The history of introduced tree species in Europe in a nutshell

Chapter · May 2018

CITATIONS
0

READS
74

5 authors, including:

Bart Nyssen
University of Leuven
11 PUBLICATIONS **1** CITATION
SEE PROFILE

Bart Muys
University of Leuven
471 PUBLICATIONS **13,436** CITATIONS
SEE PROFILE

Patrick Pyttel
University of Freiburg
41 PUBLICATIONS **175** CITATIONS
SEE PROFILE

1.2 The history of introduced tree species in Europe in a nutshell

Bart Nyssen, Uwe Eduard Schmidt, Bart Muys, Pieter Bas van der Lei and Patrick Pyttel

The roots of the current European tree species diversity and composition lie in the distant past. During the late Neogene–Quaternary period, in the last 2.6 Million years (see Chapter 1.1. in this book), extreme climate changes (i.e. ice ages) have caused dramatic range shifts of the European tree flora. It is generally accepted that, during these glacial periods, tree species distributions were much smaller when compared to the current inter-glacial period. The Mediterranean Sea in the southern part of Europe and the rather unsuitable environment for tree growth in the North restricted temperate European tree species during the glacial periods to the Iberian, Italian and Balkan peninsulas (Petit et al. 2003). Multiple processes and factors have led to the current distribution ranges and abundances of tree species occurring in Europe. However, this distribution does not necessarily coincide with the potential range that is based on their ecological requirements and competitive status. However, it often reflects the patterns of past human interventions (Keitt et al. 2001). The dynamics of (re-)colonisation, or invasion, are very much species specific.

The deliberate introduction of plant species from one geographical area into another is a process that started millennia ago, in the Mesolithic era, and has continued ever since.

It is known from pollen studies that hazel (*Corylus avellana* L.) was the first tree or shrub species of the temperate zone that reached central Europe after the late glacial periods. A surprising element is that it probably happened with the aid of Mesolithic hunter-gatherers who used the tree as a food source. There is evidence of the role humans had in this early migration of hazel, as hazelnut shells have been found in archaeological excavations of fire places, while hazel pollen was not reported to be present yet at the same period (Zagwijn 1994).

Food for humans and feed for their livestock was the first dominant driver for anthropogenic tree introduction (Zagwijn 1994) with the need for wood becoming more predominant at later stages. Although these drivers represent basic human needs, we should not underestimate the role of less materialistic drivers such as human curiosity and the sense for aesthetics or spiritualism in the process of introductions of new tree species. The continuous expansion of agriculture, the frequent migrations of people from one geographical area to the next, the extension of trade, the colonisation of new territories, the movement of troops in wars, etc. are all important vectors of the shifts in the tree species distributions (Culiţă 2007).

Figure 1. David Douglas went searching in Canada for nature's secrets; during one of his expeditions he was surrounded by a group of heavily-armed Indians while selecting and picking seedlings of Douglas fir trees.

The process of postglacial re-colonisation was still ongoing when the establishment of Phoenician, Greek and mainly Roman trade networks rapidly broadened the distribution range of archeophytic tree species, such as the sycamore maple (Acer *pseudoplatanus* L.), sweet chestnut (*Castanea sativa* Mill.) and common walnut (*Juglans regia* L.). Subsequently, the inter-continental transfer of valuable tree species was already ongoing during the expansion of the Roman Empire. The quince (*Cydonia oblonga* Mill.), for example, was brought from Central Asia, via South-western Asia to South-eastern Europe, whereas the common medlar (*Mespilus germanica* L.) was transplanted by the Assyrians from the Caucasus to Turkey. The apple tree (*Malus pumila* Mill.) was introduced to Europe via the Silk Road (Goudzwaard 2013).

Another famous example of an archeophytic tree species is sweet chestnut that is a species that has played a distinctive role in providing food for humans and livestock, as well as being a source of timber. Prehistoric people used its fruits for food, and its wood for building palafittes (Neolithic dwellings built on piles on lakes in Switzerland and northern Italy), canoes and cabins. Man began to cultivate sweet chestnut between the Caspian and the Black Sea around 900–700 BC (Adua 1998). From there, chestnut cultivation spread quickly to Greece from where it reached the Balkan region. Because of its wide range of uses, the Greeks increased its cultivation and bred new varieties. Likewise, the Romans recognised its large potential (i.e. use of tan bark, high growth potential, easy grafting) and they selected new varieties and propagated chestnut cultivation in Italy, France, Spain, Portugal, Switzerland and Britain (Adua 1998).

The reasons behind the introduction of new tree species to Europe beyond medieval times, i.e. in 16th and 17th century, were rather unrelated to nutrition or timber; the main drivers of tree introductions during these times were mostly curiosity and scientific interest.

With the exploration and subsequent colonisation of the world, humans became increasingly mobile, which, in 17th century, also led to the world opening to the natural sciences with diverse forest ecosystems of other temperate regions capturing the imagination. Botanists tried to get a complete overview of existing species, collected them and presented them in herbaria, and established live collections in arboreta. Many arboreta and botanical gardens were already established in 16th century. In their colonies, Europeans grew familiar plants and trees from their home countries and, at home they enriched their gardens with new species from the colonies. The oldest known introduction of a North American tree species to Europe dates from 1536: the white cedar (*Thuja occidentalis* L.) in France (Wein 1930). In 17th century, the introduced tree species became an integrated part of the new French garden and park culture, which spread from the mid-18th century all over Europe. In 1683, the horse chestnut (*Aesculus hippocastanum* L.), originating from south-eastern Europe, was already present in parks in Finland (Ruotsalainen (Ruotsalainen 2006). This interest in the world of plants culminated in the publication of the *Species Plantarum* in 1753 by Linnaeus.

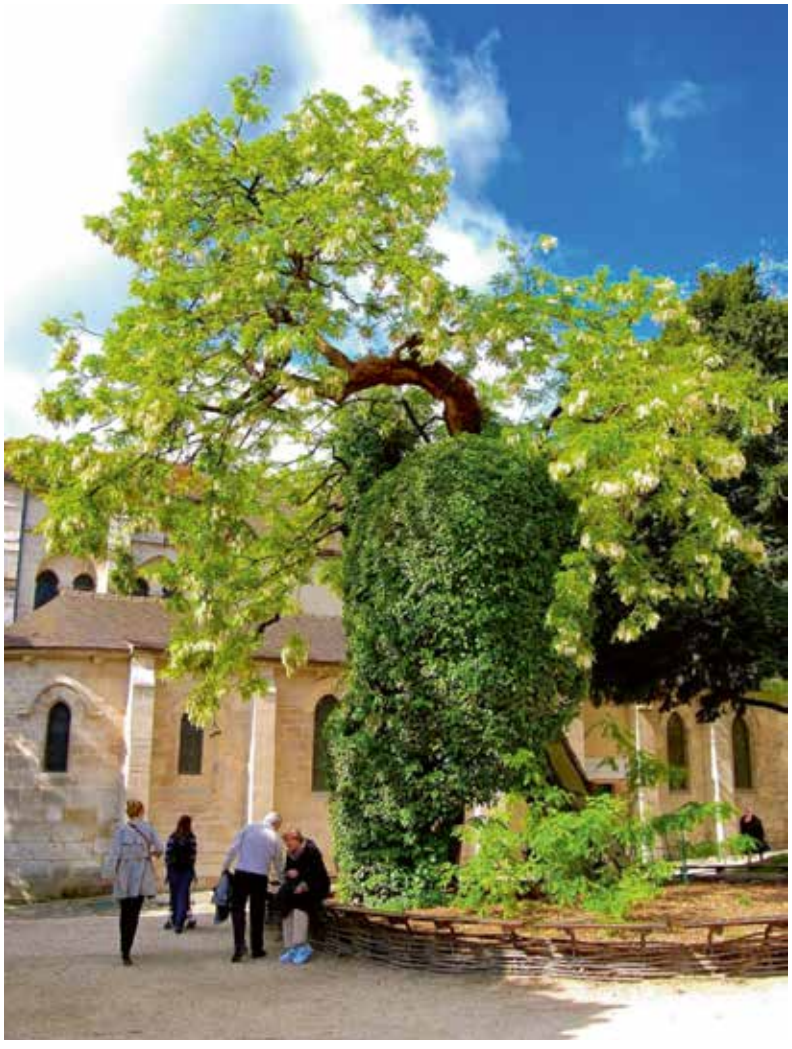

Figure 2. The first European black locust, planted by Jean Robin in 1601, is still alive on the Square René Viviani in Paris (photos: B. Berman).

Black locust (*Robinia pseudoacacia* L.) became the second North American tree species that was introduced from North America to Europe (Keresztesi 1988). The first black locust, planted by the botanist Jean Robin in 1601, is still alive on the bank of the River Seine in the centre of Paris. It was planted in other places in France in 1635 (Vor et al. 2015), in the Netherlands in 1646 (Buis 1985), in Germany in 1672 (Vor et al. 2015) and introduced into Hungary between 1710 and 1720 (Keresztesi 1983). Since its early introductions, black locust has been widely dispersed across Europe as well as across and in other temperate and Mediterranean zones of the world.

The introduction into Europe of another North American species, black cherry (*Prunus serotina* Erhr.), occurred two decades after the introduction of black locust. Jean Robin describes the species under the name Cerasus americana latifolia in the Enchiridion isagogicum from 1623 (Buis 1985). Half a century later, red oak (*Quercus rubra* L.) was introduced in Switzerland in 1691 (Badoux 1932) and in Germany in 1740, mainly planted as a park tree (Göhre and Wagenknecht 1955).

Figure 3. Trading of red oak and chestnut oak (Quercus prinus L.) acorns in North America at the end the 18th century (Burgsdorf von 1787). The German text "Europen zur Bereicherung" means: "For the enrichment of Europe".

In 1705, Lord Weymouth brought eastern white pine seedlings (*Pinus strobus* L.; also called Weymouth pine) to England (Maloy 1997) from the eastern part of North America with Douglas fir (*Pseudotsuga menziesii* (Mirb.) Franco) being the first tree species from the western part of North America to be introduced to Europe, specifically in 1827 to Great Britain (Troup 1932) and in about 1830 to Germany, mostly for aesthetic reasons (Vor et al. 2015). Introductions of noble fir (*Abies procera* Rehd.) in 1830, Sitka spruce (*Picea sitchensis* (Bong.) Carrière) in 1832 and grand fir (*Abies grandis* (Douglas ex D.Don) Lindl.) in 1833 followed soon after. The Lawson cypress (*Chamaecyparis lawsoniana* (A. Murray) Parl.) and the Western hemlock (*Tsuga heterophylla* (Raf.) Sarg.) were introduced some decades later in 1854 and 1851, respectively (Troup 1932). The Australian silver wattle (*Acacia dealbata* Link), also called mimosa, was introduced to Europe around 1800, and was widely planted in the 19th century on the French Mediterranean coast, mainly for its winter flowering.

Figure 4. Mimosa or silver wattle that is also referred to as the 'King of Winter' for its yellow winter flowering in the Mediterranean region of Provence (photo: G. Pavaut)

Other plants from Oceania were first introduced to Europe about 1804 in the form of the Tasmanian blue gum (*Eucalyptus globulus* Labill.) (Penfold and Willis 1961). With regard to species of forestry interest, the Japanese larch (*Larix kaempferi* (Lamb.) Carrière) was late introduction to Europe, being introduced only in 1893 (Troup 1932). This larch species was, however, not the first tree species from Asia to be introduced; in 1740, a Jesuit priest introduced the tree of heaven (*Ailanthus altissima* (Mill.) Swingle) from China for the high quality silk that was produced when ailanthus silkmoth (Samia cynthia Drury) was grown on its leaves (Fotiadis et al. 2011) with the aim of producing silk in Europe.

The beginning of the industrialisation, the second half of 18th century, marked the advent of modern forestry.

The enormous expansion of the European population led already in the Middle Ages to regional wood shortages, which was the result of deforestation and consequent degradation of the remaining forests. Besides deforestation for agricultural purposes and cattle and sheep pasture, forest litter raking and excessive harvests of fuel wood for the early industrial production had caused forest devastation. Especially the early industrial production of salt, saltpetre, beer, bricks, lime, charcoal, glass, iron and steel needed large amounts of wood (Radkau and

Schäfer 1987). This overexploitation of European forests persisted until the society realised the need for forest restoration and reforestation at the end of 19th century (Schütz 1990).

In the course of the development of modern forestry and the application of robust reforestation measures after a long period of overexploitation, conifers and broadleaved tree species were planted on a larger scale. The role of introduced tree species slowly turned from a dendrological curiosity into an issue of great economic importance. From the mid-18th century, black locust was increasingly planted across Europe, initially, in most cases as coppice for firewood, viticulture and beekeeping, but later mainly for silvicultural purposes (Vor et al. 2015). It is also important to note that the species was mostly planted in monocultures in Eastern Europe. Along with the expansion of black locust, the first forestry use of red oak in Central Europe arises at this time (Göhre and Wagenknecht 1955). As for the southern Europe, the first Tasmanian blue gum plantations were established in Portugal in 1863 (Cortés y Morales 1883) and in Spain in 1874 (Penfold and Willis 1961)

The large-scale plantations comprising of introduced tree species were initiated by innovative land owners and curious scientists. The experiences with new tree species that were gained in parks were transferred to forests. Germany took the lead in these developments thanks to the well-developed forestry knowledge. Well-known early plantings of North American tree species can be found on the Harbke Estate in Saksen-Anhalt, Germany (Du Roi 1771) on the basis of which Von Burgsdorff realised the importance of his first plantations of North American tree species and published his experiences (Burgsdorf von 1787). In addition, the German dendrologist von Wangenheim described the introduced tree species relevant for planting in Germany in 1781 (Wangenheim von 1781).

Since the end of 19th century, the systematic forest restoration and the large scale plantations of introduced tree species were organised by the state forest services in many European countries. The introduction of tree species boosted the European research on forest ecology and management. For example, in 1871 the German administrative organisation of experimental forest stations was established. One of the main goals of research was to test the introduction of North American and Japanese tree species on a large scale. In Prussia, in 1880, Bismarck formulated the question "whether and to what extent it would be possible to enrich our forest flora by naturalisation of alien tree species" (Schwappach 1907). The Prussian state forest organisation started with exotic tree species cultivation trials in 1881. Other countries followed this example. The Belgian agriculture minister decided in 1897 that research on the suitability of introduced tree species with rapid growth and high productivity was necessary in wooded areas in order to increase the profitability of forests (Rouffignon 1899). In response, a network of 23 forestry arboreta (with stands of trees in contrast to botanical arboreta with individual trees) was established throughout the country between 1890 and 1914, comparing the growth and response to silvicultural treatments of introduced tree species over a long site gradient (Delevoy and Galoux 1949). In France, the 'Société Nationale d'Acclimatation' encouraged the planting of introduced tree species for timber production (Naudin et al. 1887).

However, the scale of these plantings in 19th century remained limited. The inventory of the royal Prussian forester Weise in 1882 shows that the plantings where introduced tree species were used in the Prussian Rhenan provinces were still very limited. It consisted of ten eastern white pine plantations while Douglas fir was only planted in one forest (in addition to several city gardens). The largest plantings of red oak in the Prussian kingdom were established in the Saar province, covering an area of 100 ha (Weise 1882). In accordance to that governmental agencies, the focus was concentrated mainly on the cultivation of experiments using the

most promising introduced tree species such as Douglas fir, Japanese larch, red oak, black cherry, Sitka spruce, eastern white pine, black walnut (*Juglans nigra* L.), shagbark hickory (*Carya ovata* Mill.) and grand fir (Schwappach 1918).

Some of the introduced tree species were never planted in forests or they proved to be unsuitable for wood production. This is for example the case for ash-leaved maple (*Acer negundo* L.), tree of heaven, green ash (*Fraxinus pennsylvanica* Marshall; also known as red ash), honey locust (*Gleditsia triacanthos* L.) and staghorn sumac (*Rhus typhina* L.) (Vor et al. 2015).

The non-European tree species that are currently present in European forests on a substantial scale are those that were used for reforestation in Europe in 20th century.

In southern Europe, the introduced tree species used for reforestation purposes in 20th centurywere mainly silver wattle (*Acacia dealbata* Link), Australian blackwood (*Acacia melanoxylon* R. Br.), Long-leaved wattle (*Acacia longifolia* (Andr.) Willd.), Tasmanian blue gum and red gum (*Eucalyptus camaldulensis* Dehnh.). The tree of heaven was also used for reforesting and afforestation purposes in Hungary, the Czech Republic, and the south-eastern Europe (Kowarik and Säumel 2007). In central and northern Europe, Douglas fir is the most planted introduced tree species used for forestry purposes. In Germany for example, it is currently growing on ca. 217 600 ha representing 2.0 % of the total forest area (Vor et al. 2015). The second and the third most commonly occurring introduced tree species in German forests are Japanese larch covering 0.67 % and red oak representing 0.4 %, respectively of the forest area (Vor et al. 2015). Red oak is widespread all over western, central, southern and south-eastern Europe with the largest concentrations in Germany, France, Belgium and the Netherlands (Vor et al. 2015). Black locust is also present in large parts of Europe, especially in southern and eastern European countries. In Hungary, 23 % of the forest area consists of black locust, which equates to 415 000 ha (Rédei et al. 2012).

The most planted tree of the Abies genus is silver fir (*Abies alba* Mill.), but also grand fir, and to a lesser extent, noble fir and balsam fir (*Abies balsamea* (L.) Mill.) have also been planted (Vor et al. 2015). The only non-European species of pine planted in large amounts is eastern white pine. However, its area has been decreasing due to the needle rust affecting it (Vor et al. 2015). Jack pine (*Pinus banksiana* Lamb.) and lodgepole pine (*Pinus contorta* Douglas ex Loudon) have been planted to some extent in Europe. In Great Britain and Ireland, the main introduced plantation tree species has been Sitka spruce (Quine and Humphrey 2010). Japanese larch was also considered as 'a useful species for establishing a first crop on the better types of heatherland' in the British Isles (Troup 1932).

Figure 5. 125 year old Black cherry near Aachen (Germany), planted by Adam Schwappach.

During the 20th century reforestation, black cherry was planted together with silver birch (*Betula pendula* Roth) and speckled alder (*Alnus incana* (L.) Moench) on sandy soils in north-western Europe. Black cherry was, in fact, the most planted broadleaf tree species after 1920's on these poor sites. The first use of black cherry in forestry was as an admixture species in the Netherlands in 1898 planted by Van Schermbeek (Bakker 1963). In Belgium, black cherry was used in the first half of 20th century as a soil improver when reforesting drift sands and heathlands (Masson 1920). In Germany, reforestation peaked after the Second World War. Between 1950 and 1980, hundreds of thousands of hectares were reforested in Germany, on the sandy soils in northern Germany where mostly Scots pine and Japanese larch were used. Black cherry was a part of the classic planting plan (Starfinger et al. 2003). It is not surprising that black cherry is nowadays extensively present on the sand belt from Belgium and the Netherlands over the North German plains and into Poland and Hungary (Sitzia et al. 2016).

Following are four central messages based on the short historical overview of the introduction process of tree species in to Europe

1. The active introduction of new tree species has always been driven by human needs and dates, at least, back to the Mesolithic (about 10.000 to 5.000 BC). Tree species introductions, in combination with increasing human land use, have strongly shaped the composition of European forests.

2. The motivations for the earliest introductions were mostly driven by the establishment of reliable food sources. Hazel is the earliest example, but oak, sweet chestnut and European beech have also been spread northward for this reason. The introductions of new tree species from the New World were driven by human curiosity, mainly that of botanists, but also by ornamental and aesthetic reasons.

3. Due to the growing wood demands that rose during the industrialisation of Europe, a significant part of the European forest cover was restored in 19th and 20th century. This restoration of overexploited forests and the reforestation of wastelands catalysed the use of the introduced tree species. Since 19th century, introduced tree species became part of the modern plantation forestry, which was, from a social-ecological viewpoint, closely linked to the development of the capitalistic economy of growth.

4. The current need for adaptation of forest ecosystems to a relatively rapidly changing environment urges finding a proper role and place of introduced tree species in forest ecosystems. In this reality, natural forest references are in large parts of Europe a hypothetical situation of little practical use (for details, please see Chapter 3.6.). The already naturalised introduced tree species could best be integrated in forest management (Sitzia et al. 2016).

The question, whether the restoration of degraded forests and the reforestation of Europe would have been possible without the use of introduced tree species, is hypothetical. More important is the analysis of the role of these tree species in today's adaptive and integrative close-to-nature forest management.

European forestry science and reforestation – The essentials in brief

The enormous expansion of the European population in the Middle Ages led to a regional wood shortage and subsequently into the deforestation and the degradation of vast forest landscapes. Besides deforestation for agricultural purposes and pasture, litter raking and excessive fuel wood demands of early industries caused considerable forest devastation. Especially the production of salt, saltpetre, beer, bricks, lime, charcoal, glass, iron and steel needed huge amounts of fuel wood (Radkau and Schäfer 1987, Schütz 1990). This overexploitation of European forests persisted until the end of the 19th century and reforestation at end of the 19th century (Schütz 1990).

During the times of over-exploitation, the scientific knowledge of forest restoration on a large scale was absent; forestry basically did not exist as a scientific discipline. Driven by the wood shortage for ship building and mining, the foundations for the European forestry were laid by Evelyns book 'Sylva' that was written in 1664 for navy commissioners in England. Decades later, the mining administrator, at the court of Kursachsen in Freiberg, Von Carlowitz wrote the 'Sylvicultura oeconomica´ in 1713 (Radkau and Schäfer 1987). Both Evelyn and Von Carlowitz called for forest restoration and for limiting the wood extraction to the level of the increment; i.e. at a sustainable level.

However, it would be incorrect to place these early science-based foresters in complete disconnection from the past. There are indications that they were inspired by traditions in France and Belgium, where the know-how of managing oak forests as coppice with standards or high forest (tire et aire) goes back centuries (Vandekerkhove et al. 2016). The earliest written concepts of 'sustained yield' and 'normal forest' date back to the Middle Ages. The *Ordinance of Brunoy* by the French king Philips VI (1346) states that 'forest masters will survey and visit all the existing forests and woodlands and realise any appropriate cuttings, with reference to what the forests and woodlands can hold sustainably in good condition in the long term' (Lionnet and Peyron 2008).

In the first generation of modern forestry handbooks including *de l'Exploitation des Bois* (Forest Management) by Duhamel du Monceau, published in French in 1764 and in German in 1766, and books by Knoop (1790) in the Netherlands, Hartig (1791) in Germany, or de Poederlé (1792) in Belgium were published. However, it took until the end of 18th century and the beginning of 19th century before the academic education in forestry started in Europe. This education started first in Germany with the foundation by Cotta of the forest academy in Tharandt (1813) and attracted many foreign students. In France, the École National des Eaux et Forêts of Nancy was founded in 1824. The 19th century forestry concept was mainly formed by Georg Ludwig Hartig (1764–1833) in northern Germany and by Heinrich Cotta (1763–1844) in southern Germany. Both Hartig and Cotta based their forest restoration models on agricultural concepts that were widely accepted in this period (Schütz 1990). Forestry entered an era that was characterised by monoculture plantations of highly productive coniferous trees harvested by clearcutting. This industrial German forestry model that was characterised by monoculture and clearcutting was to dominate the forest development across Europe and beyond.

The industrial development fostered the conversion of broadleaved forests into presumably more productive coniferous plantations in order to meet the demands for standardised commodities. Due to such demands, the local wood shortages were taken as the major political reason to set the scene for the desired changes to come in the forest management (Grewe 2004). The big breakthrough in forest restoration was enabled by the rise of coal and fuel. This drastically diminished the need for firewood and the local resistance against the forest conversion of coppice and coppice with standards into industrial monocultures was suppressed (Schütz 1999).

The dominance of monocultures, coniferous tree species and clearcutting was from the beginning criticised by the proponents of 'close-to-nature' forestry, which, by now has become a widely accepted forestry concept.

Wilhelm Pfeil (1783–1859) was the first forestry scientist who tried liberating forestry from these dogmatic principles by opposing every generalisation of forestry measurements. However, the big change in conceptualising forest management came around 1880 when Karl Gayer, the forestry professor at Munich, based his close-to-nature forestry on the concepts of mixed uneven-aged forests and natural regeneration. The extending research and publications on the close-to-nature forestry concept remained rather marginal and most of 20th century reforestations were still carried out following the 'rational' plantations principles.

It is only since the 1970s, that this situation changed and more ecological and multifunctional types of forest management have become dominant creating diverse, mixed and well-structured forests strongly resilient to the dominance of introduced tree species with the application of the close-to-nature forestry concept enabling the integration of introduced tree species in forest ecosystems.

References

Adua, M. 1998. ADUA, M. The sweet chestnut throughout history from the Miocene to the third millennium. In: II International Symposium on Chestnut 494: 29-36.

Badoux, H. 1932. Les essences forestières exotiques en Suisse.

Bakker, J. (1963). De ontwikkelingsgeschiedenis van Prunus serotina Ehrh. Nederland. Nederlands Bosbouwkundig Tijdschrift 35: 201-206.

Buis, J. 1985. Historia forestis. HES Uitg., Wageningen.

Burgsdorf von, F. A. L. 1787. Versuch einer vollständigen Geschichte vorzüglicher Holzarten in systematischen Abhandlungen zur Erweiterung der Naturkunde und Forsthaushaltungs-Wissenschaft. Zweyter Theil die einheimischen und fremden Eichenarten. Erster Band. Physikalische Geschichte, Berlin.

Cortés y Morales, B. 1883. Manual del cultivo del eucalipto gigantesco y de su superioridad para el arbolado. M.P. Montoya y Compañia, Madrid.

Culiţă, S. 2007. Considerations regarding the alien plants from Moldavian flora (Romania), deliberately introduced by man. Journal of Plant Development.

Delevoy, G., and Galoux, A.1949. Les arboretums de l'administration des eaux et forêts. Station de recherches de Groenendaal.

Du Roi, J. P. 1771. Die harbkesche wilde Baumzucht: theils nordamerikanischer und anderer fremder, theils einheimischer Bäume, Sträucher und strauchartiger Pflanzen, nach den Kennzeichen der Anzucht, den Eigenschaften und der Benutzung beschrieben (Vol.2). Fürstl. Waisenhaus-Buchhandlung.

Göhre, K., and Wagenknecht E. 1955. Die Roteiche und ihr Holz. Deutscher Bauernverlag Berlin.

Goudzwaard, L. 2013. Loofbomen in Nederland en Vlaanderen: soorten en hybriden. KNNV.

Grewe, B. S. 2004. Der versperrte Wald: Ressourcenmangel in der bayerischen Pfalz (1814-1870). Böhlau Verlag Köln Weimar.

Keitt, T. H., Lewis, M. A. and Holt, R. D. 2001. Allee effects, invasion pinning, and species' borders. The American Naturalist 157: 203-216.

Keresztesi, B. 1983. Breeding and cultivation of black locust, Robinia pseudoacacia, in Hungary. Forest ecology and management 6: 217-244.

Keresztesi, B. 1988. The black locust. Akadémiai Kiadó.

Kowarik, I., and Säumel, I. 2007. Biological flora of central Europe: Ailanthus altissima (Mill.) swingle. Perspectives in Plant Ecology, Evolution and Systematics 8: 207-237.

Lionnet, M.-J., and Peyron, J.-L. 2008. European Silviculture and the Education of Gifford Pinchot in Nancy. Pages 30-38 in V. Alaric Sample and S. Anderson, editors. Common Goals for Sustainable Forest Management: Divergence and Reconvergence of American and European Forestry. Forest History Society, Durham NC and Pinchot Institute for Conservation, Washington DC.

Maloy, O. C. 1997. White pine blister rust control in North America: a case history. Annual review of phytopathology 35: 87-109.

Masson, J. 1920. Chronique forestière. Bulletin de la Société Centrale Forestière de Belgique 27: 384-386.

Naudin, C., von Mueller F., and Mueller F. J. H. 1887. Manuel de l'acclimateur: ou, Choix de plantes recommandées pour l'agriculture, l'industrie et la médecine, et adaptées aux divers climate de l'Europe et des pays tropicaux. Société d'acclimatation.

Penfold, A., and Willis, J. 1961. The eucalyptus. New York: Interscience.

Petit, R. J., Aguinagalde, I., de Beaulieu, J.-L., Bittkau, C., Brewer, S., Cheddadi, R., Ennos, R., Fineschi, S., Grivet, D. and Lascoux, M. 2003. Glacial refugia: hotspots but not melting pots of genetic diversity. Science 300: 1563-1565.

Quine, C. P., and Humphrey, J. W. 2010. Plantations of exotic tree species in Britain: irrelevant for biodiversity or novel habitat for native species? Biodiversity and Conservation 19: 1503-1512.

Radkau, J., and Schäfer, I. 1987. Holz. Rowohlt.

Rédei, K., Csiha, I., Keserű, Z., Kamandiné Végh, Á. and Győri, J. 2012. The silviculture of black locust (Robinia pseudoacacia L.) in Hungary: a review. SEEFOR (South-east European forestry) 2: 101-107.

Rouffignon. 1899. Une visite du parc du domaine de la guerre à Beverloo. Bulletin de la Société Centrale Forestière de Belgique 6: 294-299.

Ruotsalainen, S. 2006. Tree species experiments at the northern timberline region in Finland. Eurasian Journal of Forest Research 9: 51-60.

Schütz, J.-P. 1990. Sylviculture 1: Principes d'éducation des forêts. PPUR presses polytechniques.

Schütz, J.-P. 1999. Naturnaher Waldbau: gestern, heute, morgenl Near-Natural Silviculture: Past, Present and Future. Schweizerische Zeitschrift fur Forstwesen 150: 478-483.

Schwappach, A. 1907. Über die wichtigsten für deutsche Forsten geeigneten Laubholzarten. Mitteilungen der Deutschen Dendrologischen Gesellschaft 16.

Schwappach, A. F. 1918. Forstwissenschaft. GJ Göschen.

Schwerin von, F. 1906. Prunus serotina Ehrhardt. Mitteilungen der Deutschen Dendrologischen Gesellschaft 15: 1–3

Sitzia, T., Campagnaro, T., Kowarik, I., and Trentanovi, G. 2016. Using forest management to control invasive alien species: helping implement the new European regulation on invasive alien species. Biological invasions 18: 1-7.

Starfinger, U., Kowarik, I., Rode, M. and Schepker H. 2003. From desirable ornamental plant to pest to accepted addition to the flora?–the perception of an alien tree species through the centuries. Biological invasions 5: 323-335.

Troup, R. S. 1932. Exotic forest trees in the British Empire.

Vandekerkhove, K., Baeté, H., Van Der Aa, B., De Keersmaeker, L., Thomaes, A., Leyman, A. and Verheyen, K. 2016. 500 years of coppice-with-standards management in Meerdaal Forest (Central Belgium). iForest-Biogeosciences and Forestry: 543.

Vor, T., Bolte, A., Spellmann, H.and Ammer, C. 2015. Potenziale und Risiken eingeführter Baumarten. Göttinger Forstwissenschaften Bd. 7: 296.

Wangenheim von, F. A. J. 1781. Beschreibung einiger nordamericanischen Holz-und Buscharten, mit Anwendung auf teutsche Forsten. JC Dieterich.

Wein, K. 1930. Die erste Einführung nordamerikanischer Gehölze in Europa. Mitteilungen der Deutschen Dendrologischen Gesellschaft 42: 137-163.

Weise, W. 1882. Das Vorkommen gewisser fremdländischer Holzarten in Deutschland: nach amtlichen Erhebungen mitgetheilt.

Zagwijn, W. 1994. Reconstruction of climate change during the Holocene in western and central Europe based on pollen records of indicator species. Vegetation History and Archaeobotany 3: 65-88.