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RESEARCH ARTICLE

The oak forest of the Dendropark “Olexandria”. Part 1. From indigenous to anthropogenically transformed plantation

 Nataliia Boiko,  Nina Dragan *,  Nataliia Doiko

The “Olexandria” State Dendrological Park of the National Academy of Science of Ukraine, 09113 Bila Tserkva – 13, Kyiv region, Ukraine;
* ninapark@ukr.net

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Abstract

This study aimed to determine the level of preservation of primeval forest criteria and the extent of anthropogenic transformation in the old-growth oak forest of the Dendropark “Olexandria”. This age-old oak forest of natural origin covers an area of 31.8 ha with 1413 oaks. Another 8.8 ha of the oak plantations with 462 oaks belong to artificial landscape compositions.

For over 200 years of existence since the creation of the Dendropark “Olexandria”, the oak forest has preserved a number of criteria characteristics of virgin forests. In particular, it kept the complex mosaic-tiered forest structure. The indigenous associations of oak forests of hazel-ash (*Querceta (roboris) coryloso-aegopodiosum*) and Tatar maple-stellar (*Querceta (roboris) acerioso (tatarici) stellariosum*) remained. The dominant species, *Quercus robur*, retained the function of a unifier with a share in the first tier of 70–100 %. The floristic core of the main forest-forming species has been preserved too.

The oak forest is a habitat for many woody and herbaceous plants of the local flora, including threatened species. The oak forest is characterized by high structural complexity, particularly a diverse epiphytic lichen flora, the presence of rare species, and 15 indicator species of old-growth forests and virgin forests. The oak forest is a habitat for 62 species of birds, mostly inhabitants of forests. A large part of the oak forest contains dead wood of the uniflorus species and its companions in various stages of decomposition.

The anthropogenic interference in the oak forest has been long and varied. Since the foundation of the park and subsequently, the oak forest has been subjected to excessive fragmentation and introduction of introductions, creating decorative landscape compositions within the oak forest, mainly in the central part. This caused significant ecotonisation of the oak forest and displacement of *Q. robur*.

Current research has revealed a number of criteria that classify the oak forest as a successor to the primeval forest, which gives the oak forest an exceptional value.

Keywords: Dendropark “Olexandria”, natural oak forest, virgin forest criteria, oak forest seduction, anthropogenic transformation

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Introduction

In recent years, there has been an acute realization that the planet is losing unique natural forests, the primary custodians of biodiversity (Sabatini et al., 2020). One of the leading international agreements to preserve biodiversity, the Convention on Biological Diversity (CBD, 2023), was signed in 1992 in Rio de Janeiro by 160 countries, including Ukraine. The respective Conference of the Parties (COP) meetings occur every two years. The 15th COP meeting, which was held in two stages in 2021 and 2022, resulted in the establishment the Kunming-Montreal Global Biodiversity Framework. Twenty-three goals that participating countries must achieve by 2030 were ascertained (CBD, 2023). The Biodiversity Strategy 2030 emphasizes the need to identify, map, monitor, and strictly protect all remaining primary forests in the European Union (Barredo et al., 2021). Complete georeferenced maps of primeval forests for 33 European countries were compiled (Barredo et al., 2021; Sabatini et al., 2021). Nowadays, Europe mostly has semi-natural forests. Only ca. 4% of primeval indigenous forests remained (Forest Europe, 2015), and even this tiny share is very fragmented (Chylarecki & Selva, 2016). That is why one of the 23 goals of the Biodiversity Strategy is to increase the area of protected areas in the participating countries to 30% of land and water (Watson et al., 2018) and to restore the nature that has been disturbed in these areas.

Among Ukrainian environmental assets, forests are one having the fundamental value and cover ca. 9.6 million ha. Natural forests occupy about half of this area (Gensiruk, 2002). The most valuable are oak forests since they are the most highly productive and floristically prosperous forest communities. Oaks forests are one of the main sylvatic formations in Ukraine, accounting for about a third of all forests. The share of natural oak forests here is relatively small (Shelyag-Sosonko, 1974). However, many remnants of natural oak forests are preserved in old parks (Klymenko et al., 1996; Oleksiyenko & Hatalaska, 2012).

There are many subcategories among the objects of the nature reserve fund of Ukraine. Among them, the oldest plantations, including virgin forests (primeval forests), quasi-virgin forests, and natural forests, deserve special

attention (Law of Ukraine, 2017). According to the Methodology (2018), virgin forests (virgin forest ecosystems) are primordial ancient forests (primeval forest, natural forest ecosystems) that were formed naturally and did not suffer direct anthropogenic impact during development. Quasi-virgin forests are conditionally virgin forest ecosystems that experienced a minor temporary anthropogenic impact that, however, did not change the natural structure of forest stands and, upon termination of which, the natural state of ecosystems was fully restored within a short period (Methodology, 2018). Natural forests (natural forest ecosystems) are forests in which anthropogenic impact has occurred locally and temporarily. However, it has not changed the coenotic structure of phytocoenoses, and, therefore, the natural forest ecosystems can regenerate (recover) naturally to the conditions of primeval forest ecosystems within a short period (Methodology, 2018).

There are some common criteria between these three categories of forests. All of them are formed by native (autochthonous) species of trees and shrubs that correspond to the forest type; they are of natural origin. In all categories of forest, there should be individual trees of the main tier that have reached the age physiological limit and have exceptional maximum diameters for this area and signs of age-related mortality. Common to all three categories of forest is the lack of documented information and visible traces of litter harvesting.

There are also differences between virgin, quasi-virgin, and natural forests. This includes structural features, presence and stages of decomposition of dead wood, existence and characteristics of infrastructure, and the capacity and amount of dead wood removal (Methodology, 2018).

The environmental protection categories also include the concept of old-growth forests (CBD, 2023). These are plantations in native or secondary forests that have developed structures and species, usually associated with an older primary forest of the same type (Bauhus et al., 2009). The concepts of primeval and old-growth forests adopted by international initiatives have much in common (Buchwald, 2005; Forest Europe, 2015). In old-growth forests, pioneer species are allowed in small quantities. Anthropogenic impacts

should be negligible. Only regulated recreation is allowed (Shparyk et al., 2017).

In Europe, primeval forests are considered the standard of forest vegetation. According to Buchwald (2005), this term is generalized to forests with different levels of naturalness: virgin, primeval, old-growth, and long-virgin. Primeval forests are ecosystems where signs of past human influence are minimal or absent, and ecological processes are dynamic, with little anthropogenic impact (Barredo et al., 2021). A forest qualifies as primeval if the signs of previous anthropogenic impact, if any, are highly eroded within decades (at least 60–80 years) after the end of forest management.

Over 230 years ago, the Nature Park “Olexandria” was established on the territory of the natural oak forest, now the famous State Dendrological Park “Olexandria” of the National Academy of Sciences of Ukraine (Galkin, 2010). The oak trees remain the main landscape-forming elements for the arboretum, and the common oak has retained the function of a dominant species (Haydamak, 2006). The unique oak forest, among other vegetation of the park, is included in the list of natural heritage objects of the national heritage of Ukraine (State Register, 2022). The oak forest is a vital biotope of the park (Dragan et al., 2018) and a crucial botanical object of Ukraine (Galkin, 2010).

Considering the great attention to natural, primeval forests and even their small disturbed fragments in Europe, the oak forest of natural origin in the Dendropark “Olexandria” receives a particular value. The study of its disturbance and preservation is of exceptional relevance. Therefore, our study aimed to assess the conservation status of this oak forest and determine the level of its disturbance and transformation.

Material and methods

When analyzing the conservation status of the oak forest, we were guided by the fact that primeval forests serve as a model for understanding natural disturbances and succession dynamics, helping to assess the human impact on forest ecosystems and understand the potential and limitations of natural resource use (Bauhus et al., 2009; Kuuluvainen & Aakala, 2011; Král et al., 2014).

Determining the conservation status of the oak grove of the Dendropark “Olexandria”, we applied the Methodology (2018) and the Law of Ukraine (2017). The structure of oak stands was studied according to the recommendations of Mazing (1973). The sanitary condition of oak trees was determined following the current Sanitary Rules (1995). Disease infestation of trees was determined visually by the presence of fruiting bodies, canker wounds, hollows, dry tops, etc. (Goichuk & Reshetnyk, 2010). The current decline was calculated as a percentage relation of the sum of dying trees (category IV of vital status), fresh deadwood (trees that died in the current and previous years), and fresh windfall and windthrow to a total amount of oaks in the stand (Sanitary Rules, 1995).

Results and discussion

The oak grove of the Dendropark “Olexandria” was described as a compact array of mostly high-growth oak plantations, mostly 200–250 years old, with absolute dominance of the main species in the first tier, with an area of 41.5 ha, which thematically and territorially occupies a middle position in the overall composition of the park. It has a peculiar compositional core, on which a significant part of non-grove landscapes is present (Haydamak et al., 1994; Haydamak, 2006). As part of the oak forest (Fig. 1), the authors identified areas of forest-type oak forest with a complex tiered and horizontal structure with an area of 32.7 ha (78.8 % of the total area) and areas of park-type oak forest – pure single-tiered plantations with a well-developed broad grass and cereal cover with an area of 8.8 ha (21.2 %) (Haydamak, 2006). The park-type oak forest plots, based on their highly simplified coenotic structure, were considered highly degraded and artificially transformed areas of natural plantation – the “Dancing Oaks” glade (Quarter 8) and the “Grassy Oaks” (Quarter 12).

At the end of 2022, the total area of the oak forest was 40.6 ha, with 1875 oaks in total. Without artificially created park-type plots, the area of the natural oak forest is 31.8 ha, with 1413 oaks growing on it. The area of the artificially created oak forest, hence, is 8.8 ha; it has 462 oaks, which are about 180 years old. (Haydamak, 2006).

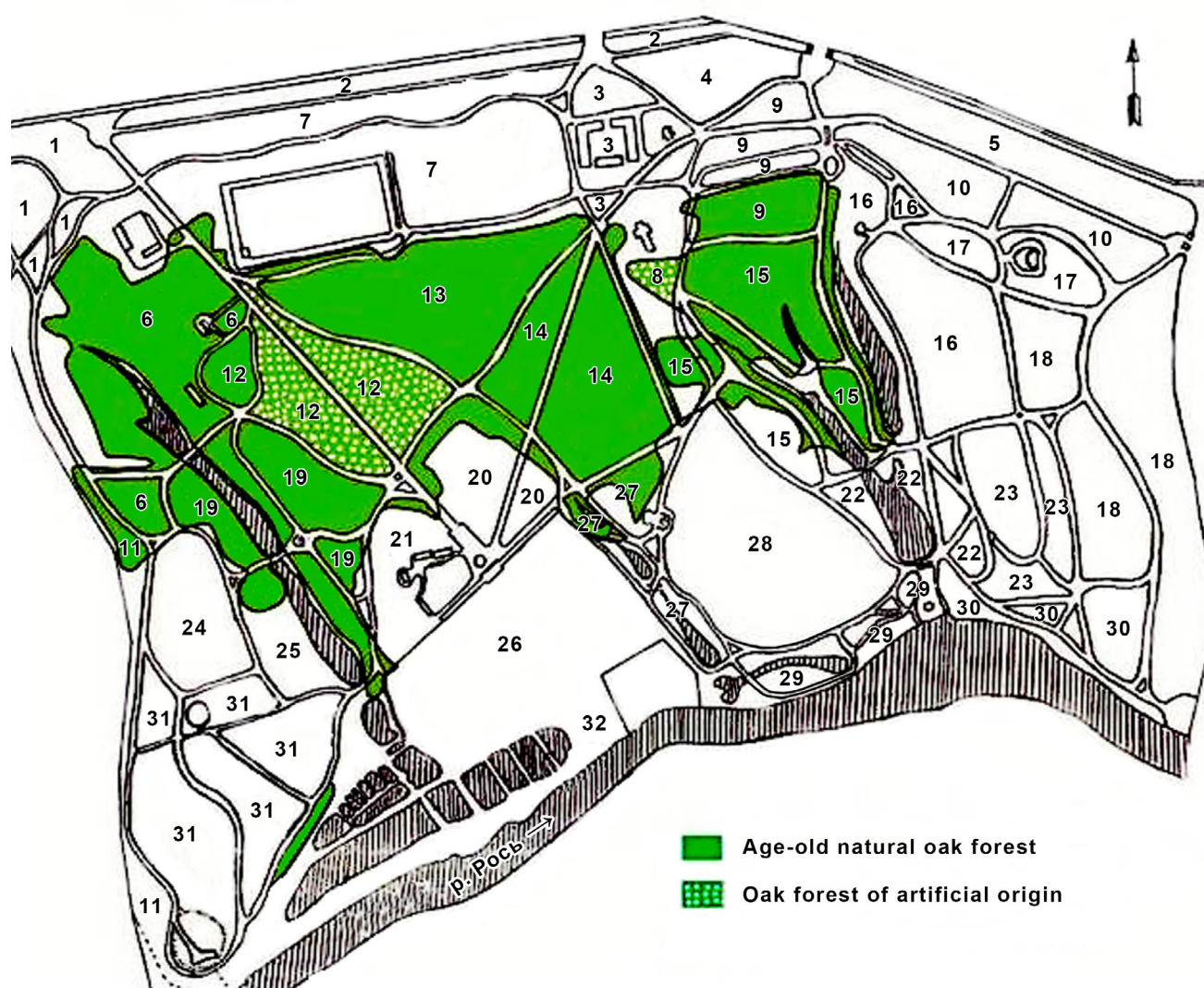


Figure 1. The origination structure of the age-old oak forest of the Dendropark “Olexandria” of the NAS of Ukraine.

According to the criterion of species composition, the oak forest of the Dendropark “Oleksandria” corresponds to all three types of forests (virgin, quasi-virgin, and natural). It is formed by native species of trees and shrubs typical for forest oaks of the Right-Bank Forest-Steppe of Ukraine. The oak forest is of natural origin, which is also characteristic of all of the three mentioned forest types. According to the structure criterion, the oak forest of the Dendropark “Olexandria”, with stands of complex horizontal and vertical structures, can be attributed to the type of natural forests. The dominant species *Quercus robur* L. is represented here by mature and overripe stands. Natural regeneration of *Q. robur* does not occur, although oak seedlings appear in most landscape areas of the oak forest. Some young sprouts are found only on the forest

edges and in light windows, mainly in the western part of the forest. The populations of satellites include all stages of development and have a certain number of mature and overripe specimens. Some specimens of the main tier oak satellites have reached the physiological limit and have maximum diameters for the plots. The vast majority of *Q. robur* trees are 200- to 250-years old. In 2012, in the eastern and western parts of the oak forest, we described several specimens with trunk girths of 798 and 880 cm. These trees are now dead.

All three described forest types are characterized by the presence of dead wood. For virgin forests – all stages of decomposition should be observed; for quasi-virgin forests – mainly all stages of decomposition should be observed; and for natural forests – some stages of decomposition should be present.

Dead wood of the unifier species and its companions of certain decomposition stages is located in the western part of the oak forest in the Dendropark "Olexandria". There is less dead wood in the eastern and central parts of the oak forest, but in recent years, its amount has increased.

Concerning several criteria of the anthropogenic impact, a significant difference between the oak forest of the Dendropark "Olexandria" and virgin and quasi-virgin forests was found. According to the criterion of forest management infrastructure, the oak forest corresponds to natural forests, where visible traces of forest management infrastructure, past economic activity, and pedestrian and vehicular traffic are allowed. Following the felling criterion for quasi-virgin forests, no more than five main stand trees per hectare may be removed. In addition to this allowance, isolated cases of dead wood removal are allowed for natural forests. Describing the damage to the arboretum's vegetation during the revolution in 1917 and subsequent years, as well as during WWII in 1941–1945, [Galkin \(2012\)](#) pointed out the removal of wood of valuable tree species. In particular, a 3 ha pine forest in the eastern part of the park is mentioned as being cut. Obviously, oaks and their companions were also removed. In Europe, when describing primeval forests, it was not excluded that the forests had never been cut down in the past ([Buchwald, 2005](#)). We can cautiously assume that the western part of the oak forest, with its complex, fragmented mesorelief and the absence of access roads at that time, escaped significant destruction. An indirect confirmation of this is that the density of oaks in the western part of the oak forest is 51.3 specimens/ha, while in the eastern and central parts, it is only 35–40 specimens/ha. However, this is just an assumption because a number of environmental factors of biotic and abiotic origin can affect the oak growth density.

Regarding the criterion of non-timber forest resources, the requirements for all three forest types are the same. There should be no documented information or visible traces of industrial massive harvesting of non-timber forest products. Non-industrial collection of non-wood forest products without visible traces of harvesting is allowed. There should be no industrial harvesting of non-wood forest

products in the arboretum. The principal requirements relate to the criterion of the forest litter – there must be no documented information about cases of harvesting of forest litter and their visible traces. The oak forest of the Dendropark "Olexandria" fully meets this criterion.

Given the great danger to forest plantations from livestock grazing, this criterion is considered in all survey methodologies for identifying primeval and old-growth forests ([Shparyk et al., 2017](#); [Methodology, 2018](#)). For virgin forests, it is necessary to have no information on livestock grazing and their visible traces. For quasi-virgin forests, only seasonal passage of domestic animals is allowed. Infrequent passage of domestic animals during the season is allowed for natural forests. When the arboretum was managed by the Bila Tserkva Agricultural Institute (1930–1940s), cattle grazing took place on the park territory ([Galkin, 2012](#)). However, it is not specified in which areas this took place. We can assume that there was no grazing in the oak forest, which had dense undergrowth and undergrowth, with sparse herbs. Glades and, possibly, the grassy oak forest were more attractive for this purpose.

Concerning the criterion of recreational pressure, virgin forests are characterized by the absence of recreational infrastructure and signs of recreational pressure. In contrast, quasi-virgin and natural forests are allowed to have trails up to 1m wide, which are used for recreation and tourism and carry minimal recreational pressure. Currently, no recreational activity (tourism, excursions) exists on the oak forest territory. The excursion route does not pass through the territory of the grove or its borders.

According to the area and shape criteria, the oak tree of the arboretum meets the requirements. The area of the oak forest of natural origin (31.8 ha) exceeds the required area of 20 ha according to the [Methodology \(2018\)](#).

Criteria for determining forest status include forest age and structural changes ([Law of Ukraine, 2017](#); [Shparyk et al., 2017](#); [Methodology, 2018](#)). According to silvicultural criteria, oak forests are the typical broadleaf forests characterized by a mosaic-tiered structure and high species richness, ensuring their ecosystems' stability ([Gensiruk, 2002](#)).

Natural oak forests are one of the most complex terrestrial ecosystems capable of surviving for centuries under unchanged environmental conditions (Gensiruk, 2002). Simplification of the structure of oak forests is applied as a criterion for determining the degree of their disturbance and anthropogenic degradation (Franklin & Pelt, 2004).

Nowadays, the oak forest in the Dendropark “Olexandria” consists of areas of different landscapes, phytocoenotic, spatial and compositional structures, and varying degrees of disturbance (Haydamak, 2006). The oak forest of the arboretum is presented as a hierarchical system, the floristic core of which is made up of the main forest-forming species: *Q. robur*, *Acer platanoides* L. and *A. campestre* L., *Fraxinus excelsior* L., *Tilia cordata* Mill., *Carpinus betulus* L., *Alnus glutinosa* (L.) Gaertn., *Pyrus communis* L., *Malus sylvestris* (L.) Mill., *Ulmus laevis* Pall. and *U. scabra* Mill., and *Cerasus avium* (L.) Moench. The role of the dominant species (unifier species) was retained by *Q. robur*, whose share in the first tree layer is 70–100%. Monodominant stands of *Q. robur* were formed in the western, least disturbed part of the oak forest of the arboretum (Table 1).

Extensive introductions were realized in the central and eastern parts of the oak forest. Decorative landscape compositions along the boundaries of the oak forest plots were created involving introduced and native species. In the center of the oak forest, there are few introducers. The creation of decorative compositions of introduced and native species within the oak forest led to the formation of massive ecotones, where introducers occasionally displaced the dominant species, *Q. robur* (Dragan, 2011).

Thus, since the creation of the park, the oak forest has been subjected to various anthropogenic interventions, which actively continued until the transfer of Dendropark “Olexandria” to the Academy of Sciences of the UkrSSR. Gradually, these interventions were reduced, and their influence was leveled. The most apparent negative results of the negative impacts that the oak forest has not been able to overcome, the consequences of which are only progressing in some areas of the oak forest, are the excessive fragmentation of the oak forest and the planting of introduced species and ornamental compositions.

This has led to the ecotonisation of the oak forest and the creation of places of the most significant deterioration and the principal loss of the dominant species, *Q. robur*.

The long natural existence of primeval, old-growth forests, including natural processes of disturbance and regeneration, contributes to the creation of high structural complexity in such forests. This complexity leads to a great variety and number of forest microhabitats (Franklin & Pelt, 2004). These include dead wood, tree cavities, the formation of the fruiting bodies of saproxylic fungi, and other epiphytic and epixylic fungi. Oak forests serve as a habitat or shelter for a range of beetles, birds, bats, and other animals. Primary and old-growth forests are species-rich and contain specialized flora and fauna (Eckelt et al., 2018; Paillet et al., 2018). Even considering that primeval and old-growth forests are highly fragmented, in addition to the invaluableity of their existence (Watson et al., 2018), they are crucial for biodiversity conservation as habitats for endangered species (Eckelt et al., 2018; Paillet et al., 2018). The role of such forests surrounded by anthropogenic landscapes is particularly valuable (Vandekerkhove et al., 2011; Di Marco et al., 2019).

The shrub layer of the oak forest in the arboretum consists of *Corylus avellana* L., *Sambucus nigra* L., *Euonymus europea* L., *E. verrucosa* Scop., *Swida sanguinea* (L.) Opiz, *Rhamnus cathartica* L., and *Prunus padus* L.

In the herbaceous layer, 150 species of herbaceous plants were registered. Among them, the dominant species are *Aegopodium podagraria* L., *Stellaria holostea* L., *Chaerophyllum temulum* L., *Glechoma hederacea* L., *Lamium maculatum* (L.) L., and *Viola odorata* L. The spring ephemerooids are represented by eight species, including *Galanthus nivalis* L. (Didukh, 2009) and *Scilla bifolia* L. (regionally rare in the Kyiv region) (Peregrym & Andrienko, 2012).

Despite the increase in the number of adventitious species in recent years (Franklin & Pelt, 2004), including such invasive species as *Bromus carinatus* Hook. & Arn., *Impatiens parviflora* DC., and *Geranium robertianum* L., the herbaceous cover remains typical for oak forests, and invasive species grow mainly along the forest edges.

One of the most important aspects of the value of a forest habitat, in particular

Table 1. Structure of oak forest phytocoenoses in different landscape areas of the Dendropark "Olexandria".

Quarter number	First tier	Second tier
	dominant, sudominant	dominant
6	<i>Quercus robur</i> 100 %	<i>Acer platanoides</i> 50 %, <i>Acer campestre</i> 30 %, <i>Tilia cordata</i> 20 %
8	<i>Quercus robur</i> 90 %, <i>Tilia cordata</i> 10 %	<i>Acer platanoides</i> 80 %, <i>Tilia cordata</i> 10 %, <i>Acer campestre</i> 10 %
13	<i>Quercus robur</i> 90 %, <i>Acer platanoides</i> 10 %	<i>Acer platanoides</i> 40 %, <i>Acer campestre</i> 20 %, <i>Fraxinus excelsior</i> 15 %, <i>Tilia cordata</i> 15 %, <i>Ulmus scabra</i> 10 %
14	<i>Quercus robur</i> 80 %, <i>Acer platanoides</i> 10 %, <i>Tilia cordata</i> 10 %	<i>Tilia cordata</i> 50 %, <i>Acer platanoides</i> 20 %, <i>Acer campestre</i> 10 %, <i>Fraxinus excelsior</i> 10 %, <i>Ulmus scabra</i> 10 %
15	<i>Quercus robur</i> 70 %, <i>Acer platanoides</i> 10 %, <i>Tilia cordata</i> 10 %, <i>Fraxinus excelsior</i> 10 %	<i>Carpinus betulus</i> 30 %, <i>Fraxinus excelsior</i> 20 %, <i>Acer campestre</i> 20 %, <i>Tilia cordata</i> 15 %, <i>Acer platanoides</i> 15 %
19	<i>Quercus robur</i> 100 %	<i>Tilia cordata</i> 60 %, <i>Acer platanoides</i> 20 %, <i>Acer campestre</i> 20 %
25	<i>Quercus robur</i> 100 %	<i>Acer campestre</i> 50 %, <i>Acer platanoides</i> 30 %, <i>Ulmus scabra</i> 20 %
27	<i>Quercus robur</i> 100 %	<i>Acer platanoides</i> 70 %, <i>Tilia cordata</i> 10 %, <i>Acer campestre</i> 10 %, <i>Fraxinus excelsior</i> 10 %

an oak forest, is the presence of threatened plant species and their habitats. Among the threatened species, there is *Fraxinus excelsior*, which has the NT category (IUCN, 2022). *Malus sylvestris*, having DD category, is also present in the oak forest of the arboretum. In the herbaceous layer, species included in the list of regionally rare plants of Kyiv region are present: *Matteuccia struthiopteris* (L.) Tod., *Scilla bifolia*, and *Gagea pusilla* (F.W. Schmidt) Schult. & Schult. Fil. (Dragan et al., 2018).

Liubov Pleskach (Dragan et al., 2018) found that the epiphytic lichen flora, which forms along the trunk of *Q. robur* and its satellites, includes 91 species and four forms of lichens and five species of lichenicolous fungi. The author found a rare species *Gyalecta truncigena* (Ach.) Hepp, which is included in the Red Book of Ukraine (Didukh, 2009). Among the rare lichens there were found *Biatoridium monasteriense* J. Lahmex Korb., *Xanthoria pollessica* S.Y. Kondr. & A.P. Yatsyna, *Ramalina baltica* Lettau. Among lichenicolous fungi there were found *Lichenochora obscurioides* (Linds.) Triebel & Rambold and *Tremella phaeophyscia* Diederich & M.S. Christ.

The largest number of epiphytic lichen species (48 species) was recorded on the bark

of *Q. robur*. From the group of bushy epiphytic lichens, the most commonly represented are *Evernia prunastri* L., *Ramalina pollinaria* (Westr.) Ach., and *R. subfarinacea* (Cromb.) Nyl.

A group of 15 indicator species of old-growth forests was found in the lichen flora of the arboretum oak tree (Dragan et al., 2018): *Arthonia radiata* (Pers.) Ach., *Arthothelium ruanum* (A. Massal.) Korb., *Bacidia rubella* (Hoffm.) A. Massal., *Biatoridium monasteriense*, *Chaenotheca chrysocephala* (Ach.) Th. Fr., *C. furfuraceae* (L.) Tibell, *Flavoparmelia caperata* (L.) Hale, *Gyalecta truncigena* and other. Dragan et al. (2018) found that *Chaenotheca* species, which are indicators of virgin forests and show the integrity of forest systems, are pretty widespread in old-growth oak forests.

The arboretum's oak forest is a habitat for 62 species of birds, among which forest-related predominate. The background species are *Fringilla coelebs* Linnaeus, 1758, *Turdus philomelos* Brehm, 1831, *T. merula* Linnaeus, 1758, *Ficedula albicollis* (Temminck, 1815), *Luscinia luscinia* (Linnaeus, 1758), *Parus major* Linnaeus, 1758, and *Passer montanus* (Linnaeus, 1758). There also occur *Sitta europaea* Linnaeus, 1758, *Erithacus rubecula*

(Linnaeus, 1758), *Alcedo atthis* (Linnaeus, 1758), *Muscicapa striata* (Pallas, 1764), and *Chloris chloris* Linnaeus, 1758 (Galkin, 2012).

The oak forest of the Dendropark “Olexandria” lies at the junction of different associations. The residue of *Corylus avellana* L. and *Acer tataricum* L. in the undergrowth is evidence of this. Taking into account the confounders of the grass layer, the following indigenous associations are distinguished – *Querceta (roboris) coryloso-aegopodiosum* and *Querceta (roboris) acerioso (tatarici) stellariosum* (Haydamak et al., 1994).

Thus, the oak forest of the Dendropark “Olexandria” has undergone significant changes over more than 200 years of anthropogenic intervention, mainly concerning its integrity, structure, felling, removal of dead wood, and possible grazing. These interventions were mostly related to the central and eastern parts of the oak forest, and were not mentioned for the western part. On the contrary, it was emphasized that the western part of the park and, accordingly, the oak forest, was left untouched by the founders of the park for hunting purposes in the natural forest. In the 1960s, it experienced timber cuttings, including those that happened in the oak forest. Despite significant anthropogenic interference in the oak forest of the Dendropark “Olexandria”, it has retained many features typical for primeval forests and virgin forests. In particular, a complex vertical and horizontal structure, high mosaicism and species richness with the dominance of the floristic core, and a decisive identifying role of the common oak are still observed there. Nowadays, the oak forest is characterized by high biodiversity.

However, today, the oak forest is highly fragmented and has a different degree of preservation. With some conventions, a part of the oak forest of the Dendropark “Oleksandria” (10 ha or 30.6% of the total area of the oak forest of natural origin) can be classified as a natural old forest according to the Methodology (2018). Due to significant anthropogenic interference in the past, a significant part of the oak forest has lost most of the criteria that would allow it to be classified as a certain environmental category, even natural or old-growth forest.

Given the value of the oak grove of the Dendropark “Olexandria”, and the significant

preservation of the criteria of primeval and old-growth forests in some of its parts, it requires strict protection and promotion. Such a program should include a range of measures. This should involve restricting recreational and economic activities on the grove’s territory and removing some plants, especially invasive ones and those that have been introduced. The issue of preserving dead wood on the territory of the grove is more complicated. Since the 1960s, the arboretum has been functioning as a landscape park with highly decorative positions. In the central part of the park, the oak forest is small, fragmented, and surrounded by landscape compositions. The prominent decline of the number of oak trees occurs here in ecotones located near the alleys. Often, dry oaks fall and block the alleys. Leaving dead wood here will create the appearance of neglect rather than an old forest. However, there are few such areas. In most of the natural oak forest, leaving dead wood of both the unifier species and its satellites is advisable and necessary. This will help to preserve the biodiversity characteristic of oak forests and restore the criteria for oak forests to be classified as old-growth forests.

Our research has shown that the causes of the degradation of oak forests and their consequences differ in forest plantations and fragments of natural plantations located in ancient parks and, currently, in botanical institutions. In the first case, the leading cause is deforestation and cattle grazing. In the second case, it is the fragmentation of the territory of natural plantations, the introduction of non-native plant species, and the creation of decorative compositions involving them.

For a complete picture of the oak grove and an analysis of its viability, it is necessary to survey the health state of oak phytocoenoses. This should include the study of phytosanitary conditions for the unifier species and its satellites; the analysis of the consequences of long-term oak dieback; the state and prospects of natural recovery of oak populations and its satellites; and the possibility, ways, and expediency of restoring the oak grove of the Dendropark “Olexandria”. These issues will be addressed in the following article of the series.

Conclusions

Based on comprehensive investigations, the size of the old-growth oak forest of the Dendropark "Olexandria" was established, its characteristics were ascertained, and the main causes and direction of anthropogenic transformations of the oak forest were identified. From the total 40.6 ha of the arboretum old-growth oak forest (1875 old oak trees), the natural oak forest covers 31.8 ha (1413 oaks).

The oak forest of the Dendropark "Oleksandria" has preserved many characteristics of natural forests and virgin forests: it has a natural origin, a complex vertical and horizontal structure, high mosaicism and species richness with the dominance of the floristic core, a strong unifying role of the common oak, high biodiversity; high species richness of lichen flora, including 15 indicator species of old forests and virgin forests.

The oak forest of the Dendropark "Oleksandria" has a large number of forest microhabitats (dead wood, tree cavities, fruiting bodies of saproxylic fungi, etc. In the studied oak forest, there were delimited two indigenous associations – hazel-ash oak forest (*Querceta (roboris) coryloso-aegopodiosum* and Tatar maple-stellar oak forest (*Querceta (roboris) acerioso (tatarici) stellariosum*).

Nowadays, the integrity of the oak forest has been lost. In a certain part of the oak forest, the species composition has changed, and the ecotonization of the oak forest has occurred with an increased loss of oaks and their companions and a deterioration in their phytosanitary condition. Areas of oak woodland with preserved certain criteria of virgin forests and natural forests located in the western part of the park, while anthropogenically transformed – in the central and eastern parts of the park.

References

- Barredo, J., Brailescu, C., Teller, A., Sabatini, F.M., Mauri, A. & Janouskova, K. (2021). *Mapping and assessment of primary and old-growth forests in Europe*. EUR 30661 EN. Publications Office of the European Union, Luxembourg. <https://doi.org/10.2760/13239>
- Bauhus, J., Puettmann, K., & Messier, C. (2009). Silviculture for old-growth attributes. *Forest Ecology and Management*, 258(4), 525–537. <https://doi.org/10.1016/j.foreco.2009.01.053>
- Buchwald, E.A. (2005, January 11–19). Hierarchical terminology for more or less natural forests in relation to sustainable management and biodiversity conservation. In *Proceedings of "Tird expert meeting on harmonizing forest-related definitions for use by various stakeholders"* (pp. 111–127). Food and Agriculture Organization of the United Nations.
- CBD. (2023). *Convention on Biological Diversity*. <https://www.cbd.int/>
- Chylarecki, P., & Selva, N. (2016). Ancient forest: spare it from clearance. *Nature*, 530, 419–419. <https://doi.org/10.1038/530419b>
- Di Marco, M., Ferrier, S., Harwood, T.D., Hoskins, A.J., & Watson, J.E. (2019). Wilderness areas halve the extinction risk of terrestrial biodiversity. *Nature*, 573, 582–585. <https://doi.org/10.1038/s41586-019-1567-7>
- Didukh, Y.P. (2009). *The red book of Ukraine*. Kyiv, Globalconsulting. (In Ukrainian)
- Dragan, N.V. (2011, May 25–28). Causes and features of the degradation of the ancient forest of the dendrological park "Oleksandria" of the NASU. In *Proceedings of the International Scientific Conference "Problems of preservation, restoration and stabilization of steppe ecosystems"* (pp. 24–30). Mariupol, Renata. (In Ukrainian)
- Dragan, N.V., Kalachnikona, L.V., & Pleskach, L.Y. (2018, April 19–21). Old-aged oakery – key biotope of the dendrological park "Olexandria" of the NAS of Ukraine. In Didukh Y., & Dubyna, D. (Eds.), *Proceedings of Scientific-Theoretical Conference "Classification of vegetation and biotopes of Ukraine"* (pp. 109–115). Kyiv. (In Ukrainian)
- Eckelt, A., Müller, J., Bense, U., Brustel, H., Bußler, H., Chittaro, Y., Cizek, L., Frei, A., Holzer, E., Kadej, M., Kahlen, M., Köhler, F., Möller, G., Mühle, H., Sanchez, A., Schaffrath, U., Schmidl, J., Smolis, A., Szallies, A., Németh, T., Wurst, C., Thorn, S., Christensen, R.H.B., & Seibold, S. (2018). "Primeval forest relict beetles" of Central Europe: a set of 168 umbrella species for the protection of primeval forest remnants. *Journal of Insect Conservation*, 22(1), 15–28. <https://doi.org/10.1007/s10841-017-0028-6>
- Forest Europe. (2015). *Relevant terms and definitions used for the updated pan-European indicators for sustainable forest management*. https://foresteurope.org/wp-content/uploads/2017/02/3AG_UPI_Updated_Terms_Definitions.pdf
- Franklin, J., & Pelt, R. (2004). Spatial aspects of structural complexity in old-growth forests. *Journal of Forestry*, 102(3), 22–28. <https://doi.org/10.1093/jof/102.3.22>

- Galkin, S.I. (2010). The historical plantings of Dendrological Park "Olexandria" of the NAS of Ukraine as the key botanical territories on the Ukraine. *Plant Introduction*, 47, 77–81. (In Ukrainian). <https://zenodo.org/doi/10.5281/zenodo.2550421>
- Galkin, S.I. (2012). The main stages of creation of Dendrological Park "Olexandria" of the NAS of Ukraine. *Plant Introduction*, 56, 76–82. (In Ukrainian). <https://doi.org/10.5281/zenodo.2541142>
- Gensiruk, S.A. (2002). *Forests of Ukraine*. Lviv, Publishing house of Taras Shevchenko Scientific Society. (In Ukrainian)
- Goichuk, A.F., & Reshetnyk, L.L. (2010). *Forest phytopathology in definitions, figures, diagrams*. Zhytomyr, Polissia. (In Ukrainian)
- Haydamak, V.M. (2006, May 22–25). Oak forest of the Dendropark "Olexandria": modern structure and condition, ways of optimization. In *Proceedings of Conference "Construction and reconstruction of botanical gardens and Arboretums in Ukraine"* (pp. 31–33). Simferopol, Botanical Garden of Tauria National University. (In Ukrainian)
- Haydamak, V.M., Mordatenko, L.P., & Golovko, E.A. (1994). *The oak forest of the Dendropark "Olexandria": condition, problems of optimisation and restoration*. Bila Tserkva, Dendropark "Oleksandriya". (In Ukrainian)
- IUCN. (2022). *The IUCN red list of threatened species. Version 2022-2*. <https://www.iucnredlist.org>
- Klymenko, Y.O., Kuznetsov, S.I., & Cherniak, V.M. (1996). *Ancient parks of Ukraine of national importance. Handbook. Part 1. Polissia and Forest-Steppe*. Ternopil, Mandrivets. (In Ukrainian)
- Král, K., McMahon, S.M., Janík, D., Adam, D., & Vrška, T. (2014). Patch mosaic of developmental stages in central European natural forests along vegetation gradient. *Forest Ecology and Management*, 330, 17–28. <https://doi.org/10.1016/j.foreco.2014.06.034>
- Kuuluvainen, T., & Aakala, T. (2011). Natural forest dynamics in boreal Fennoscandia: a review and classification. *Silva Fennica*, 45(5), Article 73. <https://doi.org/10.14214/sf.73>
- Law of Ukraine. (2017). Law of Ukraine on amending some legislative acts of Ukraine regarding the protection of primeval forests in accordance with the Framework Convention on the Protection and Sustainable Development of the Carpathians. *Vidomosti Verkhovnoi Rady*, 37, Article. 379. <https://zakon.rada.gov.ua/laws/show/2063-19#Text>
- Mazing, V.V. (1973). What is the structure of biogeocoenosis. In *Problems of biogeocenology* (pp. 148–156). Moscow, Nauka. (in Russian)
- Methodology. (2018). *Methodology for determining whether forest areas belong to virgin forests, quasi-virgin forests, and natural forests*. Ministry of Environment and Natural Resources of Ukraine. Order Nr. 161. (In Ukrainian). <https://zakon.rada.gov.ua/laws/show/z0707-18#Text>
- Oleksiychenko, N.O., & Hatalaska, N.V. (2012). *Parks-monuments of landscape art of the Central Dnipro Upland region. Part 1*. Kyiv, Komprint. (In Ukrainian)
- Paillet, Y., Archaux, F., du Puy, S., Bouget, C., Boulanger, V., Debaive, N., Gilg, O., Gosselin, F., & Guilbert, E. (2018). The indicator side of tree microhabitats: a multi-taxon approach based on bats, birds and saproxylic beetles. *Journal of Applied Ecology*, 55(5), 2147–2159. <https://doi.org/10.1111/1365-2664.13181>
- Peregrym, M.M., & Andrienko, T.L. (2012). *Official lists of regionally rare plants of administrative territories of Ukraine*. Kyiv, Altpress. (In Ukrainian)
- Sabatini, F.M., Bluhm, H., Kun, Z., Aksenov, D., Atauri, J.A., Buchwald, E., Burrascano, S., Cateau, E., Diku, A., Duarte, I.M., Fernández López, Á.B., Garbarino, M., Grigoriadis, N., Horváth, F., Keren, S., Kitenberga, M., Kiš, A., Kraut, A., Ibsch, P.L., Larrieu, L., Lombardi, F., Matović, B., Melu, R.N., Meyer, P., Midteng, R., Mikac, S., Mikoláš, M., Mozgeris, G., Panayotov, M., Pisek, R., Nunes, L., Ruete, A., Schickhofer, M., Simovski, B., Stillhard, J., Stojanović, D.B., Szwagrzyk, J., Tikkanen, O., Toromani, E., Volosyanchuk, R., Vrška, T., Waldherr, M., Yermokhin, M., Zlatanov, T., Zagidullina, A., & Kuemmerle, T. (2021). European primary forest database v2.0. *Scientific Data*, 8, Article 220. <https://doi.org/10.1038/s41597-021-00988-7>
- Sabatini, F.M., Keeton, W.S., Lindner, M., Svoboda, M., Verkerk, P.J., Bauhus, J., Bruelheide, H., Burrascano, S., Debaive, N., Duarte, I.M., Garbarino, M., Grigoriadis, N., Lombardi, F., Mikoláš, M., Meyer, P., Motta, R., Mozgeris, G., Nunes, L., Ódor, P., Panayotov, M., Ruete, A., Simovski, B., Stillhard, J., Svensson, J.T., Szwagrzyk, J., Tikkanen, O., Vandekerckhove, K., Volosyanchuk, R., Vrška, T., Zlatanov, T., & Kuemmerle, T. (2020). Protection gaps and restoration opportunities for primary forests in Europe. *Diversity and Distributions*, 26(12), 1646–1662. <https://doi.org/10.1111/ddi.13158>
- Sanitary Rules. (1995). *Sanitary rules in forests of Ukraine*. Cabinet of Ministers of Ukraine. Order Nr. 555. (In Ukrainian). <https://zakon.rada.gov.ua/laws/show/555-95>
- Shelyag-Sosonko, Y.R. (1974). *Forests of the oak formation on the territory of Ukraine and their evolution*. Kyiv, Naukova Dumka. (In Ukrainian)

- Shparyk, Y., Cherniavskiy, M., Kagalo, A., Bondaruk, G., Savchyn, M., Ponepoliak, M., Forgil, Y., Zelenchuk, Y., Volosyanchuk, R., & Prots, B. (2017). Criteria and methodology for virgin and old growth (quasi-virgin) forests identification (second edition). Lviv, Liga Press. (In Ukrainian). <https://doi.org/10.13140/RG.2.2.24096.69127>
- State Register. (2022). *State register of scientific objects constituting national heritage*. Ministry of Education and Science of Ukraine. <https://registry.nauka.gov.ua/registry/natcnadbania/>
- Vandekerckhove, K., De Keersmaecker, L., Walley, R., Köhler, F., Crevecoeur, L., Govaere, L., Thomaes, A., & Verheyen, K. (2011). Reappearance of old-growth elements in lowland woodlands in northern Belgium: do the associated species follow? *Silva Fennica*, 45, 5–78. <https://doi.org/10.14214/sf.78>
- Watson, J.E., Evans, T., Venter, O., Williams, B.A., Tulloch, A.I., Stewart, C.L., Thompson, I.D., Ray, J.C., Murray, K.A., Salazar, Á., McAlpine, C.A., Potapov, P.V., Walston, J., Robinson, J., Painter, M., Wilkie, D.S., Filardi, C.E., Laurance, W.F., Houghton, R.A., Maxwell, S.L., Grantham, H.S., Samper, C., Wang, S., Laestadius, L., Runtz, R.K., Silva-Chávez, G., Ervin, J., & Lindenmayer, D.B. (2018). The exceptional value of intact forest ecosystems. *Nature Ecology & Evolution*, 2, 599–610. <https://doi.org/10.1038/s41559-018-0490-x>

Діброва Дендропарку "Олександрія". Частина 1. Від корінного до антропогенно трансформованого насадження

Наталія Бойко, Ніна Драган *, Наталія Дойко

Державний дендрологічний парк "Олександрія" НАН України, Біла Церква – 13, Київська область, 09113, Україна; * ninapark@ukr.net

Метою даної праці було визначення рівня збереження критеріїв первісних лісів та міри антропогенної трансформації в віковій діброві дендропарку "Олександрія". Вікове дубове насадження природного походження займає площу 31,8 га на якій зростає 1413 дубів. Ще 8,8 га діброви з 462 дубами є штучними ландшафтними композиціями.

За більш як 200 річне існування з часу створення парку "Олександрія" в діброві збереглося цілий ряд критеріїв, характерних для пралісів. Зокрема, збереглися складна мозаїчно-ярусна структура. Також збереглися корінні асоціації – дубові ліси ліщиново-яглицеві (*Querceta (roboris) coryloso-aegopodiosum*) і татарськокленово-зірочникові (*Querceta (roboris) acerioso (tatarici) stellariosum*). Домінуючий вид, *Quercus robur*, зберіг функцію едифікатора з долею в першому ярусі 70–100 %. Збережене флористичне ядро із головних лісотвірних видів.

Діброва є оселищем для цілого ряду деревних і трав'яних рослин місцевої флори, в тому числі і зникаючих видів. Для діброви характерна висока структурна складність, зокрема виявлено різноманітну епіфітну ліхенофлору, рідкісні види, 15 індикаторних видів старих лісів і пралісів. Діброва є оселищем для 62 видів птахів, переважно жителів лісових біотопів. На значній частині діброви знаходиться мертва деревина виду едифікатора і його супутників різних стадій розкладу.

Антропогенне втручання в діброву було тривалим і різноманітним. З часів заснування парку і після цього діброва зазнала надмірної фрагментації і введення до її складу інтродуцентів, створення в межах діброви декоративних ландшафтних композицій, головним чином в центральній частині діброви. Це викликало значну екотонізацію діброви і витіснення *Q. robur*.

Це дослідження дозволило виявити цілий ряд критеріїв, що відносять діброву як до спадкоємця первісного лісу, що надає діброві особливої цінності.

Ключові слова: дендропарк "Олександрія", природна діброва, критерії пралісів, спокушеність діброви, антропогенна трансформація