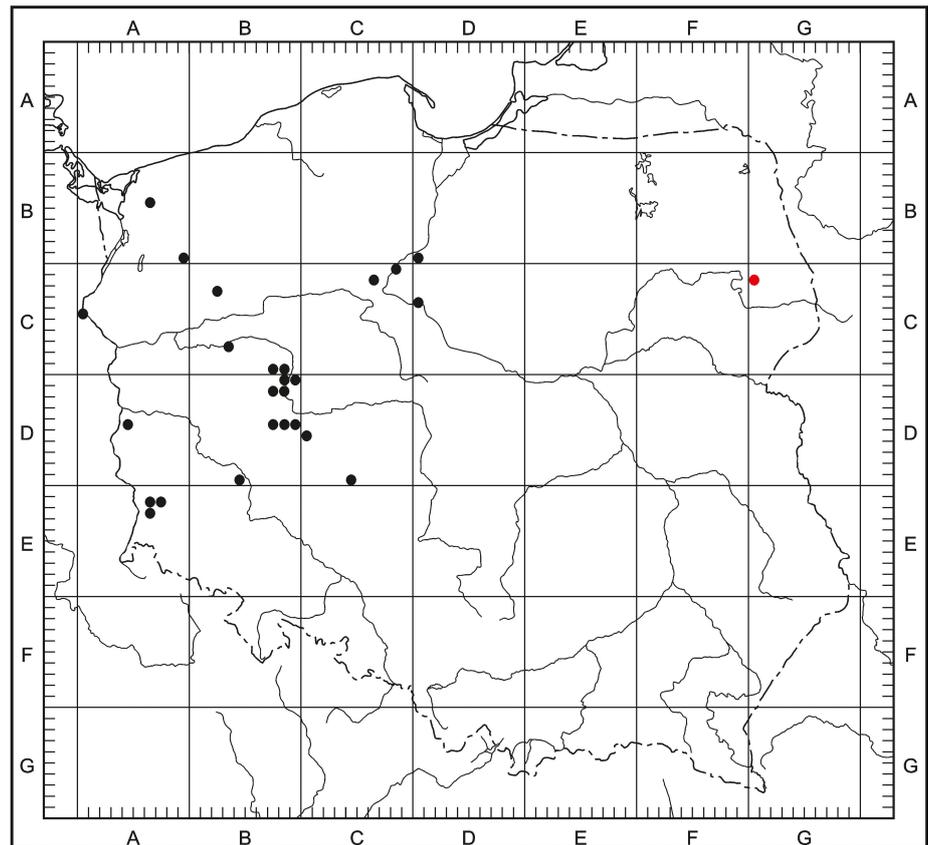


Figure 2. Distribution map of *Prunus virginiana* in Poland (black circles indicate known records after Zajac and Zajac (2019), red circle indicates a new record).

Wiatrowska 2013; Zajac and Zajac 2019). The earliest known record confirming the naturalisation of the species in Poland was provided in 1980 by J. Zieliński, who found the plant in thickets on the edge of oak-hornbeam forest at Maltańskie Lake in Poznań, Greater Poland province (Danielewicz and Wiatrowska 2013). Over the next 10 years, three more localities (two in Poznań and one in Puszczykowo near Poznań) were found (Danielewicz and Wiatrowska 2013). In 1991–2000, the number of localities increased from four to 18, and the species has been recorded not only in Greater Poland province but also in the provinces of Kuyavia-Pomerania, West Pomerania, Lubusz and Lower Silesia (Danielewicz and Wiatrowska 2013). In 2001–2010 and 2011–2020, the number of localities increased to 22 and 33, respectively. However, the species has been recorded only in the above-mentioned provinces (Danielewicz and Wiatrowska 2013; Zajac and Zajac 2019). In north-eastern Poland, it has not been reported as a spontaneously occurring alien species so far (Brzosko et al. 2016; Zajac and Zajac 2019). Currently, a new locality in Białystok is the easternmost point of the *P. virginiana* distribution in the country, indicating a significant range extension of the species. It is situated about 300 km from the nearest stands in Gogolin and Toruń in western Poland, within the unit GC10 of the ATPOL cartogram grid, and the total number of units with the *P. virginiana* localities is 26 (Figure 2). The distribution of *P. virginiana* in

Poland is poorly recognized due to a lack of intensive floristic studies and frequent misidentification with *P. padus* (Danielewicz and Wiatrowska 2013). Therefore, it cannot be ruled out that the species has more localities in the north-eastern and other parts of Poland. It is difficult to state clearly whether *P. virginiana* was introduced to Białystok by humans or transported by wild birds or mammals from a site located away from the city. The individuals of *P. virginiana* were found at a distance of about 75 m from Zwierzyniecki Park and 30 m from the fence of private property near Letniska Street. However, neither in the park nor on the property were other individuals of the plant found during the study. The fleshy drupes of *P. virginiana* are attractive to many frugivorous birds and mammals that are also involved in its seed dispersal (Vilkitis 1974; Mulligan and Munro 1981; Johnson 2000). Birds are prevalent seed dispersal agents for invasive alien trees and shrubs, and they can transport seeds over long distances (Richardson and Rejmánek 2011). If the seeds of *P. virginiana* did not come from long-distance transport, they were most likely introduced by birds or mammals from one of the allotments or other green spaces located within the city. There are various wild animals in Białystok that can potentially spread the seeds of this species, such as thrushes (*Turdus philomelos* C.L. Brehm), blackbirds (*Turdus merula* L.), finches (*Fringilla coelebs* L.) and foxes (*Vulpes vulpes* L.) (Kwiatkowski and Gajko 2011). Due to the high probability of seed transport by wild animals to Zwierzyniecki Forest and the Zwierzyniecki Forest Nature Reserve, the plant should be removed and its new emergences need to be monitored and controlled. To be fully established in a new area, alien plants must sustain self-replacing populations for at least 10 years without direct intervention by people (Pyšek et al. 2004). The size of the individuals as well as the ability to produce fruit suggest that *P. virginiana* has been present in the new locality in Białystok for at least several years. However, further observations are needed to confirm the establishment of the species in the local flora.

Although *P. virginiana* has been established in western Poland for quite a long time (> 40 years), it is not considered an invasive or a potentially invasive species (Tokarska-Guzik et al. 2012, 2021; Danielewicz and Wiatrowska 2013; Danielewicz et al. 2020). The number of its localities is low and increasing slowly, and its populations are not abundant, in contrast to the commonly distributed and invasive *P. serotina* (Danielewicz et al. 2020). According to Danielewicz and Wiatrowska (2013), *P. virginiana* is usually found in the shrub layer of oak-hornbeam forests, elm-ash and ash-alder riparian forests, pine forests, as well as in mesophilous thickets on the edge of broad-leaved forests and pine forests. It also occurs in semi-natural and anthropogenic habitats, such as thickets on the edge of semi-natural forests and railway embankments. It usually forms small clusters consisting of a few to several individuals occupying an area of about 50–100 m², and the largest compact patches of this species reaching up to 400 m²

were observed in Wielkopolski National Park. Moreover, in the vicinity of Poznań, as well as in Lower Silesian coniferous forests, seedlings of *P. virginiana* were usually found at a small distance (up to about 100 m) from fruit-bearing individuals most frequently growing at the edge of forests (Danielewicz and Wiatrowska 2013). Therefore, in our opinion *P. virginiana* does not currently meet the criteria of invasive alien plant species proposed by Pyšek et al. (2004). However, Danielewicz and Wiatrowska (2013) stated that further studies are needed to confirm the invasiveness of *P. virginiana* in Poland. Particular attention should be paid to the ability of wild birds and mammals to transport seeds of the species over long distances, as well as the impact of new introductions on establishment in new regions and the impact of *P. virginiana* on native species and plant communities. Despite the threat from *P. virginiana* to forest communities in Wielkopolski National Park projected by Purcel (2009), it has not yet been confirmed that the species significantly transformed plant communities or displaced native species in Poland (Danielewicz and Wiatrowska 2013; Danielewicz et al. 2020). Perhaps *P. virginiana* needs more time to establish abundant populations, expand geographic range and fully manifest its invasiveness. Nevertheless, we suggest treating this species as potentially invasive in Poland, because it shows good competitive ability, can form compact patches in various habitats, including natural and semi-natural ones, as well as it can be easily dispersed by birds or mammals. In Sweden, *P. virginiana* has been evaluated as a species with a high index of invasive concern (close to *P. serotina*), although it is only scattered in some regions (Tyler et al. 2015). Like many other shrubs of Rosaceae, *P. virginiana* prefers open areas and forest edges (Mulligan and Munro 1981). In open areas it produces more seeds than in shaded areas. However, the seeds can germinate under closed forest canopies and seedlings can survive and mature in partially shaded habitats (Mulligan and Munro 1981; Johnson 2000). In forests, it can form a tall shrub layer reducing the survival of *Quercus* seedlings (Lorimer et al. 1994). Moreover, it readily colonizes open areas, often as a pioneer species, creating dense thickets (Vilkitis 1974; Mulligan and Munro 1981). It is also well adapted to disturbance by fire and regenerates fast from root crowns and lateral root fragments (Johnson 2000). According to Vilkitis (1974), *P. virginiana* is a very competitive shrub due to its tolerance to adverse ecological conditions such as cold temperatures, shade and drought, and its ability to sprout prolifically. It is widely adaptable to temperature extremes, being found in USDA hardiness zones 2 to 7 naturally, and in the zone 10, if planted (Crowder et al. 2015). It also occurs in a wide range of soil types, from abandoned construction sites, with almost no soil depth or fertility, to deep virgin grasslands, with deep profiles and a high level of nutrients. Moreover, it grows on soils with different textures, from silt to sandy loam, but it does not do well on heavy clay soils (Crowder et al. 2015). For example, *P. virginiana* has been established in riparian communities in

Anchorage in the interior-boreal ecogeographic region of Alaska in North America (ANHP 2011), as well as in deciduous and coniferous forests and shrub communities in the forest-steppe zone in Ukraine in Europe (Pashkevych and Burda 2017), proving its wide tolerance to temperature and habitat conditions. Since *P. virginiana* easily escapes from cultivation and often becomes established in places close to its cultivation (ANHP 2011; Mayorov et al. 2012; Danielewicz and Wiatrowska 2013; Pashkevych and Burda 2017), it should be monitored and controlled, especially when it is grown near protected areas such as national parks and nature reserves.

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Authors' contribution

AP: research conceptualization, methodology, writing original draft, manuscript improvement after review; EJ: investigation and data collection, writing the original draft, manuscript improvement after review.

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