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Prospects for the introduction of *Betula pendula* f. *dalecarlica* (L.F.) C.K. Schneid. in akmolinsk region, Kazakhstan

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ABSTRACT

The article presents the results of a study of the introduction and prospects for introducing silver birch, *Betula pendula* f. *dalecarlica* (L.fil.) Schneid. in the extreme continental climate of the Akmola region, Kazakhstan. Primary tests of rare tree species were conducted based on Astana's Botanical Garden (AstBS). The results of the study indicate the high decorativeness and resistance of this species to adverse environmental influences, what allows recommending this tree planting for urban landscaping, which is considered a promising type of use of its potential in landscape design and gardening, as well as for complex use as part of medicinal gardens. Dalecarlian birch contains a fairly high amount of biologically active substances in leaves and bark. The primary results of tests of the rare tree species, Dalecarlian birch in the Akmola region are presented, which will expand the range of sustainable ornamental species for landscaping cities and towns in the region. Recommendations for further research are given.

Keywords: *Betula pendula* f. *dalecarlian*, Ornamental, Medicinal plant, Sustainability, Urban gardening.
Article type: Short Communication.

INTRODUCTION

One of the tasks of the introduction process is to create and expand the gene pool of plants by introducing promising genera and species into the culture that were not previously found in certain climatic conditions or by transferring them into the culture from places of natural growth. The New Botanical Garden (Astana) actively conducts research on the conservation of plant biodiversity by attracting, reproducing, and preserving plants ex-situ as part of solving strategic problems outlined by the International Program of Botanical Gardens for Plant Conservation (Korchagina 1980; Koropochinsky & Vstovskaya 2012) and other programs and conventions (Bailey 1961; Petunkina & Sarsatskaya 2015). The botanical garden's collection of trees and shrubs was created in 2018. The collection of trees and shrubs of the Astana Botanical Garden currently includes 149 taxa and 127 species belonging to 59 genera from 25 families. The collection consists of 60 trees, 85 shrubs, two subshrubs, one tree or shrub, and 1 liana, of which conifers and 118 deciduous species represent 31 taxa. The most numerous families are Rosaceae, including 41 taxa; Pinaceae 16 taxa, Cupressaceae 15 taxa, Betulaceae 2 taxa; as well as small families, including Phyllanthocin, Rhamnaceous, Celastraceous, Tamaricaceae and Vitaceae with 1 taxon each. The problem of landscaping the capital of Kazakhstan and its regions is a pressing issue today. The successful introduction of new species of tree and shrub plants, attractive for their decorative properties, will undoubtedly affect not only the appearance of the city but also serve as a scientific basis for the development of introduction research. The Akmola region's physical and geographical position, combined with its sharply

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continental climate, prevents the attraction of many interesting and beautiful landscaping plants. However, we have begun research on the introduction of new plant species from natural flora—*Betula pendula* f. *dalecarlian* (L.fil.) Schneid. The genus *Betula* L. is a group of deciduous trees from the family Betulaceae, famous for their unique beauty. These trees are characterized by white trunks, a graceful crown, and arching, branching trunks. In some cases, the bark is dark in color and peels off, which also makes it decorative. In spring, their trunks are decorated with long catkins, while in autumn, the leaves change color to a bright yellow hue (Korchagina 1980). Birch is one of the northern hemisphere's most widely distributed tree genera, living in various climates from the subtropics to the tundra. The diversity of birches is especially great in temperate forest zones. Birch trees play an important role in the formation of forest communities, prevailing 60% in deciduous and coniferous-deciduous forests. Many of them are pioneers, populating clearings, fires, and wastelands, where they create pure stands. Birch trees are highly frost-resistant, are not afraid of spring frosts, and can grow in permafrost conditions. They are diverse in soil requirements, growing both on sandy and loamy, and on poor and rich soils, on wet banks of rivers and seas, in swamps, marshy tundras, dry rocky slopes and sultry steppes. Most birch trees prefer sunny places, but there are also shade-tolerant species. The birches' sizes vary from large trees 30-45 m high with a trunk diameter of up to 120-150 cm to shrubby and small species. The bark of birches is usually smooth and peels off in thin sheets. Depending on the species, it can be white, yellowish, pinkish, gray, brown, or even black. The root system of birches is powerful, with superficial roots or roots extending obliquely into the depths. Birch growth is slow in the initial years but then accelerates, which helps them outpace competing herbaceous plants (Electronic resource:http://www.wikia). Birch trees, growing in Central and Northern Kazakhstan, are one of the most common and valuable tree species, which significantly impact the appearance and composition of deciduous and coniferous-deciduous (mixed) forests in this region. The range of the genus covers a vast territory of the northern hemisphere from the subtropics to the arctic tundra zone (Koropochinsky & Vstovskaya 2012). In addition to their ecological role, species of the genus *Betula* are very popular in landscape design, contributing not only to stylistic design but also to improving the microclimate in cities. One of the main indicators in selecting an assortment for landscaping is decorativeness. The overall assessment of decorativeness consists of many factors. At first glance, the degree of flowering and fruiting for representatives of *Betula*'s genus plays a small role in assessing decorativeness. Dalecarlian birch, *B. pendula* f. *dalecarlian* (L.F.) Schneid. is one of the interesting varieties of the silver birch, family Birch (Betulaceae). This species is native to Sweden and is considered native to the Scandinavian Peninsula. In the European part of Russia, living in proximity to other deciduous species is extremely rare. Dalecarlian birch is a medium-sized tree with a narrow, spreading crown. The maximum height reaches 20 meters, and annual growth can be 35 cm. Its characteristic feature is deeply dissected leaves, which give the tree an elegant appearance (Petunkina & Sarsatskaya 2015). The leaves are green for most of the year, but in the fall, they acquire golden hues, which makes the tree picturesque and decorative. Quite a light-loving mesophile (plants adapted to soil and atmosphere of average humidity and cannot tolerate large amounts of salt in the soil), microthermal (satisfied with a small amount of heat with uniform and moderate irrigation). This type of birch is actively used in landscaping European cities and private gardens. It is cultivated in many temperate countries under different names such as silver birch 'Crispa' or 'Laciniata'. It is also resistant to gas pollution, which makes it an ideal choice for planting in city parks, alleys and squares. However, despite its widespread use and decorative qualities, studies of the biology and ecology of Dalecarlian birch in the urbanized areas of the Akmola region, until now, have remained unstudied. Still, Most birches are widespread in ornamental gardening, as described by Bailey (1961) and mentioned in other sources, "Trees and Shrubs of the USSR" (Lean Industry 1982). Introducing rare and ornamental tree species, such as Dalecarlian birch, into gardening and landscape design practices is essential for creating unique and sustainable urban environments. These species can add uniqueness to the landscape, enrich the local flora, and contribute to biodiversity conservation. They are also highly resistant to gas pollution and other adverse environmental factors. It is noted that Dalecarlian birch helps improve the microclimate in urban areas where it grows. Its dense crown creates coolness, reduces air temperature, and helps moisten the environment.The use of Dalekarli birch in landscape design and landscaping of urban areas of the Akmola region will make it more attractive and environmentally sustainable.

MATERIALS AND METHODS

As part of the study, materials presented in the Collection of Trees and Shrubs on the territory of the Astana Botanical Garden, where three species of the genus *Betula*, which are introduced, were studied. The studies were

conducted between 2020 and 2023. We used a methodology for assessing the general condition of plants developed by A.G. Golovach (Golovach 1980), which was transformed into a 5-point scale, where 5 means the best condition of the plants. A 6-point scale was used for this purpose to study the degree of flowering, specially developed for trees and shrubs (Golovach 1980) where 5 points correspond to the highest degree of flowering. To assess the decorativeness of plants, a 4-point scale was used (Emelyanova 2016), where 4 points indicate the highest decorativeness. Visual inspections were carried out to study resistance to diseases and pests, taking into account the influence of these factors on decorativeness. The assessment was carried out using a 3-point scale developed in the laboratory (0 - absence of lesion or damage, 1 - presence of lesion or damage without loss of decorativeness, 2 - presence of lesion or damage with loss of decorativeness). Winter hardiness was assessed after leaf bloom using a 7-point scale developed by P.I. Lapin and S.V. Sidneva (Lapin & Sidneva 1975). These methods allowed us to conduct a comprehensive study of the state of the genus *Betula* on the territory of the Astana Botanical Garden and obtain data on its adaptation and potential for introduction in this region. We used methods of observation, measurement, data collection on tree growth and development, and analysis of microclimatic conditions and soil composition.

RESULTS AND DISCUSSION

The collection of tree and shrub plants in the Astana Botanical Garden was created in 2018, where scientific research is carried out in different directions. This is the study of natural populations of woody plants to solve theoretical and practical problems in the field of dendrology, including issues of variability, systematics, taxonomy, selection of species and hybrids in nature, and the formation of collections. However, one of the main tasks is the introduction of woody plants from various ecological and geographical areas and work on the selection of some species for the purpose of their adaptation and introduction into the culture, the introduction of species, forms, varieties, and hybrids of woody plants into the urban environment and the study of their condition in urbanized areas. Tests of *Betula pendula* f. *dalecarlian* (L.F.) Schneid. were carried out for the first time at the Astana Botanical Garden (Astana) in the sharply continental climatic conditions of Northern Kazakhstan. To date, Dalecarlian birch has not been involved in landscaping the cities of Kazakhstan. It is quite a light-loving mesophile (plants adapted to soil and atmosphere of average humidity and cannot tolerate large amounts of salt in the soil), and microthermal (satisfied with a small amount of heat with uniform and moderate irrigation). In August 2020, with joint participation with KazNIILKhA named after A. Bukeikhan", on the territory of the Astana Botanical Garden asthenia were planted 62 specimens of *B. pendula* f. *dalecarlica* (L.fill.) Schneid V zone expositions I/III in "North-East Kazakhstan". Of the 62 planted young seedlings, 55 specimens survived, which demonstrates a high survival rate (88.7%) at the initial stage of the experiment with birch. In July 2022, 18 more specimens were added. Their survival rate was good, at 83%. By the fall of 2023, the total number was 41 copies, and the survival rate was 34%. According to phenological and morphometric parameters, no disturbances in these processes were registered. In terms of winter hardiness, Dalecarlian birch was classified in category II. Currently, *B. pendula* f. *dalecarlica* (L.fil.) Schneid. looks promising for introduction in the harsh continental climate of Northern Kazakhstan. This species is resistant to adverse environmental influences and has an average degree of flowering. Our research has shown that Dalecarlian birch can be successfully introduced into the urban environment of the Akmola region. Trees of this species showed a good increase in height and volume of wood; on average, within one year, it was 29.35. Phenological observations of shoot growth are shown in Table 1. The study revealed that the degree of flowering and fruiting play an essential role in plant introduction, as they determine the possibility of seed propagation in new conditions. However, it should be noted that a significant number of species whose pollen, when inhaled, can cause severe allergic reactions in adults and children, limiting their use in medicinal gardens, gardens, and green buildings. This also applies to species of the genus Birch (*Betula*). In this context, Dalecarlid birch has a low degree of flowering (2 points); the number of inflorescences does not exceed 20% of the full and abundant flowering of plants, which reduces possible allergenicity. In 2021, plant growth from June 1 to September 10 was 29.35 cm. In 2022, it was 26.5 cm, while in 2023, 23.5 cm. The maximum growth occured in June and July, 29-32 cm. Subsequently, this indicator practically did not change, and only by the end of the second ten days of July it dropped to 23 cm (Fig. 1). The nature of the dynamics of plant growth over three years different, which indicates the speed of plant growth. In the first ten days of June, the growth rate of plants begun to increase, and in the third ten days of June, it reached 28 cm, subsequently, in 2022 and 2023, it changed until the end of July, on average, by 20 cm. In the first ten days of August, the growth rate of Dalecarlian birch begun

to decrease. This is indicated by the amount of growth, which at the end of August was only 22 cm. The average height of plants during this period was 24 cm.

Table 1. Phenological observations of *Betula pendula* f. *dalecarlica* (L.fil.) Schneid.

year	Winter hardiness	Observations on vegetative shoots *Betula pendula f. dalecarlica* (L.fil.) Schneid. (Betulaceae)										
		Pch1	Pch2	Pb¹	Pb²	O1	O2	L1	L2	L3	L4	L⁵
2020		-	-	-	-	-	-	-	-	-	12 ± 8.09	13 ± 3.09
2021	II	06.04	23.04	23.04	02.06	13 ± 5.05	19 ± 5.09	03.05	28.05	10 ± 3.07	10 ± 5.09	16 ± 5.09
2022	II	18.04	17.04	23.04	02.06	11 ± 5.05	23 ± 30.08	02.05	22.05	08 ± 3.07	09 ± 7.09	17 ± 29.08
2023	II	16.04	21.04	19.04	29.05	11 ± 7.05	21 ± 24.08	18.05	23.05	09 ± 15.08	10 ± 18.08	14 ± 23.08

Pch1 - swelling of the kidneys;

Pch2 - bud opening;

Pb¹ - the beginning of linear growth of shoots;

Pb² - end of linear growth of shoots;

O1 - partial lignification of shoots;

O2 - complete lignification of shoots;

L1 - foliation of leaves;

L2 - leaves have their characteristic shape, but have not reached normal size;

L3 – completion of leaf growth and ripening;

L4 - coloring of dying leaves;

L⁵ - leaf fall.

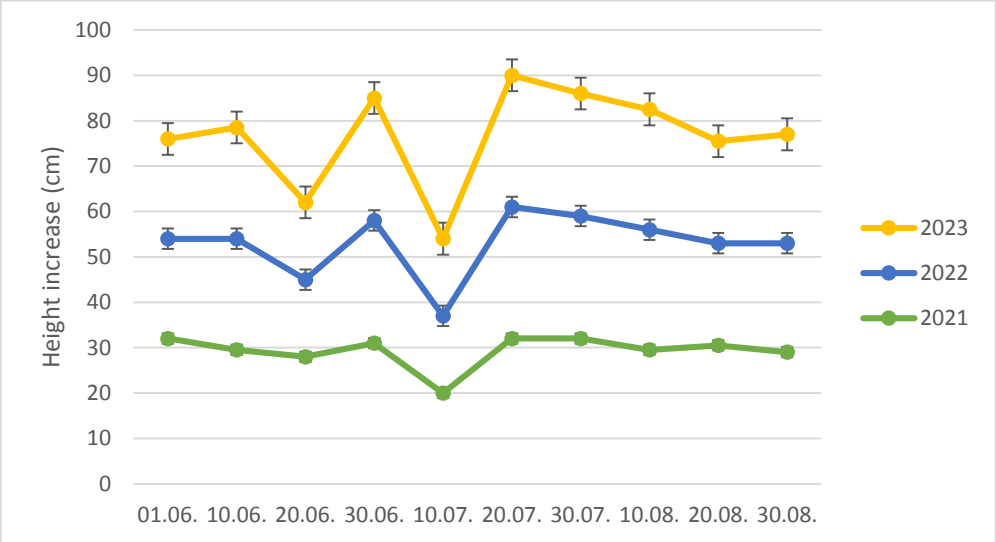

Fig. 1. Growth dynamics *Betula pendula f. dalecarlica* (L.fil.) Schneid. in the Astana Botanical Garden.

A b

V G d

Fig. 2. *Betula pendula* f. *dalecarlica* (L.fil.) Schneid.; a – preparation for planting, b – planting, c – appearance of leaves d – shelter for the winter in 2020, d – growth in 2021.

CONCLUSION

As a result, over four years of testing, Dalecarlian birch, *Betula pendula* f. *dalecarlica* (L.fil.) Schneid. has shown a good survival rate. Of the planted plants, 41 specimens remain today, which is 34.0% of the original number. No disturbances in phenological and morphometric parameters were registered. In terms of winter hardiness, Dalecarlian birch was classified in category II. The potential for the introduction of Dalecarlian birch in the harsh continental climate of Northern Kazakhstan is a promising development. Over 4 years, the average growth was 80 cm. This species is resistant to adverse environmental influences and has an average degree of flowering. It's worth noting that *B. pendula* f. *dalecarlica* has the potential for versatile use as an ornamental plant, thanks to its high ornamental value, and as a medicinal plant. It can be a valuable addition to medicinal gardens at sanatoriums, rest homes, hospitals, schools, and private homes. The introduction of Dalecarlian birch in the Akmola region will significantly expand the range of sustainable ornamental species for landscaping and reforestation. The high content of biologically active substances in the leaves and bark of this tree makes it a valuable resource for medicinal purposes.

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