Received: 02.01.2024 Revised: 27.06.2024 Accepted: 15.08.2024

BIOLOGICAL SYSTEMS: Theory and Innovation

Journal homepage: https://bioscience.com.ua/en
Vol. 15, No. 3, 2024, 79-92

UDC 574:581.5

DOI: 10.31548/biologiya/3.2024.79

Edaphic aspect in the ecological structure of the dendroflora in the "Nova Sofiyivka" park

Olha Porokhniava*
PhD in Biological Sciences, Senior Researcher
National Dendrological Park "Sofiyivka" of the National Academy of Sciences of Ukraine
20300, 12a Kyivska Str., Uman, Ukraine
https://orcid.org/0000-0002-9636-9990

Yurii Rumiankov
PhD in Biological Sciences, Head of the Laboratory
National Dendrological Park "Sofiyivka" of the National Academy of Sciences of Ukraine
20300, 12a Kyivska Str., Uman, Ukraine
https://orcid.org/0000-0002-6253-7618

Tetiana Kopylova
PhD in Biological Sciences, Senior Researcher
National Dendrological Park "Sofiyivka" of the National Academy of Sciences of Ukraine
20300, 12a Kyivska Str., Uman, Ukraine
https://orcid.org/0009-0003-0328-5777

Liudmyla Vegera
PhD in Biological Sciences, Senior Researcher
National Dendrological Park "Sofiyivka" of the National Academy of Sciences of Ukraine
20300, 12a Kyivska Str., Uman, Ukraine
https://orcid.org/0000-0003-2512-2664

Valentyna Ponomarenko
PhD in Biological Sciences, Senior Researcher
National Dendrological Park "Sofiyivka" of the National Academy of Sciences of Ukraine
20300, 12a Kyivska Str., Uman, Ukraine
https://orcid.org/0000-0002-2872-6693

Abstract. The conflict between the needs of plants and the ecological characteristics of edaphotope directly affects the aesthetics of the landscape. In this connection, the compliance of the needs of woody plants with edaphic conditions was investigated. The purpose of the study was to determine the edaphic component of the ecological structure of the dendroflora of "Nova Sofiyivka" park to predict the potential viability of plant communities. The paper used descriptive, statistical, and comparative research methods. The description of the park's dendroflora was made according to the instructions for the inventory of green spaces in localities of Ukraine. The species composition was determined using plant identification guides, and the relevance of species names was verified according to the current international classification. Ecological analysis of dendroflora was performed based on ecological scales, in which plants were divided into 7 ecological groups depending on the soil moisture regime, moisture variability, aeration, acidity, total salt regime, carbonates and nitrogen content. In the

Suggested Citation:
Porokhniava, O., Rumiankov, Yu., Kopylova, T., Vegera, L., & Ponomarenko, V. (2024). Edaphic aspect in the ecological structure of the dendroflora in the "Nova Sofiyivka" park. *Biological Systems: Theory and Innovation*, 15(3), 79-92. doi: 10.31548/biologiya/3.2024.79.

*Corresponding author

dendrology of the park, mesophytes predominate in terms of sensitivity to the soil moisture regime, hemihydrocontrastophobes predominate in terms of variability, hemiaerophobes predominate in terms of air regime, neutrophils predominate in terms of acidity, mesotrophs predominate in terms of salt regime, acarbonatophiles predominate in terms of carbonates content, and nitrophiles predominate in terms of nitrogen content. The survey revealed a rational solution to the problem of providing appropriate soil moisture conditions for plants belonging to the eco-groups of hydrocontrastophobes, hygromesophytes, and hygrophytes. To meet the needs of eco-groups of subacidophiles and acidophiles in low soil acidity, the root-containing soil layer was replaced with a peat mixture with the appropriate pH before planting. The practical significance of the results obtained lies in the possibility of their use by gardening specialists to optimise plantings, considering edaphic conditions that affect the increase in plant resistance and reduce the intensity of plant care. Plants for which planting sites are selected based on their environmental needs are more vital and durable

Keywords: species composition; edaphotope; eco-group; coenosis; urbanised environment

INTRODUCTION

The expansion of urbanised territories leads to disruption of the natural ecosystem by changing the structure and processes of its functioning as a result of anthropogenic activities. In order to at least partially compensate for destructive natural phenomena to reduce negative environmental, socio-economic, and other consequences, integrated green areas are created in the urban environment.

The context of sustainable development of urbanised territories is based on the establishment of residential garden and park landscapes using plant communities formed from highly decorative and sustainable plants (Orlóci & Fekete, 2023). Urban greening is not only aesthetically pleasing, but its role in *ex situ* plant biodiversity conservation strategies is equally important (Ismail *et al.*, 2021; Wang *et al.*, 2024). The creation of decorative compositions contributes to the introduction and maintenance of valuable collections of woody and herbaceous plants, which leads to the establishment of a unique artificial phytocenosis. As indicated by S. Didenko & O. Shynder (2023), mature artificial phytocenoses are the most resistant to colonisation by undesirable native species and many rare plants are found in such plant communities, which successfully form stable populations. Results of the study by T. Krivomaz *et al.* (2022) indicate that green spaces improve microclimatic conditions in an urbanised environment, enrich the air with oxygen, promote the absorption of excess carbon dioxide, purify dust, and reduce the number of pathogenic microorganisms.

According to J. Konarska *et al.* (2023), woody plants provide numerous ecosystem services, including mitigation of urban heat. However, the cooling effect of plantings is often reduced due to reduced growth of vegetative organs and poor sanitary condition, which is associated with difficult growing conditions in an urbanised environment, which can be compensated by an increase in the area of green areas. Recreational, cognitive, educational, and cultural functions of parks are of great social importance. The study by J. Cubino & J. Retana (2023) concluded that biodiversity and the quantitative composition of plantings have a high level of correlation with human life expectancy. A high level of biodiversity and the saturation of space with plant communities increases human viability. In this regard, increasing the area occupied by green spaces is a promising area for optimising urban space. The species composition of urban flora depends on the bio-ecological characteristics of plants and the microclimatic conditions of green areas (Muzychenko e*t al.*, 2020). Environmental monitoring of flora is especially important in conditions of anthropogenically altered landscapes to assess the current state and predict trends in changes in its components in the future (Stakhiv *et al.*, 2021; Optasyuk & Hrygorchuk, 2021; Oliferchuk *et al.*, 2023).

The stability of the created coenosis can be predicted based on the analysis of the ecological structure of the dendroflora. Ecological analysis determines the ecological and biological features of species and their relationships with the habitat. T. Marucha *et al.* (2023) point out that in the conditions of significant anthropogenic impact on the natural environment, issues related to determining the current state of the vegetation cover of protected areas are of particular relevance, because the development of scientific foundations for rational use of natural resources and protection of the plant world is impossible without a deep study of the flora. When creating new garden and park facilities, it is important to consider the compliance of the range of plants used with the ecotope. Problems of conflict between plant needs and environmental conditions strongly affect the aesthetic condition of plantings. According to N. Melnychuk & Ya. Henyk (2019), climate-forming properties of the main sinusia unifiers should be used for the development of park and forest park phytocoenoses with high aesthetic value and favourable sanitary and hygienic conditions. S. Rogovskyi *et al*. (2023) indicate that the viability of trees, in addition to abiotic factors, is also affected by excessive thickening of the stand and competition between plants for light, moisture, and mineral nutrition elements. Edaphic conditions affect the natural restoration of plant communities. The importance of this statement is highlighted in the paper by T. Murphy *et al*. (2024), where the authors scientifically confirmed the critical importance of soil moisture for plant survival at an early stage of ontogenesis.

Edaphotope directly affects the structure and productivity of plant communities, their stability, durability, and aesthetic appeal. The purpose of the study was to investigate the edaphic components of the ecological structure of the dendroflora in the park under study to assess the potential viability of the site's ecosystems. To achieve this goal, the following tasks were defined: to perform an inventory of dendroflora; to analyse the fastidiousness of woody plants to edaphic environmental conditions; to identify the compliance of the growing conditions of woody plants with their edaphic needs.

MATERIALS AND METHODS

As of 2020, the territory of the city of Uman is 4,787 hectares, of which 1,239.6 hectares are green spaces, including city parks, squares, street greenery, educational institutions, memorial areas, household plots, etc. "Nova Sofiyivka" park is a new recreational facility that was opened to the public on 14 July 2019. The Park is part of the National Dendrological Park "Sofiyivka" of the National Academy of Sciences of Ukraine (Fig. 1).

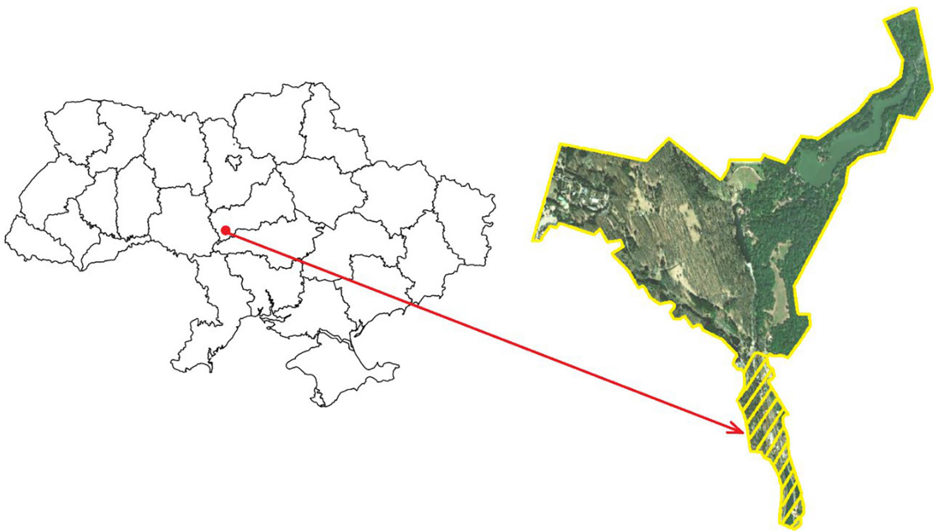

Figure 1. Location of the "Nova Sofiyivka" park
Source: compiled by the authors

All compositions on its territory were created during 2018-2019 on an area cleared of previous vegetation using a modern range of ornamental plants. The park, with an area of 10.7 hectares, was created in the lower reaches of the Kamianka River, outside the historical part of Sofiyivka. The new part is built in an eclectic style, consists of nine separate ideological and planning compositions placed along the riverbed and combined into one complex using an alley and trail network. The study was conducted during 2020-2023. The inventory control of the park's dendroflora was carried out in accordance with the Instructions for the Inventory of Green Spaces in Settlements of Ukraine (Order of the State Committee for Construction, Architecture and Housing Policy of Ukraine No. 226 "On the Approval of the Instructions for the Inventory of Green Spaces for the Inventory of Green Spaces in Settlements of Ukraine", 2001). The preparatory stage included determining the territory to be inventoried, preparing a map scheme for accounting for plantings, developing an inventory plan, and selecting accounting methods. The continuous inventory method was chosen for the study. The actual field survey consisted of establishing the boundaries of the inventoried plots. A visual inspection of each tree plant was carried out, and data on species, age, sanitary condition, height, trunk diameter at a height of 1.3 m, crown diameter, and plant location on a map were recorded. The stage of processing the results for our study included the creation of a summary list of the number of plants, grouping of plants by species composition, summing up the amount and percentage of participation in the plantation.

Species identification was performed using Plants of the World Online (n.d.), and the relevance of species names was checked according to the international classification The Word Flora Online (n.d.). The ecological analysis of dendroflora was performed based on ecological scales developed by Ya.P. Didukh (Didukh, 2011). The park's dendroflora in the edaphotope category was divided into eco-groups according to the ratio of plants to the soil moisture regime, moisture variability, soil aeration, acidity, total salt regime, carbonates and nitrogen content. The paper used a descriptive method that consisted in determining the edaphic conditions optimal for successful growth and development of plants, a statistical method that helped to identify the frequency of occurrence of a species in the structure of dendroflora, and a comparative method that evaluated whether the requirements of plants meet the conditions of edaphotope. The research was carried out in accordance with the current legislation of Ukraine, international standards for editors and authors, recommendations of the Committee on Publication Ethics (COPE) and according to the Ethical Code of a Scientist of Ukraine (Resolution of the National Academy of Sciences of Ukraine No. 2 "On the Ethical Code of a Scientist", 2009). The principles of the UN Convention on Biological Diversity (Convention on Biological Diversity, 1992) were not violated. The paper contains original data provided directly by the authors, who are listed in the authorship of the publication.

RESULTS AND DISCUSSION

The territory of "Nova Sofiyivka" park is dominated by regraded chernozem, which is concentrated on the slopes of ravines, while meadow-bog soil dominates in the lower reaches along the riverbed. Regraded chernozem contains 3.7-4% humus, has a high level of absorbed cations, which contain the most calcium – 21.0-28.0 mg-Eq per 100 g of soil. The content of metabolic magnesium is 4.0-4.7 mg-Eq per 100 g of soil. Content of SiO_2 is approximately 80.0%, Fe_2O_3 – 3.1-3.2%, AL_2O_3 – 10.0-11.0%, CaO – 1.9-2.5%, MgO – 0.9-1.5%, P_2O_5 – 11.0-14.1 mg/100 g, K_2O – 8.6-11.8 mg/100 g. The share of total phosphorus is 0.1-0.15%, potassium – 1.9-2.7%, nitrogen – 0.1-0.2%. The degree of base saturation is high – over 90%. According to the pH of the salt extract, the regraded chernozem is neutral – 5.7-6.4%. Meadow-marsh soil contains 3.0-4.1% humus. The sum of exchange cations varies deep into the profile in the range of 14.2-31.9 mg-Eq per 100 g of soil.

The degree of saturation of the soil absorption complex is about 90%. Content of SiO_2 – 62.7-86.2%, Fe_2O_3 – 1.0-2.6%, AL_2O_3 – 3.2-6.5%, CaO – 3.2-10.5%, MgO – 0.4-0.8%, nitrogen – 0.08-0.30%, P_2O_5 – 1.73-2.52 mg/100 g, K_2O – 0.68-0.85 mg/100 g. The acidity of salt extract is 7.0-7.2%. An inventory of the dendroflora of "Nova Sofiyivka" park revealed that 112 taxa of woody plants were used to form plant compositions. The range of woody plants was selected to create a cultural phytocenosis focused on the dominance of mesophytes – plants adapted to fresh forest and meadow habitats (Fig. 2).

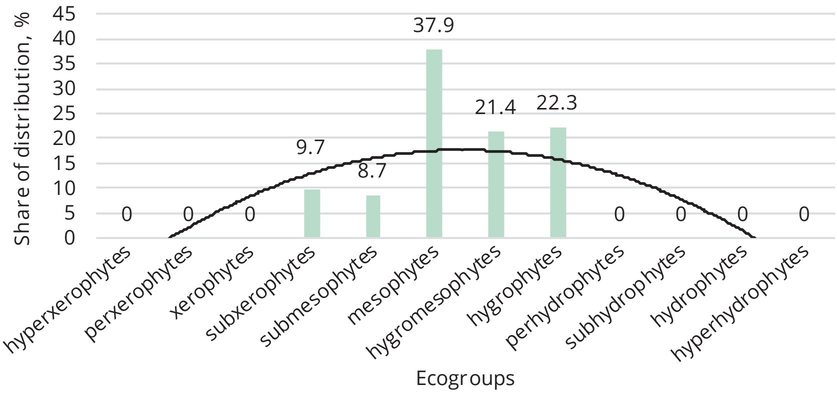

Figure 2. Distribution of dendroflora species in "Nova Sofiyivka" park into eco-groups in relation to the soil moisture regime
Source: compiled by the authors

It was found that the groups of hygromesophytes – plants of moist forest-meadow habitats and hygrophytes adapted to grey-earth forest-meadow ecotopes – occupy almost the same share, differing by less than 1%. Types of subxerophytes characterised by the ability to grow in meadow-steppe conditions with low moisture content and submesophytes – adapted to fairly dry forest-meadow habitats with moderate moisture content of the soil layer, have the smallest share of participation in the coenosis. No other groups were found in the park's dendroflora. The use of dendroflora with such a composition is a rational solution, since the dominance of mesophytes is characteristic of most of the flora of the temperate zone, to which the "Nova Sofiyivka" park geographically belongs. Significant share of hygromesophytes and hygrophytes require waterlogged areas, the requirements of these plant groups are met by taking into consideration the terrain in the selection of planting sites and regular artificial irrigation.

Relation of species to soil moisture conditions has one of the priority values when creating plantings, because an improperly selected range of plants can lead to the collapse of the plantings and disrupt the entire compositional design. The dendroflora of "Nova Sofiyivka" park is dominated by a group of hemihydrocontrastophobes, which are in the central part of the ecological scale (Fig. 3).

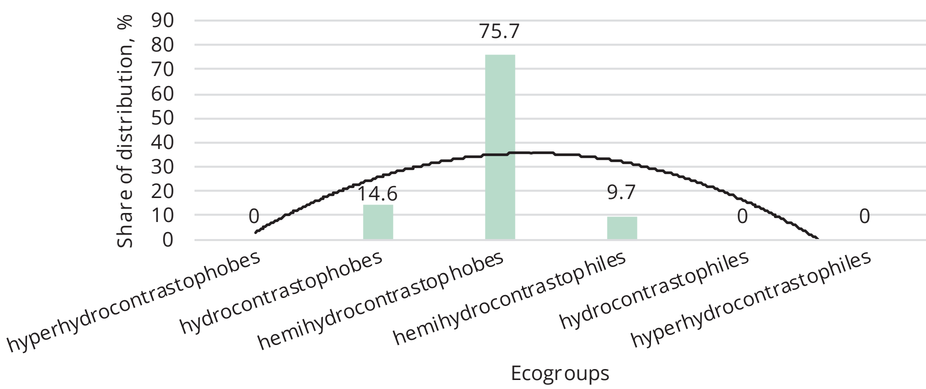

Figure 3. Distribution of dendroflora species in "Nova Sofiyivka" park into eco-groups in relation to changes in humidification conditions
Source: compiled by the authors

Plants of this group need moderate uneven moistening of the root layer of the soil with its complete soaking. The eco-group of hydrocontrastophobes (plants of ecotopes with uniform stable moistening by soil and partially surface waters of the root layer) is significantly inferior in quantity to the previous group. Hemihydrocontrastophiles have the smallest proportion in the composition of dendroflora, they successfully withstand dry forest-meadow and meadow-steppe conditions with uneven moisture of the root-bearing soil layer. Other eco-groups are not represented in the dendroflora.

The fastidiousness of selected woody plants to the stability and intensity of soil moisture is fully satisfied on the territory of the park, especially for hydrocontrastophobes for which low-lying planting sites with surface ground water are selected and an irrigation system is provided. Analysis of the ratio of park dendroflora to soil aeration (Fig. 4) showed the absolute dominance of the group of hemiaerophobes – plants that grow on moderately aerated soils. The location of the polynomial trend indicates the emergence of a range of plants from species that do not require specific wetlands or highly aerated soils. In terms of soil acidity, the park's dendroflora is dominated by neutrophils – species that successfully grow on soils with an acidity of pH = 6.5-7.1 (Fig. 5).

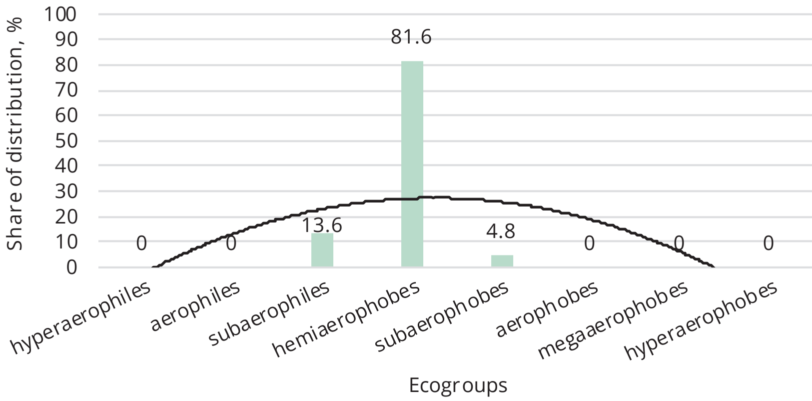

Figure 4. Distribution of dendroflora species in "Nova Sofiyivka" park into eco-groups in relation to soil aeration

Source: compiled by the authors

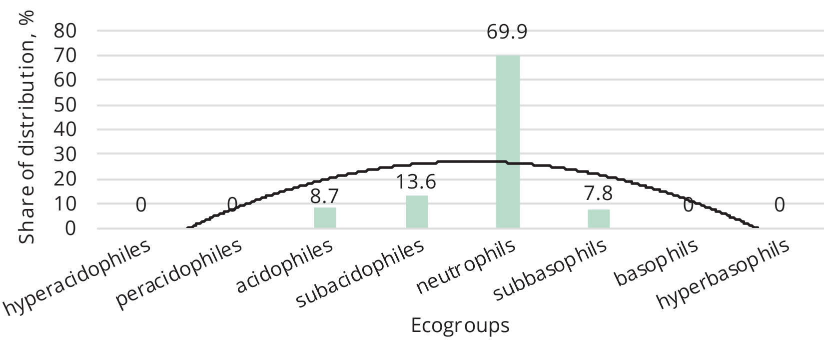

Figure 5. Distribution of dendroflora species in "Nova Sofiyivka" park into eco-groups in relation to soil acidity

Source: compiled by the authors

The predominance of such plants in the selection of the assortment for landscaping facilitates their adaptation to new conditions, as the soils of the region of implementation are neutral. Acidophiles and subacidophiles together occupy a fairly significant share – 22.3%, due to their bioecological characteristics, they require acidic (pH = 4.5-5.5) and slightly acidic (pH = 5.5-6.5) soils. To meet the needs of these plants, the soil was replaced with a peat mixture with the appropriate acidity, which is especially important for growing rhododendrons, hydrangeas, and magnolias. Subbasiphils make up only 7.8%, these species grow best on alkaline soils with pH = 7.2-7.7, but they also withstand neutral conditions quite well and generally do not require replacing the soil mixture and creating special soil conditions. The distribution of species by salt regime revealed absolute dominance of the mesotrophic group in the composition of dendroflora (Fig. 6) that require non-saline sod-podzolic, grey forest and meadow-swamp soils with a washing regime.

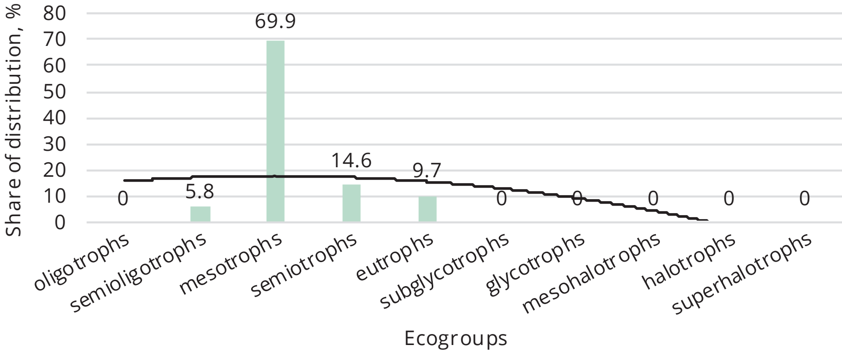

Figure 6. Distribution of dendroflora species in “Nova Sofiyivka” park into ecological groups in relation to the general salt regime of the soil
Source: compiled by the authors

The second place with a share of 14.6% is occupied by a group of semieutrophs growing on dark grey forest soils, podzolic chernozems enriched with salt (150-200 mg/L) with the content of HCO_3^- – 4-16 mg/100 g of soil, and traces of SO_4^- and Cl^- in some types. Such soils are characterised by leaching and podzolisation processes. Groups of eutrophs and semioligotrophs occupy a small share, plants of the first group need soils enriched with salts of upper chernozems, developed sod-podzolic soils with no signs of salinity, the second group can withstand washing poor in salt, strongly leached sod-podzolic and brown forest soils. The deviation of the polynomial trend indicates that there are no species in the range of used plants that require soils with chloride salting, because the soil conditions of the object of greening implementation are not able to meet the requirements of eco-groups of plants placed on the right side of the graph. According to the sensitivity to the content of carbonates in the soil, the park’s dendroflora is divided into 7 eco-groups (Fig. 7).

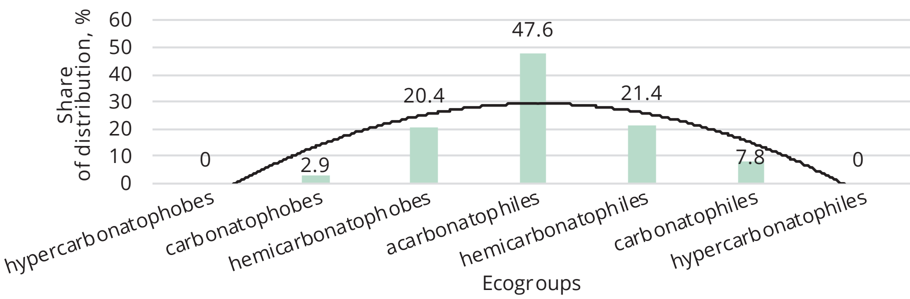

Figure 7. Distribution of dendroflora species in “Nova Sofiyivka” park into ecological groups in relation to the content of carbonates in the soil
Source: compiled by the authors

According to these data, the dominant group of acarbonatophiles requires neutral habitats and is tolerant to a small content of carbonates in the soil (CaO, MgO = 0.5-1.5%), which do not rise to the upper layers due to the washing regime. These are the characteristics of podzolised grey forest soils formed on loessial soils.

The groups hemicarbonatophobes and hemicarbonatophiles differ by 1% and occupy an intermediate position. The first group includes plants that avoid carbonate substrates and grow on podzolic, meadow, and gley soils, while the second group grows on washed – out, sufficiently carbonate-rich chernozems (CaO, MgO = 1.5-5%). The proportion of carbonatophiles (plants that prefer to grow on carbonate soils where CaO, MgO = 5-10%) and carbonatophobes (plants that do not grow on carbonate soils (CaO, MgO = 0.05%), but on soils formed on acidic silicate soils (sands, granites, gneiss, etc.) is not significant and is less than 10%. A slight deviation of the polynomial trend to the right indicates the predominance of carbonatophilic species in the dendroflora, which corresponds to the natural edaphic conditions of the "Nova Sofiyivka" park, which is located on the granite batolite, the main parent rock of most of the territory is a forest rich in calcium carbonates and modern alluvial-deluvial deposits. The content of nitrogen compounds is one of the most important components of soil trophicity, and 3 groups of plants are distinguished in the park's dendroflora by their tolerance to this edaphic factor (Fig. 8).

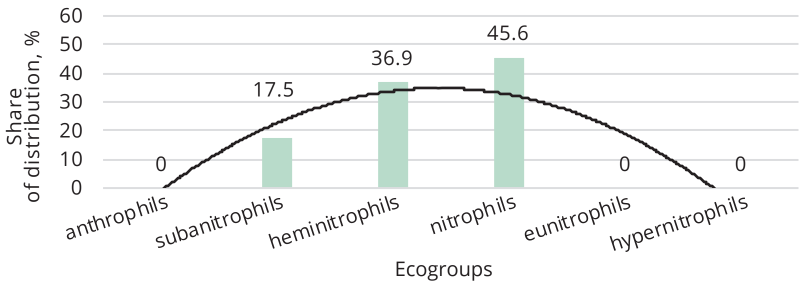

Figure 8. Distribution of dendroflora species in "Nova Sofiyivka" park into ecological groups in relation to the nitrogen content in the soil
Source: compiled by the authors

The leading place belongs to nitrophiles, which need soils sufficiently provided with mineral nitrogen. The second place is occupied by geminitrophils – plants that grow on soils that are moderately provided with mineral nitrogen. The smallest proportion is allocated to subanitrophiles that can withstand oligotrophic soils poor in mineral nitrogen. The detected trend deviation to the left indicates that the range of woody plants can grow successfully in soils with a low content of nitrogen compounds. The detailed analysis of the compliance of the edaphic needs of woody plants with the conditions of the ecotope applied in the study allowed assessing the adequacy of the selection of an assortment of plants for the created landscaping object.

The detailed analysis applied in this paper helped to find out whether the edaphic needs of woody plants correspond to the conditions of the park's ecotope. As indicated by V. Melnyk & N. Denysyuk (2020), to implement the tasks of the modern environmental policy of Ukraine and other legal documents regulating the issues of greening urbanised territories, it is important to conduct research on the taxonomic and ecological structure of dendroflora of parks and squares. The researchers prove that the compliance of growing conditions with the ecological requirements of woody and shrubby plants is the basis for the creation of durable green spaces, so in Rivne, the predominant group in terms of moisture demand is mesophytes, which accounted for 70.0% of all described plants, the percentage of xerophytes, xeromesophytes, and mesohygrophytes varied from 13.0-17.0%, the smallest share was hygrophytes – about 2.0%.

This ratio of ecological groups, according to the researchers, is conditioned by the lack of optimal humidification conditions. Mesophytes are a fairly common ecological group, which is confirmed in the studies by M. Tsybulia (2021) dedicated to the flora of the "Male Polissia" National Nature Park and A. Dzyba (2023), who investigated the ecological classification of dendroflora of parks-monuments of landscape art. The dominance of this group of plants is proved in the descriptions of the flora of the tracts of the Vizhnytskyi National Nature Park by T. Morozova (2024) and the study by A. Lisnichuk & N. Hutsalo (2020) dedicated to the analysis of plant expositions of the Kremenets Botanical Garden. To create the "Nova Sofiyivka" park, preference is given to woody mesophytes adapted to fresh forest habitats with complete moistening of the root layer of the soil by rain and meltwater. The use of mesophytes is a rational solution, because they dominate the flora of the Right-Bank Forest-Steppe of Ukraine (Dayneko, 2020).

During the period of climate change, as noted by T. Hwang *et al*. (2020), it is expected that temperatures will rise and hydrological extremes will increase, despite the fact that warming has some positive effects on plants, contributes to an increase in the duration of the growing season and an increase of CO_2 concentrations in the atmosphere, the increased variability of the hydrological component of the climate will lead to an increase in the duration of dry periods, which can cause mass death of woody plants. For these reasons, the use of drought-resistant plants will allow creating long-lasting decorative park spaces.

The study by O. Ivanchenko & V. Bessonova (2020) emphasised that in the conditions of the central moderately arid agroclimatic region, xerophytes predominate in the humidification regime – 39.0%, mesophytes – 28.5% – are in second place, and hygrophytes – 0.7% – have the smallest share. The expediency of using xeromesophytes is clearly substantiated by T. Boiko *et al.* (2020), who revealed the problems of resistance of woody plants in the conditions of southern Ukraine, and proves the prospects of using this group of plants. The "Nova Sofiyivka" contains two groups of plants resistant to arid conditions – subxerophytes (9.7%) and submesophytes (8.7%), which can later form the basis of park compositions.

Eco-groups of hygrophytes (22.3%) and hygromesophytes (21.4%) have a significant share in the park's dendroflora, but all these plants are located in areas with surface underground water and in conditions of constant artificial irrigation. In general, the park's dendroflora is correctly selected in relation to the soil moisture regime, dominated by the eco-group of mesophytes, which is successfully combined in compositions with subxerophytes and submesophytes. The created plantings are stable in arid conditions, which is quite promising due to the aridisation of the Forest-Steppe (Kalashnikova & Doroshenko, 2020). Soil moisture affects the distribution of woody plants (Davis *et al.*, 2022), is important for drought monitoring and climate modelling (Gallego-Elvira *et al.*, 2019; Li & Sawada, 2022). In terms of tolerance to the variability of soil moisture, the park is dominated by hemihydrocontrastophobes, plants of this ecological group can withstand uneven moisture, which fully corresponds to the weather and climatic conditions of the area of introduction. Most of the park's plants (81.6%) belong to hemiaerophobes, which do not require specific soil air conditions for successful growth and development.

Soil acidity is essential for the absorption of phosphorus, which is an essential element for plant nutrition and affects the growth of vegetative organs. However, M. Wavrek *et al.* (2023) indicate that the availability of this element is limited by pH, it decreases above 7.5 and below 6.5, with the most optimal pH for accumulation considered to be 6.5. The pH values of the park's soils indicate a sufficient proportion of phosphorus for the successful growth and development of cultigenic dendroflora. The level of soil acidity has a significant impact on growth processes, for example O. Didur *et al*. (2023) they prove the existence of a close relationship between pH levels and soil buffering values, that is, the potential of the soil that controls the accumulation and consumption of a certain element of fertility. In terms of soil pH, neutrophils dominate the park – 69.9%, which corresponds to the existing soil acidity. However, acidophiles and subacidophiles have a fairly significant proportion of dendroflora and require completely different soil pH values for successful nutrition and functioning. Non-compliance of acidity indicators with the needs of plants for these groups affects the functioning of the roots, which leads to chlorosis, slowing growth and low viability (Turner *et al.*, 2020). To meet the needs of subacidophilic and acidophilic plants, the soil was replaced with a peat mixture with a pH of 4.5-6.5 before planting.

As noted by Ü. Ateş & D. Demiroğlu (2024), the creation of sustainable green areas is crucial in urban design and is not possible without considering environmental factors and environmental characteristics of the implementation area. The researchers suggest that plants with high environmental tolerance should be used for this purpose. In the study devoted to woody plants in modern and historical parks in Kilis (Turkey), the researchers stressed that almost half (46.8%) of plants in resistant plant communities had a high tolerance to soil salinity. The salt regime directly affects the processes of soil formation and plant adaptation. The basis of the dendroflora of the "Nova Sofiyivka" park was created with the participation of mesotrophs. The selected group of plants prevails in stable dendrocenoses with average soil trophism, which was proved by I. Komarova & E. Yevtushenko (2021), and S. Pototska (2024), so high viability of these woody plants in the park is to be expected. Mineral nitrogen is an integral element of plant nutrition, nitrophils and geminitrophils are the basis of plantings due to the demand for soil nitrogen content in the park, and the edaphic conditions of the park for these groups of plants are adequate and meet their needs. It is important to control the level of nitrogen in the soil, because plant groups in areas with a low nitrogen content are more sensitive to fluctuations in soil moisture than plant groups in areas rich in nitrogen (Shovon *et al.*, 2020).

Due to the fact that "Nova Sofiyivka" park was created on a completely modified site, almost 90% of the territory was subject to complete reconstruction and optimisation, so in the next 10-20 years a number of floral changes should be expected, which are outlined and substantiated in the study by K. Molozhon *et al.* (2023), which indicates that under reconstruction conditions, soil aeration increases, the level of variability in the moisture regime and acidity of edaphotope increases, and the content of carbonates and nitrogen increases. The conditions of the reconstructed object become more suitable for hemihydrocontrastophobes, acarbonatophiles, eunitrophiles, and hemiaerophobes. Based on the analysis of the ecological structure of the dendroflora, it was determined that the edaphic conditions meet the needs of the park's woody plants. Further observations on the adaptation and success of plant growth and development and studies of edaphic indicators that affect the phytoindication assessment will reveal phytocenotic processes in park communities in more detail.

CONCLUSIONS

The ecological structure of the Dendroflora of "Nova Sofiyivka" park was investigated in the context of the edaphic aspect. The flora included 112 taxa of woody plants. In relation to the water regime of the soil, the largest number of taxa belonged to mesophytes, which need complete moistening of the root layer. Plants of this group met the conditions of edaphotope, which simplifies agricultural care techniques. Hygrophytes (22.3%) and hygromesophytes (21.4%) are most vulnerable to moisture deficiency, which led to the selection of low-lying planting sites and additional use of artificial irrigation. Subxerophytes (9.7%) and submesophytes (8.7%) are the most drought-resistant of the existing eco-groups and the most promising in the conditions of climate aridisation. In terms of tolerance to soil moisture variability, hemihydrocontrastophobes dominate (75.7%), which can withstand moderately uneven soil moisture in the park. It was found that hemiaerophobic plants (81.6%), which are fully adapted to the existing moderately aerated soil, are most demanding for soil aeration. The distribution of dendroflora in relation to soil acidity showed a preference for neutrophils (69.9%), which successfully grow on neutral soils of the park. For acid-dependent plants – acidophiles (8.7%) and subacidophiles (13.6%), specific soil conditions have been created (artificial substrate with peat dominance), plants of these groups need constant monitoring of the soil pH level.

The dominance of the mesotrophic group in the dendroflora composition (69.9%) is consistent with the existing soils with average trophic content. The carbonate content in the park's soils fully meets the needs of acarbonatophilic plants (47.6%). Nitrophiles predominate in soil nitrogen (45.6%) – plants are typical for soils sufficiently provided with mineral nitrogen, but a significant proportion of geminitrophiles (36.9%) and subanitrophiles (17.5%) indicates tolerance to soils with a low content of nitrogen compounds, which will positively affect the stability of the plant group. Further study of the viability and mechanisms of plant adaptation to changing conditions of the "Nova Sofiyivka" park's environmental habitat as an object of intensive recreation during the period of climate change will reveal the mechanisms of regulating the balance in the human-plant-soil system. Detailed research is required to investigate changes in the mechanical and biochemical composition of soils depending on the age structure of the dendroflora and the stage of reconstruction of the park.

ACKNOWLEDGEMENTS

The authors of the article express their gratitude to the acting director of the National Dendrological Park "Sofiyivka" of the National Academy of Sciences of Ukraine, PhD in Biologycal Sciences, Senior Researcher Volodymyr Hrabovyi for initiating this study and scientific advice on the practical implementation of the research.

CONFLICT OF INTEREST

None.

REFERENCES

[1] Ateş, Ü., & Demiroğlu, D. (2024). Evaluation of plant use with high ecological tolerance for climate change resistant landscape in Kilis sample parks. *Journal of Architectural Sciences and Applications*, 9(1), 568-584. doi: 10.30785/mbud.1463782.

[2] Boiko, T.O., Boiko, P.M., & Dementieva, O.I. (2020). Ecological and biological analysis of woody plants of the *Fabaceae* Lindl. family of the city of Kherson. *Tauride Scientific Bulletin: Ecology, Ichthyology and Aquaculture*, 114, 241-247. doi: 10.32851/2226-0099.2020.114.29.

[3] Committee on Publication Ethics. (n.d.). Retrieved from https://publicationethics.org/.

[4] Convention on Biological Diversity. (1992, June). Retrieved from https://zakon.rada.gov.ua/laws/show/995_030#Text.

[5] Cubino, J.P., & Retana, J. (2023). Socioeconomics explain tree diversity, abundance, and composition in the compact city of Barcelona, Spain. *Landscape and Urban Planning*, 236, article number 104778, doi: 10.1016/j.landurbplan.2023.104778.

[6] Davis, A.R., Hultine, K.R., Sala, O.E., & Throop, H.L. (2022). Seedling responses to soil moisture amount versus pulse frequency in a successfully encroaching semi-arid shrub. *Oecologia*, 199, 441-451. doi: 10.1007/s00442-022-05193-w.

[7] Dayneko, P.M. (2020). Systematic structure of the ancient settlements' flora in the Lower Dnipro. *Chornomorski Botanical Journal*, 16(3), 230-239. doi: 10.32999/ksu1990-553X/2020-16-3-4.

[8] Didenko, S., & Shynder, O. (2023). Analysis of the structure of flora of artificial phytocoenosis and assessment of its competitiveness against invasion of alien plants and their suitability for the creation introduction populations of rare species of the Caucasian flora. *Agrobiodiversity for Improving Nutrition, Health and Life Quality*, 7(1), 17-26. doi: 10.15414/ainhlq.2023.0003.

[9] Didukh, Ya.P. (2011). *The ecological scales for the species of Ukrainian flora and their use in synphytoindication*. Kyiv: Phytosociocentre.

[10] Didur, O., *et al*. (2023). Environmental quality assessment of soil as a component of green spaces in parks of the megalopolis. *Agrology*, 6(4), 92-96. doi: 10.32819/021115.

[11] Dzyba, A. (2023). Structures of the dendroflora of park-monuments of landscape art in the Ukrainian Polissya. *Agrolife Scientific Journal*, 1(12), 72-80. doi: 10.17930/AGL202319.

[12] Gallego-Elvira, B., Taylor, C.M., Harris, P.P., & Ghent, D. (2019). Evaluation of regional-scale soil moisture-surface flux dynamics in Earth system models basedon satellite observations of land surface temperature. *Geophysical Research Letters*, 46(10), 5480-5488. doi: 10.1029/2019GL082962.

[13] Hwang, T., Band, L.E., Miniat, C.F., Vose, J.M., Knoepp, J.D., Song, C., & Bolstad, P.V. (2020). Climate change may increase the drought stress of mesophytic trees downslope with ongoing forest mesophication under a history of fire suppression. *Frontiers in Forests and Global Change*, 3, article number 17. doi: 10.3389/ffgc.2020.00017.

[14] International standards for editors and authors. (n.d.). Retrieved from http://surl.li/jguiyh.

[15] Ismail, S.A., Pouteau, R., van Kleunen, M., Maurel, N., & Kueffer, C. (2021). Horticultural plant use as a so-far neglected pillar of ex situ conservation. *Conservation Letters*, 14(5), article number e12825, doi: 10.1111/conl.12825.

[16] Ivanchenko, O.E., & Bessonova, V.P. (2020). Species diversity and aesthetic characteristics of the plantings of the settlement park (urban-type settlement Ilarionove). *Issues of Steppe Forestry and Forest Reclamation of Soils*, 49, 26-47. doi: 10.15421/442003.

[17] Kalashnikova, L., & Doroshenko, Yu. (2020). Comprehensive assessment of rare species of Magnoliophyta of the collection of dendrological park "Olexandria". *Ecological Sciences*, 3(30), 176-181. doi: 10.32846/2306-9716/2020.eco.3-30.29.

[18] Komarova, I.O., & Yevtushenko, E.O. (2021). Ecological structure of plant groups of Kryvyi Rih urban industrial complex. *Ecological Herald of Kryvorizhzhya*, 6, 106-118. doi: 10.31812/eco-bulletin-krd.v6i0.4564.

[19] Konarska, J., Tarvainen, L., Bäcklin, O., Räntfors, M., & Uddling, J. (2023). Surface paving more important than species in determining the physiology, growth and cooling effects of urban trees. *Landscape and Urban Planning*, 240, article number 104872. doi: 10.1016/j.landurbplan.2023.104872.

[20] Krivomaz, T., Tyshchenko, O., & Suleymanov, I. (2022). Plants for biophilic design in green building. *Theory and Practice of Design: 20 Landscape Art*, 1(25), 236-248. doi: 10.18372/2415-8151.25.16801.

[21] Li, S., & Sawada, Y. (2022). Soil moisture-vegetation interaction from near-global in-situ soil moisture measurements. *Environmental Research Letters*, 17(11), article number 114028. doi: 10.1088/1748-9326/ac9c1f.

[22] Lisnichuk, A.M., & Hutsalo, N.B. (2020). The structure of botanical displays in Kremenets Botanical Garden. *Scientific Issue Ternopil Volodymyr Hnatiuk National Pedagogical University: Biology*, 3-4(80), 20-26. doi: 10.25128/2078-2357.20.3-4.3.

[23] Marucha, T.V., Arkushyna, H.F., & Kryvokhyzha, Ye.M. (2023). Actual problems of preserving the rare flora of Polissia in connection with military operations. *Ukrainian Journal of Natural Sciences*, 4, 149-159. doi: 10.32782/naturaljournal.4.2023.16.

[24] Melnychuk, N.Ya., & Henyk, Ya.V. (2019). Landscape and ecologicl features of the formation of green spaces of Lviv urban system. *Scientific Herald of Lviv National Forestry University*, 29(9), 9-14. doi: 10.36930/40290901.

[25] Melnyk, V.Y., & Denysyuk, N.V. (2020). Taxonomic and ecological structure of the dendroflora of the parks and squares of the city of Rivne. In K. Urszula, S. Henryk & R.A. Vozhehova (Eds.), *Scientific developments of Ukraine and EU in the area of natural sciences* (pp. 523-540). Rivne: Rivne State University for the Humanities. doi: 10.30525/978-9934-588-73-0/2.7.

[26] Molozhon, K.O., Lisovets, O.I., Kunakh, O.M., & Zhukov, O.V. (2023). The structure of beta-diversity explains why the relevance of phytoindication increases under the influence of park reconstruction. *Regulatory Mechanisms in Biosystems*, 14(4), 634-651. doi: 10.15421/022392.

[27] Morozova, T. (2024). Floristic, taxonomic and ecological-indicator characteristics of the tracts of Vyzhnytsia National Nature Park. *Biota. Human. Technology*, 1, 53-63. doi: 10.58407/bht.1.24.5.

[28] Murphy, T.R., Hanley, M.E., Ellis, J.S., & Lunt, P.H. (2024). Soil saturation limits early oak establishment in upland pastures for restoration of Atlantic oak woodlands. *Forest Ecology and Management*, 561, article number 121895. doi: 10.1016/j.foreco.2024.121895.

[29] Muzychenko, O., Lishchuk S., & Karaim, O. (2020). Ecological structure of the flora of waste heaps of Novovolynsk mining district. *Lesia Ukrainka Eastern European National University Scientific Bulletin: Biological Sciences*, 2(390), 38-44. doi: 10.29038/2617-4723-2020-390-2-38-44.

[30] Oliferchuk, V., Shukel, I., & Kuzyarin, O. (2023). Ecological and biological structure of flora of devasted lands at surfur quarries. *Agroecological Journal*, 1, 65-75. doi: 10.33730/2077-4893.1.2023.276729.

[31] Optasyuk, O.M., & Hrygorchuk, I.D. (2021). Analysis of the structure of the synanthropic fraction of flora of Dunaivtsi (Khmelnytsky Region). *Scientific Issue Ternopil Volodymyr Hnatiuk National Pedagogical University: Biology*, 81(3), 6-13. doi: 10.25128/2078-2357.21.3.1.

[32] Order of the State Committee for Construction, Architecture and Housing Policy of Ukraine No. 226 "On the Approval of the Instructions for the Inventory of Green Spaces in Settlements of Ukraine". (2001, December). Retrieved from https://zakon.rada.gov.ua/laws/main/z0182-02#Text.

[33] Orlóci, L., & Fekete, A. (2023). Ornamental plants and urban gardening. *Plants*, 12(24), article number 4096. doi: 10.3390/plants12244096.
[34] Plants of the World Online. (n.d.). Retrieved from https://powo.science.kew.org/.
[35] Pototska, S.O. (2024). Inventory and assessing ecosystem services of centuries-old trees of the city of Chernihiv using the i-Tree Eco Tool. *Ukrainian Journal of Natural Sciences*, 8, 58-67. doi: 10.32782/naturaljournal.8.2024.6.
[36] Resolution of the National Academy of Sciences of Ukraine No. 2 “On the Ethical Code of a Scientist”. (2009, April). Retrieved from https://zakon.rada.gov.ua/rada/show/v0002550-09#Text.
[37] Rogovskyi, S., Ishchuk, L., Strutynska, Y., Yarmola, M., & Krutsilov, A.I. (2023). Results of the dendroflora inventory and assessment of the plantations of the Tomylivskyi Park, a monument of landscape art. *Agrobiology*, 1, 215-229. doi: 10.33245/2310-9270-2023-179-1-215-229.
[38] Shovon, T.A., Rozendaal, D.M.A., Gagnon, D., Gendron, F., Vetter, M., & Vanderwel, M.C. (2020). Plant communities on nitrogen-rich soil are less sensitive to soil moisture than plant communities on nitrogen-poor soil. *Journal of Ecology*, 108(1), 133-144. doi: 10.1111/1365-2745.13251.
[39] Stakhiv, V., Voloshyn, S., Stakhiv, L., Sokolova, A., & Farafonov, S. (2021). Taxation inventory and dendroflora Zdorovia Park, Zolochiv. *Acta Carpathica*, 1, 62-73. doi: 10.32782/2450-8640.2021.1.8.
[40] Tsybulia, M. (2021). Ecological and coenotic structure of the flora of the National Natural Park “Male Polissya”. *Ecological Sciences*, 7(34), 101-104. doi: 10.32846/2306-9716/2021.eco.7-34.17.
[41] Turner, A.J., Arzola, C.I., & Nunez, G.H. (2020). High pH stress affects root morphology and nutritional status of hydroponically grown *Rhododendron* (*Rhododendron* spp.). *Plants*, 9(8), article number 1019. doi: 10.3390/plants9081019.
[42] Wang, D., Xu, P.-Y., An, B.-W., & Guo, Q.-P. (2024). Urban green infrastructure: Bridging biodiversity conservation and sustainable urban development through adaptive management approach. *Frontiers in Ecology and Evolution*, 12, article number 1440477. doi: 10.3389/fevo.2024.1440477.
[43] Wavrek, M.T., Jean-Philippe, S., & McKinney, M.L. (2023). Ecological and soil data applied to conservation management of an urban forest. *Forests*, 14(3), article number 487. doi: 10.3390/f14030487.
[44] The Word Flora Online. (n.d.). Retrieved from http://www.worldfloraonline.org/classification.

Едафічний аспект в екологічній структурі дендрофлори парку «Нова Софіївка»

Ольга Порохнява

Кандидат біологічних наук, старший науковий співробітник
Національний дендрологічний парк «Софіївка» НАН України
20300, вул. Київська, 12а, м. Умань, Україна
https://orcid.org/0000-0002-9636-9990

Юрій Рум'янков

Кандидат біологічних наук, завідувач лабораторії
Національний дендрологічний парк «Софіївка» НАН України
20300, вул. Київська, 12а, м. Умань, Україна
https://orcid.org/0000-0002-6253-7618

Тетяна Копилова

Кандидат біологічних наук, старший науковий співробітник
Національний дендрологічний парк «Софіївка» НАН України
20300, вул. Київська, 12а, м. Умань, Україна
https://orcid.org/0009-0003-0328-5777

Людмила Вегера

Кандидат біологічних наук, старший науковий співробітник
Національний дендрологічний парк «Софіївка» НАН України
20300, вул. Київська, 12а, м. Умань, Україна
https://orcid.org/0000-0003-2512-2664

Валентина Пономаренко

Кандидат біологічних наук, старший науковий співробітник
Національний дендрологічний парк «Софіївка» НАН України
20300, вул. Київська, 12а, м. Умань, Україна
https://orcid.org/0000-0002-2872-6693

Анотація. Конфлікт між потребами рослин та екологічними характеристиками едафотопу безпосередньо впливає на естетику ландшафту. У зв'язку з чим досліджено відповідність потреб деревних рослин едафічним умовам. Мета дослідження передбачала визначення едафічної складової екологічної структури дендрофлори парку «Нова Софіївка» для прогнозування потенційної життєздатності рослинного угрупування. У роботі застосовано описовий, статистичний та порівняльний методи дослідження. Опис дендрофлори парку виконано згідно інструкції з інвентаризації зелених насаджень у населених пунктах України. Видовий склад визначено за допомогою визначників рослин, актуальність видових назв узгоджено відповідно до сучасної міжнародної класифікації. Екологічний аналіз дендрофлори виконано на основі екологічних шкал, у яких рослини було розділено на 7 екогруп залежно від режиму зволоження ґрунту, мінливості зволоження, аерації, кислотності, загального сольового режиму, вмісту карбонатів та азоту. У дендрофлорі парку за вибагливістю до режиму зволоження ґрунту переважають мезофіти, за мінливістю – гемігідроконтрастофоби, за повітряним режимом – геміаерофоби, за кислотністю – нейтрофіли, за сольовим режимом – мезотрофи, за вмістом карбонатів – акарбонатофіли, за вмістом азоту – нітрофіли. Обстеження виявило раціональне вирішення проблеми забезпечення відповідними умовами ґрунтового зволоження рослин, що належать до екогруп гідроконтрастофобів, гігромезофітів та гігрофітів. Для задоволення потреб екогруп субацидофілів та ацидофілів у низькій кислотності ґрунту перед посадкою рослин було застосовано заміну кореневмісного шару ґрунту на торфосуміш з відповідним pH. Практична цінність отриманих результатів полягає у можливості їх використання фахівцями садово-паркового господарства для оптимізації посадок з врахуванням едафічних умов, що впливають на підвищення стійкості рослин та зменшують інтенсивність догляду за насадженнями, адже рослини для яких підібрані місця посадки з врахуванням їх екологічних потреб більш життєві та довговічні

Ключові слова: видовий склад; едафотоп; екогрупа; ценоз; урбанізоване середовище