

Dendrological garden named after R.I. Schroeder in Moscow as a unique protected area with international historical roots

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ABSTRACT

In the article, we analyzed historic stages and dynamics of forming the collection of woody plants in Dendrological garden named after R.I. Schroeder, Russian State Agrarian University – Moscow Timiryazev Agricultural Academy – the oldest historical park in Moscow, created by the genius of the patriarch of Russian gardening with Danish roots – Richard Ivanovich Schroeder (1822-1903). During its heyday at the end of 19th century, the garden's collection included 1038 species, varieties, forms and hybrids, contributing to the wide distribution of rare and interesting species throughout Russia. Today the gene pool of the dendrological garden includes representatives of 6 families of Gymnosperms, belonging to 17 genera, and 45 families of Angiosperms, belonging to 119 genera, in total – almost 900 species, varieties, forms and hybrids. The most numerous families in terms of the number of species and forms are Rosaceae (127), Pinaceae (84), Cupressaceae (63) and Ericaceae (45). The garden contains plants listed in the Red Book of Russian Federation with different categories of rarity (30 species from 25 genera and 17 families); the collection is constantly being replenished in order to enrich the cultural flora and protect the biodiversity and gene pool of plant species on the world through field collections and expeditions, as well as exchange with other botanical institutions. Currently, the dendrological garden named after R.I. Schroeder Moscow Timiryazev's Agricultural Academy is a unique living collection and base for the study of woody plants in Central Russia.

Key words: Plant, Moscow Timiryazev's Agricultural Academy, R.I. Schroeder, Protected areas, Gene pool, Taxonomic composition, History and dynamics of collection formation.

Article type: Review Article.

INTRODUCTION

Dendrological gardens represent a category of specially protected natural areas. According to the Federal law «On Specially Protected Natural Areas» № 33-FZ from 14.03.1995 (ed. from 03.07.2016), dendrological gardens are environmental institutions whose tasks include creating special collections of plants in order to preserve the diversity and enrichment of the flora, as well as carrying out scientific, educational and environmental activities (About specially protected..., 2016). Dendrological gardens serve as a base for studying plant systematics and taxonomy; their ecology, phenological deviations under climate change, plant physiology and their relationships with consumers, genetic changes during forced isolation (Donaldson, 2009; Primack *et al.* 2021; Philpott *et al.* 2022). Dendrological gardens are unique banks of genetic materials, and also play a huge role in the process of environmental education of human population (Chapman *et al.* 2018; Chen & Sun 2018; Breman *et al.* 2021). Territories of dendrological gardens are intended only for the fulfillment of their direct tasks, while land plots are transferred for perpetual use to dendrological gardens, as well as to research or educational institutions in whose jurisdiction they are located (Babich 2016; Galinovskaya 2010; Ganitsky 2021). Specially protected natural areas of this category may have federal or regional significance (status; Pyrkova 2010; About state supervision... 2019).

According to classification of the International Union for Conservation of Nature, dendrological gardens, as well as nature reserves, most of all correspond to category IV – Specially Protected Natural Areas, managed through active human intervention to maintain habitats and/or other conditions necessary for existence of certain species (; Gorbatovsky *et al.* 2007; Slashchev 2012; About approval of the Rules ... 2021). Dendrological gardens currently significantly complement the system of territorial forms of nature conservation and ensure the conservation of significant areas of natural and anthropogenic landscapes (Golding *et al.* 2010; Evsegneeva 2011; Ibragimov 2015; Baranchikov 2023). For conservation work of Russia, the dendrological garden is a relatively new form of organizing the protection of territories (Potapov & Yudin 2011). Dendrological garden named after R.I. Schroeder, Russian State Agrarian University – Moscow Timiryazev Agricultural Academy – the oldest historical park in Moscow with a rich collection of trees and shrubs (including species from the Red book of Russian Federation) and glorious traditions, are specially protected natural area with federal status (Specially protected natural areas ... 2017). The status of protected area was assigned to this territory in 1995, and it was part of the Petrovsko-Razumovskoye complex reserve in 1998-2010. Dendrological garden named after R.I. Schroeder also included in the list of monuments of landscape art protected by the state (Gorbunov & Demidov 2012). The garden was created by the genius of the patriarch of Russian gardening with Danish roots – Richard Ivanovich Schroeder (1822-1903) in 1862, that is it appeared several years earlier than the founding of the Petrovskaya (Timiryazev) Academy itself (1865). Schroeder founded a dendrological park, a nursery and a dwarf fruit garden on an area of 12.6 hectares. The dendrological garden bears the name of its founder, who headed it for 40 years without a break, and is located on the territory of an old estate near Moscow, the history of which begins with records in census books of the 16th century (Ignatieva & Lavrichenko 1985).

MATERIALS AND METHODS

The article is based on a critical analysis of the main literary sources on the topic of research over 150 years of existence of the Arboretum. Historical documents in the Central Scientific Library named after N.I. Zheleznyov Russian Agrarian University - Moscow Agricultural Academy named after K.A. Timiryazev as well as archival materials from the Arboretum funds were studied. The authors took into account their personal experience of working with collections of living plants in the Arboretum and conducting excursions there for students and schoolchildren.

RESULTS AND DISCUSSION

History of arboretum and collection formation

R.I. Schroeder was born on January 12, 1822 in Denmark, in small Lottrup town, near Gorgens City (Polyakov *et al.* 1998; Radjabov *et al.* 2022). He received his education in the field of practical horticulture in Copenhagen. Botanical Garden in Copenhagen is the oldest institution of its kind in Europe. It was founded in 1600 and moved to its current location in 1870. The future patriarch of Russian gardening, Richard Schroeder, interned (practiced) there in the early 40s of 19th century. The garden is part of the Danish Natural History Museum at the University of Copenhagen. This is a wonderful landscaped area with green lawns and clumps of plants. The park is mainly designed in a landscape style with elements of a regular French park, with a system of ponds and greenhouse. After completing his studies here, Schroeder was left as a teacher and gardener at the Jutland Horticultural Society, then in the spring of 1844 first appeared in St. Petersburg, Russia.

Stage I. pre-revolutionary (heads - R.I. Schroeder, and E.A. Meyer). From 1862 to 1903 R.I. Schroeder was in charge of gardening institutions of the Petrovsky (now the RSAU-MTAA) Academy. He restored the neglected park, founded an orchard with a nursery, a vegetable garden, a nursery for ornamental plants, alleys, hedges, and began work on creating of dendrological garden. The organizational and gardening talent of the young specialist was fully revealed here, and the skills he acquired in Denmark were used. The arboretum was opened to visitors in 1870. L.N. Tolstoy, F.M. Dostoevsky, I.I. Levitan, K.G. Paustovsky, V.V. Mayakovsky visited the Dendrological Garden. An outstanding biologist of the XX century N.I. Vavilov had an internship during his student years. R.I. Schroeder investigated the issues of introduction and acclimatization of trees and shrubs from all over the world in the conditions of central Russia. Studying introduced plants, R.I. Schroeder concluded that the success of introduction largely depends on the origin of starting material. The results of work on plant acclimatization were summed up by R.I. Schroeder in the «Index of Plants of the Arboretum of the Moscow Agricultural Institute», published in 1899 and including a list of 1038 species, varieties, forms and hybrids,

indicating their frost resistance, features of agricultural technology and application, which contributed to the widespread distribution of introduced trees and shrubs throughout Russia (Schroeder 1899).

Stage II. revolutionary (V.I. Edelshtein).

Stage III. restoration and further development (20-30s, P.G. Schitt, N.N. Timofeev, S.I. Matveev, S.D. Georgievsky, and S.N. Kulagin). In the first years of Soviet power, the decrees of 1924 «On the protection of natural monuments, gardens and parks» and «On the registration and protection of monuments of art, antiquity and nature» were adopted. A «List of gardens and parks recognized as inviolable natural monuments» was also published (1923), which included the Petrovsko-Razumovskoye estate (Reimers & Shtilmark 1978).

Stage IV. The Great Patriotic War and subsequent development of collection (N.L. Timofeeva, I.P. Ignatieva, and E.V. Lavrichenko).

Stage V. Modern (from 1988 to the present, V.N. Arkhangelsky, D.E. Shurshin, and A.V. Gromadin).

Dendrological Garden named after R.I. Schroeder in Moscow is second in age only to the Botanical Garden of Moscow State University: the Apothecary's Garden, but unlike it, the arboretum has practically not changed its boundaries. Since the 19th century, traces of paths, drainage ditch systems, and an alpine slide have been preserved here. Some oaks and lindens reach 200 years of age. The garden features a large collection of plants – almost 900 species, forms and hybrids of tree and shrub flora of Asia, Europe, North America and other regions (Arboretum of the Moscow Agricultural Academy 2010).

Current state, structure and development prospects

Today the dendrological garden named after R.I. Shroeder is a unique center for introduction, acclimatization, and conservation of rare and endangered plants of the natural flora *ex situ*. The main task of the arboretum is to model artificial phytocenoses based on the principle of their natural standards (Oldfield 2009). Experience has shown that the most promising method of plant protection is the method of preserving them in self-renewing introduced populations as part of artificial phytocenoses (Cannon & Kua 2017; Mounce *et al.* 2017; Abeli *et al.* 2020; Grace *et al.* 2021). The garden staff made a significant contribution to study of ontogenetic morphogenesis of plants, biomorphology, forest taxation, and phytocenology. The obtained experimental data are widely used in solving applied problems on introduction and acclimatization of trees and shrubs, their seed and natural vegetative reproduction, introduction of new plant species into urban landscaping, etc. Trees and shrubs are located throughout the vast territory of the dendrological garden according to a systematic principle: plants belonging to the same botanical family are planted in one area, where they are easier to morphologically recognize and compare. The large area of the arboretum allows each plant genus to be represented by a number of species. To create fragments of forest phytocenoses on the arboretum territory, local vegetation cover was used, on which single and group plantings of introduced species of trees and shrubs were created. Creation of a tree canopy was the basis for the successful introduction of associated species on the arboretum territory. In climatic conditions of the Moscow region, the best results were obtained when creating forest groupings of species of European, Caucasian and Far Eastern flora. Fragments of the arboretum exposition are located taking into account the landscape features of territory and implement various compositional ideas of its creators. As a result, the following main groupings (combinations) of plants can be distinguished (Trulevich 1991):

Multi-tiered multi-component ecological-phytocenotic groups. Upper tier is represented by tall tree species, middle tier is occupied mainly by undergrowth of medium- and low-growing shrubs, lower tier is grass cover.

Two-tiered multicomponent ecological-phytocenotic groups. Only 2 tiers are distinguished – the upper one is represented by tree species, and lower tier is occupied by various herbaceous plants.

The territory of dendrological garden is divided into functional zones: exhibition zone, visits to which are determined by directorate of specially protected natural area; scientific-experimental zone, access to which is available only to specialists working here; administrative zone. Dendrological garden named after R.I. Schroeder was laid out according to laws of landscape park. Large and small groups of trees and shrubs are picturesquely placed in vast clearings, creating perspective. On the arboretum territory it is also possible to see plantings of solitaires from various tall trees, for example, *Quercus robur* L., *Aesculus hippocastanum* L., *Robinia pseudoacacia* L., etc. Dendrological garden named after R.I. Shroeder makes a great contribution to study of bioecological characteristics of plants, development of methods for accounting and rational use of plant resources in national economy of different geographical zones, measures for conservation and restoration of rare, specially protected and endangered species of trees and shrubs, for example, *Betula pendula* f. *dalecarlica* (L. f.) Schneid.,

Ginkgo biloba L., *Catalpa bignonioides* Walter, *Laurocerasus officinalis* M. Roem, *Liriodendron tulipifera* L., *Magnolia kobus* DC., *Cotinus coggygria* Scop., etc. Since geomorphology, climate, soil, and phytocenoses have been sufficiently studied on the arboretum territory, it represents an ideal base for conducting fundamental research work and setting up long-term experiments. The results of research work carried out on the arboretum territory are widely presented in various monographs, textbooks, teaching aids, used in writing candidate and doctoral dissertations, scientific articles and serve as a valuable contribution to development of national biological science (Matyukhin *et al.* 2009; Cheryatova, 2020; Cheryatova, 2021; Gromadin, Matyukhin, 2022; Sakhonenko *et al.* 2023). Currently, dendrological and botanical gardens are an integral part of system of specially protected natural area of Russia and world; they belong to industry-specific specially protected natural areas of museum type (Reimers & Shtilmark, 1978), combining two important functions – scientific-collection and collection-educational. This is exactly a place that dendrological garden named after R.I. Schroeder of Russian State Agrarian University – Moscow Timiryazev Agricultural Academy occupies in overall system.

CONCLUSION

Today, the dendrological garden named after R.I. Schroeder is a unique territory with enormous potential, fulfilling a number of important tasks:

Environmental activities. Dendrological garden named after R.I. Schroeder constantly develops cooperation with botanical gardens near and far abroad, interacts with key scientific and education institutions in Russia, which contributes to the joint formation of new approaches to the conservation and enhancement of biodiversity. Arboretum plays a special role in human society, intuitively linked to urban green spaces, including public gardens, parks, nature reserves, and forests. This allows urban spaces to create a healthy environment for human population. Today, the dendrological garden continues to focus on practical work to preserve plant diversity *in situ* and *ex situ*. Currently, the staff of dendrological garden is actively working to restore species that previously grew in the garden, but have fallen out of collection plantings. Introduction of new species is one of the main ways to mobilize and preserve plants of different floras under the international program for biodiversity conservation. Therefore, new plant species for garden are planted annually in a permanent place in the garden. Over the past ten years, the collection fund of the Arboretum has been replenished with fifty new plant species.

Scientific. The role of scientific research and discoveries based on living plant collections has been a striking feature of activities throughout the history of development of the Arboretum. On the basis of dendrological garden, fundamental and applied research is continuously carried out, aimed at expanding the range and preserving biodiversity through the processes of introduction and acclimatization. Replenishment of the collection fund of the Arboretum occurs mainly due to the receipt of seeds from other botanical gardens and arboreturns near and far abroad under the international seed exchange program (seed delectus). Arboretum employees also bring seeds, cuttings and seedlings of trees and shrubs from numerous business trips and scientific botanical expeditions. Some rare garden plant forms are also purchased from private nurseries. The arboretum contains a collection of rare, endangered and Red Book species and forms of trees and shrubs. The main direction of research is study of the phenological characteristics of trees and shrubs, since phenology is a key indicator of biological consequences of changes in climatic conditions. The Arboretum is an ideal place to study a large number of species of trees and shrubs growing in the typical climatic conditions of Central Russia. The closely-related species of woody plants in experiments on introduction and acclimatization show great similarity in the rates and rhythms of phenophases, which indicates the paramount importance of understanding the strategies of their large and small life cycles. Based on many years of scientific research into the bioecological characteristics of introduced plants, species recommended for implementation in the practice of urban gardening in Moscow were selected.

Enlightenment and education. In society, there is a naive attitude towards the importance of plants and insufficient awareness of the human influence on plant life; many people lack environmental thinking and an environmental culture of behavior. Dendrological Garden named after R.I. Schroeder is called upon to solve this problem in botanical and urban space. On the territory of the arboretum, educational work is carried out with the population, the motives and beliefs of people are studied in terms of awareness of plants, their biodiversity, existing programs for the protection of flora and fauna, as well as the cultural heritage of historical natural monuments. Researchers and teachers of the Russian State Agrarian University-Moscow Agricultural Academy named after K.A. Timiryazev is constantly being interviewed for federal television channels and radio on issues of protection and reproduction of the garden's bioresource collections. Dendrologists discuss how we might better understand and

harness the function of dendrological gardens in urban contexts, using botanical spaces to further enhance public interest in plant life and thereby challenge environmental ignorance. Employees of the dendrological garden and teachers of the Department of Botany, Plant Breeding and Seed have developed routes for educational excursions, created an educational film, video excursions and a slide library.

Aesthetic. The Dendrological Garden named after R.I. Schroeder has collected multiple collections of generic complexes of trees and shrubs, which give incredible natural color not only to the garden itself, but also to the surrounding area. In order to popularize the techniques of landscape architecture, an artificial pond was created on the territory of the arboretum, framed by beautiful flowering shrubs and conifers. Thanks to the prolonged decorative effect of some garden plant forms, visitors can admire the dendroflora of the garden all year round. Large and small groups of trees and shrubs planted on the territory of the Arboretum, as well as decorative compositions of perennial herbaceous plants, help visitors to form not only an aesthetic perception, but also to receive incredible aesthetic pleasure. The increasing pace of urbanization and depletion of the gene pool of the world dendroflora poses challenges for dendrological gardens related to the replenishment of cultivable plant habitats for the conservation and rational use of the biological resources of our planet. Along with representatives of the native flora, the importance of attracted foreign species with valuable biological and economic qualities is increasing. Currently, in front of the Dendrological Garden named after R.I. Schroeder faces great challenges in further developing the scientific foundations of natural resource management, introduction, acclimatization, protection and reproduction of rare and specially protected trees and shrubs. Thus, holding on territory of the Dendrological garden named after R.I. Schroeder's research, cultural, educational and environmental activities will allow not only to preserve, but also to increase the valuable gene pool of forest plants in Russia. Over its over 150-year history, the Dendrological Garden named after R.I. Schroeder has become a unique collection of living plants, one of the major introduction centers and a base for fundamental scientific and scientific-practical research on the study of woody plants in Central Russia, contributing to the implementation of various programs for the conservation of biodiversity.

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