

ESCAPING, NATURALIZED AND NATIVE WOODY PLANT TAXA AROUND THE ARBORETUM IN HØRSHOLM.

Henry Nielsen and Jerry W. Leverenz

Arboretum of the Royal Veterinary and Agricultural University
Kirkegårdsvej 3A
DK-2970 Hørsholm, Denmark
e-mail: jwl@kvl.dk

Vedplanter omkring Arboretet i Hørsholm: forvildede, naturaliserede og oprindelige.

Key words: Woody plants, dispersal, escaping plants, naturalized plants, native plants, Denmark, Zealand.

ABSTRACT

The partly urbanized environment around The Arboretum of the Royal Veterinary and Agricultural University in Hørsholm, Denmark, has been surveyed to detect the presence of naturally regenerating taxa of woody plants. Emphasis was placed on detecting taxa presently escaping and/or becoming naturalized. Checklists of the presumed native and exotic woody species found within approximately two km distance from the Arboretum are given. There were more than twice as many exotics as native woody plant species regenerating in this area, but the number of naturalized exotic woody species (25) is about 60% of the number of native species (41). About 20 % of the exotic woody plants found, are known to be escapes from modern forestry, including experimental cultivation plots. The rest are known to be garden plants from urban areas with many private gardens, though some are more characteristically planted in the more roomy community parks. Surprisingly, none of the taxa found and identified, appear to have arrived by seed that could only come from the Arboretum, i.e. taxa not cultivated in the surrounding gardens, forest plots etc. Nevertheless, almost all of the woody plants on the checklists are also cultivated in the Arboretum, though often from exotic proveniences. We cannot

rule out some hybridization via pollen from the Arboretum's collection. However, the small population sizes of the taxa within the collection should minimize this effect. Our results indicate that the effect of the cultivated woody plants on the surrounding vegetation is of the same magnitude as in other areas in Denmark without a major Arboretum.

INTRODUCTION

Man has probably been introducing exotic taxa of trees and bushes into Denmark for a thousand years, or more. For example *Juglans regia* remains have been found in the Viking village of Hedeby from the 9th and 10th centuries (Lange 1994 p. 176). The first known introductions were mainly to produce food, for medical purposes (*Salix alba*, Lange 1994, p. 299) or other beneficial reasons, but many introductions of the last 200 years have been for amenity. Some introduced plants are clearly now becoming "wild" that is, they cannot be separated from native species present in the actual vegetation without historical knowledge of their previous occurrences. The rate of introductions has increased in recent years. Nevertheless, most of the alien woody species currently cultivated in central Europe had been introduced before the end of the 19th century (Kowarik 2001), so recent introductions largely represent new proveniences or genotypes of already-tried species. On rare occasions introductions have become noxious pests that are difficult to control. Some notable invasive woody plants in Denmark are *Rosa rugosa*, *Acer pseudoplatanus* and *Prunus serotina* (Calov 2001).

Denmark is obliged to reduce the risk of biological invasion as a co-signatory of the Convention on Biological Diversity (article 8h of the convention). Arboreta are a potential source of introduced species but they are also centres of knowledge of the performance of introduced species, and thus may serve to help control unwanted invasive species. In this paper we focus on the occurrence of escaped woody plants in the area within approximately 2 km from the Arboretum, and discuss briefly regeneration within the Arboretum itself. We have not examined the possibilities of the accidental introduction by the Arboretum of insects, bacteria or fungi. Such studies require an expertise that we do not currently possess.

The Arboretum in Hørsholm was established on an almost treeless farmland in 1936 (Jensen 1994). The Arboretum currently holds about 10500 registered woody plants representing about 2500 taxa in 294 different genera (Leverenz 2002). Many of these taxa have been producing seed within the last 50 years. The Arboretum is not the only local source of introduced plant material. In the 1780's the oldest forest nursery in Denmark (Hørsholm Planteskole) was established within the study area and was responsible for numerous introductions of many exotic woody plants in the 19th century (Nielsen 1978). In the immediate vicinity of the Arboretum is a cemetery to the north and east, which contains a diversity of woody plants (Clausen 1997). Other areas include farmland with fields and pasture to the south and west, a cultivated forest (Folehaven) to the east, and an old amenity park (Hørsholm Slotshave) to the north. Slightly further away is an area with office buildings surrounded by parkland with recent plantings containing exotic woody species (Forskningscentret i Hørsholm), several private gardens of different ages, various temporary constructions sites and some rather recently made roads with as yet unstable vegetation alongside them.

MATERIALS AND METHODS

This study arose out of an investigation for Atlas Flora Danica (AFD), the formal name for an investigation of the present distribution of vascular plants within Denmark. A list of taxa was made supplementing the number of wild and escaped vascular plant species already known to the AFD from in and around the Arboretum in the Hørsholm area (square number 6440 of the special AFD-system). This square is 25 km², including some areas of fresh water lakes. Special interest was paid to the occurrence of woody species, and the expectation was to find some escaped exotics originating from the Arboretums collections. The Arboretum largely lays just inside the eastern edge of the square 6440, so an additional area adjacent to the Arboretums eastern end, but outside this square was studied to supplement the results of the initial investigation.

In this paper we present lists of wild, nautralized and escaping woody plant taxa, which has been registered and documented within either of these two areas, but within 2 km of the Arboretum. Wild species are those that are considered to be native to Denmark. A natura-



Fig. 1. *Ribes sanguineum* is sometimes self-sown and naturalizing in open forest. The Arboretum in Hørsholm. Photo: Knud Ib Christensen.

Ribes sanguineum, Blod-Ribs, som undertiden er selvsået og naturaliseret i åbne skove. Arboretet i Hørsholm. Foto: Knud Ib Christensen.

lized taxon is originally introduced, competitive with the local vegetation for at least one generation, and deemed capable of producing further successful generations. An escaped taxon is one occurring without being intentionally planted or sown, but not yet naturalized. In this study it was quite common to find a large number of seedlings within 10 meters of the probable mother tree. Such plants are accepted as escapes except within the Arboretum itself. Escaping and naturalized species spreading either by seeds or vigorously by vegetative means were counted. Vegetatively spreading individuals with strong vegetative propagation for more than 30 years may be defined as naturalized (or “resident”, Jonsell 2000, p. xxi). Planted taxa were not to be registered, nor were the few regenerating taxa within the confines of the Arboretum itself (but see discussion). Each taxon was normally only registered once.

The search for woody plant species in an urbanized area like the area surrounding the Arboretum is strongly limited by the large areas of private gardens. Following the AFD rules, taxa were not registered or even searched for in private gardens. The area searched consisted mainly of a few forests and urban parks as well as ruderal places and

construction sites. We sampled all major and most minor habitat types occurring within the area. Experience and guesses as to where the species might occur were used to choose sites for investigation within the area. Good hunting grounds for woody species are places with fresh open soil existing for more than a year, for example in abandoned fallow fields or at construction sites where the work have been temporarily stopped. Incidentally, human disturbed areas strongly favour the establishment of exotic species (Kowarik 1995). Another habitat with many escaping woody species present (especially those producing berries) is under more or less solitary, tall trees with an open under-vegetation of herbs and grasses below, because such trees are a preferred perching place for birds like pigeons and crows. Forest habitats were thoroughly searched for the occurrence of regenerating woody species, especially in their glens or in the recently thinned or cleared areas. It is important to realize, that it is impractical to cover every square meter of the study area, so not all taxa occurring are expected to have been found. Nevertheless a good sampling of the native species as well as escaping and established exotic species was probably made, as only 3 expected native woody species remained undetected out of total of about 44 (see results).

Herbarium specimens have been made of all important or not readily identifiable taxa. Several specimens of *Cotoneaster* taxa from this study await identification. Although only 4 taxa have been given in Table 2, it is very likely that other cotoneasters are also escaping in the area.

Most of the *Rubus* found were identified by Anfred Pedersen, Vordingborg, Denmark, associated with the AFD investigation. The remaining taxa were identified by the first author. The precision of identifications was mostly to about the level of subspecies. Cultivars are not listed. Few hybrids were detected, but determining the exact parents of hybrid taxa is notoriously difficult and some may have been overlooked.

RESULTS

An alphabetic list of the native woody taxa found within two kilometres of the Arboretum is shown in Table 1. We found 41 out of 44 expected native woody species. From this it can be assumed that the sampling method used, uncovered about 90% of the woody flora. The three un-

detected native bushes were *Calluna vulgaris*, *Salix repens* and *Vaccinium uliginosum*. (*Calluna vulgaris* was found just outside the 2 km limit.)

An alphabetic list of the escaped and naturalized exotic woody taxa found within two kilometres of the Arboretum is shown in Table 2. Clearly naturalized species are marked with {N}. We found 106 definitely escaped or naturalized taxa and an additional 47 possible escapes. Thus more than twice as many exotic than native woody species have regenerated within the area.

Only about 10 taxa are as yet unidentified, mainly of the genera *Cotoneaster* and *Salix*. We cannot rule out that they derived from the collection of the Arboretum.

It is notable that some species in our list were not listed as having escaped in Denmark in a more general checklist for the Nordic countries (Weidema 2000).

The number of fully naturalized exotic woody species is difficult to judge only from their occurrence in our study area of the immediate vicinity of the Arboretum. Therefore we have classified plants as naturalized if they are known to be naturalized in North Eastern Zealand. Based on this there were 25 naturalized species in the area or about 15% of the total number found. The number of naturalized exotics found was about 60% of the number of native species found. These naturalized taxa include the locally-rare *Prunus serotina*, *Rosa rugosa* and *Rubus laciniatus*, which were present around Hørsholm as least as escapes, and certainly are naturalized in North Eastern Zealand. The following taxa might also have been listed but we could not judge whether the stands were old enough: *Cornus sericea* (also known as *C. alba* subsp. *stolonifera*), *Populus canescens*, *Rhus hirta* (also known as *Rh. typhina*), two taxa of *Spiraea* allied to *S. salicifolia* and *Symphoricarpos albus* (also known as *S. rivularis*).

A few of the naturalized exotics in our list are native to other parts of Denmark. These include: *Acer campestre*, *Carpinus betulus*, *Ilex aquifolium*, *Ribes alpinum*, *Sarothamnus scoparia*, *Sorbus intermedia* and *Taxus baccata*. Some of the exotics listed as naturalized in Table 2 may not have been here long enough for a second generation but are regenerating so vigorously that they have been listed as naturalized. These species include *Berberis thunbergii*, *Cotoneaster bullata* (and other unidentified *Cotoneaster* species), *Ilex aquifolium*, *Larix* sp. (mainly *Larix x marschlinsii?*), *Mahonia aquifolium*, *Pseudotsuga menziesii*, *Rubus armeniacus* and *Taxus baccata*. A few of the older naturalized woody species

probably have been present for several generations: *Acer pseudoplatanus*, *Alnus incana*, *Ligustrum vulgare*, *Picea abies*, *Prunus cerasifera*, *Salix alba* and *Sambucus racemosa*. Most of these are occurring naturally in Southern Sweden and/or Northern Germany, the only exception being *Prunus cerasifera*, which is thought to be from Caucasia.

All of the identified taxa listed in Table 2 are rather common exotics used in forestry, public parks, or in gardens. None of the positively identified taxa were unique to the Arboretum collection. However, there were five genera containing a number of unidentified taxa (*Berberis* spp., *Cotoneaster* spp., *Crataegus* spp., *Salix* spp., *Spiraea* spp.). We cannot rule out that these genera with unidentified material might contain taxa escaped from the unique collections of the arboretum.

DISCUSSION

By far the largest part (ca. 80%) of the escaped and naturalized woody plant taxa found within the study area are common garden plants. Some individuals have probably originated from public parks. The spreading can occur by seed, but often it appeared to occur by the transport of soil or garden waste.

Some taxa have spread by seed from their use in commercial or experimental forest stands. This is especially true for *Abies alba*, *Abies procera*, *Abies nordmanniana*, *Chamaecyparis lawsoniana*, *Picea abies*, *Picea sitchensis*, *Pseudotsuga menziesii* and *Thuja plicata*. Most of these seedlings and saplings are found in the near vicinity of the mother trees. *Abies procera* and *Chamaecyparis lawsoniana* could be found having vigorous regeneration in restricted areas in the forest, but regeneration of *Pseudotsuga menziesii* was much more wide-spread, as single young plants far away from known old trees were seen in several places. It should be noted that *Pseudotsuga menziesii* is vigorously regenerating and considered a problem in some nature reserves of Germany (Kowarik & Starfinger 2001, p. 11).

Some species were found spreading outside areas where they were being cultivated but were probably planted and spreading by root suckers creating small stands. These species include *Populus tremula* x *tremuloides*, *Populus trichocarpa*, *Ulmus carpiniifolia* and perhaps some *Rubus* species.

Only a few of the species were frequent in the mixed urban environment. These were:

Cotoneaster bullatus, *Laburnum anagyroides* s.lato, *Ligustrum vulgare*, *Ilex aquifolium*, *Prunus cerasifera*, *Acer pseudoplatanus*, and *Ribes alpinum*. It should be noted that many different varieties of yew (*Taxus*) were found as saplings but remain unidentified. A few of these yews most likely were the hybrid between *T. baccata* and *T. cuspidata* (*Taxus x media*).

WITHIN THE ARBORETUM

While this study was not aimed at studying the regeneration of taxa within the confines of the Arboretum itself, it is still important to discuss briefly what has been observed inside. The vast majority of self-sown woody plants within the arboretum are also common outside the Arboretum. These include *Fraxinus excelsior*, *Acer pseudoplatanus*, *Quercus robur*, *Quercus rubra*, *Sorbus aucuparia*, *Crataegus* sp., *Ilex aquifolium*, *Taxus baccata*, *Sambucus racemosa* and *Sambucus nigra*. However, several exotic taxa in the Arboretum are noteworthy for their locally abundant regeneration close to the source tree. These include *Acer cappadocicum*, *Acer circinatum* and *Acer rufinerve* within the Arboretum's *Acer* collection as well as *Juglans* sp., *Carya* sp. and *Pterocarya* sp. within the *Juglandaceae* collection. These species should be studied as they apparently have the potential to spread in Denmark. Several of these species and especially *Acer cappadocicum* are able to regenerate vigorously in the soil directly under the mother tree, a characteristic that might be associated with invasiveness (Kilronomos 2002). *Pinus contorta* is also noteworthy for producing seedlings in the Frihedslyst area in spite of the young age of the mother trees (25 years) and vigorous competition from grasses and herbaceous weeds. *Pinus contorta* is well known to be an invasive tree species (Ledgard 2001).

For the most part it is difficult to assess the potential spreading from within the Arboretum's collection, because the ground is mostly covered by a dense cover of grass and herbaceous weeds. Furthermore these weeds are typically cut once per year along with any small woody plants. Nevertheless, a few species are spreading inside the Arboretum with abundant suckering. Mowing once a year is not sufficient to control them. These should be watched. They include *Abnus cordata*, *Rubus odoratus*, *Rubus parvifolius*, *Sorbaria sorbifolia*, and perhaps also *Symphoricarpos albus* and *Salix xsmithiana*, the latter apparently spreading by rooting from broken twigs like in *Salix fragilis* – a condition not known in either of its parents *S. viminalis* and *S. caprea*.

A few exotic species of trees and bushes are growing on the banks of two small lakes, Springdam and Ubberød Dam, immediately neighbouring the Arboretum but outside its fence. These probably result from planted plants from the Arboretum nursery, for example as part of a project to introduce plants for the benefit of wildlife (Jensen 1994). One might also suggest that some should be counted as escapes, but they have apparently not spread any further and no regeneration was observed. The special woody species recently found here are mainly some unidentified bushes of *Crataegus* and *Salix*, but in the 1980's *Lonicera caerulea* was found here, and registered as an escape (voucher seen in Copenhagen herbarium, C). As far as is known, this was the only place in Denmark, where it has been noted to escape; however it was not found in this study. Even though the area in and around "Forskningscentret i Hørsholm" also has been planted with exotics by the Arboretum, none of the special trees and bushes here have been noted to have natural regeneration.

Among the many exotic species that are self-sown in the vicinity of the Arboretum in Hørsholm (Table 2), not one has been shown to grow exclusively in the Arboretum. The very largest part has spread from private gardens and a lesser amount from public parks or forests plantations. Thus the Arboretum was not shown to have an effect on the surrounding woody plant flora, in contrast to our original expectation.

However, it cannot be shown that there is no effect, because the Arboretum collection can contribute to the gene pool of the native and commonly escaping and naturalizing woody plants. This is especially noteworthy because the Arboretum has often collected and planted Danish species but from proveniences occurring outside of Denmark. An example is the *Viburnum opulus* from Japan that is growing vigorously in our collection.

One of the Arboretum's tasks has been to obtain better woody plants for use in Denmark. For example four commercially available "DAFO" taxa are listed as having their origin in the Arboretums collections. Probably other commercially available plants in Denmark have arrived via the Arboretum. This may be the most significant vector by which the Arboretum's collection has affected the garden flora and ultimately the natural flora.

To summarize, the Arboretum has likely affected the gene pool of the wild species and added potential new species to the Danish woody

flora. However the effect is so small that we have not been able to observe an effect on the flora in the vicinity. Our results indicate that the effect of the cultivated woody plants on the surrounding vegetation is of the same magnitude as in other areas in Denmark without a major Arboretum.

POSSIBLE MECHANISMS LIMITING SPREADING FROM THE ARBORETUM: DISPERSAL BY SEED

In general there is a large decrease in seedling establishment with distance from mother trees (Kowarik & Starfinger 2001, p. 43 & p. 91). Although bird dispersed seed of many species seem to reach further distances from the mother plants, studies show that less than 10 % of tree seeds are dispersed long distances (1 to 10 km) irrespective if they are wind or animal dispersed (Levin 2000, p. 89). Rarity of seed dispersal of more than 100 metres partly explains the lack of escaped woody species coming from the Arboretum. However, the exceptionally rough structure of the tree canopy of the Arboretum caused by the large variety of plants, would probably act to increase long distance dispersal by wind by allowing eddies to penetrate the canopy and lift seeds above tree height for long distance dispersal (Nathan *et al.* 2002).

A second cause for the tiny effect of the Arboretum on the surrounding flora is the small population size of the taxa in the collection. The number of individuals of any given species in the Arboretum is generally less than five, and commonly only one individual exists, although a few species are currently represented by more than 100 individuals. This minimizes both the quantity and quality of seed produced. Pollination success for both animal and wind pollinated plants decreases dramatically with population size. This reduces the number of seeds produced (Levin 2000, p. 162, Koski 1975). Selfing and inbreeding depression is also enhanced in very small populations thereby reducing the quality of the seeds of many species. Most temperate tree species are strongly out-crossing. This allows the buildup of recessive deleterious genes within the population. From this one would expect them to show strong inbreeding depression causing high seedling mortality and low vigour of the survivors.

A third reason for the lack of spreading is mal-adaptation to the climate in Hørsholm. This alone reduces growth, flowering, pollination and seed-set of many plants in the collection even though the Arboretum is constantly seeking better adapted proveniences.

Fourthly interspecific competition, herbivory, pathogens, and lack of suitable habitats or ecological niches in the surrounding areas for many of the Arboretum's species must play an important role.

DISPERSAL OF POLLEN

From our results, it cannot be ruled out that the Arboretum's collection of trees contributes to the local gene pool by pollination. However, the effect is probably small. Firstly, small populations of either wind pollinated or animal pollinated plants only need to be isolated by a distance of a few tens of meters to dramatically reduce the successful pollination of neighboring populations, in contrast to large plant populations (Koski 1975, and Rieger et al. 2002). Most of the species in the Arboretum's collection are more than 50 meters from possible pollen acceptors outside the boundaries. Secondly, poor timing of pollen release in comparison with the flowering of local populations (and even total failure) from the arboretum's exotic provenances also reduces the risk.

CONCLUSION

To sum up there are multiple factors that strongly reduce the escape of the Arboretum's collection into the surrounding flora by seeds or pollen. Based on the results from Kovarik (1995b) it is likely that the success of naturalization from the arboretum's plants will be less than 1 % even after 200 years. Nevertheless we plan to continue to monitor the reproductive behaviour and success of the taxa within and around our collection.

Based both on this survey and on the data from other studies cited above, we hypothesize that the Arboretum's plant collection has not had a significant direct effect on the surrounding flora and vegetation. This hypothesis could be tested by further field studies, as well as by using DNA fingerprinting techniques on Arboretum taxa and on the same taxa escaping in the surroundings.

RESUMÉ

Omegnen af Arboretet i Hørsholm (Den Kgl. Veterinær- og Landbohøjskole) er blevet undersøgt for forekomst af selvsåede arter af vedplanter inden for en afstand af 2 kilometer. Hovedvægten er lagt på at

udarbejde en liste over de forvildede og/eller naturaliserede arter, men også de formodet oprindelige arter er optalt. Der blev fundet mere end dobbelt så mange indførte (over 100) som oprindelige arter (ca. 40). Af de indførte arter er ca. 25 naturaliserede i området, det er kun omkring 60 % af antallet af de formodet oprindelige.

Omkring 20 % af områdets forvildede vedplantearter stammer fra det moderne skovbrug – medregnet forstlige forsøgsplantninger. Resten af de forvildede arter kommer fra private haver eller mere eller mindre offentlige parkanlæg. Forbløffende nok er der ingen af de fundne arter, der kun kan komme fra Arboretet i Hørsholm – men det skal dog siges, at der er enkelte endnu ubestemte indsamlinger fra svært bestemmelige slægter som Dværgmispel (*Cotoneaster*), Tjørn (*Crataegus*) og Pil (*Salix*).

Næsten alle områdets vedplantearter bliver også dyrket i Arboretet i Hørsholm, men ofte som usædvanlige provenienser. Det kan ikke udelukkes, at der foregår hybridisering med pollen fra Arboretet, men da der ofte er meget få individer i samlingen, er virkningen på omegnens genpuljer formentlig kun lille. Vores resultat kunne tyde på, at de indførte vedplantearter omkring Arboretet i Hørsholm påvirker omgivelsernes vegetation i samme grad som indførte vedplanter gør i tilsvarende egne af Danmark uden et Arboret.

Table 1: Woody species found in the area surrounding the Arboretum in Hørsholm and considered to be native here.

Some species might have been introduced and naturalized from cultivation a few hundred years ago or more – especially the fruit trees and berry bushes. They are noted as: “ancient introduction?” Some species (noted as “recent introduction”) might have been introduced within the last 200 years to the local area. An “X” in the number column indicates an unfound, but expected species.

Species	Danish name	notes
1. <i>Acer platanoides</i>	Spids-Løn	
2. <i>Alnus glutinosa</i>	Rød-El	
3. <i>Betula pendula</i>	Vorte-Birk	
4. <i>Betula pubescens</i>	Dun-Birk	
X. <i>Calluna vulgaris</i>	Hedelyng	not seen, but found 3 km away
5. <i>Cornus sanguinea</i>	Rød Kornel	recent introduction?
6. <i>Corylus avellana</i>	Almindelig Hassel	ancient introduction?
7. <i>Crataegus laevigata</i>	Alm. Hvidtjørn	
8. <i>Crataegus monogyna</i>	Engriflet Hvidtjørn	ancient introduction?
9. <i>Euonymus europaeus</i>	Alm. Benved	
10. <i>Fraxinus excelsior</i>	Alm. Ask	
11. <i>Hedera helix</i>	Alm. Vedbend	recent introduction?
12. <i>Lonicera periclymenum</i>	Alm. Gedeblad	
13. <i>Lonicera xylosteum</i>	Dunet Gedeblad	
14. <i>Malus sylvestris</i>	Skov-Æble	ancient introduction?
15. <i>Populus tremula</i>	Bævre-Asp	
16. <i>Prunus avium</i>	Fugle-Kirsebær	ancient introduction?
17. <i>Prunus padus</i>	Alm. Hæg	
18. <i>Prunus spinosa</i>	Slåen	
19. <i>Rhamnus cathartica</i>	Vrietorn	recent introduction?
20. <i>Rhamnus frangula</i>	Tørst	
21. <i>Ribes nigrum</i>	Solbær	
22. <i>Ribes cf. spicatum</i>	Vild Ribs	ancient introduction?
23. <i>Ribes uva-crispa</i>	Stikkelsbær	ancient introduction?
24. <i>Rosa canina</i>	Hunde-Rose	
25. <i>Rosa dumalis</i>	Blågrøn Rose	
26. <i>Rubus caesius</i>	Korbær	
27. <i>Rubus corylifolius</i>	Hassel-Brombær	
28. <i>Rubus idaeus</i>	Hindbær	

29. <i>Rubus nessensis</i>	Opret Brombær	
30. <i>Rubus plicatus</i>	Alm. Brombær	
31. <i>Rubus radula</i>	Rasperu Brombær	
32. <i>Rubus vestitus</i>	Rundbladet Brombær	recent introduction?
33. <i>Salix aurita</i>	Øret Pil	
34. <i>Salix caprea</i>	Selje-Pil	
35. <i>Salix cinerea</i>	Grå-Pil	
36. <i>Salix pentandra</i>	Femhannet Pil	
X. <i>Salix repens</i>	Krybende pil	not seen
37. <i>Sambucus nigra</i>	Alm. Hyld	ancient introduction?
38. <i>Sorbus aucuparia</i>	Alm. Røn	
39. <i>Ulmus glabra</i>	Skov-Elm	
40. <i>Vaccinium myrtillus</i>	Alm. Blåbær	
X. <i>Vaccinium uliginosum</i>	Mose-Bølle	not seen
41. <i>Viburnum opulus</i>	Alm. Kvalkved	

Table 2: Escaped and naturalised species of woody plants in the area surrounding the Arboretum in Hørsholm.

2A. definitely escaped or naturalized taxa.

Those species considered naturalized are marked with an “N” in the notes column.

Species	Danish name	notes
1. <i>Acer campestre</i>	Navr	N
2. <i>Acer ginnala</i>	Ild-Løn	
3. <i>Acer negundo</i>	Askebladet Løn	
4. <i>Acer pseudoplatanus</i>	Ahorn (eller Ær)	N
5. <i>Abies alba</i>	Alm. Ædelgran	N
6. <i>Abies nordmannia</i>	Nordmannsgran	
7. <i>Abies procera</i>	Sølvgran eller "Nobilis"	
8. <i>Aesculus hippocastanum</i>	Alm. Hestekastanje	N?
9. <i>Alnus incana</i>	Grå-El	N
10. <i>Amelanchier</i> cf. <i>spicata</i>	Aks-Bærmispel	
11. <i>Berberis thunbergii</i>	Hæk-Berberis	N
12. <i>Berberis vulgaris</i>	Alm. Berberis	
13. <i>Berberis</i> cf. <i>aggregata</i>	Perle-Berberis	
14. <i>Berberis</i> cf. <i>thunbergii</i> x <i>vulgaris</i>	Hybrid-Berberis	
15. <i>Buddleja davidii</i>	Alm. Sommerfuglebusk	
16. <i>Caragana arborescens</i>	Alm. Ærtetræ	
17. <i>Carpinus betulus</i>	Alm. Avnbøg	N
18. <i>Castanea sativa</i>	Ægte Kastanje	
19. <i>Chaenomeles japonica</i>	Lille Japankvæde	
20. <i>Chamaecyparis lawsoniana</i>	Lawsons Ædelcypres	
21. <i>Clematis tangutica</i>	Guld-Klematis	
22. <i>Clematis vitalba</i>	Alm. Skovranke	
23. <i>Cornus sericea</i> (<i>C. alba</i> var. <i>stolonifera</i>)	Krybende Kornel	N?
24. <i>Cotoneaster bullatus</i>	Storbladet Dværgmispel	N
25. <i>Cotoneaster</i> sp. 2	Dværgmispel-art	Undetermined
25. <i>Cotoneaster</i> sp. 3	Dværgmispel-art	Undetermined
25. <i>Cotoneaster</i> sp. 4	Dværgmispel-art	Undetermined
26. <i>Crataegus</i> spp.	Tjørne	Undetermined
27. <i>Forsythia xintermedia</i>	Alm. Vårguld	

28. <i>Hedera hibernica</i>	Irsk Vedbend	
30. <i>Ilex aquifolium</i>	Alm. Kristtjørn	N
31. <i>Juglans regia</i>	Ægte Valnød	
32. <i>Laburnum anagyroides</i> s.lato	Guldregn	
33. <i>Larix cf. xmarschlinsii</i>	Hybrid-Lærk	N
34. <i>Ligustrum obtusifolium</i>	Butbladet Liguster	
35. <i>Ligustrum ovalifolium</i>	Bredbladet Liguster	
36. <i>Ligustrum vulgare</i>	Alm. Liguster	N
37. <i>Lonicera henryi</i>	Henrys Gedeblad	
38. <i>Mahonia aquifolium</i>	Alm. Mahonie	N
39. <i>Malus domestica</i> s.lato	Sød-Æble	N
40. <i>Malus</i> spp.	Flere ubestemte æbler	
41. <i>Parthenocissus inserta</i> s.lato	Klatre-Vildvin	
42. <i>Philadelphus cf. coronarius</i>	Alm. Pibeved	
43. <i>Picea abies</i>	Rød-Gran	N
44. <i>Picea glauca</i>	Hvid-Gran	
45. <i>Picea sitchensis</i>	Sitka-Gran	
46. <i>Pinus sylvestris</i>	Skov-Fyr	
47. <i>Populus alba</i>	Sølv-Poppel	
48. <i>Populus xcanescens</i>	Grå-Poppel	N?
49. <i>Populus tremuloides</i>	Amerikansk Asp	
50. <i>Populus trichocarpa</i>	Vestamerikansk Balsam-Poppel	
51. <i>Populus xwettsteinii</i>	Hybrid-Asp	
52. <i>Potentilla fruticosa</i>	Busk-Potentil	
53. <i>Prunus cerasifera</i>	"Mirabel"	N
54. <i>Prunus domestica</i>	Have-Blomme	
55. <i>Prunus lauracerasus</i>	Laurbær-Kirsebær	
56. <i>Prunus mahaleb</i>	Weichsel	
57. <i>Prunus serotina</i>	Glansbladet Hæg	
58. <i>Pseudotsuga menziesii</i>	Douglasgran	N
59. <i>Pyracantha coccinea</i>	Alm. Ildtorn	
60. <i>Pyrus communis</i> s.lato	Pære	
61. <i>Quercus cerris</i>	Tyrkisk Eg	
62. <i>Quercus petraea</i>	Vinter-Eg	
63. <i>Quercus rubra</i>	Rød-Eg	
64. <i>Rhus hirta</i>	Alm. Hjortetakstræ	
65. <i>Ribes alpinum</i>	Fjeld-Ribs	N
66. <i>Ribes sanguineum</i>	Blod-Ribs	

67. <i>Robinia pseudacacia</i>	Alm. Robinie	
68. <i>Rosa multiflora</i>	Mangeblomstret Rose	
69. <i>Rosa rubiginosa</i>	Æble-Rose	
70. <i>Rosa rubrifolia</i>	Kobber-Rose	
71. <i>Rosa rugosa</i>	Rynket Rose	
72. <i>Rosa virginiana</i>	Glansbladet Rose	
73. <i>Rosa</i> spp.	Flere endnu ubestemte havearter	
74. <i>Rubus allegheniensis</i>	Alleghenny-Brombær	
75. <i>Rubus armeniacus</i>	Have-Brombær	
76. <i>Rubus laciniatus</i>	Fliget Brombær	N
77. <i>Rubus pergratus</i>	Canadisk Brombær	
78. <i>Rubus spectabilis</i>	Laksebær	
79. <i>Salix alba</i>	Hvid-Pil	N
80. <i>Salix dasyclados</i>	Lådden Pil	N?
81. <i>Salix fragilis</i>	Skør-Pil	
82. <i>Salix cinerea</i> ssp. <i>oleifolia</i>	Rust-Pil	
83. <i>Salix matsudana</i> 'Tortousa'	Proptrækker-Pil	
84. <i>Salix xmeyeriana</i>	Glans-Pil	
85. <i>Salix xrubens</i>	Grøn Pil	
86. <i>Salix xsmithiana</i>	Lancet-Pil	
87. <i>Salix viminalis</i>	Bånd-Pil	N
88. <i>Salix</i> spp.	Flere ubestemte	
89. <i>Sambucus racemosa</i>	Drue-Hyld	N
90. <i>Sarothamnus scoparius</i>	Alm. Gyvel	N
91. <i>Sorbaria sorbifolia</i>	Alm. Tusindtop	
92. <i>Sorbus intermedia</i>	Selje-Røn	N
93. <i>Sorbus mougeotii</i>	Vogeser-Røn	
94. <i>Spiraea</i> sp. 1	Spiræa-art	N?
95. <i>Spiraea</i> sp. 2	Spiræa-art	
96. <i>Spiraea</i> sp. 3	Spiræa-art	
97. <i>Symphoricarpos xchenaultii</i>	Rød Snebær	
98. <i>Symphoricarpos rivularis</i>	Alm. Snebær	N?
99. <i>Syringa vulgaris</i>	Alm. Syrén	
100. <i>Taxus baccata</i>	Alm. Taks	N
101. <i>Taxus xmedia</i>	Hybrid-Taks	
102. <i>Thuja plicata</i>	Kæmpe-Thuja	
103. <i>Tilia platyphyllos</i>	Storbladet Lind	
104. <i>Ulmus minor</i>	Småbladet Elm	

105. <i>Vinca major</i>	Stor Singrøn	
106. <i>Vinca minor</i>	Liden Singrøn	

2 B. Woody taxa, which might be escapes near the Arboretum

Notes: An “X” in the number column indicates an unfound, but expected taxon. pp = found here, but all occurrences are probably planted. “Unconfirmed” includes herbarium specimens not yet verified.

Species	Danish name	notes
1. <i>Abies concolor</i>	Langnålet Ædelgran	unconfirmed
2. <i>Acer saccharinum</i>	Sølv-Løn	pp
X. <i>Ailanthus altissima</i>	Skyrækker	expected
3. <i>Alnus viridis</i> s.lato	Grøn El	pp
4. <i>Betula alleghaniensis</i>	Gul Birk	pp
5. <i>Cercidiphyllum japonicum</i>	Hjertetræ	pp
X. <i>Colutea arborescens</i>	Blærebælg	expected
X. <i>Cornus alba</i> s.str.	Hvid Kornel	expected
6. <i>Cornus mas</i>	Kirsebær-Kornel	pp
7. <i>Corylus avellana</i> x <i>maxima</i>	“Lambertsød”	pp
8. <i>Corylus colurna</i>	Tyrkisk Hassel	unconfirmed
9. <i>Corylus xcolurnoides</i>	“Lille Træ-Hassel”	pp
10. <i>Cotoneaster</i> ssp.	Dværgmispler	pp
11. <i>Crataegus</i> spp.	Tjørne	pp
X. <i>Daphne mezereum</i>	Alm. Pebertræ	expected
12. <i>Deutzia</i> sp.	Stjernetop	pp
X. <i>Elaeagnus commutata</i>	Alm. Sølvblad	expected
13. <i>Elaeagnus umbellata</i>	Klosterfruens Syltetøjsbusk	unconfirmed
14. <i>Euonymus</i> sp.	Bened-art	pp
X. <i>Ficus carica</i>	Alm. Figentræ	expected
X. <i>Genista tinctoria</i>	Farve-Visse	expected
15. <i>Helianthemum nummularium</i>	Alm. Soløje	pp
X. <i>Hippophae rhamnoides</i> (found just outside the area)	Alm. Havtorn	expected
16. <i>Kerria japonica</i>	Ranunkelbusk	pp
17. <i>Kolkwitzia amabilis</i>	Dronningebusk	pp
18. <i>Larix decidua</i>	Europæisk Lærk	pp
19. <i>Lonicera ledebourii</i>	Californisk Gedeblad	pp

20. <i>Lonicera pileata</i> s.lato	“Stedsegrøn Gedeblad”	pp
21. <i>Lonicera tatarica</i>	Tatarisk Gedeblad	pp
22. <i>Lycium barbarum</i>	Alm. Bukketorn	pp
23. <i>Mahonia xdecumbens</i>	“Lav Mahonie”	unconfirmed
24. <i>Malus</i> spp.	Pryd-Æbler	pp
25. <i>Pachysandra terminalis</i>	Vinterglans	recently dumped garden rubbish
26. <i>Physocarpus opulifolius</i>	Blærespiraea	pp
27. <i>Picea omorica</i>	Serbisk Gran	pp
28. <i>Pinus mugo</i>	Bjerg-Fyr	pp
29. <i>Pinus nigra</i>	Østrigsk Fyr	unconfirmed
X. <i>Populus balsamifera</i>	Balsam-Poppel	expected
X. <i>Populus xcanadensis</i>	Landevejs-Poppel	expected
X. <i>Populus xjackii</i>	Ontarisk Poppel	expected
30. <i>Populus simonii</i>	Kinesisk Poppel	pp
31. <i>Prunus cerasus</i>	Sur-Kirsebær	pp
32. <i>Prunus incisa</i>	“Fliget Kirsebær”	pp
33. <i>Prunus virginiana</i>	Virginsk Hæg	unconfirmed
X. <i>Ribes aureum</i>	Guld-Ribs	expected
34. <i>Ribes rubrum</i>	Have-Ribs	pp
X. <i>Rosa pimpinellifolia</i>	Klit-Rose	expected
X. <i>Rosa tomentosa</i> s.lato	Filt-Rose	expected
X. <i>Rosa villosa</i> s.lato	Spansk Hyben	expected
35. <i>Rubus odoratus/parviflorus</i>	Rosen-Brombær	Arboret only
36. <i>Salix babylonica</i> -hybrids	Hænge-Pile	pp
37. <i>Salix daphnoides</i>	Dug-Pil	pp
X. <i>Salix myrsinifolia</i>	Sort Pil	expected
38. <i>Salix purpurea</i>	Purpur-Pil	pp
39. <i>Salix sachalinensis</i> ‘Sekka’	Drage-Pil	pp
40. <i>Salix sitchensis</i>	Sitka-Pil	pp
41. <i>Salix triandra</i>	Mandel-Pil	pp
42. <i>Sorbaria arborea</i>	”Stor Tusindtop”	pp
43. <i>Spiraea</i> spp.	Spiræa-arter	pp
X. <i>Tilia cordata</i>	Småbladet Lind	expected
44. <i>Tilia xeuropaea</i>	Park-Lind	pp
45. <i>Ulmus xhollandica</i>	Hollandsk Elm	pp
46. <i>Ulmus laevis</i>	Skærm-Elm	pp
47. <i>Viburnum lantana</i>	Pibe-kvælkved	pp
X. <i>Viscum album</i>	Mistelten	expected

REFERENCES:

- Calov, G. 2001: Floraforfalskning – introduktion af planter. I: Naturrådet Temarapport 1, 2001. Invasive arter og GMO'er – nye trusler mod naturen. 58-67.
- Clausen, H. 1997: Hørsholm Kirkegård (Hoersholm's Graveyard)-Dansk Dendrologisk Årsskrift XV: 9-54.
- Jensen, N. 1994: Guide til Arboretet i Hørsholm (Guide to the Arboretum in Hørsholm, Denmark) – Dansk Dendrologisk Årsskrift XII: 1-237.
- Jonsell, B. (ed.) 2000: Flora Nordica Vol 1. Lycopodiaceae to Polygonaceae. 344 pp. – The Bergius Foundation, Stockholm
- Kilnomos, J.N. 2002: Feedback with soil biota contributes to plant rarity and invasiveness in communities. – Nature 417:67-70.
- Koski, V. 1975: Natural pollination in seed orchards with special reference to pines. Pp 83-100. – In: Faulkned, R. (ed.), Seed orchards, Forestry Commission Bulletin 54. Her Majesty's Stationery Office publisher, London.
- Kowarik, I. 1995: On the role of alien species in urban flora and vegetation. In: Pysek, P, Prach, K., Reymanek, M. and Wade, M. (eds.) Plant Invasions – General aspects and special problems. pp 85-103. Academic Publishing, Amsterdam.
- Kowarik, I. 2001: Biological invasions as result and vector of global change. In: Contributions to Global Change Research. A report by the German National Committee on Global Change Research. pp 80-88. Bonn.
- Kowarik I. and Starfinger, U. (eds.) 2001: Biological Invasions in Germany – A Challenge to Act? – Bundesamt für Naturschutz (BfN) Bonn. 104 pp.
- Lange, J. 1994: Kulturplanternes indførselshistorie i Danmark (Introduction History of Cultivated Plants in Denmark).– Jordbrugsforlaget, Frederiksberg 458 pp.
- Ledgard, N. 2001: The spread of lodgepole pine (*Pinus contorta*, Dougl.) in New Zealand. Forest Ecol. and Management 141: 43-57.
- Leverenz, J.W. 2002: Inventory of the living plant collection at the Arboretum of the Royal Veterinary and Agricultural University in Hørsholm. – Arboretum Working paper 2002/1. ISSN: 1399-5189, 269 pp.
- Levin, D.A. 2000: The Origin, Expansion, and Demise of Plant Species. – Oxford University Press, New York 230 pp.
- Nathan, R., Katul, G.G., Horn, H.S., Thomas, S.M., Oren, R., Abissar, R., Paccala, S.W. and Levin S.A. 2002: Mechanisms of long-distance dispersal of seeds by wind. Nature 418: 409-413.
- Nielsen, P. Chr. 1978: Fremmede træarter i Danmark indtil omkring år 1800 (Foreign tree species in Denmark until about the year 1800). – Dansk Dendrologisk Årsskrift V(1):7-41 .
- Rieger, M.A., Lamon, M., Preston, C., Powles, S.B. and Roush, R.T. 2002: Pollen-mediated movement of herbicide resistance between commercial canola fields. Science 296: 2386-2388.

Weidema, I.R. (ed.) 2000: Introduced species in the Nordic Countries. – Nord 2000:13 Nordic Council of Ministers, Copenhagen. 242 pp.