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## The Dunkeld larch (*Larix* × *marschlinsii* Coaz) in Estonia

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**Abstract:** It is commonly known that Japanese larch, *Larix kaempferi* was first introduced in Europe in Great Britain in 1861. In the presence of European larches, *L. decidua* it was not long before the first hybrids between these species, called Dunkeld larches (*Larix* × *marschlinsii*), emerged there. It was found that there were several hybrid larch trees in Estonia that sprouted before one of their parent species was introduced in Europe. One of the oldest Dunkeld larches growing in Tallinn is about 210 years old. The radial growth of three Dunkeld larches in Estonia (in the cities of Pärnu and Tallinn and in the manor park of Suure-Kambja) and the determination of their age by cumulative growth graphs are discussed, with consideration given to the available knowledge on the introduction of Japanese larch. The conclusion is that there may have existed earlier alternative introduction routes of Japanese larch into northern Europe via Russia.

**Additional key words:** cumulative growth, dendrochronology, history of introduction, *Larix decidua*, *Larix kaempferi*, tree age

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### Introduction

Larches are known for their high capacity for hybridization. Distinction has been made between two ways of hybridization: one in the nature, in their growing areas, and the other in arboretums, parks and forest plantations. The best known are hybrids growing in forests, arboretums and parks (Bobrov 1972).

The most problematic are hybrids of larches with Japanese larches, which have often been described in Finland and in Estonia. In Finland, six hybrids have been recorded: *L. decidua* ssp. *decidua* × *L. kaempferi*, *L. decidua* ssp. *polonica* × *L. kaempferi*, *L. decidua* × *L. gmelinii* var. *japonica* × *L. kaempferi*, *L. gmelinii* var. *japonica* × *L. kaempferi*, *L. decidua* × *L. kaempferi* × *L. sibirica*, *L. kaempferi* × *L. sibirica* (Uusikivi 2001, 2006: personal communication). The same hybrids also oc-

cur in Estonia (Paves 2004); in addition, other hybrids have been registered here, such as *L. gmelinii* × *L. kaempferi*. Which of these have been introduced into these two countries or have sprouted locally is not quite clear. An analysis to that effect would extend beyond the scope of this article. The most widespread hybrid among them is *Larix* × *marschlinsii* (*L. decidua* × *L. kaempferi*).

According to E. G. Bobrov (1972), dendrologists have been interested in specific larches growing in the east of Russia for more than 150 years. They have often described these species by binary epithets. Bobrov has called them hybrids of *L. leptolepis* × *decidua*.

It can be concluded from the description and the cone drawing that Dunkeld larch has been recorded by E. Regel (1871: 101) under the name of *L. decidua* var. *pendulina*. Other synonyms of this variety are

*Pinus larix* Paxa et *compacta* Endl. 1847 and *L. decidua pendula* Henkel et Hochst. 1865 (Regel 1871; Rehder 1978). The best-known tree was recorded in St Petersburg (formerly Leningrad) Botanical Garden. Its height (H) was up to 30 m and Diameter at Breast Height (DBH) was 40 cm (Sokolov and Shishkin 1949). G. Krüssmann (1983), who also refers to the specimen in St Petersburg, uses E. Regel's name for the larch, but as a cultivar, 'Pendulina' (the tree has several branches). According to A. G. Golovtsh (1980), there were two trees f. *pendula* Rgl. in Leningrad Botanical Garden – height (H) = 25.5 m and 20.5 m; DBH = 60 cm and 49 cm. Might one of them be f. *pendulina* is not clear to us. It is possible that both or one of them coincides with the one that is described by E. Regel as *L. decidua* f. *pendula*.

In a review of conifers in the Baltic (Lithuania, Latvia and Estonia) and Kaliningrad regions prepared in the late 1970s no Dunkeld larches growing in old manor parks were mentioned (Paivel 1970).

In Finland, old Dunkeld larches have been reported by N. Karhu (1995) and T. Uusikivi (2001). N. Karhu (1995) presents data about five trees, their Perimeter at Breast Height (PBH) ranging between 200 and 310 cm and H between 18.5 and 28.5 m. One of the five is growing in Helsinki, two in Tampere and one in Hämeenlinna. The thickest was the tree in Kumalahti with its PBH = 310 cm and H = 18.5 m. It is also known that young larches were planted near Myllyjärvi in 1844, one of which was Dunkeld larch (*L. decidua* ssp. *decidua* × *L. kaempferi*), with the height of more than 30 m and PBH = 349 cm (21.9.2005). It is said that this is the oldest and largest Dunkeld larch in Finland (Uusikivi 2006: personal communication).

Assuming that hybridization occurred in Europe, the earliest possible time for it is limited with the time of introduction of Japanese larch in Europe. In the case of introduced species, the time of introduction of the second species limits the earliest possible time for hybridization. E. Kaempfer has recorded Japanese larch, or Kara-matsu, in Japan in 1712 (Thunberg 1784; Wilson 1916). John Gould Veitch, who was the first to introduce the tree in Europe, sent its seeds from Japan to Great Britain in 1861. Of those seeds, one tree sprouted and was planted in Hunnewell Pinetum (Wilson 1916).

The origin and formation of Dunkeld larch has been described by Coaz (1917) as well as Hendry and Flood (1919). The latter authors have also provided a detailed description of European, Japanese and hybrid larches, comparing their distinctive features. The mechanism of hybridization has been treated by Murray (1915), and the nomenclature by Nelson (1980).

In 1879, seeds of larch, which later were identified as Japanese larch, were delivered to the Swiss Consulate General in Japan. The seeds were sown in the nurseries of Zurich Polytechnical Institute and Bern

Botanical Garden. In 1882, Japanese larch was planted in the forest garden of Tscharnerholz, near the town of Murten. In 1901, seeds of that tree were sown in Bern Botanical Garden, and later seedlings were planted near Marschlins castle (in Grinon Canton). The trees growing there proved to be very vigorous, and in 1916 produced cones resembling those of Japanese larch. Forest scientist Coaz drew a conclusion that these trees were not Japanese larches but hybrids of European and Japanese larch (Coaz 1917).

In Perthshire, Scotland, ten Japanese larches were planted at the mansion of Dunkeld. The larches were very viable. The approximate height of the trees at the age of 31 in 1916 was 15 m. A number European larches grew in their vicinity. It made cross-fertilization possible. Seedlings from seeds of the Japanese larches were planted out at Inver, near Dunkeld, in 1904. In 1916, it appeared that the 16-year-old trees did not resemble Japanese larches, and were identified as hybrids named Dunkeld larches. The approximate height of the biggest of five trees measured in 1919 was 12 m (Henry and Flood 1919).

The name of the hybrids is *Larix* × *marschlinsii* Coaz 1917, non *L. × marschlinsii* auct. pre-1982, verified on 22 September 1995 by Systematic Botany Laboratory. Nomen number: 316718 (United States..., 2006). Synonyms of the hybrid species include *Larix* × *henryana* Rehder 1919, *Larix* × *eurolepis* A. Henry 1919 nom. illeg. and *L. × hybrida* Farqhar ex Rehder 1917 (Rehder 1978; Nelson 1980).

The present article addresses the age of some old Dunkeld larches in Estonia based on the example of Suure-Kambja Manor Park, the city of Pärnu and the summer manor of Cederhelm Park (Tallinn). The origin of Dunkeld larch is discussed and a preliminary assessment on how the trees made their appearance is given.

## Materials and methods

Big larch trees growing in several parks and avenues in Estonia were measured and their species determined by the first author.

Hybrid identification was carried out at first in the field using morphological features – cones, needles, growth and architecture parameters. Later, all the features determined were checked. Identification tables by T. Uusikivi (2001) were mostly used. In 2006, tree phenology was also studied where necessary.

Other specialists verified the identification of hybrid larch species. The age of the larches was established by the second author. At present, we have found Dunkeld larches growing in three localities in Estonia: in Tallinn, in Pärnu and at Suure-Kambja (Tartu County) (Fig. 1).

At Suure-Kambja, near Tartu, south Estonia, there grow two huge larch trees in the park symmetrically

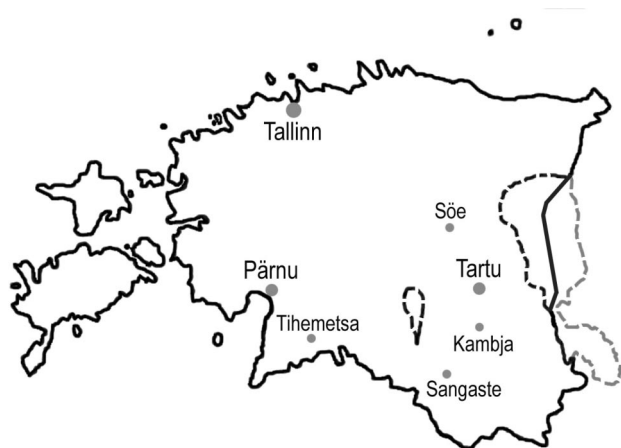


Fig. 1. Location of the hybrid larch (*Larix × marschlinii* Coaz) sites in Estonia: Tallinn, Pärnu and Suure-Kambja. Larch sites Sangaste, Sõe, Tartu and Tihemetsa are mentioned in the text

to the ruins of the former manor house. The northern one was identified as a hybrid larch (PBH = 395 cm, 2006) whereas the southern one (a two-branched tree) is a European larch (PBH = 461 cm).

In Pärnu, an avenue of seven larches in Pühavaimu Street, in front of the house at Pühavaimu 26, contains at least one hybrid tree (herbarium specimen TAA-003321, Institute of Agricultural and Environmental Sciences, Estonian University of Life Sciences), namely the southernmost one (No. 7, H = 19.3 m, DBH = 69 cm, 2006). The hybrid tree was recorded by H. Sander in 2004 and the species identification was verified by O. Abner and J. Elliku from Tallinn Botanical Garden and T. Uusikivi from the University of Helsinki. The age of the seven larches was determined by tree rings.

In Tallinn, four old and big larches grow in a small park of a former summer mansion of Cederhelm adjoining the now Mooni and Endla streets. Two trees (H = 22.5 m, DBH = 81 cm, and H = 18.5 m, DBH = 73 cm, 2005) were identified as Dunkeld larches (herbarium specimens TAA-0003322 and TAA-0003323 of the two trees).

All the trees were cored by a Suunto increment borer from the north and the south at breast height (1.3 m). The perimeter of the tree trunks at breast height was measured by a metal measuring tape. The approximate thickness of bark at the coring places was recorded. The widths of the tree rings were measured in 0.01 mm units by a Lintab measuring device. The quality of the measured tree-ring series was checked by program Cofecha and by graphs. As the borer core often did not reach the pith, the age of the trees was determined using graphs of cumulative growth (Läänelaid et al. 2001; Läänelaid and Sander 2004).

The diameter of the trunk was calculated from the perimeter, with bark thickness subtracted. In the case

of different ring widths in the opposite radii (in the cores) the diameter was divided into two radii (northern and southern radius) in proportion to the average ring width in each core. Then the length of the part of radius not covered by the measured tree rings in the core was calculated. Ring widths were cumulatively added to the uncovered part of the radius until the present thickness of the trunk was achieved. The cumulative radial growth curves were depicted graphically with years on the abscissa and the corresponding trunk radii on the ordinate. Assuming that the same growth trend had continued across the whole radius, the graph line was smoothly extended to its intersection with the X-axis. The point of intersection shows the year of zero age of the tree at coring height, 1.3 m, i. e. the year when the height of the tree was still less than 1.3 meters. The actual age of the tree is somewhat longer, including the period of time for the seedling to reach sampling height. The length of that period, to be added to the zero age of the tree, may be about a decade.

## Results

### Introduction of some larch species into Estonia

In Estonia, the first larches were probably introduced in the 17<sup>th</sup> century. It is documented that larches were planted in the manor park of Suure-Kambja, south Estonia, as early as in the 1730s (Paivel 1968).

In the 18<sup>th</sup> century, Siberian larch (*L. sibirica*) was introduced into Estonia (Hupel 1796; Friebe 1805). European and Siberian larches have come to be among the most common alien tree species in Estonia for a hundred years already. They grow in many manor parks, farmyards and town parks. In 1954–1970, European larch was recorded growing on 581 sites and Siberian larch on 543 sites in Estonian parks (Paivel 1970).

The first written record of Japanese larch in our parks comes from Klinge (1883), who recommended to cultivate Japanese larch (according to Klinge, *L. japonica* Carr.), *L. griffithiana* (Lindl. et Gord.) Carr. (according to Klinge, *L. Griffithii* Hook.) and *Pseudolarix amabilis* (J. Nels.) Rehd. (according to Klinge, *L. Kaempferi* Fort). The first known act of introduction of Japanese larch was performed by Earl F. von Berg, who planted it on his Sangaste manorial estate in the late 19<sup>th</sup> century (Paves 2004). In 1954–1970, Japanese larch was recorded at about 22 sites in Estonia. The biggest tree grows in Sangaste park (H = 30 m, DBH = 58 cm, 1968) (Paivel 1970). According to the most recent data, the height of the biggest Japanese larch in Sangaste Manor Park is H = 39.0 m and that of a European larch at Paistu, Viljandi County, is H =



43.0 m (2000). These two trees are the tallest in Estonia (Relve 2003). The highest concentration of Japanese larch – 18 trees – can be found in Hummuli Park, south Estonia. Their age exceeds 100 years (Sander et al. 2005).

The history of the introduction of the hybrid Dunkeld larch into Estonia is not clear. The first Dunkeld larch in Estonia was recorded by Paivel in M. Rand's arboretum on Saaremaa Island in 1954 (H = 10 m, DBH = 16 cm) (Elliku et al. 1997). The origin of that tree is unknown; most probably, it was a spontaneous hybrid.

The most interesting are the trees of European larch, Japanese larch, Dunkeld larch and Kurile larch (*L. gmelinii* var. *japonica*) recorded in the manor park of Suure-Kambja in 1958 (Elliku and Paivel 1989 a,b). Unfortunately, only the European larch was measured back then, and we are unable to estimate the age and origin of the Japanese, Dunkeld and Kurile larches. Assumedly, these trees were planted before 1918.

As is known, the first seeds of the hybrid larch were ordered from European seed stores as late as in the 1980s. Trees from those seeds grow mainly in Söe Arboretum (Erik 2004). In fact, many of the hybrid larches in Estonia (e.g. in Tallinn and at Järvelja, east Estonia), now 70–80 years old, have arisen locally, on sites where Japanese and European larches have been growing nearby. From Järvelja, seeds of Japanese larch were taken to Luua Arboretum, where trees grown from those seeds were later identified as hybrids (*L. kaempferi* × *L. decidua*) (Ilves 2002). The origin of old hybrid larches recorded in former manor parks across Estonia in 1954–1973 by A. Paivel, since 1983 by J. Elliku and U. Roht (all from Tallinn Botanical Garden), since 1996 by J. Elliku and H. Sander and since 2006 by T. Uusikivi, is mostly unclear. As the acts of identification of the trees have been performed at different time and by different authors and the corresponding records are located in different places, the distribution of Dunkeld larch in Estonia is still unclear.

### The age of Dunkeld larch trees

There are two big larch trees growing in Suure-Kambja Park, near Tartu, south Estonia. The southern, two-trunk tree, was identified as European larch and the northern tree as Dunkeld larch. The cumulative graphs of growth in the northern and southern radii of the trees point to the year 1875 as zero-year (Fig. 2). The uppermost graph curve represents the growth of the northern radius of the southern tree. Because of very wide tree rings the northern core did not reach pith. Both of the big larch trees at Suure-Kambja are of the same age, having sprouted from seed around AD 1865. The wide tree rings of the Suure-Kambja larches throughout their lifetime are noteworthy.

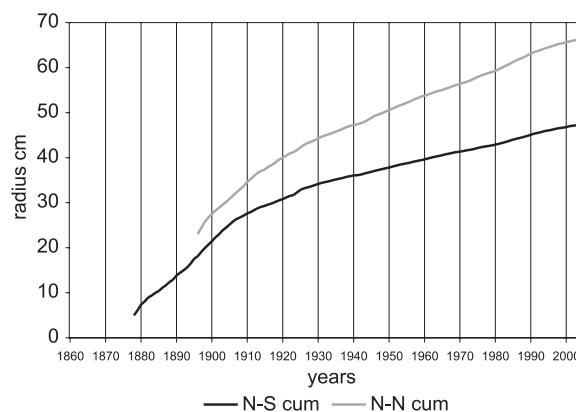


Fig. 2. Cumulative radial growth of the Eurojapanese larch (*Larix* × *marschlinsii* Coaz, northern and southern radius) in Suure-Kambja manor park near Tartu, South Estonia. Abscissa – years, ordinate – trunk radius in centimeters. The extensions of these curves cross X-axis at about AD 1875

Seven larch trees are growing along Pühavaimu Street in Pärnu, southwest Estonia. The southernmost of these, No. 7, was identified as Dunkeld larch. All these trees, except for one that is older (No. 6), are of the same age, their zero-year being 1870. The growth rate of the Dunkeld larch is fairly average compared to the other larches lining the avenue. This larch sprouted from seed around AD 1860 (Fig. 3).

A site known to hold two Dunkeld larches is situated in the small park of a former Cederhelm summer manor, now a part of the city of Tallinn. The park lies between Mooni and Endla streets. The larches growing in it were first recorded by dendrologist Marina Shestakov and botanist Külli Tamm from Tallinn Botanical Garden (Shestakov and Tamm 1986), but they did not identify the species of the larches. In 2002 six larch trees were recorded there (Abner and Elliku 2002). Four of them were Siberian larches and two Dunkeld larches. During the November storm of 2003 two trees were uprooted, and only four trees remained by 2004. This year, H. Sander identified two of the trees as Siberian larches and one as Dunkeld larch. One tree, was dubiously identified as *L. decidua*. Later, T. Uusikivi identified the species of the two last trees as *L. × marshlinsii* (Uusikivi: 16.06.2006, personal identification of the trees in the park).

In 2004, Henn Pärn from the Institute of Forestry and Rural Engineering, Estonian University of Life Sciences, counted the tree rings in the borer cores from the larches in Cederhelm Park and found the age of the trees to be 200 years at the height of 1.3 m (the sample reached the pith). A. Läänelaid repeated the procedure of coring and age determination on these larches in 2005. The cumulative growth curves at breast height point to AD 1805 as the approximate zero-year of the larches (Fig. 4). This means that the larches sprouted around AD 1795 and are more than 200 years old now.

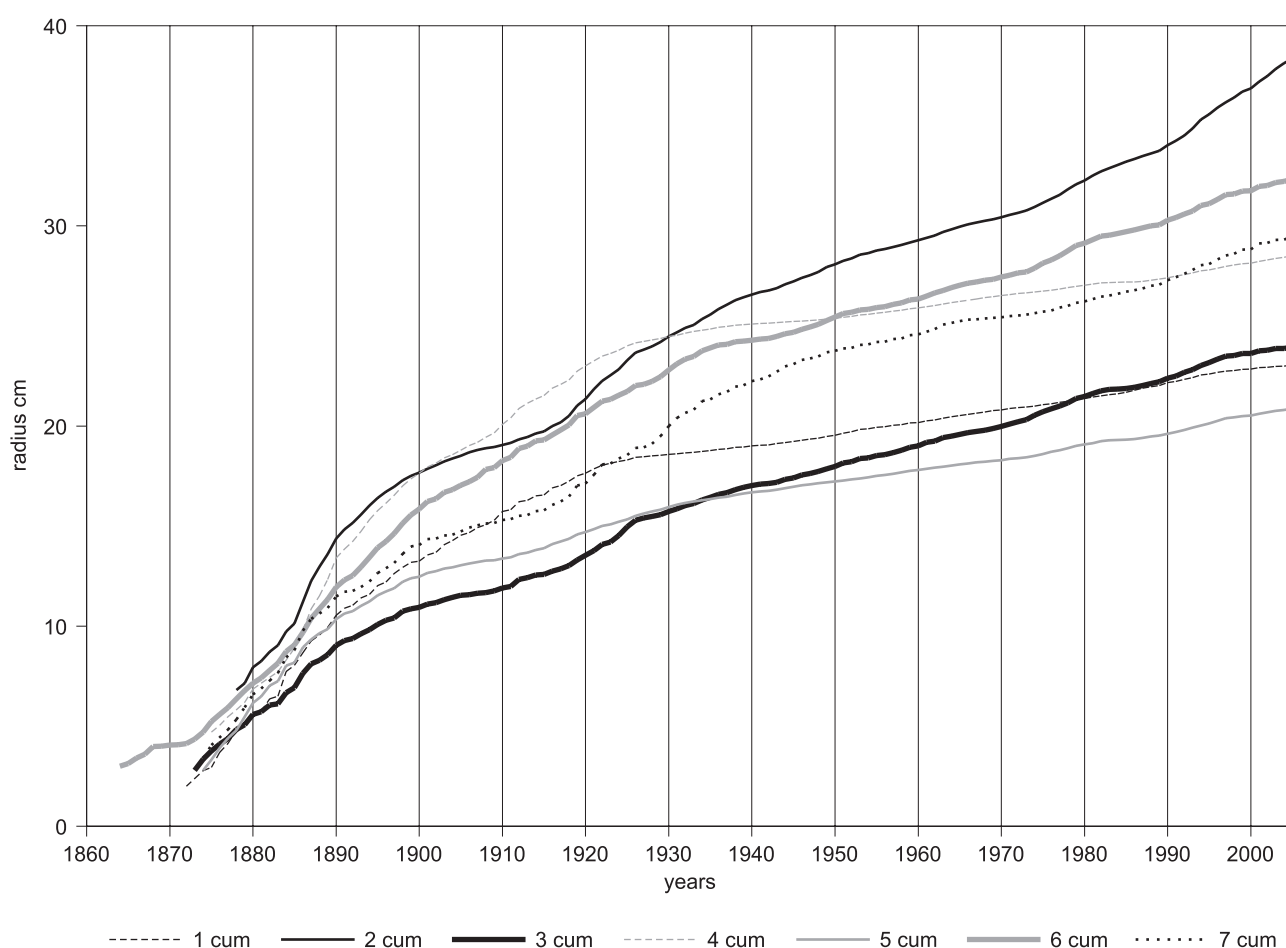


Fig. 3. Cumulative radial growth of seven larches growing along Pühavaimu street in Pärnu. The growth curve of Dunkeld larch (*Larix × marschlinsii* Coaz) is the bold one. Abscissa – years, ordinate – trunk radius in centimeters. The extensions of the curves (except one) cross the X-axis at about 1870

## Discussion and conclusions

The relatively young age of the big larches at Suure-Kambja was a surprise. Up to now, it was deemed that these two larch trees had been planted in the 1730s and were therefore about 280 years old (age since sprouting of seeds). Now it has appeared from the tree ring study that they are half that age – only 140 years old (age since sprouting of seeds), which puts the estimated time of planting in the park at around AD 1880. The extraordinary width of the annual rings accounts for their small number in the huge trunk: the ring width in the two radii of the Dunkeld larch (the northern tree) is nearly 3.5 mm on average and 13 mm at its maximum! The ring widths of the southern tree are nearly the same (average 3.6 mm, maximum 12.6 mm). Large rings in youth are characteristic of the first-generation hybrids. Wide rings at an older age testify to good growing conditions for individual trees in fertile soil.

The Dunkeld larch in Pärnu appeared to be just a little older than the ones at Suure-Kambja: its zero-year is AD 1870. This means that the probable sprouting year from seed is ca 1860 (age from seed

ca 146 years in 2006) and the probable planting year is around 1875. The evidence from the dendrochronological age determination method for these larches is also supported by written documents. In 1873, a private school of Jochmann was opened in the house at Pühavaimu Street 26. It can be assumed that the planting of larches in front of the schoolhouse took place soon after the establishment of the school. The cumulative growth graphs show that the radial increment rate of the Dunkeld larch at Pühavaimu Street was fairly average compared to the other larches in the row. Thus, larch No 7 does not stand out from the others by that characteristic. The hybrid origin of the rest of the larch trees cannot be excluded either.

Aged more than 200 years, the Dunkeld larches growing in Cederhelm Park, Tallinn, are the oldest specimens of this hybrid discovered in Estonia so far. This indicates that hybrids between European and Japanese larch were certain to exist long before the official time of introduction of the latter into Europe.

Now the question arises about the introduction of Japanese larch into Europe prior to 1861. As we do not possess documented data on the introduction of

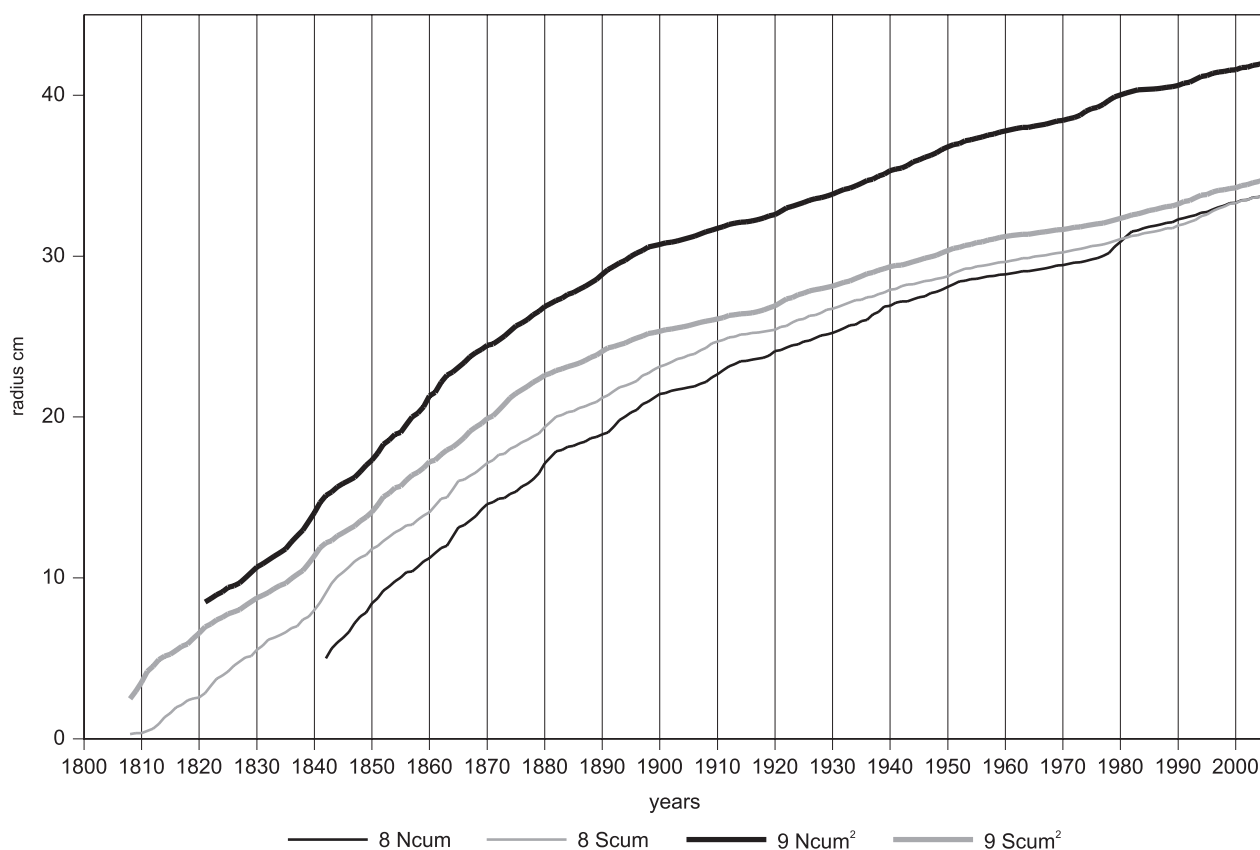


Fig. 4. Cumulative radial growth of two Dunkeld larches (No. 8 and 9, both two radii) from Cederhelm park in Tallinn. Abscissa – years, ordinate – trunk radius in centimeters. The extensions of the curves cross the X-axis at about 1805

the species, we have to look for potential introducers. However, the following is only our guess.

In the 17th century, as Japan became more open to the European world, the introduction of Japanese plants began in Europe. The office of the Dutch East India Company (in Japan since 1609, in Hirado, Nagasaki) operated on Deshima Island (1641–1860) in the Bay of Nagasaki. Many well-known persons were employed by the company, including some who were interested in botany. Among them was chemist Godefried Haeck, gardener and botanist Georg Meister, physician and scientist Casper Schamberger, physician and merchant Andreas Cleyer, Engelbert Kaempfer, Carl Peter Thunberg, and others, who were interested in Japanese flora and visited the country in the 17<sup>th</sup> and 18<sup>th</sup> centuries (Michel 1986, 1991, 1999, 2005 etc.; Thunberg 1784; Nelson 1999; Stearn 1999).

In the 18<sup>th</sup> century, Tallinn was a small provincial town of Russia. Nevertheless, it had uninterrupted relations with Western Europe since its establishment in 1219, and after the Northern War also with Russia, especially with St Petersburg. It is possible that in the 18<sup>th</sup> century it was not Japanese but Dunkeld larch that reached Estonia.

It is also possible that Japanese larch first reached Estonia and Finland through Moscow or St Petersburg.

In the 18<sup>th</sup> century, it was common in Russia that educated people cultivated exotic species, exchanged

seeds, collected herbaria and travelled on faraway expeditions. Two of the expeditions were made to Kamchatka. Moscow and St Petersburg functioned as two centres for operation. In 1706, an apothecary garden was established in Moscow. In addition, the city and its surroundings held more than fifty gardens owned by the tsar, monasteries and private persons. In 1714, an apothecary garden was founded in St. Petersburg. Another important botanical centre in the city was the first public museum in Russia – the *Kunstammer* and the Botanical Garden of the Academy of Sciences.

In 1730, Russia's first botanical garden was established in the village of Krasnoye, near Solikamsk. Moscow University, founded in 1755, also influenced the development of botany in Russia. In 1756, P.A. Demidov set up a large private botanical garden in Moscow. In the late 18<sup>th</sup> century, a botanical garden and a scientific institute was founded in Gorenki, near Moscow. Botany in Russia had close connections with Western Europe. Carl Linnaeus received plenty of material from Russia. Personal relations between botanists were good. Unfortunately, no records are available about the introduction of Japanese plants into Russia, not even in a profound work on the history of botany in Russia (Sokoloff et al. 2002).

Another possibility is that Japanese larch reached Russia through the East India Company. It is very

probable that Russian sailors or Baltic Germans visited Japan by means of the East India Company, bringing seeds of Japanese larch to Estonia and Finland via St. Petersburg. Their hybrids with European larches may have emerged either in St. Petersburg or its surroundings, or in various places in Estonia and Finland. Nevertheless, it is somewhat surprising for the oldest known Japanese larches growing in Estonia to sprout as late as in the 1890s.

Murray (1915) has suggested that the hybrid larch may actually be a modification of Japanese larch developed due to different climatic and edaphic conditions in Europe. This explanation, however, appears not very likely to us.

Theoretically, it is also possible that the hybrid larch has originated in Japan, after the introduction of European larch there. Unfortunately, we do not have any data on the introduction of European larch into Japan as yet. To solve the problem of the origin of Dunkeld larches in Europe it is necessary to investigate the early acts of introduction of Japanese larch into Europe and vice versa.

Finally, it should be noted that despite the aforesaid there is no doubt in the reliability of identification of Dunkeld larches described above. In particular, this is concerned with the oldest one, which is growing in Cederhelm Park. There is no evidence of Japanese larch being introduced before 1861. Neither is there any evidence of old Japanese larches in Western Europe, Estonia, Finland or Russia. At the same time, there are Dunkeld larches growing in Estonia (in Tallinn the age of the trees is 110–130 years) whose identity has been established beyond any doubt. The best known of them, aged about 125 years, is presently known to grow in Hirve Park, Tallinn. It is most probably a *L. kaempferi* × *L. decidua*. Consequently, there are Dunkeld larches in Estonia that date from a time before the hybrids appeared in Western Europe. We think therefore that research on the subject should continue, and that morphological and genetic studies are necessary.

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