

**Galkin, S., Kalashnikova, L.,
Doiko, N., Rubis V., and Boiko, N.**

Olexandria National Arboretum, NAS of Ukraine, Bila Tserkva, Kyiv Oblast

EFFECTIVE USE OF ENVIRONMENTAL ASSETS OF OLEXANDRIA NATIONAL DENDROPARK OF NASU IN THE ENVIRONMENTAL NETWORK CONCEPT OF UKRAINE



The article contains information about scientific research and engineering works carried out to create an ecological trail in Olexandria national deontological park of NASU in the concept of ecological network development in Ukraine. The objectives and criteria for developing the route of the ecological trail in Olexandria deontological park have been outlined. The new species to enrich the phytodiversity of the deontological park and the measures to optimize the habitat of introduced and native plant communities, rare and endangered species of plants and animals, as well as the expository and collection sites have been listed; technical measures for the arrangement of ecological trail have been offered.

Key words: environmental network, ecological trail, route, constituent elements, rare and endangered species, landscape compositions, natural and artificial communities.

Every year, changes in the environment or its complete destruction attain menacing proportions and lead to negative consequences for the humanity.

Everyday dozens of animal and plant species disappear from the face of the globe. The environmental network is a new form of the nature protection, which allows for the needs of both the wildlife and the human society; it is an important mechanism for the conservation of biodiversity and the sustainable development of regions [1]. The ultimate goal of the econet is not only to preserve the most valuable and the least disturbed areas of nature, but also to provide the conditions necessary for the survival of populations on the landscapes used in economic activity [2]. The ecological trails are created on the environmental network objects to teach people to see different forms of anthropogenic pressure and to assess the

effects of human activity on the environment and the nature in general, to promote the environmental culture and to educate people in the course of their relationship with the nature.

Today, the dendrological parks are important centers of biodiversity conservation. In recent decades, they have assumed great prominence in the society due to the environmental and educational activities of their employees. Together with botanical gardens, nature reserves, and national parks, the arboretums are key areas (natural nuclei) of the Ecological Network of Ukraine. The dendrological parks at the national and local level (45 sites) and the park monuments of landscape architecture (539 sites) have no match among the protected areas by their quantity and occupied area.

HISTORY OF ECOLOGICAL TRAILS

The concept of ecological trails appeared in the United States, in the early twentieth century, when forester Benton McKay offered to pave the path

along the Appalachian Ridge and called it «*a reserve for pedestrians*». In 1922, a path having a length of 3300 km was established; in 1968, it was named *the National Landscape Path*. Later, the protected trails were established in the national parks of the Rocky Mountains (*the Continental Divide Trail*) and on the coast of America (*the Pacific Crest Trail*) [3, 4].

In Ukraine, the first historical ecological trail of this kind (*the Golitsyn Trail*) was paved in 1916. It was located 7 km from Sudak and ran along the mountain cliffs. In the late 1980th, the creation of ecological trails intensified: as a result, there appeared *the Irpin-Bilychi Trail* on the outskirts of Kyiv, *Along the Horyn River Trail*, *The Sidehills of Hosiivo Trail*, and *Teremky Forest Trail*, in Kyiv, and others. The educational ecological trails have been designed and implemented on large areas of natural reserve assets: in the national parks (the Carpathian National Park, the Shatsk National Park, and the Podolian Tovtry), in the nature reserves of the Crimea and in the *Medobory* reserve (*the Acute Trail*, *the Bohit Trail*, and *Path to a Forest Hermit*), in the wildlife sanctuaries around the city Kyiv (*Lisnyky*), and so on [5, 6, and 7]. In recent years, ecological trails have been developed in the Nikitsky and the Kremenetsky botanical gardens [8], as well as in the botanical garden of the Vernadsky Tauric National University (Simferopol) [9]. The first ecological trail of *Olexandria* park was developed by G. Klastorna, in 1990. It consisted of 14 natural and historical sites [10]. In 2005, the ecological trail project was added with information about the flora and the status of aquatic ecosystems in the park [11].

MATERIALS AND METHODS FOR PAVING THE ECOLOGICAL TRAILS

The object of this research was the natural assets of *Olexandria* National Arboretum of NASU used to create a social and natural structure, the ecological trails.

In the park, there have been preserved unique natural complexes. Among them, there are an ancient oak grove, riverside areas of the Ros River,

ponds, steppe hillsides, and meadows. The modern park landscapes belong to the moderately depressed or quasi-natural ecosystems with a low technological transformation. The genetic fund of trees, shrubs, and herbaceous plants of the arboretum has been included in the National Register of Scientific Objects Constituting the National Acquisitions pursuant to the Resolution of the cabinet of Ministers of Ukraine no.472 of August 19, 2002. The arboretum as object of natural reserve fund (NRF) ensures the preservation of landscape and biodiversity that are valuable and typical for the region [12]. According to the classification of plant communities listed in the Green Book of Ukraine, the park phytocenoses belong to those of economic and reference significance and are protected by phyto-historical, botanical, geographical, and chorological features [13].

The objective of the project is to take special measures for optimizing the habitat of introduced and native plant communities, as well as of rare and endangered species of plants and animals; the locations of the new exposition and collection sites and the sites with the largest manmade load and for creating an ecological trail on their basis.

The key tasks for creating the ecological trails:

- ✦ To familiarize the visitors with the wildlife (native and introduced plants, native species) and with the inanimate nature;
- ✦ To develop and to implement the proper environmental activities (installation of name plates, information stands, interpretive displays, and other equipment); and
- ✦ To promote the environment protection measures.

The method for creating the ecological trails is based on the route approach. It implies the selection of route, its design and arrangement, as well as the monitoring of the ecological trail status and the animate and inanimate objects. The route was selected in accordance with the Guidelines for the Establishment of Ecological Trails [3] allowing for the recreational, aesthetic (paving along the existing grid of alleys in the attractive area), information, and educational aspects. The route

was designed for moving from one object to another to show the full range of different landscapes of the park, including the manmade and the highly transformed ones.

RESULTS AND DISCUSSION

The ecological trail is complex in terms of its topical content and linear in terms of its route. Its length is 7 km; the time of walk with stops for rest included is 4 hours. The visitor can walk along the trail as part of tour group or independently. The maximum number of people in the group is 30. The trail operates seasonally, from May till November.

The current phytodiversity of the park consists of 2021 taxonomic units [14, 15]; in addition, the arboretum has 80 species of animals, including 4 species of amphibians, 5 species of reptiles, 62 species of birds, and 7 species of mammals [16].

When paving the route 25 constituents of ecological trail were identified. They are the typical natural and artificial groupings, landscape compositions, architectural and hydraulic structures where the visitors can explore the nature and the park history.

The natural grouping of the park is an ancient oak grove having an area of 6.8 ha. On this are, there are growing more than 2,100 oaks aged 200–250 years (some of trees are 400 years old), with an average height of 27 meters and a trunk diameter of 1.5–2 m. The oak grove is characterized by diversified landscape structures that differ in shape and composition of the tree stand, quantitative and qualitative composition of strata, spatial characteristics, and the degree of degradation of recreation. Among them, there are the woodlands, the oak plantations (pure or containing insignificant amount of other species in the first story), with understory, typical undergrowth, herbaceous vegetation, and forest floor. There are also the park plantations: the monodominant single-storied stand with thin undergrowth and well-developed grass stratum. In the springtime, in the oak grove, one can find the remainder of natural population of rare species *Galanthus nivalis* L. listed in the Red Book of Ukraine.

On the *Palieva Hora* (Palii Hill), there are the remainder of steppe ecosystem with piecemeal *Stipeta capillatae* grouping listed in the Green Book of Ukraine [17] and the red-book listed plants [18]: *Stipa capillata* L., *Adonis vernalis* L., *Pulsatilla grandis* Wend., *Pulsatilla pratensis* (L.) Mill. Thirty four species (7.7% of the total number of herbaceous plants of the park) grow only on the steppe site Palieva Hora. Among them, there are *Achillea nobilis* L., *Asyneuma canescens* (Waldst & Kit.) Griseb. & Schenk, *Artemisia austriaca* Jacq., *Asplenium septentrionale* (L.) Hoffm. (as few as 5 plants at the bottom part of the hillside), *Iris hungarica* Waldst. et Kit., *Dianthus andrzejowskianus* (Zapal.) Kulcz., etc.

The vegetation of deciduous woods of the park (including that growing in the Globe valley and in the Western Valley gully) is typical, with a population of regionally rare species *Matteuccia struthiopteris* L. (Figs. 1, 2, see color inset).

The artificial groupings of typical species with diversity of introduced plants are represented by pine forest, birchwood, and by *Velyka*, *Nahirna*, and *Horikhova* lawns (Figs. 3, 4, see color inset).

The woody vegetation of the park consists of 1218 taxonomic units (607 species, 2 subspecies, 15 variations, 291 forms and 303 varieties referred to 2 order, 3 classes, 57 families, and 148 genera), 25 of them are native species [14]. The herbaceous layer is represented by 803 species and intraspecific taxa belonging to 4 classes, 91 families, and 364 genera; 389 species of them are forest herbs and meadow-steppe plants [15]. While walking along the trail the visitors can get acquainted with plants of native species of woody and herbaceous vegetation, including: *Quercus robur* L. (Fig. 5, see color inset), *Carpinus betulus* L., *Fraxinus excelsior* L., *Populus canescens* (Ait.) Smith, *Populus nigra* L., *Alnus glutinosa* (L.) Gaerrth., *Salix alba* L., *Salix acutifolia* Willd., *Salix caprea* L., *Populus tremula* L., *Asarum europaeum* L., *Scilla bifolia* L., *Anemone ranunculoides* L., *Ficaria verna* Huds., *Gagea lutea* (L.) Ker.-Gawl., *Gagea minima* (L.) Ker.-Gawl., *Corydalis solida* (L.) Clair., *Stellaria graminea* L., *Viola odorata* L., *Pulmonaria*

obscura Dumort, *Stellaria holostea* L., *Galeobdolon luteum* Huds.), *Glechoma hederacea* L., *Aegopodium podagraria* L., *Lamium purpureum* L.

In order to optimize the woody vegetation of the park, new species of early spring ephemeroids (*Puschkinia scilloides* Adams and *Puschkinia scilloides* Alba), as well as the introduced species (*Aegonychon purpureo-caeruleum* (L.) Golub, *Staphylea colchica* Stev., *Ajuga pyramidalis* L., *Polygonatum humile* Fisch. ex Maxim) have been planted.

The artificially created landscape compositions (*Velyka* Lawn) embrace 220 introduced hardwood (12 species) trees and 200 conifers (7 species). The rare introduced species aged 180–220 years have historical, scientific, and memorial value: *Pinus strobus* L., *Pinus nigra* Arn., *Pinus sylvestris* L., *Picea abies* (L.) Karst., *Liriodendron tulipifera* L., *Larix decidua* Mill., *Betula pendula* Roth, *Aesculus hippocastanum* L., *Gleditsia triacanthos* L., *Acer pseudoplatanus* L., *Quercus rubra* L., *Juniperus virginiana* L., *Robinia pseudoacacia* L., *Juglans nigra* L., *Tilia euchlora* Koch., etc. (Fig. 6, see color inset).

The park collection of rare plants protected by the Red Book of Ukraine includes 84 species belonging to 63 genera, 37 families, 3 classes (25 species of trees and 59 herbaceous species); 37 of them form the native and the introduced populations and biogroups of 22 quarters of the park. While walking along the ecological trail the visitors can see the following red-book listed species: *Fraxinus ornus* L., *Chamaecytisus podolicus* (Blocki) Klaskova, *Taxus baccata* L., *Larix polonica* Racib., *Euonymus nana* Bieb., *Spiraea polonica* Blocki, *Syringa josikaea* Jacq., *Staphylea pinnata* L., *Cephalaria litvinovii* Bobr. *Asphodelina lutea* (L.) Reichenb., *Cerastium biebersteinii* DC., *Dianthus gratianopolitanus* Vill., *Dianthus pseudoserotinus* Blocki, *Campanula carpatica* Jacq., *Astragalus borysthenicus* Klok., *Stipa lessingiana* Trin. et Rupr., *Stipatirsa* L., *Stipa pennata* L., *Biscutella laevigata* L., *Sorbus torminalis* L., *Chamaecytisus roshelii* (Wierzb.) Rothm., *Aquilegia nigricans* Baumg., and *Aquilegia transsilvanica* (Fig. 7, see color inset).

The *Lion Spring* landscape composition was created in the second half of the twentieth century, in

the Central Valley gully. The introduced species *Rhus toxicodendron* L. grows on the slopes of the gully. In the springtime, the first tree to bloom here is rare in Ukraine *Leucojum vernum* L. In order to optimize the composition, *Microbiota decussata* Kom. was planted on the slopes of the gully; while hygrophilous plants *Actaea spicata* L., *Thalictrum aquilegifolium* L., *Lysimachia nummularia* L. Aurea, *Rodgersia pinnata* Franch., *Astilboides tabularis* (Hemsl.) Engl., *Epimedium* hybr. Sasaki, *Aceriphyllum rossii* (Oliv.) Koidz. Karasuba were bedded out at the bottom (Fig. 8, see color inset).

The *Royal Garden* landscape composition shows the history of relations between the Branicki family and the House of Romanov. The restoration of this site, including the *Hornbeam Arbor* as core of composition, was carried out in 2005–2008. Among the woody plants, the most attractive are majestic *Fraxinus excelsior* trees; the herbaceous layer is represented by large dense curtains of introduced species *Vinca minor* L. Among others, the ecological trail project included the restoration of the *Jasmine Alley* with *Philadelphus coronarius* L. and the planting of *Spiraea x cinerea* Zab. Grefsheim, *Taxus baccata*, *Rhodotypos kerrioides* Sieb. et Zucc., and *Puschkinia scilloides* Alba.

The total area of 25 artificial park ponds is 10.5 hectares. The *Central Valley* cascade was created in the late 18th century. Today, it includes the following ponds: *the Goldfish Aquarium*, *the Swan's Lake*, *the Popovic's Lake*, and *the Silver Haze*.

The aquatic and riverside vegetation of the park embraces 118 species of plants, including *Petasites hybridus* (L.) Gaertn., Mey. et Scherb. (Fig. 9, see color inset), *Iris pseudocorus* L., *Caltha palustris* L., *Scirpussyl vaticus* L., *Myosotis palustris* (L.) L., *Nymphaea alba* L., *Nymphaea candida* J. et C. Presl, and *Nuphar lutea* (L.) Smith. The last three species are listed in the Red Book of Macrophytes of Ukraine [19]. On the slopes, around the ponds, there are new species and cultivars, including *Ligularia dentata* (A. Gray) Hara 'Britt Marie Crawford', *Ligularia przewalskii* (Maxim.) Diels Osiris Caf Noir, *Filipendula palmata* (Pall.) Maxim., *Sanguisorba canadensis* Raf., *Campanula alliarifolia*

Willd. and *C. pyramidalis* L., *Helianthemum hybridum* hort. and *H. nummularium* (L.) Mill. C., *Phlomis tuberosa* L., *Prunella grandiflora* (L.) Scholler, *Allium altaicum* Pall., *A. odorum* L. and *Allium nutans* L., *Artemisia umbelliformis* Lam., *Linum perenne* L., *Inula helenium* L., *Anthericum ramosum* L., *Verbascum phoeniceum* L., and *Astrantia major* L.

Within the ecological trail project, the landscape sites near architectural structures of the 18th century (*the Moon Terrace, the Pavilion, and the Chinese Bridge*) were optimized with *Juniperus sabina* L., *Taxus baccata*, *Berberis thunbergii* DC., and *Populus si monii* Carr.

Among other elements, the ecological trail includes the following research, exposition, and collection sites: *the Syringarium, the Pinetum, and the Rose Garden*. *The Pinetum* reckons up 44 species and 170 cultivars; *the Syringarium* collection numbers 34 lilac varieties of Ukrainian and foreign breeding; and 115 rose varieties bloom in *the Rose Garden*.

The master plan of ecological trail is incorporated in the park layout (Fig. 10, see color inset) with indication of the name and length of the trail, the time of walk, the route, as well as the accommodation and recreational facilities. The big boards with the layout of all stops are mounted at the beginning of the route, near the Main Entrance, as well as near the North Entrance and the administration building.

To provide ecological information the trail was equipped with 30 indicators, 3 boards, 6 stands, 20 name plates, 20 information plates, 12 bird boxes, and 5 bird feeders; for the convenience of visitors, along the trail, there are 69 native and introduced species and cultivars of woody and herbaceous plants planted; 3 recreation sites and a source of drinking water arranged; 3 viewing platforms (*the Globe Valley and the Lion Spring*) repaired; 60 garden benches mounted, and the alleys renovated.

Guidelines for creating the ecological paths in arboretums and parks referred to the monuments of park and garden art of the national importance have been developed upon the results of the project [16].

CONCLUSIONS

For the first ever time in Ukraine, including the arboretums of national importance, a 7 km long ecological trail has been established within the territory of *Olexandria* dendrological park. The objective of the project is to instill in the population a culture of relations with the nature; to take special measures for optimizing the habitat of the native and introduced plant communities, as well as of rare and endangered species of plants and animals; the locations of the new exposition and collection sites and the sites with the largest man-made load and for creating an ecological trail on their basis. This objective has been achieved.

The activities undertaken using the natural assets of *Olexandria* arboretum within the framework of ecological network conception can set an example of educative and environmental activities for the ecologists, botanists, specialists in environmental protection, teachers, and students of natural faculties of universities and for other citizens who care about the problems of preservation of the native wildlife.

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*С.І. Галкін, Л.В. Калашнікова,
Н.М. Дойко, В.Л. Рубіс, Н.С. Бойко*

Державний дендрологічний парк «Олександрія»
НАН України, Біла Церква

РАЦИОНАЛЬНЕ ВИКОРИСТАННЯ ПРИРОДНОГО
ПОТЕНЦІАЛУ ДЕРЖАВНОГО
ДЕНДРОЛОГІЧНОГО ПАРКУ «ОЛЕКСАНДРІЯ»
НАН УКРАЇНИ В КОНЦЕПЦІЇ РОЗВИТКУ
ЕКОЛОГІЧНОЇ МЕРЕЖІ УКРАЇНИ

Надано інформацію про наукові розробки та технологічні заходи по створенню у Державному дендрологічному

парку «Олександрія» НАН України екологічної стежки в концепції розвитку екологічної мережі України. Окреслено завдання та критерії розробки маршруту екологічної стежки в дендропарку «Олександрія». Наведено перелік нових видів для збагачення фіторізноманіття дендропарку та оптимізації місць існування природних та інтродукційних рослинних угруповань, раритетних та рідкісних видів рослин і тварин, експозиційно-колекційних ділянок. Наведено перелік технологічних заходів для улаштування екологічної стежки.

Ключові слова: екологічна мережа, екологічна стежка, маршрут, складові елементи, раритетні та рідкісні види, ландшафтні композиції, природні та штучні угруповання.

*С.И. Галкин, Л.В. Калашникова,
Н.М. Дойко, В.Л. Рубис, Н.С. Бойко*

Государственный дендрологический парк
«Александрия» НАН Украины, Белая Церковь

РАЦИОНАЛЬНОЕ ИСПОЛЬЗОВАНИЕ
ПРИРОДНОГО ПОТЕНЦИАЛА
ГОСУДАРСТВЕННОГО ДЕНДРОЛОГИЧЕСКОГО
ПАРКА «АЛЕКСАНДРИЯ» НАН УКРАИНЫ
В КОНЦЕПЦИИ РАЗВИТИЯ ЭКОЛОГИЧЕСКОЙ
СЕТИ УКРАИНЫ

Представлена информация о научных разработках и технологических мероприятиях, проведенных для создания в Государственном дендрологическом парке «Александрия» НАН Украины экологической тропы в рамках концепции развития экологической сети Украины. Обозначены задачи и критерии разработки маршрута экологической тропы в дендропарке «Александрия». Представлен перечень новых видов для обогащения фитообразия дендропарка и оптимизации мест существования естественных и интродукционных растительных сообществ, раритетных и редчайших видов растений и животных, экспозиционно-коллекционных участков, а также перечень технологических мер по устройству экологической тропы.

Ключевые слова: экологическая сеть, экологическая тропа, маршрут, составные элементы, раритетные и редкие растения, ландшафтные композиции, природные сообщества.

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DOIKO, N., RUBIS, V., and BOIKO, N.



Fig. 1. The ancient oak grove



Fig. 2. The *Palieva Hora* (the Palii Hill)



Fig. 3. The *Velyka* Lawn



Fig. 4. The *Horikhova* Lawn



Fig. 5. Quercus robur L.



Fig. 6. Liriodendron tulipifera L.



Fig. 7. *a* – *Taxus baccata* L.; *b* – *Syringa josikaea* Jacq.; *c* – *Chamaecytisus podolicus* (Blocki) Klaskova



Fig. 8. The *Lion Spring*



a



b

Fig. 9. The *Popovic's Lake*: *a* – *Iris pseudocorus*; *b* – *Pitasites hybridus*



Fig. 10. The master plan of ecological trail in the *Olexandria* dendrological park