

Spontaneous grassland vegetation of the garden and park landscapes of Middle Pobuzhzhia (Central Ukraine)

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Abstract: The spontaneous grassland vegetation of the garden and park landscapes of Middle Pobuzhzhia (Central Ukraine) has been studied for the first time. An inventory of its syntaxonomical diversity has been carried out. The material for the study was 70 relevés (which included 258 species) of grassland vegetation sampled between 2007 and 2017 in 15 parks and gardens (one dendrological park, one botanical garden and 13 monuments of landscape gardening). The relevés were stored in a TURBOVEG database. The data analysis was performed in the JUICE program using a modified TWINSpan algorithm. Diagnostic species were determined using fidelity measure of phi-coefficient. The resulting classification scheme includes four classes, four orders, four alliances, five associations and one community. Phytoindicative evaluation was carried out on environmental factors: soil humidity, acidity, total salt regime, carbonate content in soil, nitrogen content, aeration of soil, light. The ordination of the resulting clusters revealed the leading role of soil humidity and fertility in their differentiation. The clusters were divided into two groups: mesic (Community of *Lamium maculatum* and *Ficaria verna*; *Lolietum perennis* Gams 1927; *Sagino procumbentis*-*Bryetum argentei* Diemont et al. 1940) and dry (*Trifolium medii*-*Agrimoniaetum* Müller 1962; *Salvia pratensis*-*Poetum angustifoliae* Korotchenko & Didukh 1997; *Medicago romanicae*-*Poetum angustifoliae* Tkachenko et al. 1987). The study confirms that spontaneous grassland vegetation of garden and park landscapes is a sensitive indicator of the state of their disturbance and can be used for monitoring purposes.

Keywords: garden; grassland; habitat; Middle Pobuzhzhia; park; Southern Bug River basin; steppe; Ukraine; vegetation.

Nomenclature: Cherepanov (1995) for vascular plants; Mucina et al. (2016) for syntaxa.

Abbreviations: Ae = aeration of soil; Ca = carbonate content in soil; DCA= Detrended Correspondence Analysis; Hd = soil humidity; Lc = light; NAS= National Academy of Science; Nt = nitrogen content; Rc = acidity; Sl = total salt regime.

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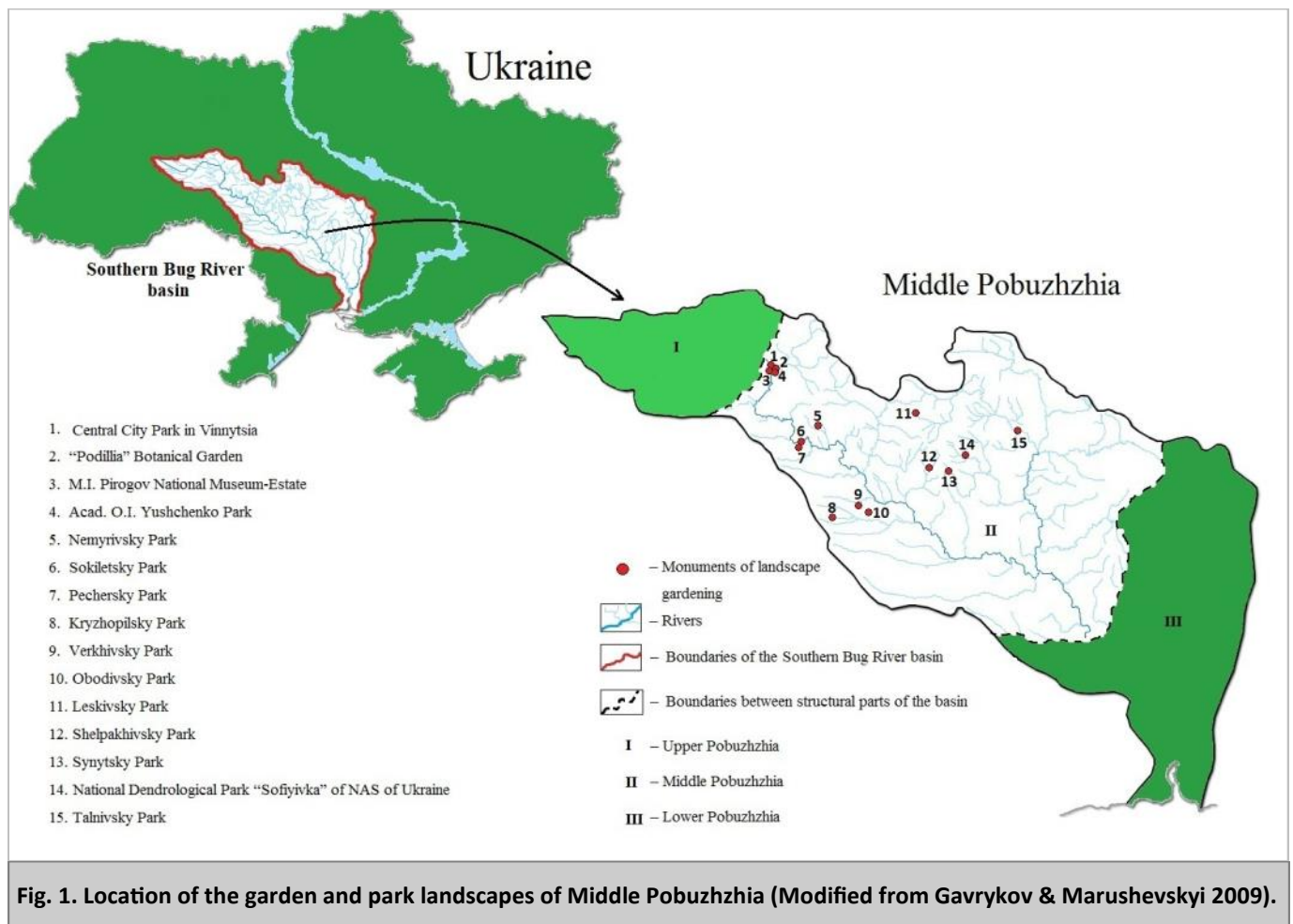
Introduction

Garden and park landscapes are anthropogenic, and combine natural components (rocks and their surface forms, water, soils, vegetation, etc.) with small architectural forms and structures and road infrastructure. They form an interconnected unity in which features of social perception of the world are reflected through the prism of social, economic and political development (Denisik & Kravtsova 2012).

Park and garden landscapes have been the subjects of various scientific works, but as objects of vegetation science they are insufficiently studied. The garden and park land-

scapes of Middle Pobuzhzhia are determined by their location in the basin of the Southern Bug River, with a rich floristic composition and a variety of natural complexes.

The spontaneous vegetation cover of botanical gardens and arboreta is characterized by a high degree of species-richness and diversity, as it is composed of several groups of plants: 1) native species related to the prevailing vegetation types, especially the zonal ones; 2) weed species, diaspores of which are introduced with planting material of ornamental plants; 3) ruderal species, the diaspores of which are introduced by visitors, 4) ergasiophytes ("escapees from cultivation"), and 5) native species planted in the park coenoses with an *ex-situ* conservation purpose, and which have



formed stable populations capable of independent recovery and spontaneous spread (Kuzemko et al. 2011).

Grassland communities (meadows, clearings, lawns), as a part of spontaneous vegetation, are a lifeline for many plants and animals. They can be used to assess environmental quality in urban ecosystems using biological monitoring methods. Therefore, the study of the spontaneous vegetation of parks is an important scientific and conservation issue. The aim of the work is to provide an inventory of syntaxonomical diversity of spontaneous grassland vegetation of garden and park landscapes in Middle Pobuzhzhia and to reveal their syntaxonomic diversity and peculiarities.

Study area

Middle Pobuzhzhia is a historical and geographical region. It includes the central part of the Southern Bug River basin (Central Ukraine) (Fig. 1). The source of the river is in the Podillian Uplands and it flows via the Bug estuary into the Black Sea. The area of its basin is 63,700 km². In general, the climate of the Southern Bug River basin is moderately continental with mild winters and rather warm humid summers. The mean annual temperature is 7.1–8.1 °C. Annual rainfall is 550–669 mm, gradually decreasing from the north to south. From a geological point of view, Middle Pobuzhzhia is located within the Ukrainian Crystalline Shield, which is one of the largest elevated sites of the crystalline foundation of

the Eastern European Platform. The light and dark gray podzolized as well as black soils prevail in the region (Denisik 2002; Vorona et al. 2009).

According to the geobotanical zoning of Ukraine, Middle Pobuzhzhia is situated within the Eurasian Steppe region, which belongs to the Holarctic. It includes the Forest-Steppe subregion, Eastern European Forest-Steppe province, Ukrainian Forest-Steppe subprovince (Didukh & Shelyag-Sosonko 2003).

Garden and park landscapes of Middle Pobuzhzhia include botanical gardens, dendrological parks and monuments of landscape gardening in Vinnytsia and Cherkasy regions of Ukraine. They have more than 200 years of history, rich floristic composition and various natural complexes, of great scientific and artistic interest (Table 1).

Methods

The material for the study was 70 relevés (which included 258 species in total) of grassland vegetation sampled between 2007 and 2017 in parks and gardens of Middle Pobuzhzhia (botanical gardens, dendrological parks and monuments of landscape gardening) in the Vinnytsia and Cherkasy regions of Ukraine: 15 localities in total (Fig. 1, Table 1). The sampled plots were recorded within homogeneous vegetation cover, with total cover of trees and shrubs

Table 1. Main characteristics of the studied gardens and parks.

No	Name	Legal status	Location	Time of establishment	Year of implementation of legal protection	Area [hectares]	Terms of research
1	Central City Park in Vinnytsia (Central Park of Culture and Recreation named after M. Gorky)	monuments of landscape gardening of national importance	Vinnytsia, 49°14'09" N; 28°27'15" E	First half of the 19th century	1987	30.0	July 2016
2	"Podillia" Botanical Garden	monuments of landscape gardening of national importance	Vinnytsia 49°13'04" N; 28°25'13" E	20th century (1963)	1987	72.0	July 2016
3	M.I. Pirogov National Museum-Estate	monuments of landscape gardening of local importance	Vinnytsia 49°12'57" N; 28°24'30" E	20th century (1944)	1995	18.9	July 2016
4	Acad. O.I. Yushchenko Park	monuments of landscape gardening of local importance	Vinnytsia 49°12'53" N; 28°26'26" E	1902	1972	15.0	July 2016
5	Nemyrivsky Park	monuments of landscape gardening of national importance	Nemyriv, 48°58'01" N; 28°50'42" E	18th century (1787)	1960	76.87	June 2015 April 2016
6	Sokiletsky Park	monuments of landscape gardening of local importance	Sokilets village, Nemyriv district 48°51'44" N; 28°43'05" E	17th – 18th centuries	1972	30.4	June 2015
7	Pechersky Park	monuments of landscape gardening of national importance	Pechera village Tulchin district 48°51'41" N; 28°42'38" E	End of the 17th century	1984	19.0	June 2015
8	Kryzhopilsky Park	monuments of landscape gardening of local importance	Kryzhopil urban village, Kryzhopil district, 48°22'48" N; 28°52'36" E	End of the 19th century	2009	29.0	July 2016
9	Verkhivsky Park	monuments of landscape gardening of national importance	Verkhivka village, Trostyanets district 48°26'31" N; 29°08'53" E	End of the 19th century (1891)	1960	25.0	September 2017
10	Obodivsky Park	monuments of landscape gardening of national importance	Obodivka village, Trostyanets district 48°24'14" N; 29°15'31" E	End of the 19th century	1960	17.0	September 2017
11	Leskivsky Park	monuments of landscape gardening of local importance	Leskove village, Monastyrishe district 48°59'37" N; 29°52'47" E	18th century (1772)	1996	89.0	August 2017
12	Shelpakhivsky Park	monuments of landscape gardening of local importance	Shelpakhivka village, Khrystynivka district 48°42'7" N; 29°55'1" E	18th century	2000	20.0	April 2016
13	Synytsky Park	monuments of landscape gardening of local importance	Synytsia village, Khrystynivka district 48°41'51" N; 30°03'41" E	18th century	1972	42.0	April 2016
14	National Dendrological Park "Sofiyivka" of NAS of Ukraine	monuments of landscape gardening of national importance	Uman town, Uman district 48°45'47" N; 30°13'21" E	1796	1983	179.2	2015–2017
15	Talnivsky Park	monuments of landscape gardening of national importance	Talne town, Talne district, 48°51'53" N; 30°41'59" E	End of the 19th century	1960	406.0	April 2016 June 2016

of no more than 30%. The sampling was made according to standard methods of phytosociological studies, with species cover recorded as a percentage. The plot size was 16 m². The relevés were stored in a TURBOVEG database (Hennekens & Schaminee 2001). The data analysis was performed in the JUICE program (Tichý 2002) using a modified TWINSpan algorithm (Roleček et al. 2009) with one pseudo-species cut level at 1% and Sørensen dissimilarity index as a heterogeneity measure. Diagnostic species of the resulting vegetation units were determined using fidelity measure of phi-coefficient (Tichý & Chytrý 2006) using the Fisher's exact test at $p < 0.05$. Species with phi-coefficient values more than 0.4 were considered as highly diagnostic and more than 0.2 as diagnostic. For the syntaxonomic interpretation of the resulting units, Ukrainian sources (Solomakha 2008; Kuzemko 2016), as well as Czech and Slovak sources (Chytrý 2007; Janišová 2007), were used. Phytoindicative evaluation of the units made in the JUICE program used Didukh ecological scales on seven environmental factors: Hd (soil humidity), Rc (acidity), SI (total salt regime), Ca (carbonate content in soil), Nt (nitrogen content), Ae (aeration of soil), Lc (light) (Didukh 2011). To identify distribution of the resulting units in multidimensional spaces of environmental factors, the DCA ordination (Hill & Gauch 1980) in the R-project software (Venables et al. 2011) was conducted.

Results

As a result of the phytosociological analysis, six clusters were identified (Table 2).

Cluster 1 – *Lamium maculatum* + *Ficaria verna* community

Shaded mesic grasslands (lawns and shaded park grassland). They developed on well-moistened areas along rivers or streams, on meadows of small size, often shaded, sometimes with artificial watering. This group does not include newly created lawns, with floristic composition consisting of herbs whose seeds originate from grass mixtures used to establish the lawn. Instead, we include here lawns that are more than five years old, with unmanaged, spontaneous formation of the community (Fig. 2).

Total cover of the vegetation is usually high – 90–100%. The highest constancy was observed for *Geum urbanum*, *Glechoma hederacea*, *Phalacrologa annuum*, *Taraxacum officinale* and dominant species *Arrhenatherum elatius* and *Quercus robur* (juv.). The peculiarity of this community is the significant component of typical forest species and tree seedlings that penetrate into the community from the surrounding tree plantations. Obviously, in the absence of proper management (mowing), such communities would quickly turn into forest. This feature of the unit did not allow attribution to any known associations, since it clearly represents a succession stage.

The community was recorded in National Dendrological Park “Sofiyivka” of NAS of Ukraine, Nemyrivsky Park, Sokiletsky Park, Pechersky Park, Verkhivsky Park, Obodivsky Park, Synytsky Park, Talnivsky Park, Central City Park in Vinnytsia, “Podillia” Botanical Garden, Kryzhopilsky Park.



Fig. 2. *Lamium maculatum* + *Ficaria verna* community (National Dendrological Park “Sofiyivka”). Photo: A. Kovtoniuk.

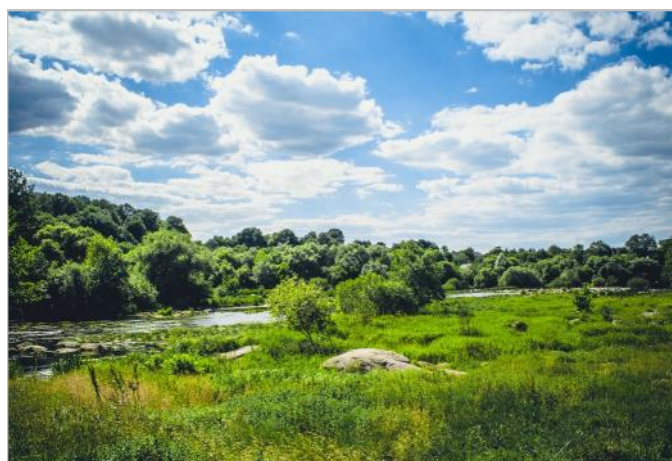


Fig. 3. *Lolietum perennis* Gams 1927 (Sokiletsky Park). Photo: A. Kovtoniuk.



Fig. 4. *Sagino procumbentis*-*Bryetum argentei* Diemont et al. 1940 (Nemyrivsky Park). Photo: A. Kovtoniuk.

Table 2. Synoptic table of the units of spontaneous grassland vegetation of gardens and parks of Middle Pobuzhzhia. The table includes only species with diagnostic value. The numbers in the columns correspond to the values of the phi-coefficient $\times 100$: species with $\phi \times 100 > 40$ (highly diagnostic) are shaded in dark green, and > 20 (diagnostic) are shaded in light-green color.

Cluster number	1	2	3	4	5	6	Cluster number	1	2	3	4	5	6
Number of relevés	12	9	18	9	10	12							
<i>Lamium maculatum</i>	58.9	---	---	---	---	---	<i>Echinops sphaerocephalus</i>	---	---	---	43.9	---	---
<i>Acer campestre</i>	51.9	---	---	---	---	---	<i>Betula pendula</i>	---	---	---	43.9	---	---
<i>Ficaria verna</i>	46.6	---	---	---	---	---	<i>Brachypodium pinnatum</i>	---	---	---	43.9	---	---
<i>Galium aparine</i>	43.5	---	---	---	---	---	<i>Heracleum sibiricum</i>	---	---	---	43.9	---	---
<i>Alliaria petiolata</i>	40.5	---	---	---	---	---	<i>Rumex crispus</i>	---	---	---	43.9	---	---
<i>Lamium purpureum</i>	37.8	---	---	---	---	---	<i>Genista tinctoria</i>	---	---	---	43.9	---	---
<i>Gagea lutea</i>	37.8	---	---	---	---	---	<i>Linaria vulgaris</i>	---	---	---	43.9	---	---
<i>Acer pseudoplatanus</i>	37.8	---	---	---	---	---	<i>Potentilla argentea</i>	---	---	---	37.1	---	---
<i>Stellaria holostea</i>	37.8	---	---	---	---	---	<i>Plantago lanceolata</i>	---	---	---	36.3	---	---
<i>Tilia cordata</i>	37.8	---	---	---	---	---	<i>Veronica arvensis</i>	---	---	---	34.8	---	---
<i>Acer negundo</i>	34.2	---	---	---	---	---	<i>Potentilla obscura</i>	---	---	---	33.4	---	---
<i>Setaria viridis</i>	---	74.4	---	---	---	---	<i>Medicago falcata</i>	---	---	---	31.7	---	---
<i>Portulaca oleracea</i>	---	72.2	---	---	---	---	<i>Phalacrologoma annuum</i>	---	---	---	29.6	---	---
<i>Conyza canadensis</i>	---	71.4	---	---	---	---	<i>Carex praecox</i>	---	---	---	27.9	---	---
<i>Sagina procumbens</i>	---	58.4	---	---	---	---	<i>Securigera varia</i>	---	---	---	---	51.3	---
<i>Veronica hederifolia</i>	---	54.2	---	---	---	---	<i>Potentilla recta</i>	---	---	---	---	50.7	---
<i>Galinsoga parviflora</i>	---	54.2	---	---	---	---	<i>Centaurea jacea</i>	---	---	---	---	47.9	---
<i>Polygonum aviculare</i>	---	50.4	19.2	---	---	---	<i>Pimpinella saxifraga</i>	---	---	---	---	46.2	---
<i>Amaranthus retroflexus</i>	---	45.1	---	---	---	---	<i>Stachys recta</i>	---	---	---	---	43.2	---
<i>Juglans regia</i>	---	43.9	---	---	---	---	<i>Filipendula vulgaris</i>	---	---	---	---	41.5	---
<i>Rorippa sylvestris</i>	---	43.9	---	---	---	---	<i>Euphorbia cyparissias</i>	---	---	---	---	41	---
<i>Rorippa species</i>	---	43.9	---	---	---	---	<i>Veronica prostrata</i>	---	---	---	---	41	---
<i>Echinochloa crusgalli</i>	---	43.9	---	---	---	---	<i>Medicago romanica</i>	---	---	---	---	35.4	---
<i>Amaranthus hybridus</i>	---	43.9	---	---	---	---	<i>Berteroa incana</i>	---	---	---	---	33.8	---
<i>Poa annua</i>	---	40.8	---	---	---	---	<i>Leontodon autumnalis</i>	---	---	---	---	30.9	---
<i>Xanthoxalis stricta</i>	---	35.6	---	---	---	---	<i>Ornithogalum umbellatum</i>	---	---	---	---	---	61.1
<i>Lolium perenne</i>	---	---	67.8	---	---	---	<i>Phlomis tuberosa</i>	---	---	---	---	---	60.1
<i>Arctium lappa</i>	---	---	40.9	---	---	---	<i>Ranunculus polyanthemus</i>	---	---	---	---	---	39.4
<i>Plagiochila major</i>	---	---	38.7	---	---	---	<i>Betonica officinalis</i>	---	---	---	---	---	37.8
<i>Medicago sativa</i>	---	---	37.8	---	---	---	<i>Festuca rupicola</i>	---	---	---	---	---	37.8
<i>Geum urbanum</i>	---	---	35.4	---	---	---	<i>Koeleria cristata</i>	---	---	---	---	---	37.8
<i>Duchesnea indica</i>	---	---	28	---	---	---	<i>Galium verum</i>	---	---	---	---	---	32.6
<i>Trifolium repens</i>	---	---	27.9	---	---	---	<i>Knautia arvensis</i>	---	---	---	---	---	32
<i>Artemisia obscura</i>	---	---	25.6	---	---	---	<i>Viola odorata</i>	34.5	---	40.8	---	---	---
<i>Ranunculus repens</i>	---	---	25.6	---	---	---	<i>Plantago major</i>	---	39.1	33.5	---	---	---
<i>Achillea setacea</i>	---	---	25.6	---	---	---	<i>Agrimonia eupatoria</i>	---	---	---	45.8	28.4	---
<i>Bromus mollis</i>	---	---	25.3	---	---	---	<i>Elytrigia repens</i>	---	---	18.2	33.3	35.3	---
<i>Trifolium pratense</i>	---	---	21.9	---	---	---	<i>Poa angustifolia</i>	---	---	---	32.4	---	64.2
<i>Taraxacum officinale</i>	---	---	21.6	---	---	---	<i>Achillea millefolium</i>	---	---	---	26.2	36.4	---
<i>Daucus carota</i>	---	---	---	65.1	---	---	<i>Festuca valesiaca</i>	---	---	---	---	48.3	34.4
<i>Lotus corniculatus</i>	---	---	---	47.2	---	---	<i>Salvia pratensis</i>	---	---	---	---	38.2	59.2
<i>Cichorium intybus</i>	---	---	---	45.1	---	---	<i>Centaurea scabiosa</i>	---	---	---	---	36.2	36.2
							<i>Plantago media</i>	---	---	---	---	32	44.4

Cluster 2 – *Lolietum perennis* Gams 1927

Open mesic grasslands (lawns and meadows). They are developed mainly in the floodplains of rivers and streams, in places receiving limited recreational use. They are almost indistinguishable from semi-natural grasslands (especially pastures) in their floristic composition (Fig. 3).

Total cover of community plots was usually high – 90-100%, but significantly lower with increasing anthropogenic pressure. The highest constancies were observed for *Achillea millefolium*, *Capsella bursa-pastoris*, *Convolvulus arvensis*, *Dactylis glomerata*, *Elytrigia repens*, *Polygonum aviculare* and dominant species *Lolium perenne* and *Poa pratensis*.

The considerable presence, in the floristic composition, of species resistant to trampling is noteworthy. Given their aesthetic attractiveness and proximity to rivers and other reservoirs, they are most often used in parks as picnic areas, but heavy use of these areas significantly affects their habitat condition, sometimes leading to complete degradation.

The community was revealed in National Dendrological Park “Sofiyivka”, Nemyrivsky Park, Sokiletsky Park, Pechersky Park, Talnivsky Park, Central City Park in Vinnytsia, “Podillia” Botanical Garden, M.I. Pirogov National Museum-Estate, Acad. O.I. Yushchenko Park.

Cluster 3 – *Sagino procumbentis-Bryetum argentei* Die-mont et al. 1940

This unit includes mesic and dry grassland communities that are developed under constant trampling along trails, around the most attractive architectural elements (gazebos, statues, fountains etc.) and in picnic sites. They can even develop in the cracks between pavement slabs (Fig. 4), being the final stage of anthropogenic transformation of mesic grasslands under the influence of trampling. This unit would be better attributed to synanthropic vegetation than to grasslands, but including it helps to illustrate the complete pattern of grassland vegetation of the gardens and parks, including the final stage of recreation process.

Total cover of communities usually high – 90–95%. The highest constancy is observed for *Convolvulus arvensis*, *Lolium perenne*, *Medicago lupulina*, *Taraxacum officinale*, *Trifolium repens* and the dominant species *Poa annua*.

The community was revealed in National Dendrological Park “Sofiyivka”, Nemyrivsky Park, Sokiletsky Park, Pechersky Park, Talnivsky Park, Verkhivsky Park, Obodivsky Park, Leskivsky Park, Shelpakhivsky Park, Synytsky Park.

Cluster 4 – *Trifolio medii-Agrimonetum* Müller 1962

This community develops along thermophilous fringes or small clearings. In floristic composition, it is quite similar to natural fringes, but is characterized by a significant proportion of synanthropic species, due to the recreational influence (Fig. 5).

The highest constancies were observed for *Arrhenatherum elatius*, *Convolvulus arvensis*, *Dactylis glomerata*, *Festuca*



Fig. 5. *Trifolio medii-Agrimonetum* Müller 1962 (“Podillia” Botanical Garden). Photo: A. Kovtoniuk.



Fig. 6. *Salvio pratensis-Poetum angustifoliae* Korotchenko & Didukh 1997 (Nemyrivsky Park). Photo: A. Kovtoniuk.

valesiaca, *Medicago lupulina*, *Plantago media*, *Taraxacum officinale*, *Trifolium pratense*, *Trifolium repens* and *Viola hirta*. Dominant species in the vegetation plots were *Arrhenatherum elatius*, *Festuca valesiaca* and *Poa angustifolia*.

Total cover of communities usually – 60–75%. The community was observed in National Dendrological Park “Sofiyivka”, Central City Park in Vinnytsia, “Podillia” Botanical Garden, M.I. Pirogov National Museum-Estate, Acad. O.I. Yushchenko Park, Kryzhopilsky Park, Talnivsky Park.

Cluster 5 – *Salvio pratensis-Poetum angustifoliae* Korotchenko & Didukh 1997

This grassland community was usually found in open, unshaded areas and is the remnant of natural meadow-steppe vegetation that probably existed here before the park or garden was created. In most sites it develops on northern slopes or the bottom parts of slopes of different aspects. It probably experiences little recreational load (Fig. 6).



Fig. 7. *Medicago romanicae*-*Poetum angustifoliae* Tkachenko et al. 1987 (National Dendrological Park “Sofiyivka”). Photo: A. Kovtoniuk.

Total cover of the community is usually high – 75–90%. The highest constancies were observed for *Lotus corniculatus*, *Taraxacum officinale*, and dominant species are *Carex praecox*, *Elytrigia repens*, *Festuca valesiaca* and *Taraxacum officinale*.

Usually, the differences between this community and natural meadow steppes are fine and manifests in a larger proportion of synanthropic species. In the absence of proper care (mowing), degradation is observed due to an excessive accumulation of litter and the appearance of seedlings of trees and shrubs. However, with excessive mowing – more than twice during the growing season – their floristic composition is significantly impoverished.

The communities of this association were observed in National Dendrological Park “Sofiyivka”, Nemyrivsky Park, Talnivsky Park and “Podillia” Botanical Garden.

Cluster 6 – *Medicago romanicae*-*Poetum angustifoliae* Tkachenko et al. 1987

This association develops in open, dry areas mainly on watersheds, southern exposures and the upper sections of slopes of various aspects (Fig. 7). In common with the previ-

ous unit, it is almost indistinguishable from natural meadow -steppe, and include a number of geophytes – *Ornithogalum umbellatum*, *Gagea lutea*, *Muscari botryoides*, *Leopoldia comosa* – as well as some rare species, including some listed in the Red Data Book of Ukraine (Didukh 2009). We found *Pulsatilla pratensis* in *Medicago romanicae*-*Poetum angustifoliae* in Sokilets Park. Formerly, *Pulsatilla pratensis* and *Stipa pennata* were also found in National Dendrological Park “Sofiyivka” (Tseshkovskiy 1927; Horyacheva 1960), but have now probably disappeared, having not been confirmed during last 50 years.

Total cover in the association plots was typically high, ranging from 80 to 95%. The highest constancies were observed for *Achillea millefolium*, *Agrimonia eupatoria*, *Arrhenatherum elatius*, *Centaurea jacea*, *Convolvulus arvensis*, *Medicago falcata*, *Taraxacum officinale* and *Veronica chamaedrys*. The principal dominant species were *Dactylis glomerata*, *Festuca valesiaca*, *Poa angustifolia* and *Salvia pratensis*.

The community was recorded in National Dendrological Park “Sofiyivka”, Nemyrivsky Park, Talnivsky Park, Verkhivsky Park, Obodivsky Park, Leskivsky Park, Shelpakhivsky Park, Synytsky Park.

The syntaxonomy of the studied vegetation includes four classes of grassland vegetation:

***Molinio-Arrhenatheretea* Tx. 1937**

Arrhenatheretalia elatioris Tx. 1931

Cynosurion cristati Tx. 1947

Comm. *Lamium maculatum* + *Ficaria verna*

Lolietum perennis Gams 1927

***Polygono arenastri-Poetea annuae* Rivas-Mart. 1975**

Polygono arenastri-Poetalia annuae Tx. in Gehu et al.

1972 corr. Rivas-Mart. et al. 1991

Saginion procumbentis Tüxen & Ohba in Géhu et al. 1972

Sagino procumbentis-Bryetum argentei Diemont et al. 1940

***Trifolio-Geranietea sanguinei* T. Müller 1962**

Origanetalia vulgaris T. Müller 1962

Trifolion medii Müller 1962

Trifolio medii-Agrimonetum Müller 1962

***Festuco-Brometea* Br.-Bl. & Tx. ex Soo 1947**

Brachypodietalia pinnati Korneck 1974

Cirsio-Brachypodion pinnati Hadač & Klika in Klika & Hadač 1944

Salvio pratensis-Poetum angustifoliae Korotchenko & Didukh 1997

Medicago romanicae-Poetum angustifoliae Tkachenko et al. 1987

The environmental features of the resulting clusters are well illustrated by the results of the DCA ordination using ecological scales of Didukh (2011). The clusters are divided into two groups: dry grasslands and mesic grasslands (Fig. 8).

The mesic grasslands group includes clusters 1–3. Cluster 1 is characterized by a wide range of environmental factors. It is located in the direction of higher soil fertility. Cluster 2 is shifted towards humidity. Cluster 3 occupies an intermediate position, although the communities of this cluster were also the most transformed.

Clusters 4, 5, 6 are displaced on the side of reduced humidity, giving reason to include them in the dry grasslands group. The narrower environmental amplitude of these three units is noteworthy, compared to the mesic group, and indicates a higher level of stability in their environmental conditions, as well as less adaptation to changes in the leading factors.

Discussion

The spontaneous grassland vegetation of gardens and parks has, until recently, been largely beyond the attention of phytosociologists. Moreover, it has mostly been neglected by experts in plant breeding, gardening and landscape architecture. Most often, these parks were investigated only in terms of their potential as attractive grounds for recreational use. The focus of such studies were open-air equipment for playgrounds and street architecture, maintenance of flower beds or lawns and the aesthetic values of the garden.

This research into the vegetation has shown that these plant communities also need attention as an integral part of park landscapes, particularly in English-style landscape parks. Phytosociological analysis of grassland communities of the gardens and parks of Middle Pobuzhzhia has shown that, despite the constant recreational impact in artificially created areas, most of them are very close to semi-natural meadows and can easily be interpreted as phytosociological units. However, compared to natural grassland communities, they usually contain more synanthropic species, as a result of the intensive recreational use of many of the parks studied. Typically, a large component of tree and shrub seedlings, originating from the surrounding tree plantations, is found in the communities, as compared to natural grasslands. That is why, in the absence of proper care, these communities can quickly turn into coppices or forest. The study confirms the hypothesis that spontaneous grassland vegetation of gardens and parks is a sensitive indicator of their state and disturbance level and can be used for monitoring purposes. For the retention of grasslands in landscape gardens, there is a requirement for appropriate care, in particular mowing. In the absence of management, even under constant recreational influence/usage, there is typically a rapid accumulation of litter, which significantly reduces the aesthetic appeal of grassland landscapes, and subsequently, rapid encroachment of trees and shrubs.

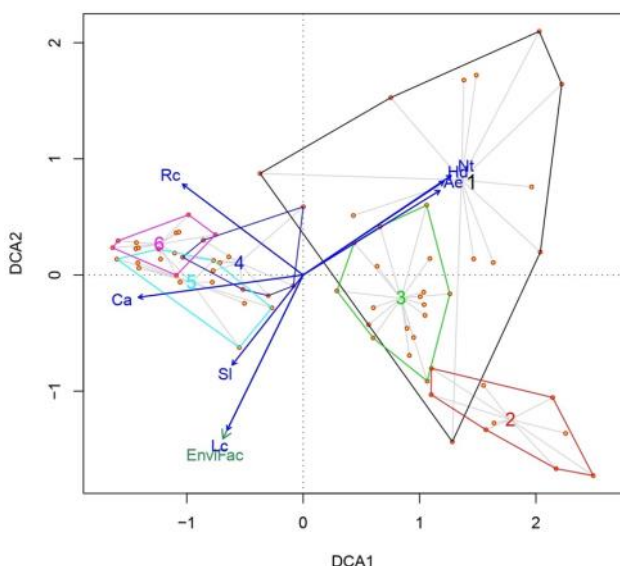


Fig. 8. Results of the DCA-ordination of the clusters. Numbers of the units correspond to the numbers in the classification scheme. Environmental vectors correspond to the ecological values of Didukh (2011) – Hd (soil humidity), Rc (acidity), SI (total salt regime), Ca (carbonate content in soil), Nt (nitrogen content), Ae (aeration of soil), Lc (light).

References

- Cherepanov, S.K. 1995. Sosudistye rasteniya Rossii i sopredelnykh gosudarstv [Vascular plants of Russia and adjacent states]. "Mir i Semia", St.-Petersburg, RU. [In Russian]
- Chytrý, M. 2007. Project vegetation of the Czech Republic: Preface and summary of methods. In: Chytrý, M. (ed.) *Vegetation of the Czech Republic 1. Grassland and heathland vegetation*, pp. 35–52. Academia, Prague, CZ.
- Denisik, G.I. 2002. *Serednie Pobuzhzhia* [Middle Pobuzhzhia]. Hipanis, Vinnytsia, UA. [In Ukrainian]
- Denisik, G.I. & Kravtsova, I.V. 2012. *Sadovo – parkovi landshafty Pravoberezhnoho lisostepu Ukrayiny* [Gardens landscape Right-Bank Ukraine Forest-steppe]. Edelweis & K., Vinnytsia – Uman, UA. [In Ukrainian]
- Didukh, Y.P. (ed.). 2009. *Chervona knyha Ukrayiny. Tsarstvo roslyny* [Red Data Book of Ukraine. Plant kingdom]. Globalkonsalting, Kyiv, UA. [In Ukrainian]
- Didukh, Y.P. 2011. *The ecological scales for the species of Ukrainian flora and their use in synphytoindication*. Phytosociocentre, Kyiv, UA.
- Didukh, Y.P. & Shelyag-Sosonko, Y.R. 2003. Geobotanichne rayonuvannya Ukrayiny ta sumizhnykh terytoriy [Geobotanical zoning of Ukraine and adjusting territories]. *Ukrainian Botanical Journal* 60, 1: 6–17. [In Ukrainian]
- Gavrykov, Y.S. & Marushevskiy, G.B. (eds.) 2009. *Ekologichnyi atlas baseinu richky Pivdennyi Bug* [Ecological atlas of the Pivdennyi Bug River basin]. Wetlands International, Vinnytsia, UA. [In Ukrainian]
- Hennekens, S.M. & Schaminée, J.H.J. 2001. TURBOVEG, a comprehensive database management system for vegetation data. *Journal of Vegetation Science* 12: 589–591.
- Hill, M.O. & Gauch, H.G. 1980. Detrended correspondence analysis: an improved ordination technique. *Vegetatio* 42: 47–58.
- Horyacheva, V.S. 1960. O dikoj travjanistoj flore parka – zapovednika "Sofievka" [About the wild grassy flora of Sofiyivka Nature Reserve]. *Sbornik nauchnykh trudov Umanskogo sel'skokhozyaystvennogo universiteta*: 375–383. [In Russian]
- Janišová, M. (ed.) 2007. *Travinnobylinná vegetácia Slovenska – elektronický expertný systém na identifikáciu syntaxónov* [Grassland Vegetation of Slovak Republic – electronic expert system for identification of syntaxa]. Botanický ústav SAV, Bratislava, SK.
- Kuzemko, A. 2016. Classification of the class *Molinio-Arrhenatheretea* in the forest and forest-steppe zones of Ukraine. *Phytocoenologia* 46: 241–256.
- Kuzemko, A.A., Sydoruk, T.M., Didenko, I.P., Shvets T.A. & Bojko, I.V. 2011. Spontanna flora Nacional'nogo dendrologichnogo parku "Sofiyivka" NAN Ukrayiny [Spontaneous flora of the National Dendrological Park "Sofiyivka" of NAS of Ukraine]. *Avtohtonni ta introdukovani roslyny* 7: 25–36. [In Ukrainian]
- Mucina, L., Bültmann, H., Dierßen, K., Theurillat, J.-P., Dengler, J., Čarni, A., Šumberová, K., Raus, T., Di Pietro, R., (...) & Tichý, L. 2016. Vegetation of Europe: Hierarchical floristic classification system of plant, lichen, and algal communities. *Applied Vegetation Science* 19, Suppl. 1: 3–264.
- Roleček, J., Tichý, L., Zelený, D. & Chytrý, M. 2009. Modified TWINSPAN classification in which the hierarchy respects cluster heterogeneity. *Journal of Vegetation Science* 20: 596–602.
- Solomakha, V.A. 2008. *Syntaksonomiya roslynnosti Ukrayiny. Tretye nablyzhennya* [The syntaxonomy of vegetation of the Ukraine. The third approximation]. Phytosociocentre, Kyiv, UA. [In Ukrainian]
- Tichý, L. 2002. JUICE, software for vegetation classification. *Journal of Vegetation Science* 13: 451–453.
- Tichý, L. & Chytrý, M. 2006. Statistical determination of diagnostic species for site groups of unequal size. *Journal of Vegetation Science* 17: 809–818.
- Tseshkovskiy, V.O. 1927. *Roslynnist' Umanshchyny* [Vegetation of the Uman Region]. Krayeznavchyy zbirnyk "Humanshchyna", OKRINO, Human, UA. [In Ukrainian]
- Venables, W.N., Smith, D.M. & the R Development Core Team 2011. *An Introduction to R. Notes on R: A Programming Environment for Data Analysis and Graphics Version 2.13.2*. <https://www.r-project.org/>
- Vorona, E.I., Kyrlyach, O.V., Maksymenyuk, O.D., Marushevskiy, G.B., Yavorskiy, D.M. & Yavorska, O.G. 2009. *Baseyn richky Bog* [The Bog River Basin]. Wetlands International Black Sea Programme, Vinnytsia – Kyiv, UA. [In Ukrainian]