

Some Rare Woody Plants in Kakheti Region

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Abstract. *The paper discusses the growth and developmental characteristics of certain rare woody plant species introduced in the Kakheti region. The study focuses on the target species: Ginkgo biloba L., Cryptomeria japonica (Thunb. ex L.F.) Don., Pinus strobus L., Liriodendron tulipifera L., Quercus alba L., Quercus rubra L., Quercus suber L., Juglans nigra L., Firmiana platanifolia Schott et Endl., Gymnocladus dioica (L.) K. Koch, Sophora japonica L., and Eucommia ulmoides Oliv. The research examines their phenology and phenometry, flowering and fruiting periods, seed quality, drought and frost resistance, the duration of cambial activity in 1–3-year-old shoots, and summarizes the outcomes of acclimatization and adaptation processes.*

The results revealed that all studied species exhibit good growth and development, their annual developmental cycle includes all morphophysiological phases, they are not damaged by frost, they flower, bear fruit, and some even propagate naturally.

It is recommended that these species be widely introduced both in natural habitats and in cultivated landscapes.

Keywords: *Introduction, growth and development, vegetation, cambial growth, flowering*

Introduction

Plant introduction is proceeding successfully in Georgia, as evidenced by the presence of over 2,000 plant species in botanical gardens. However, only a small portion of the global flora has been utilized so far. The enrichment of artificial landscapes with decorative, medicinal and other valuable plants will make a significant contribution to the greening and afforestation across Georgian cities and regions.

The Kakheti region is rich in both native and introduced woody plant species and is characterized by climatic conditions favorable to their growth. It serves as one of the important sites for the introduction of woody plants in Georgia, hosting over 200 species of introduced plants from various climatic zones.

The Kakheti region is distinguished by its diverse and complex terrain and, accordingly, a variety of natural conditions. It is quite well protected from strong winds, but remains relatively open from the southeast and is characterized by abundant precipitation, especially during the autumn and winter months.

Species that are characterized by polymorphism and whose natural distribution area share similar soil and climatic characteristics with those of Kakheti, are relatively better adapted to the climatic conditions of Kakheti. Kakheti is one of the important sites in Georgia for the introduction of woody plants. Many ornamental and valuable forestry plants from various geographical regions have been introduced here. Studying the characteristics of acclimatization and adaptation of introduced plants will facilitate their use in decorative gardening and landscaping.

Research Objective:

The research objective is to summarize the growth and development patterns, bioecological characteristics, current ecological status, and the acclimatization and adaptation features of some rare woody plant species introduced to the Kakheti region.

Research object and methods:

The object of the research is the study of introduced, rare woody plants species found in the greenery and park gardens of the Kakheti region (Telavi, Kvareli, Lagodekhi, Signaghi) and their bioecological characteristics. To this end, the following target species were selected: *Ginkgo Biloba* L., *Cryptomeria japonica* (Thunb.ex L.F.)Don., *Pinus strobus* L., *Liriodendron tulipifera* L., *Quercus alba* L., *Quercus rubra* L., *Quercus suber* L., *Juglans nigra* L., *Firmiana platanifolia* Schott Et endl., *Gymnocladus dioica* (L.) K.Koch, *Sophora japonica* L., *Eucommia ulmoides* oliv.

Tsinandali Park was selected as the site for stationary research. In order to study the above-mentioned issue, a phenological study was conducted on the target species over the past 5 years. The periods of flowering and fruiting, seed quality (determination of germination capacity), drought resistance, and the duration of cambium activity in 1- to 3-year-old shoots were studied in accordance with the methodological guidelines of A. Tsitsvidze, E. Lobzhanidze, and L. Yatsenko. [1],[2],[3]. When collecting samples for analysis, the age of the plant, light conditions, exposure to sunlight, and vegetative state were taken into account. Samples (3-5 cm long sections of 1- to 3-year-old shoots) were collected every 5 days during the period of bud opening and the end of apical growth, and every 10 days during the rest of the growing season. The five-year data were processed using the method of variation statistics.

Research results:

The study revealed that the growth rhythm and flowering phenophases of the studied plants change in accordance with the characteristics of the hydrothermal regime. In the Kakheti region these plant species begin their vegetation in spring, when the average daily air temperature reaches 5-10°C.

Ginkgo Biloba L. - is a gymnosperm, deciduous plant, naturally distributed in China, where its life expectancy can reach up to 2000 years. It was introduced to Georgia in the 19th century and is well adapted to the climatic conditions of the country. It is widespread in both eastern and western Georgia. As a mesophytic, in eastern Georgia it tolerates dry air if watered in the summer. It is characterized by the distinctive crown with beautiful leaves. In Kakheti, it is found in the Telavi, Gurjaani, Kvareli, Lagodekhi, and Signaghi regions, in the form of single specimens.

Some of its specimens reach 25 meters in height and 85-90 cm in diameter at the age of 80-100 years. It is characterized by a healthy vegetative state in Kakheti. In Tsinandali Park, the *Ginkgo Biloba* L. was introduced 150 years ago. Here it exhibits good growth and development, with vegetation beginning in the first half of April. During the study period, bud opening was observed on April 10, cambium activity started on April 12, and ended on September 28. The duration of cambial growth was 169 days. It blooms in May, produces fruit well, and demonstrates natural self-seeding.

Several times during the study period, spring frosts significantly damaged the buds of the ginkgo, which resulting in infertility. No other notable damage was observed to the tree. In addition to being a beautiful ornamental plant, it also holds significant importance in medicine. Its seeds have been used in traditional Chinese medicine since ancient times. Scientifically, ginkgo is known to contain specific compounds that enhance the elasticity of cerebral blood vessels and promote their dilation, thereby improving the brain's supply of oxygen and nutrients.

Ginkgo Biloba L. is significant as an ancient relic on the verge of extinction. It is resistant to air pollution caused by industrial emissions, as well as to fungal diseases, and it is rarely affected by insects. Therefore, the introduction of this species is recommended not only for gardens, parks, and squares but also for urban street landscaping. Its well-developed specimens can be found in the Tbilisi Central Botanical Garden and Lagodekhi.

Cryptomeria japonica (Thunb.ex L.F.) Don. - is naturally distributed in central and southern Japan and China. In many European countries it is widely used in decorative gardening and for the cultivation of forest crops. In the South Caucasus, it is characterized by the best growth and development in Western Georgia. It is found in Kakheti, in Kvareli, where it exhibits

a good vegetative state. In the Lagodekhi Nature Reserve, where there is quite deep and fertile ochre-type soil, it has a remarkable vegetative state. It reaches a height of 20 meters and a diameter of 25 cm. Average annual growth is 48 cm in height and 1, 2-5 cm in diameter. It bears fruit abundantly and produces high-quality seeds, with a germination rate of 30–40%.

There are 6 *Cryptomeria japonica* trees in Tsinandali Park. At the age of 90, it reaches 22 a height of 22 meters and a diameter of 70 cm.[1] Here, Japanese cryptomeria is affected by droughts and soil salinization. In winter, it is also damaged by frost, resulting in the withering of both terminal and lateral branches. Vegetation begins in the first half of April. During the study period, cambial growth began on April 10 and ended on September 21, lasting for 164 days. *Cryptomeria japonica* is characterized by better growth and development under the environmental conditions of Lagodekhi and Signaghi.

Pinus strobus L. - is naturally distributed in North America and Canada. In its homeland, it forms pure or mixed groves. It is characterized by a wide distribution area. It is not demanding on soil can grow in various soil types. It is frost-resistant and can withstand temperatures as low as -26 - 30°C.

It grows up to 40-50 meters in height, with a trunk diameter of 100-180 cm. The branches are arranged in a ring on the trunk, forming a wide pyramidal crown. It has thin, grayish-green needles, 5-10 cm long, which live for 2-3 years. This species is characterized by rapid growth and high-quality wood, which contributes to its widespread introduction beyond its native range.

Pinus strobus was introduced to Eastern Georgia in the in the 1880s. It adapts well to the climatic conditions of Kakheti and is therefore widely distributed. In Tsinandali Park, the species demonstrates robust growth and development. At approximately 90–100 years of age, it reaches a height of 20–21 meters and a trunk diameter of 70–75 cm. It produces abundant fruit with high-quality seeds and occasionally regenerates through self-seeding. Its growth begins in May, the duration of cambial activity is 145 - 150 days. Due to its successful growth in inner Kakheti, it can be widely introduced into decorative gardening and forest crops.

Liriodendron tulipifera L. - naturally distributed in the eastern part of North America, it forms only mixed coenoses. This deciduous tree reaches a height of 50-60 meters and is distinguished by its large, 4–6-lobed leaves and greenish-orange flowers. It is a light-demanding, frost-resistant species. If irrigated, it tolerates dry soil and air. It was introduced to the Tbilisi Botanical Garden at the beginning of the 20th century. In Tsinandali Park, a 100-year-old specimen reaches 30 meters in height and 55 cm in diameter. It is not damaged by frost, blooms and bears fruit. *Liriodendron tulipifera* L. - is characterized by good growth and development in the Kvareli and Lagodekhi regions as well.

In Tsinandali Park, the North American *Quercus alba* L. can be found - a deciduous tree reaching up to 40 m in height, characterized by an ovoid crown and erect, deeply lobed leaves. It is rare in culture. In eastern Georgia, it occurs only in Tsinandali Park, where at the age of 100 it is 22 m in height and 70 cm in diameter. Here, vegetation begins in mid-April. Cambium activation begins in the lateral branches, 2-3 days before bud opening, and lasts for 160 days. The growth of lateral branches ends in May. It bears fruit quite abundantly and produces high-quality seeds. Occasional natural self-seeding is also observed here. In Tsinandali, the species is not damaged by frost.

Quercus rubra is a deciduous tree of North American origin. In its native range, it grows 20–40 meters tall and typically spreads on slopes and along riverbanks, forming both pure and mixed forests. In Tsinandali Park, a single specimen is found, which, at the age of 50, reaches a height of 12–15 meters [4]. Vegetation begins in mid-April. Cambial growth continues 153 days. Flowering occurs in April–May, similar to its native range. With periodic irrigation, the species tolerates soil and air dryness well and is not damaged by frost. However, it produces fruit weakly. During the study period, secondary growth of lateral branches was observed in late July to mid-August. These shoots exhibit rapid growth but often do not have sufficient time to lignify and may be damaged by early frosts. In addition to Tsinandali, *Quercus rubra* L. is also found in Kvareli (Kakheti region), where it is also characterized by good growth and development, reaching a height of 16 meters and a trunk diameter of 35–40 cm.

Quercus suber L. - Naturally distributed throughout the Mediterranean countries. In Kakheti, it can be found in Kvareli region and Tsinandali Park, where several of its plants reach 2-3 meters in height, bloom and bear fruit, and are not affected by frost. [4] Vegetation begins, similar to the red oak, in mid-April. Cambium activity begins 3 days before bud break and ends in early September. Like *Quercus rubra*, *Quercus suber* undergoes flowering first, followed by leafing, and finally fruit ripening. It blooms in April - May. The coefficient of variation is 7.5%.

The lateral branches of *Quercus alba*, *Quercus rubra*, and *Quercus suber* are characterized by such rapid growth that the length of the new shoot reaches 70-90% of the entire annual increment within 20-25 days. Their growth in height stops in May-June.

Juglans nigra L. is naturally distributed in North America. It is a mesophytic species that can tolerate dry air when adequately watered. The tree prefers deep, fertile soils and tolerates calcareous substrates well. It features a dark gray to black, deeply fissured stem, and produces black or brown fruits with a grooved shell that are inedible. Its high-quality wood is widely used in furniture manufacturing. In its homeland, it can live for 300-400 years. With a strong growth potential and ornamental appeal, it is widely cultivated. *Juglans nigra* is also actively used as a rootstock for grafting common walnut varieties, both in its native range and in European countries.

In Kakheti, ქველახის ნივრად is not damaged by frosts. As in its homeland, here it blooms in May, with a flowering period lasting 20-25 days. Seed viability ranges between 15-20%. Vegetation begins at the end of April, the apical growth of shoots ends at the end of May, with an average elongation of 10 cm. Cambial activity in shoots begins 5-6 days after bud break, at the end of April and ends in early October. Cambial growth lasts for 154 days.

Firmiana platanifolia Schott Et endl. - is a valuable ornamental plant. With large leaves and smooth greenish-gray bark. It is naturally distributed in China and Japan. It can be found in Kakheti, in Telavi, Tsinandali, Lagodekhi and Signaghi. It adapts well to the climatic conditions of Kakheti. It is not damaged by frosts and summer droughts. However, under conditions of moisture deficiency, often begins to exhibit dieback at the age of 60-70 years, with partial withering of lateral branches. This indicates premature onset of senescence.

In Tsinandali Park, a 100-year-old of its specimen can be found, which is characterized by good growth and development, drought and frost resistance.[4] In Tsinandali, vegetation begins in late April. During the study period, bud opening was recorded on April 23, cambial activity began on May 2 and ended in late September. Its cambial growth lasts 145 days. The coefficient of variation is 8%. During the study period *Firmiana platanifolia* vegetation began when the minimum air temperature reached 5°-15°C. The species bears fruit abundantly, however drying of lateral and apical branches is observed. In its homeland, it blooms in July, and in Tsinandali flowering occurs from June to July.

Firmiana platanifolia also demonstrates good growth and development in the Central Botanical Garden of Tbilisi.

Gymnocladus dioica (L.) K.Koch.-Naturally distributed in North America. Several specimens are found in Tsinandali Park, characterized by good growth and development. At the age of 100-120 years, the individuals reach 25 meters in height, and 90 cm in width. although mesophytic, it tolerates dry and shallow soils well if irrigated, it is not limited in growth and bears fruit, has large bipinnately compound leaves, and finishes leaf growth in May. It begins vegetation in late April, the cambial activity begins on April 20 and lasts 163 days, until the first half of October, i.e. its radial growth is 1.5-2 months shorter than the vegetation period of the study region. It blooms in May and June, the fruits ripen in the autumn of the same year. The linear growth of lateral branches lasts 40 days, with an average increase of 20 cm.

In addition to Tsinandali Park, *Gymnocladus dioica* can be found in the village of Napareuli, Kakheti, where at the age of 100 it is 25 meters high, 55-60 cm in diameter. The species demonstrates excellent adaptation to the local soil and climatic conditions, resulting in abundant natural regeneration. Numerous self-seeded offspring form dense thickets over a considerable area around the mother plant.

Japanese Sophora (*Sophora japonica* L.) - Naturally distributed in Japan and China. It has a spreading, thinly branched stem. Its leaves contain vitamin C. The species blooms in June – July, and its fruit ripens in December – January. It is thermophilic and light-demanding, with good drought tolerance. Once it reaches fruit-bearing age, it is not affected by frost. However, it cannot tolerate shading, grows poorly on stony and saline soils. It reproduces only vegetatively, mainly by grafting. In Tsinandali Park, 13 specimens of *Sophora japonica* are present. Its 90-year-old specimen reaches 25 meters in height and 92 cm in diameter. During the observation period, bud opening began on April 9, the cambium activity began on April 12 and ended in late September, lasting 148 days. The coefficient of variation was 12.7%.

Eucommia ulmoides Oliv. - is naturally distributed in China. It is notable for its ionizing properties, the phytoncides secreted by *Eucommia* have a lethal effect on various bacteria, which is why this plant should be given a special place in landscaping. Due to the above-mentioned properties, *eucommia* plantations are built near residential buildings in its homeland - China. Additionally, the bark of *უცომშია* is widely used in traditional medicine.

უცომშია ულმოიდეს is found in the Tbilisi Botanical Garden, in the Lagodekhi State Reserve, and in Napareuli, Kakheti. In all locations, it is characterized by normal growth and development, successfully bears fruit, and produces high-quality seeds. Generally, this species prefers moist soils and demonstrates good tolerance to droughts and frosts, withstanding temperatures as low as –30°C.

Conclusion:

As a result of the research, it was determined that the introduced woody plant species distributed in the Kakheti region: *Ginkgo Biloba* L., *Cryptomeria japonica* (Thunb.ex L.F.)Don., *Pinus strobus* L., *Liriodendron tulipifera* L., *Quercus alba* L., *Quercus rubra* L., *Quercus suber* L., *Juglans nigra* L., *Firmiana platanifolia* Schott Et endl., *Gymnocladus dioica* (L.) K.Koch, *Sophora japonica* L., *Eucommia ulmoides* Oliv. adapt well to the local soil and climatic conditions. Their annual developmental cycle includes all morphological and physiological stages. These species are characterized by good growth and development, are not damaged by frosts, all of them bloom and bear fruit, and some even reproduce naturally—an important indicator of their successful adaptation to the climatic conditions of Kakheti. The wide use of these species in the greening of the Kakheti region is of great importance from both scientific and practical perspectives.

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ზოგიერთი იშვიათი მერქნიანი მცენარე კახეთის რეგიონში

ნადირაძე თამარ

იაკობ გოგებაშვილის სახელობის სახელმწიფო უნივერსიტეტი, თელავი

აბსტრაქტი

ნაშრომში განხილულია კახეთის რეგიონში ინტროდუცირებული ზოგიერთი იშვიათი მერქნიანი მცენარის ზრდა-განვითარების თავისებურებები. შესწავლილია სამიზნე სახეობების: ორნაკვითიანი გინგო (*Ginkgo Biloba* L.), იაპონური კრიპტომერია (*Cryptomeria japonica* (Thunb.ex L.F.)Don.), ვემუტის ფიჭვი *Pinus strobus* L., ლირიოდენდრონი(ხე ტიტა) *Liriodendron tulipifera* L., თეთრი მუხა (*Quercus alba* L.), წითელი მუხა (*Quercus rubra* L.), კორპის მუხა (*Quercus suber* L.), შავი კაკალი (*Juglans nigra* L.), ჭადარფოთოლა ფირმიანა (*Firmiana*

platanifolia Schott Et endl.), კანადის გიმნოკლადუსი (*Gymnocladus dioica* (L.) K.Koch, იაპონური სოფორა (*Sophora japonica* L.), თელისებრი ევკომია (*Eucommia ulmoides* Oliv.), ფენოლოგია და ფენომეტრია, ყვავილობისა და ნაყოფმსხმოიარობის პერიოდები, თესლის ხარისხი, გვალვაგამძლეობა და ყინვაგამძლეობა, კამბიუმის მოქმედების ხანგრძლივობა 1-3 წლიან ყლორტებში, შეჯამებულია აკლიმატიზაცია-ადაპტაციის შედეგები.

კვლევის შედეგად დადგინდა, რომ ყველა შესწავლილი მცენარე ხასიათდება კარგი ზრდა განვითარებით, მათი განვითარების წლიური ციკლი მოიცავს ყველა მორფოფიზიოლოგიურ პერიოდს, ყინვებისგან არ ზიანდება, ყვავილობს, მსხმოიარობს და ზოგი ბუნებრივად ც მრავლდება.

სასურველია, აღნიშნულ მცენარეთა ფართოდ გავრცელება ბუნებაში და კულტურში.

საკვანძო სიტყვები: ინტროდუქცია, ზრდა-განვითარება, ვეგეტაცია, კამბიალური ზრდა, ყვავილობა.