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BIOLOGY

Introduction of *Ginkgo biloba* L. in conditions of the North-Western Black sea region

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Abstract. The article presents historical data on the introduction of *Ginkgo biloba* L. in the North-Western Black Sea region. A comparative analysis has been made on the bioecological properties of the species under different growing conditions. An assessment has been carried out on the prospects for the widespread introduction of *Ginkgo biloba* L. for the purpose of landscaping of the city of Odessa.

Keywords: Ginkgo biloba L., introduction, North-Western Black Sea region, botanical garden, bioecological properties.

Introduction. Ginkgo biloba (*Ginkgo biloba* L.) is the only surviving relict species of the ginkgo family (Ginkgoceae). It is of scientific interest as a medicinal and highly decorative plant.

Brief review of publications on the topic. Ginkgo biloba (Ginkgo biloba L.) was discovered in 1690 by the doctor of the Dutch embassy in Japan E. Kaempfer, in 1712 he described it under the name of ginkgo (silver apricot or silver fruit). After 20 years, it was brought to Europe, and at the end of the 18th century to North America [3]. Today, ginkgo is grown in many parks and gardens in the subtropics and southern regions of the temperate zone of North America, Europe and Asia, restoring historical justice, almost repeating the ancient area of its distribution. Outdoors Ginkgo grows in Russia in Kaliningrad, Moscow, St. Petersburg, Krasnodar and Astrakhan. In the main botanical garden of the Russian Academy of Sciences, ginkgo has been growing since 1946 (three-year-old seeds had been brought from Germany), these specimens do not bloom, grow slowly and require mandatory shelter for the winter period. In the Lagolekh arboretum (Georgia), there are two growing specimens, planted in the 1860s. Both trees are about 30 meters high, the female one bears fruit, the seeds are viable.

Ginkgo has been known in culture since the 11th century. It is currently used as an ornamental, fruit and medical plant. Many variations of its decorative forms are used in landscaping [7].

The purpose of this research is to study the bioecological features of *Ginkgo biloba* L. in the conditions of Odessa city, as well as to assess the prospects for introducing the species into the landscaping of the city.

Materials and methods. Ginkgo biloba (*Ginkgo biloba* L.) is a representative of the class Ginkgopsida, Pinophyta division, the only relict species of the once numerous Ginkgo family (Ginkgoaceae), which has survived to our time from the Permian period of the Paleozoic era (about 290-250 million years) [1].

Under natural conditions, Ginkgo currently grows in China in mountain forests with a fairly high degree of humidity, in the Yangtze River basin, in the forest reserve on Mount Temusa near Hangzhou, where it forms forests along with coniferous and broadleaved species [14]. Ginkgo biloba is a dioecious deciduous tree in natural conditions reaching the hight of 35-40 m and 4-4,5 m in diameter. It lives up to 2 thousand years. The bark of adults plants in the lower part of the trunk is dark gray, longitudinally fissured. The crown is pyramidal in young plants, becoming broadly ovoid with age. Lateral branches depart from the trunk at almost a right angle. Shoots are of two types: terminal elongated (auxiblasts), growing rapidly, shortened (brachyblasts), characterized by slow growh. Leaves on elongated shoots are alternate, fanshaped on long petioles, dense, bare, wavy along the edge or dissected into lobes. On shortened shoots, the leaves are the same, but joint in bunches (3 to 5) [2].

Plants enter the generative stage at the age of 25-30 years. Ginkgo micro-and megastrobili are formed on shortened shoots. They are set up at the end of summer, but ripen at the beginning of the next growing. In early spring, before leaf flushing, the microstrobili (male strobiles) appear and, simultaneously with the leaves, the megastrobils (female ovules) emerge. Microstrobils open 7-8 days earlier than megastrobils. Microstrobili are loose, catkin-shaped, from 3-5 pieces in a bundle; when pollen ripens, they are bright yellow. The ovules are small, placed on long stalks thickened at the apex. The seed with a fleshy shell is round or oblong-ellipsoid. The seed without a fleshy cover is woody, mostly dihedral, less often 3-/4-hedral. Ginkgo is the only gymnosperm plant in which motile spermatozoa have been discovered. This brings them closer to the cycads and shows that these groups are at the same low level of evolution. The development of the embryo, and often fertilization, occurs in ginkgo in the ovules that have fallen from the tree. Ginkgo seeds do not have a dormant period and can germinate as soon as the embryon reaches its maximum development [3].

The objects of the study were Ginkgo biloba plants, which are in the collection of the ONU Botanical Garden, growing in urban plantations, and a comparative analysis has been carried out for other regions.

The climate of Odessa is dry continental with hot summers and frosty winters. The annual rainfall is 421-440 mm. Frequent long rainless periods, accompanied by high temperatures (40-50°C) on the soil, cause sever droughts. The growing conditions of Ginkgo biloba in the city are very diverse. The presence of the sea area has a significant impact on the formation of the city's microclimate. The length of the sea border along the city is 33 km. The distance from the sea coast inland is from 2 to 11 km [15].

Stationary studies have been carried out in the botanical garden of ONU and by examining plantings in the city environment.

The following methods were used to conduct the research: the degree of winter hardiness of shoots and drought resistance was assessed according to the scale of S. Ya. Sokolov [4], frost resistance was determined on the basis of visual observations during especially cold winters [8]. The general condition of Ginkgo plantations was determined on a 5-point scale [16], the abundance of fruiting – with the use of a five-point scale [11]. Phenological observations were carried out according to the existing methodology [10]. Morphological indicators of the photosynthetic apparatus of trees were studied by measuring shoots and leaf blades [12, 17].

Results and their discussion. In Ukraine, G. biloba was first introduced in 1811 in Krasnokutsky arboretum (Acclimatization garden named after I.N. Kazarin, Kharkiv region). Since 1818 it was introduced by H. Steven in the environment of the Nikitsky Botanical Garden. Nowadays, Ginkgo is found in botanical gardens and arboretums in Kiev, Lvov, Donetsk, Odessa, etc; occasionally – in the squares of cities of Polissya and the forest-steppe regions. In the Central Republican Botanical Garden plants aged 45-60 years are found [14].

In Odessa, the name G. biloba is first mentioned in the *Notes of the Imperial Society of Agriculture of Southern Russia* in an article by K. Desmet, who mentions two specimen imported from Japan in 1826. In 1884, Ginkgo was discovered in the garden of S. R. Rote, and in 1903-1904 it was listed in the *Catalogue of Three Nurseries* (Odessa) by S. R. Rote [5, 9]. In 1880, in the park named after I.I. Mechnikov, a group of ginkgo trees was planted, of which three trees are currently preserved. In 1930, in the courtyard of the Gorkiy library three specimens of Ginkgo were planted, which gave offspring for all subsequent plantings in Odessa. In the Victory park in Primorsky district of the city a group of Ginkgo (seeds from the ONU Botanical garden) was planted in the 70s of the previous century [6, 13].

In 1952-1954, a nursery was established in the Botanical garden, and later groups of Ginkgo were planted on the old and new territories. Currently, there are 4 groups including 5-8 specimens on the new territory of the Botanical garden, 28 trees in total. All groups are located in different microclimatic conditions isolated from each other. One group (5 females and 3 males) is located in an open area with sufficient lighting. These plants remained at the site of the former nursery, and in 1977 they bloomed for the first time and produced germinating seeds. Since then, they have been constantly blooming and fruiting abundantly (in some years there is no fruiting). The remaining groups are planted on the territory of the park in the second tier, fruiting is weak. In some years self-seeding is observed. The data is presented in Table 1.

Tuble 1. Characteristics of Guildo Diloba E. plants in the containons of Guessa								
Place of growth	Number of	Plant height,	Crown diameter,	Fruiting	Self-sown	Pest infestation and	General state	
	plants	m	m	Fruiting	plants	disease	General state	
Botanical garden	28	5-20	6-23	+	+	+	4	
I.I. Mechnikov square	3	15-22	30-50	+	_	+ +	2	
M. Gorkiy library area	3	25-30	35-45	+	+	+ + +	3	
Victory park	8	5-12	10-25	+	-	+ +	1	

Table 1. Characteristics of Ginkgo biloba L. plants in the conditions of Odessa

The table presents data on the quantitative composition, biometric characteristics of Ginkgo plantations in various places of growth, information on generative development and an assessment of their general condition. The low score of the general condition in Mechnikov square and Victory park is the result of the lack of agrotechnical care over the past decade, as well as the negative impact of the anthropogenic factor.

A comparative analysis of the main phenophases of Ginkgo vegetation in different climatic zones of introduction is presented in Table 2.

Tuble 21 The phenospectrum of the seasonal develo			phiene of Guidge buoba E. in alferent etimatic zones			
Region of			Period of	End of	Pollen disper-	
introduc-	Bud bursting	Foliage	shoot	vegeta-	i onen uispei-	Fruit ripening
tion			growth	tion	SION	
Moscow	2/IV	n.i.*	n.i.*	2/X	d.b.**	
Kiev	3/IV - I/V	3/V - I/VI	I/VI- 2/VIII	I/XI	2/V - 3/V	
Odessa	3/Ш - 2/IV	2/IV - I/V	3/V-3/VII	2/XI	2/IV - 2/V	2/X

Table 2. The phenospectrum of the seasonal development of Ginkgo biloba L. in different climatic zones

Note: * - no information; * * - does not bloom.

Under the environment conditions of Kiev city, the seeds do not germinate, and there is no flowering under Moscow conditions.

As evidenced by the research under Odessa environment conditions, the Ginkgo vegetation season starts earlier and finishes later compared to the northern regions. The beginning of the growth of annual shoots and its duration depend on the temperature factor and the abundance of moisture. In Odessa, Ginkgo goes through a full cycle of generative development, setting germinating seeds. Biometric measurements of the main biological indicators of fruit bearing and of the photosynthetic apparatus were carried out on model branches taken from the peripheral part of the crowns stretching out into different directions (Table 3).

Indicators	Botanical garden	I.I. Mechnikov square	M. Gorkiy library	Victory park
1	2	3	4	5
 I. Leaves: 1. Quantity per 1 m of shoot 2. Sheet area surface per 1 m of shoot, cm² 3. Dimensions, cm: petiole length leaf blade length blade width 	140±3 3097,3±5,1 5,4±0,4 4,9±0,2 7,1±0,3	98±4 3107,6±6,2 4,5±0,3 4,9±0,2 7,2±0,3	120±3 2977,9±6,2 5,3±0,3 4,5±0,3 7,3±0,2	140±5 2830,9±9,3 6,7±0,5 4,5±0,3 5,4±0,3
II. Fruits: 1. Quantity per 1 m of shoot, pcs.	10±2	—	20±4	52±6
 2. Dimensions of the fruit with pericarp, cm: petiole length fruit length fruit width 	6,7±0,5 2,8±0,1 2,4±0,1		6,9±0,5 2,3±0,1 2,4±0,1	5,2±0,4 2,2±0,1 2,0±0,1
 3. Dimensions of the fruit without the pericarp, cm: fruit length fruit width thickness 	2,3±0,1 1,7±0,1 1,4±0,1		1,9±0,1 1,7±0,1 1,3±0,1	1,9±0,1 1,4±0,1 1,2±0,1
4. Seed size, cm - length - width - thickness	2,0±0,2 1,3±0,1 1,2±0,1	— — —	1,6±0,2 1,4±0,1 1,2±0,1	1,5±0,3 1,1±0,2 1,0±0,1
5. Weight of fruit, gr: with the pericarp without the pericarp of the seed	9,8±0,4 2,2±0,2 1,7±0,1		8,1±0,3 1,9±0,2 1,6±0,1	5,0±0,7 1,3±0,4 1,1±0,1

Table 3. Biometric characteristics of Ginkgo biloba L. under the environment conditions of Odessa

Table 3 shows that changes in the average dimensional and quantitative indicators of the state of the leaf apparatus in the studied plants growing in different places do not go beyond the limits of a statistically homogenous set.

However, quantitative and weight indicators of fruiting indicate that the state of plants growing in the botanical garden and in the public garden of the M.Gorkiy library, are satisfactory, which is confirmed by the data in Table 1. The plants in *Victory* park are in a stressful, critical state, as evidenced by the abundance of small fruits with low weight.

Ginkgo biloba in the conditions of the city of Odessa is characterized as follows: drought resistance -2 points, winter hardiness -1 point, frost resistance - no damage was observed at -28°C. It is undemanding to soil conditions and wind-resistant. Recently, the presence of scale insects on the shoots has been noted, but no visual damage has been found.

In the nurseries of the botanical garden, Ginkgo is propagated annually, which has recently been in great demand. A large number of specimens were donated to the botanical garden of the Moldavian Academy of Sciences.

Conclusions. Long-term observations have shown that G. biloba is a highly decorative, drought-resistant and winter-hardy plant that is not affected by pests and diseases, which can be widely used in landscaping the Northwestern Black Sea region.

The climatic conditions of Odessa do not contradict the passage of a full cycle of vegetation in Ginkgo. Plants go through all stages of ontogeny. Fruiting is plentiful, but not regular, seeds germinate. The biomorphological characteristics of the plant correspond to the general species characteristics. According to ecological requirements, Ginkgo belongs to mesophytes. In urban conditions, it needs more soil moisture than air. In especially hot periods, watering is necessary, the plant is characterized by tolerance for winter and frost conditions. The studied plants belong to heliophytes, but tolerate slight shade without changes. The most rational use is in group plantings. Science and Education a New Dimension. Natural and Technical Sciences, X(34), Issue: 268, 2022 July. www.seanewdim.com The journal is published under Creative Commons Attribution License v4.0 CC BY 4.0

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Annotation. The article provides historical data on the introduction of *Ginkgo biloba* L. in the North-Western Black Sea region. A comparative analysis of the bioecological properties of the species under different growing conditions has been made. An assessment of the prospects of the widespread introduction of *Ginkgo biloba* L. is provided in the landscaping of the city of Odessa.

Keywords: Ginkgo biloba L., introduction, North-Western Black Sea region, botanical garden, bioecological properties.