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DISTRIBUTION OF THE INVASIVE SPECIES *Ailanthus altissima* (P. Mill.) Swingle ALONG THE DANUBE RIVER BANKS ON THE TERRITORY OF NOVI SAD

MAJA MESELDŽIJA[*], *MILICA DUDIĆ*, *SONJA STIPANOVIĆ*
Faculty of Agriculture, University of Novi Sad, Trg Dositeja Obradovića 8, 21 000 Novi Sad, Serbia
[*]*Corresponding author*: maja@polj.uns.ac.rs

SUMMARY

As an invasive species, Ailanthus altissima (P.Mill) Swingle can pose a serious threat to biodiversity and ecosystems. The purpose of this research is to determine the distribution of A. altissima along the Danube river bank in the urban and ruderal areas of Novi Sad during the period 2017-2018. The level of weediness was determined using the European Weed Research Society (EWRS) method based on the investigated species count per 1 m^2 (in 10 repetitions). A total of 7 localities with a widespread population of the species were identified and examined. The largest number of A. altissima individuals featured tree heights of up to 1 m, followed by trees of up to 10 m in height, whereas older trees exceeding 10 m in height accounted for the smallest number of individuals. The species examined was found to be predominant on chernozem and alluvial soils.

Key words: *Ailanthus altissima* (P.Mill.) Swingle, *invasive species, distribution, Danube river bank, Novi Sad*

INTRODUCTION

Modified environmental conditions in the city significantly affect the urban vegetation. The spread of invasive species is posing a serious ecological challenge worldwide as they may act as vectors of new diseases, precipitating adverse changes in biodiversity and landscape (Lazarević et al., 2012).

The invasive *A. altissima* (Mill.) Swingle, a member of the family *Simaroubaceae*, is a plant species introduced into Europe from Asia in the 18th century (Wickert et al., 2017) as food for silkworms (*Bombyx cynthia*). It is one of the most distributed broadleaved tree species preferring urban and rural disturbed areas (Sladonja & Poljuha, 2018) such as agricultural fields and transportation corridors, especially abandoned plots, meadows, vineyards or cracked city sidewalks (Filippou et al., 2014). It grows rapidly and reaches a height of 18-21 m in 10 years (Rebbeck & Jolliff, 2018) at a growth rate of more than 2 m per year in young plants. It possesses alternately arranged compound leaves, as well as heart-shaped leaf scars on older branches, and is sometimes referred to as the "stink tree" because its leaves have an unpleasant smell when crushed (Fotiadis et al., 2011). *A. altissima* grows on a variety of soil types (barren rocky grounds, clay, sand, calcareous, and gravel substrates) exposed to varying levels of annual precipitation (Kowarik & Säumel, 2007) and has adjusted to various temperatures, light volumes and moisture levels regardless of the soil stoniness or pH as well as urban pollution degrees (Bowker & Stringer, 2011). The invasive behavior of *A. altissima* can be ascribed to its physiological characteristics and the allelopathic compounds in the roots, leaves and wood (Filippou et al., 2014). However, the species can be used as a source of pharmaceutically active compounds such as ailanthone (quassinoids), which is an effective phytotoxic component potentially usable as a broad spectrum herbicide (Heisey & Heisey, 2003). Recent studies have showed that quassinoids could be used to treat some virus infections. Furthermore, *A. altissima* can be used for firewood, paper production, environmental rehabilitation, bee pastures and erosion control on slopes (EEA, 2012; Sladonja et al., 2015). It is considered a "weed" tree because of its rapid growth (Fotiadis et al., 2011), widespread shallow root system, high seed

production, tolerance in polluted environments and secretion of chemicals from the roots and stems (Vilà et al., 2006). In addition to grazing, burning and biocontrol, the control methods entail manual, mechanical and chemical means (Meloche & Murphy, 2006). The root-killing herbicides triclopyr and glyphosate currently provide the best chemical control, alongside dicamba, imazapyr and methsulfuron methyl (Eck & McGill, 2007). Badalamenti and LaMantia (2013) showed that the application of glyphosate in a drilled hole in the trunk killed 90% of the treated trees in 1 month. All treatments require the subsequent monitoring and control of the shoots emerging from seeds, roots or stumps because *Ailanthus* is difficult to remove once it has established a taproot (Kowarik & Säumel, 2007). This paper shows the distribution of *A. altissima* in the selected ruderal and urban habitats of Novi Sad during the period 2017-2018.

MATERIAL AND METHODS

The research was conducted in the period July-September 2017-2018 at the following locations in Novi Sad: Quay (the left bank of the river Danube) and Ribnjak (along the embankments on the right bank the river Danube). Both ruderal and urban habitats were studied in order to inventory the species *A. altissima.* The level of weediness was determined using the European Weed Research Society (EWRS) method (in 10 repetitions) based on the investigated species count per 1 m^2 of the locality under consideration (Püntener, 1981). Tree heights were estimated freely on the basis of the comparison with the present objects of known height.

RESULTS AND DISCUSSION

On the basis of the mapping of the invasive weed species *A. altissima* in the ruderal and urban areas in Novi Sad, the maps of its distribution were created using satellite images obtained from the Internet (Google Earth). A total of 7 localities were recorded, and the disposition of the species was sorted according to the height (Fig. 1, Tab. 1).

Table 1. Locations affected by the *A. altissima* abundance, average tree height and the type of habitat

No.	Locality	Surface (m^2)	No. of individuals/ Height (m)
1	Ribnjak under road	8	10/1m 6/10m 4/ >10m
2	Živojin Ćulum Dorm	6	12/1m 4/10m 3/ >10m
3	Entrance to Štrand	3	2/10m 3/ >10m
4	Quay	6	7/1m 5/10m
5	University park	2	2/1m 1/10m
6	Turning of Radnička Street	1	1/10m
7	Turning of Miloša Bajića Street	1	1/ >10m

Legend of the *A. altissima* tree height:


Trees up to 1 m in height


Trees up to 10 m in height


Trees above 10 m in height

The climate and environmental conditions in Serbia have been favorable for the development and spread of this species. Although it grows spontaneously on riverbanks, it also thrives well in the plains and hilly areas of Serbia. This species is very tolerant of urban conditions such as nutrient and water deficient soils and polluted airspace, and it can grow in cracks on sidewalks, roads and parking areas. Consequently, the magnitude of its expansion is greatest in big cities. It quickly spreads along railways and roads, invading more natural zones. In Hungary and the Western USA, it was recorded in peri-urban forests (Motard et al., 2011). According to Fotiadis et al. (2011), *A. altissima* was observed in association with *Salix alba* L. and *Platanus orientalis* L. in non-urban areas. The species has been reported along the Danube river and streams in France, Switzerland, the Mediterranean, and North America

(Kowarik & Säumel, 2007), as well as in the flooded areas of the Danube in association with *Populus alba* L., *P. nigra* L. and *Fraxinus excelsior* L.

The results obtained in this research indicate that the average height of the trees examined was up to 1 m (31 individuals) at 4 localities under consideration, whereas tree heights of up to 10 m were recorded at 6 localities under consideration (19 individuals). The average tree height exceeding 10 m was recorded in 11 individuals at 4 localities under consideration. The highest percentage of *A. altissima* was recorded on chernozem soils along the Danube river quay in Novi Sad, which is a predominant type of soil in Vojvodina accounting for approximately 50% of its total land area, whereas the largest number of *A. altissima* trees was recorded on alluvial soils (fluvisols) at the Ribnjak location. Fluvisols occur on all continents and in all climates, occupying some 350 million ha worldwide, of which more than half are in the tropics (FAO, 2006). It is noteworthy that *A. altissima* grows on almost all soil types, but predominantly on chernozem and alluvial soils.

In Hungary, the species colonize soils consisting of sand, dolomite, loess and limestone (Udvardy, 1998). A number of studies have suggested that *A. altissima* grows most vigorously on nutrient-rich, loamy soils, but it can also tolerate nutrient-poor soils. Pan and Bassuk (1985) found that *A. altissima* prefers sandy loams to sandy soils.

Figure 1. Satellite image of the area under consideration with marked *A. altissima* localities

Maps I, II, III and IV (Fig. 2-5) show the habitats of *A. altissima* in the area under consideration using symbols of different colors for different tree heights.

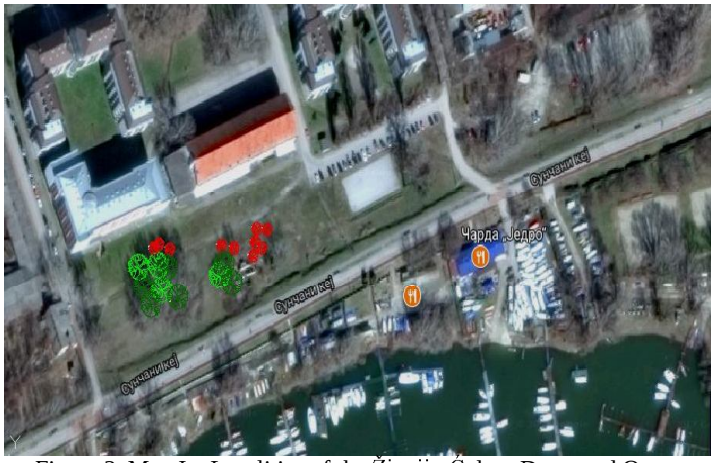

Figure 2. Map I – Localities of the Živojin Ćulum Dorm and Quay

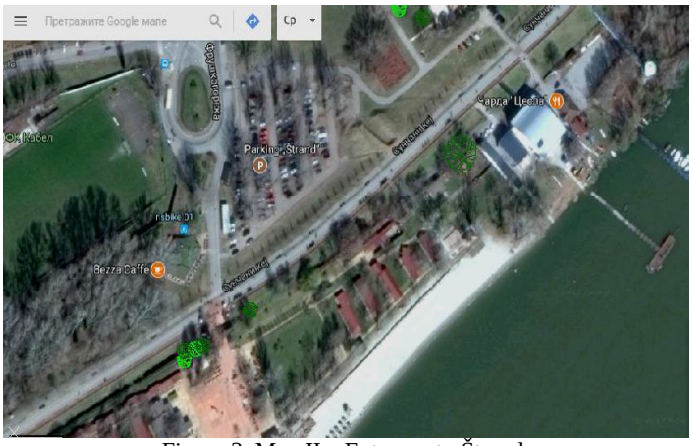

Figure 3. Map II – Entrance to Štrand

Figure 4. Map III - University park and Ribnjak under the road

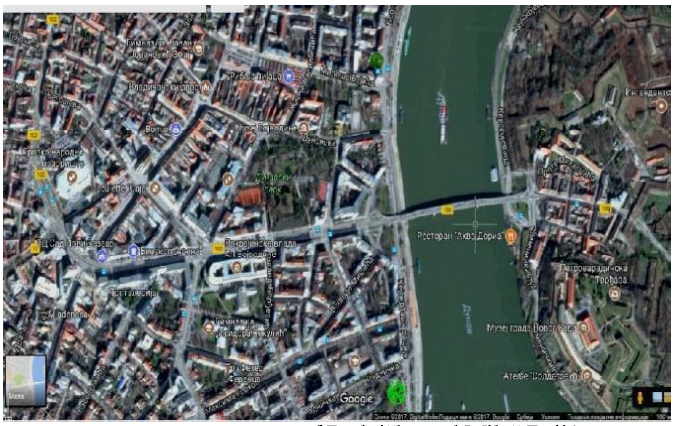

Figure 5. Map IV - Turnings of Radnička and Miloš Bajić Streets

The largest number of *A. altissima* individuals was found to have a tree height of up to 1 m, followed by trees of up to 10 m in height, whereas older trees exceeding 10 m in height accounted for the smallest number of individuals. Depending on the geographical area and habitat, the *A. altissima* tree can grow up to 30 m in height and reach the age of 130 years (Sladonja et al., 2015), averaging approximately 50 years of age. The mapping of *A. altissima* is very important in order to determine whether the population is expanding, maintaining the same extent or diminishing. A significant body of literature has argued a number of limitations of the *A. altissima* tree such as a low tolerance to cold weather and a sensitivity to shade, which could be used to prevent its further spread. As *A. altissima* belongs to the group of invasive weeds, its research is greatly significant and perpetually topical.

CONCLUSION

A total of 7 localities with a widespread population of *A. altisima* were identified and examined along the Danube river bank in the urban and ruderal areas of Novi Sad during the vegetation period 2017-2018. Most of the *A. altisima* habitats identified were found in the vicinity of the Novi Sad urban area (along Novi Sad Quey). The tree of heaven is one of the invasive species growing along the Danube river bank. The largest number of *A. altissima* individuals examined was found to exhibit a tree height of up to 1 m, followed by trees of up to 10 m in height, whereas older trees exceeding 10 m in height accounted for the smallest number of individuals. The species examined was found to be predominant on chernozem and alluvial soils. It has been established that the distribution of *A. altissima* in the area under consideration is tolerable, posing no danger to autochthonous species due to regular mechanical control practices.

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