UNIVERSITY OF SOPRON

PHD THESIS

HISTORY OF DISTRIBUTION AND PROPAGATION OF INVASIVE TREE SPECIES IN HUNGARY

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1. Introduction and Objective

Problems caused by invasive plant species are increasingly well known, and the biological characteristics of more common species are basically well explored. Continuous accumulating results have been presented to enquirers along with numerous studies in summary monographs as well (MIHÁLY and BOTTA-DUKÁT 2004, BOTTA-DUKÁT and MIHÁLY 2006, CSISZÁR 2012). The increasingly diverse knowledge has already made it possible to publish a handbook on control activities in the mid-2010s (CSISZÁR and KORDA 2015). The importance of the topic is indicated by the more and more legislation trying to address certain segments of the problem both in Hungary and in the European Union.

Despite the importance of the problem, the Hungarian history of invasive species is generally only superficial. My aim is to fill this gap in the case of six most invasive tree species in Hungary. In this research common hackberry (*Celtis occidentalis*), black cherry (*Padus serotina*), tree of heaven (*Ailanthus altissima*), box elder (*Acer negundo*), Russian olive (*Elaeagnus angustifolia*), and green ash (*Fraxinus pennsylvanica*) were included.

So far, the Hungarian history of the six species has been explored to varying degrees. In the case of black cherry the workmanship of Magdolna Juhász (JUHÁSZ 2004), tree of heaven of László Udvardy (UDVARDY 2004), box elder of Ágnes Csiszár (CSISZÁR 2008), and green ash of Ágnes Csiszár and Dénes Bartha (CSISZÁR and BARTHA 2004) can be highlighted. The authors also uncovered numerous, detailed historical information about the species. In contrast, in monographs on common hackberry and Russian olive (e.g. Bartha and Csiszár 2006a,b) the discussion of historical aspects was narrow.

During my study, I would like to answer to four basic questions:

1. When and how were these species introduced to our country?
2. How have the professional judgments of species changed?
3. How have the judgments of species changed from nature conservation point of view?
4. Which factors influenced the distribution and propagation of the species?

2. Material and Methods

2.1. Methodology for exploring the historical background

The method of my research is the exploration of the literature sources published in print from the first sources published on the topic to the present day (first half of 2019). My main goal was to make the elaborated literature as wide as possible. In addition to the literature of natural sciences, I also considered it important to review the publications in some practical sectors (mainly forestry, horticulture and beekeeping) and lay writings in detail.

2.2. Methodology for evaluating the information revealed

The importance of the species was evaluated on a five-point, linear, open-ended scale by sector. This means that a species cannot receive a value higher than 5 even if its significance has increased further to reach level 5. The information explored was evaluated on a 10-year basis. The role of the species in the given decade was judged in a subjective way, and I inferred it from the volume and content of the publications weighted together.

In the case of the sectors involved in the utilization of the species, the scale shows the role that the species played in the given sector and decade in a positive sense, so the more widely used, the higher the value.

The damage rating scale is negative, i.e. the more studies confirm the species problem, the higher the value.

Average values were also calculated for the relevant sectors. The value thus obtained is intended to illustrate the overall role played by the species in the sector and during the decade under review. In other words, value is the extent to which a given sector has contributed to the distribution of the species. I also did the same averaging for nature conservation damage. Here, the value shows the extent to which a given habitat group is affected by the damage to the species.

3. Results

3.1. History of the tree species discussed

One of the most important results of the exploration of the historical background is that the elaborating of the 1775 literature sources made the Hungarian history of the species discussed much more detailed than before. These events are presented in chronological order from the first references in the literature to the present day, in separate chapters. Tracking the history of the species provides opportunity to learn about the process by which the different sectors has been picked up, extensively utilized and, for various reasons, disregarded the species (where it has already occurred). In parallel with these events, we can also follow the evolution of the nature conservation stance on the species, and how locally emerging, rather interesting species have become one of the most important threats to Hungarian biodiversity.

Each of these six stories, presented separately, is not facilitated by the narrow framing of the thesis booklet, so the following are the most important general conclusions that can be drawn from them. The detailed histories of the species can be found in Tilia XIX (KORDA 2018).

The important and basically generalizable results of historical analysis can be deduced from the analysis of the factors involved in the propagation of species. (The role of each sector has been the subject of detailed analysis and is discussed in Chapter 3.1.) One of the most important questions is the role played by the respective state leadership in the propagation of these species and the influence of the political environment on it. The two factors are closely related, so it is worth examining them together. The issue is most illustrated perhaps in the forestry sector. The analysis has clearly shown that there are double periods of propagation in forestry for the species discussed. In all cases, the first propagation period was based on professional principles, and in the vast majority of cases it was guided by a desire for improvement. For the six species, this period can be divided into two sub-periods. The first is before the Trianon decision, when species played an important

role in planting of sandy and barren areas. An important feature of this period was that the quality of wood was a secondary issue for species planted for these purposes. At this time, these species were used barely for economic purpose, except for the green ash in the floodplains. The subsequent period lasted from the Trianon decision to the end of World War II. In addition to the above mentioned objectives, the need to reduce the wood shortages also emerged, so the issue of subordinate plantations of saline areas has become very important. It is also characteristic of this period that the use of the species was intended to improve. It is important to emphasize that it has been proven and professionally confirmed in most utilization areas at the end of the era that these species are not suitable for these purposes for various reasons, but are fundamentally unsuitable.

During these periods, the role of the state was double, on the one hand, state-owned forests took their share of the afforestation, and on the other hand, the state provided seedlings for this purpose preferentially or even free.

The second, largely forced propagation period caused by the political environment lasted from the end of World War II to the end of plan management. It is typical of this era that, although the forestry has largely neglected the use of species in the past, they have again been forced to resort to these species because of the excessive demands of plan management for afforestation. This is mainly due to the lack of sufficient propagation material of valuable tree species, thus, very large numbers of species easy to grow were used to implement the required plans.

In the subsequent period, the species began to decline in importance, which, with the exception of Russian olive, ceased to exist around the time of the change of regime.

It is also important to note that the use of species has rarely been preceded by meaningful experiments, and even if they did, the use of species on the site has begun well before their results. Thus, the substantive experience with these species has mainly come from practical utilization. By the time the negative features of the species became evident, they were widely used. In this connection, it can also

be stated that the economic damage caused by species was recognized by the forestry at an early stage, however, their utilization has been surprisingly late compared to this, and even nowadays the idea arises for energy plantations and agro-forestry.

During the detailed exploration of the history of the species it has been proved for several species that they were present in Hungary much earlier than what is accepted today. Evidence for this was found in *Ailanthus altissima* (1802), *Celtis occidentalis* (1798), *Fraxinus pennsylvanica* (1798) and *Padus serotina* (1808).

Similarly, the dates of first escapes were corrected for *Acer negundo* (1867), *Ailanthus altissima* (1887), *Elaeagnus angustifolia* (1840s), *Fraxinus pennsylvanica* (1920s) and *Padus serotina* (1909).

3.2. Analysis of utilization history

The economic role of the species was examined in 13 utilization sectors. Horticulture, beekeeping, silk production and game management were analysed independently, while forestry was divided into nine specialized areas.

Given the limitations of the scope, the results of the analysis of the role of sand afforestation are presented as an example.

Based on a joint assessment of the importance of the species, it can be stated that sand afforestation was the most important forestry area in the utilization of invasive species (Figure 1). The driving force behind this, especially until the first half of the 1900s, was to curb the running sand in the country's sandy areas, which caused serious economic and health problems.

Forestry attempts were made in the second half of the 18th century to fix the running sand, but the species discussed did not become involved until later, in the mid-1820s, first with the box elder and especially with the tree of heaven. From then until the end of the 1850s, we only read sporadic references to such uses. From the 1860s until the end of the first decade of the 1900s, the intensity of the use increased significantly, roughly evenly, which was initially explained by the increasing planting of the tree of heaven and then the box elder. By this

time, the other species discussed also appeared among the tree species used in sand afforestation, though only on an experimental basis.

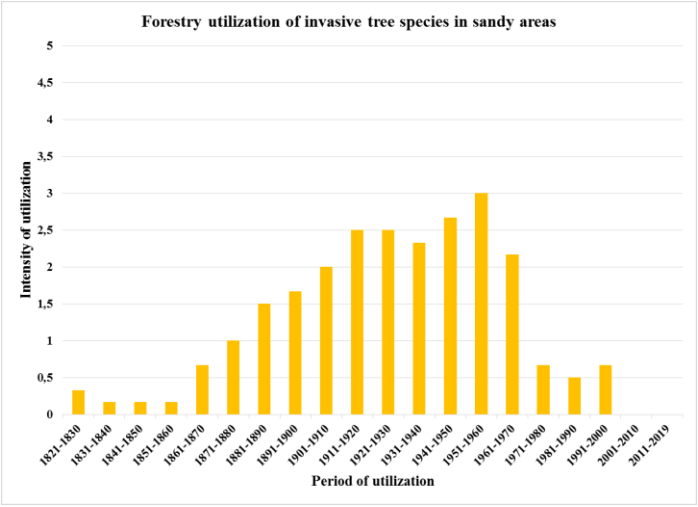

Figure 1. Intensity of forestry utilization of invasive tree species in sandy areas

The average utilization of species increased substantially between 1911 and 1940, but in the 1930s there was a slight decline due to the short-term decline in the use of box elder. Significant growth is strongly felt by the shortage of wood as a result of the Trianon decision and, in this context, by the impact of the 1923 Lowland Forestation Act. It is imperative to emphasize in these three decades that the increase in average use has been significant despite the fact that the use of tree of heaven and box elder has begun to decline, but in parallel the use of green ash, common hackberry and black cherry has increased.

Due to the exaggerated demands of plan management, the use of these species increased further in the 1940s and reached its peak in the 1950s. By this time, the importance of the tree of heaven continued to decline, but at the same time the box elder was reapplied and the black cherry and the common hackberry were spectacularly rising.

In the 1960s, plantation of these species declined dramatically, and from the 1970s to the turn of the millennium, drastically decreased. Since the 2000s, no further proposals have been made for the use of these species in sand forestation.

3.3. Analysis of nature conservation significance

The analysis of nature conservation aspects covered the impact of the natural habitats of our country (in the case of 9 habitat groups), the invasive species control and the evaluation of the legal environment intended to address the problem.

As an example, an analysis of the impact of floodplain and swamp forests is provided.

The most endangered forest habitats with the invasion of tree species include the floodplain and swamp forests (Figure 2), but among these softwood floodplain forests are also particularly affected. The first writing on the subject was published in 1957 by Tibor Simon. In his book, he was wary of criticizing the practice of planting the sedge meadows formed between floodplain and swamp forest complexes in the Northern Great Plain with green ash. He suggested the use of narrow-leafed ash instead of green ash.

Next time, more than twenty years later, can we read a publication about the habitats in question. In an article published in 1979, István Lőrincz wrote about the spreading green ash in connection with the Bird Reserve in Pély near the Tisza: „*It is feared that in a few decades this alien tree species will outcompete the native species*."

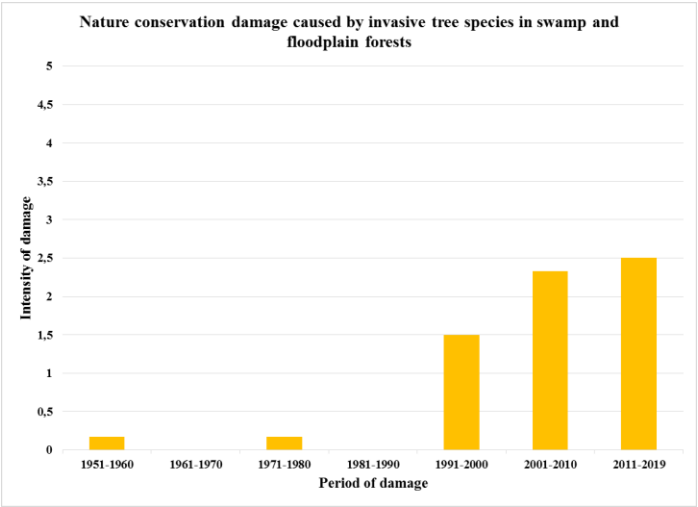

Figure 2. Nature conservation damage caused by invasive tree species in swamp and floodplain forests

His concerns were by no means unfounded, and even the publications on the subject testified that this phenomenon did not have to wait for "a few" decades. From the beginning of the 1990s, articles on the problems caused by these species were published successively. Among the habitats softwood floodplain forests were outstanding, among the species causing the damage green ash were the most prominent. In the 1990s, forestry began discussing species-related problems with such intensity that it could be characterized by four on a five-point scale. At the same time, the writings describing the damage caused by the box elder appeared, but with a much smaller emphasis than green ash. Among other species, the presence of common hackberry and tree of heaven in floodplain forests and the naturalization of the black cherry from the Nagymohos willow swamp in Kállósemjén have already been reported.

In the 2000s, the most spectacular change occurred in the case of box elder, whose significance jumped from the value two of the previous decade to the maximum of five. Green ash has also reached

this level. This has made the two species the most invasive tree species in the floodplains that cause the greatest nature conservation problems. The overwhelming majority of writings on their damage refer to softwood floodplain forests, but are often mentioned from hardwood floodplain forests and occasionally from stream alder forests. In addition, green ash also appears among the threatening factors of alder swamps and shrubs. A more significant change is that, in this decade, Russian olive has emerged as a new species among the threatening factors for willow shrubberies, though only at the mention level.

The importance of the majority of species did not change in 2010, with only a small but clear increase in the hardwood floodplain forests in the case of tree of heaven. In the case of black cherries, it is important to note that the habitats affected by its occurrence have already been extended to hardwood floodplain forests in addition to swamp forests in this decade. In the case of the box elder, the swamp forests has also been included in the list of endangered habitats.

As you read through the history of the six species, it may seem striking that no story is over, and in fact, they are only really unfolding from a conservation point of view. This points out that similar follow-up of their history will be needed in the future.

The lack of black locust (*Robinia pseudoacacia*) in the species discussed may be striking. This is because the study on the subject has shown that exploring the historical background of black locust would in itself be a greater task than the six above-mentioned species together. Accordingly, it would be advisable to examine this in the framework of an independent research, which I will try to undertake later.

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Theses

1. By the historical overview of 1775 literature references I have been able to contribute significantly to the Hungarian history of the six invasive species (*Acer negundo*, *Ailanthus altissima*, *Celtis occidentalis*, *Fraxinus pennsylvanica*, *Elaeagnus angustifolia*, *Padus serotina*) causing extreme nature conservation problems in Hungary. In the course of my research, I have been able to correct mistakes that go back several decades.

2. For several species, I was able to prove that it was present in the Hungarian flora, which was generally accepted by the expert opinion so far: *Ailanthus altissima*: 1802, *Celtis occidentalis*: 1798, *Fraxinus pennsylvanica*: 1798, *Padus serotina*: 1808. In the case of several species, it has also been proved that their spontaneous spread has already begun to be generally accepted: *Acer negundo*: 1867, *Ailanthus altissima*: 1887, *Elaeagnus angustifolia*: 1843–1847, *Fraxinus pennsylvanica*: 1920s, *Padus serotina*: 1909.

3. We have learned more about the factors that led to the large-scale distribution of each species. I pointed out the principles and the contribution of different sectors to the spread of these species, the role of the state, politics, the intention to improve, economic gain, or even chance.

4. I have elaborated a five-point scale suitable for the historical evaluation of the nature conservation and economic importance of any invasive plant species.

5. I have discovered the circumstances that ultimately shook confidence in each species within the given sector (which was not yet the case for all species and for all sectors).

6. I pointed out that the unrealistic expectation of plan management in the field of afforestation created a constraint that led to the forestry planting a large proportion of these species, despite the fact that they had been largely neglected in the past by their professional arguments.

7. In its process, it was demonstrated how the damage to the nature conservation of the species became evident, how the members of the professions responded to it, and finally, how and with what results they tried to control it. I evaluated the temporal change of nature conservation damage caused by the species on a five-point scale developed by me for each habitat group.

8. It has also been pointed out that, despite the obvious damage, the use of the species is not neglected by all sectors (e.g. apiculture of Russian olive and tree of heaven), and from time to time new ideas for utilization (e.g. energetic utilization of tree of heaven) emerge, which is sometimes realized in practice.

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