CHAPTER 21

THE DIVERSITY OF NATURAL OAK FOREST PHYTOCENOSES IN TYPICAL STEPPE RAVINES OF THE DNIPROPETROVSK REGION

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INTRODUCTION

In Ukrainian steppe zone, natural forests cover only small areas and are found primarily in ravines, gullies, and river valleys, where the topography creates a more favorable water regime and mitigates the effects of the arid climate. It is precisely the ravine (gully) forests that serve as the main centers of natural woody vegetation in the steppe and play an important role in maintaining the ecological balance of the landscapes. They perform soil conservation, water regulation, climate regulation, and erosion control functions, and also help preserve the gene pool of many plant and animal species[1, 2, 3].

Thanks to the diversity of ecological conditions created by the complex topography, slope aspect, and variations in moisture levels and soil cover[4], ravine forests are characterized by high floristic richness[5]. Their composition includes a mix of non-steppe, steppe, and meadow species, as well as rare plants with varying conservation statuses[6, 7]. In this regard, beam forests are

[1] Бельгард О. Л. Лісова рослинність південного сходу України. Київський державний університет ім. Т. Г. Шевченка. Київ : Вид-во КДУ ім. Т. Г. Шевченка, 1950. 263 с.

[2] Божко К. М. Еколого-біологічна характеристика північного варіанта байрачних лісів південно-східної України. *Вісник Дніпропетровського університету. Серія : Біологія. Екологія*. 2007. Вип. 15, Т. 1. С. 3–8.

[3] Yakovlieva-Nosar S., Bessonova V. State of coenopopulations of *Qurcus robur* L. growing in ravines located in the Dnieper river's rapids section (recreation zone of the city of Zaporizhzhya), Ukraine. *Forestry ideas*. 2021. Vol. 27, № 1 (61). P. 256–270.

[4] Bessonova V., Yakovlieva-Nosar S. Comparison of transpiration activity of *Quercus robur* L. and *Acer campestre* L. trees under different conditions of moisture supply in the Viiskova ravine. *Ukrainian Journal of Forest and Wood Science*. 2024. 15(3). P. 148–164.

[5] Яковлєва-Носарь С. О. Видове різноманіття дендрофлори байрачних лісів (зона рекреації міста Запоріжжя). *Науковий вісник НЛТУ України*. 2022, т. 32, № 5. С. 13–18.

[6] Яковлєва-Носарь С. О. Рідкісні види трав'янистих рослин степових ділянок балки Генералка (острів Хортиця). *Рослини та урбанізація* : матеріали XIII міжнародної науково-практичної конференції (Дніпро, 1 лютого 2024 р.). Дніпро, 2025. С. 93–95.

[7] Яковлєва-Носарь С. О. Рідкісні види трав'яних рослин степових схилів балки Широка (острів Хортиця). *Рослини та урбанізація* : матеріали XIV міжнародної науково-практичної конференції (Дніпро, 3 лютого 2025 р.). Дніпро, 2025. С. 156–157.

considered important centers of biodiversity in the steppe zone and natural refuges for forest flora[8].

Amid the significant transformation of steppe ecosystems due to human activities, the role of ravine forests is growing substantially. Not only do they serve as centers for the conservation of natural vegetation, but they also support the ecological stability of landscapes while performing important ecosystem functions[5].

That is why studying the floristic composition, the structure of plant communities, and the current state of ravine forests is a pressing task, and the results of such studies are crucial for developing measures for their protection, sustainable use, and conservation.

In light of the above, the objective of this study is to analyze the structure of oak communities growing under various forest conditions across five forest tracts in the Dnipropetrovsk region.

The subject of this study is the silvicultural-assessment and botanical-phytocenotic characterization of naturally occurring oak associations in the surveyed forest tracts.

1. Research objects and methods

The study focused on natural oak phytocenoses in five ravine forests – the tracts "Zhucha Balka", "Domashnia Balka" and "Rezynova Balka" (Fig. 1), located on the right bank of the Dnipro river, and the "Yatsevo" and "Dibrova" tracts, located on its left bank (Fig. 2). They belong to the ravine forests of the southern variant of the Northern Steppe and constitute the forest-park sections of the green belt forests of the city of Dnipro. The coordinates of the surveyed areas are given in Table 1.

The "Zhucha Balka" forest tract belongs to the Mykilske Forestry of the Dnipro Forest Enterprise and is located in the Solonyanskyi District of Dnipropetrovsk Oblast (Fig. 1, 1). It borders the village of Mykilsk-na-Dnipri to the south. It is part of the "Dnipro Rapids" Regional Landscape Park. In this forest tract, trial areas (TA) were established in compartment 13: TA1 – stand 1, TA2 – stand 2 (on the border with stand 1), TA3 – stand 19.

The "Domashnia Balka" tract is also located within the territory of the Mykilske Forestry (Fig. 1, 2) on the border with the lands of the Viyskova Village Council in the Solonyanskyi District. To the north, the ravine borders the village of Mykilske-on-the-Dnieper. The tract is part of the "Dnieper Rapids" Regional Landscape Park. The ravine opens into the Dnieper River valley

[8] Біотопи степової зони України / Ред. академік НАН України Я. П. Дідух. Київ – Чернівці : ДрукАРТ, 2020. 392 с.

opposite the former famous Nenasytetsky Rapids. Within this forest tract, trial areas were located in compartment 15: TA1 – stand 2; and compartment 16: TA2 – stand 3.

Table 1

Coordinates of the studied ravines

No.	Name of the forest tract	Coordinates	
		ravine tops	mouth of the ravine
Mykilske Forestry (Right Bank)			
1.	"Zhucha Balka"	48°12'30.2"N 35°08'48.9"E	48°12'47.5"N 35°10'55.6"E
2.	"Domashnia Balka"	48°12'11.2"N 35°07'58.5"E	48°11'13.4"N 35°10'28.0"E
3.	"Rezynova Balka"	48°07'46.5"N 35°00'48.6"E	48°06'51.9"N 35°02'05.6"E
Liubymivske Forestry (Left Bank)			
4.	"Yatsevo"	48°20'18.1"N 35°13'39.5"E	48°19'44.3"N 35°10'17.1"E
5.	"Dibrova"	48°18'41.0"N 35°13'22.0"E	48°18'00.7"N 35°10'44.8"E

The "Rezynova Balka" tract is located on the border between the Dnipropetrovsk and Zaporizhzhia regions; specifically, the northern main part, including the side valleys, lies within the Dnipropetrovsk region, while the administrative boundary between the two regions runs along the thalweg of the southern main part (Fig. 1, 3). This part of it is also called "Balka Kantserka". The tract belongs to the Mykilske Forestry. Trial areas were established in the northern main section, which is 2.25 km long. They were located as follows: in compartment 40: stand 2 (TA1) (the large right-hand ravine); in compartment 41: stand 1 (TA2) – the large middle ravine, stand 4 (TA3); and in compartment 42: stand 3 (TA4).

The "Yatsevo" tract is a forest reserve of national significance covering an area of 175 ha[9]. It is part of the Liubymivske Forestry, located on the left bank of the Dnipro River (Fig. 2, 1). In this ravine, trial areas were established within compartment 18: stand 3 (TA1), stand 6 (TA2); and compartment 19: stand 2 (TA3).

The "Dibrova" tract is also located within the territory administered by the Liubymivske Forestry, south of the "Yatsevo" tract (Fig. 2, 2). One trial area was surveyed; it was established in the central part of compartment 22, in stand 11.

Each of the established trial areas covered an area of 900 m^2.

[9] Манюк В. В., Манюк В. В. Природно-заповідний фонд Дніпропетровщини. Дніпро, 2010. 116 с.

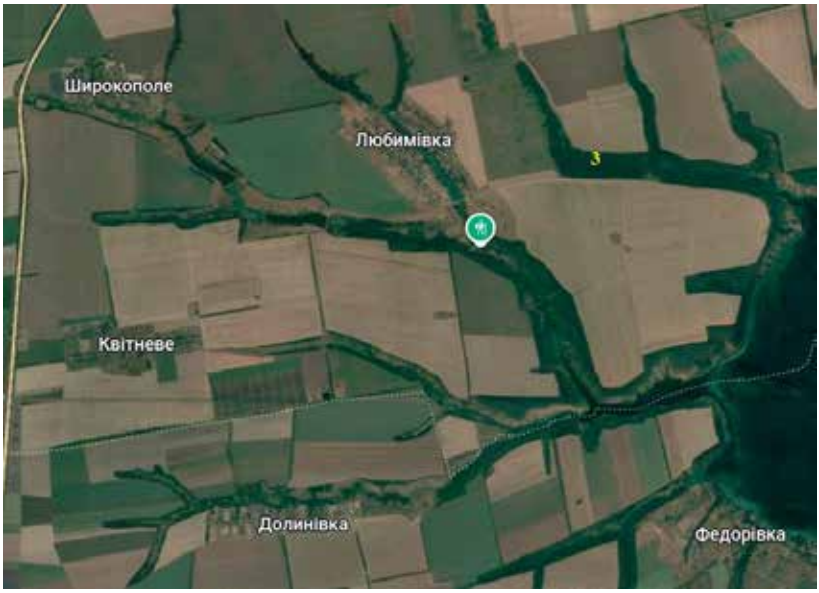


Fig. 1. Location of the studied right-bank tracts: 1 – "Zhucha Balka", 2 – "Domashnia Balka", 3 – "Rezynova Balka"

Fig. 2. Location of the surveyed left-bank tracts:
1 – "Yatsevo", 2 – "Dibrova"

Tree height was determined using a Suunto PM–5/1520 optical altimeter. The stem diameter was measured at a height of 1.3 m using a Codimex S-1 tree caliper.

The mean tree height was calculated using the following formula:

$$h_m = h_i \cdot G_i / \Sigma G, \text{ m}, \quad (1)$$

where h_m is the mean tree height, m; h_i is the mean height of the *i*-th diameter class, m; G_i is the sum of cross-sectional areas of trees in the *i*-th diameter class, cm^2; and G is the total sum of cross-sectional areas of all trees, cm^2.

The average cross-sectional area of the tree stand, g_m, was calculated using the following formula:

$$g_m = G/N, \text{ cm}^2, \quad (2)$$

where g_m is the mean basal area of the stand, cm^2; G is the total basal area of the stand, cm^2; and N is the number of trees.

The mean stand diameter (d_m) was determined from the mean stem cross-sectional area using the following formula:

$$d_m=2\ g_m\sqrt{\pi},\ \text{cm}. \quad (3)$$

The primary quantitative characteristic of a forest stand is its growing stock volume (M, m^3/ha). The growing stock volume of a forest stand is equal to the sum of the volumes of all trees comprising the stand.

The stem volume of an individual tree was calculated using the following formula:

$$V=ghf,\ \text{m}^3, \quad (4)$$

where V is the stem volume, m^3; g is the stem cross-sectional area at breast height (1.3 m), m^2; h is the stem height, m; and f is the form factor. The form factors proposed by M. Y. Tkachenko (1952) were applied using a form quotient (q_2) of 0.68.

The classes of aesthetic value, pedestrian accessibility, stand stability, and recreational degradation stage were determined according to the[10] for the forest park sections of green-belt forests.

2. Characteristics of oak forest phytocoenoses in the Right-Bank tracts

2.1. "Zhucha Balka"

The fresh oak forest with *Aegopodium podagraria* (TA1) is located in the thalweg and the lower part of a south-facing slope. The average canopy closure of the stand ranges from 0.75 to 0.80. The stand is characterized by a horizontally closed canopy. The aesthetic value class is 2, the pedestrian accessibility class is 3, the stand stability class is 2, and the recreational degradation is first stage.

The *Quercus robur* individuals are of vegetative origin, with some trees reaching up to 95 years of age. Their mensurational characteristics are presented in Table 2.

The trees are generally healthy, exhibiting good growth and development, while damage caused by pests, diseases, or adverse environmental factors is minimal. The stand is capable of maintaining its structure and ecological functions without a significant reduction in productivity.

The herbaceous layer is mainly confined to canopy openings within the forest stand. The species composition of the spring synusia is dominated by *Ficaria verna*, *Corydalis solida* (Fig. 3 A, B), *C. cava*, *Anemone ranunculoides*, *Gagea*

[10] Інструктивно-методичні вказівки щодо здійснення лісовпорядкування. Державне агентство лісових ресурсів України, ВО «Укрдержліспроєкт». Ірпінь, 2024. 161 с.

lutea. The summer synusia is primarily composed of *Aegopodium podagraria*, *Viola mirabilis* (Fig. 3 C, D), *Lamium maculatum*, *Stellaria holostea*, *Poa nemoralis*, *Galium odoratum*, *Carex pilosa*, *Salvia nemorosa*, and other species.

Table 2

Forest mensuration characteristics of the dominant tree species *Quercus robur* on the trial areas in the "Zhucha Balka" tract

Parameters		Phytocoenoses		
		TA1	TA2	TA3
FST		CL_2	CL_1	CL_{1-2}
Composition		10Qr	10Qr + Gt	10Qr
Average	*H*, m	19.5	17.2	19.2
	D, cm	32.5	22.6	32.2
N, pcs/ha		232	253	225
M, m^3/ha		162.6	174.8	162.3
Bonitet		III–IV	III–IV	III–IV

Notes: FST – forest site type; CL – clay-loam soil; Qr – Quercus robur; Gt – Gleditsia triacanthos

The forest site conditions are classified as CL_2 (fresh, mesophilic). Moisture is supplied by both atmospheric-transit precipitation and groundwater.

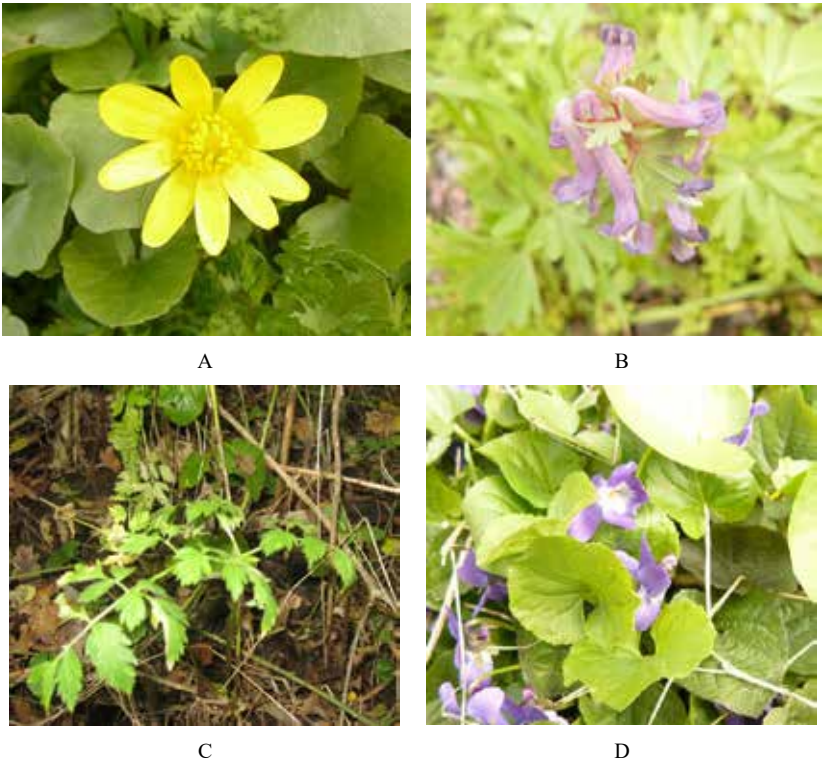
The dryish oak forest with *Poa angustifolia* (TA2) is located on the middle part of a south-facing slope. The average canopy closure of the stand is 0.70–0.75. The stand is characterized by a horizontally closed canopy. The aesthetic evaluation class is 2, the pedestrian accessibility class is 3, the stability class is 3, and the stand is at the first stage of recreational digression.

This is a pure oak stand with scattered *Gleditsia triacanthos* individuals that originated from the adjacent compartment 3, where a pure *Gleditsia triacanthos* plantation was established over an area of 0.4 ha using artificial forest regeneration. The *Quercus robur* trees are approximately 75 years old. Their mensurational characteristics are presented in Table 2.

The stand is slightly weakened but remains viable. Partial dieback of individual branches is observed in the crowns of some *Quercus robur* trees, along with signs of leaf damage caused by insect pests.

As the stand density is approximately 0.8 (0.78 on average), the projective cover of the herbaceous layer ranges from 30 to 60%. In spring, *Corydalis solida*, *Gagea minima* (Fig. 4 A), *Anemone ranunculoides*, *Ficaria verna*, *Corydalis marschalliana*, and other species appear. The summer synusia is dominated by grasses and xerophytic forbs, including *Poa angustifolia*, *Festuca valesiaca*, *Carex praecox*, *Galium verum*, *Achillea millefolium*, *Salvia nutans*,

Thymus marschallianus, *Artemisia austriaca*. *Hypericum perforatum* occurs locally (Fig. 4 B), while *Fragaria viridis* is also present, *Origanum vulgare* occurs only sporadically.



A B C D

Fig. 3. Typical herbaceous plants of the spring synusia: A – Ficaria verna; B – Corydalis solida, and summer synusia: C – Aegopodium podagraria, D – Viola mirabilis

Source: developed by the authors

The forest site conditions are classified as CL_1 (dryish, mesoxerophilic). Moisture is supplied primarily by atmospheric-transit precipitation.

The slightly fresh oak forest with *Polygonatum odoratum* (TA3) is located on the middle part of a northeast-facing slope. The average canopy closure of the stand is 0.75–0.80. The stand is characterized by a horizontally closed canopy. The *Quercus robur* trees are of vegetative origin, with an average age of 90 years, while some individuals reach 100 years. The mensurational

characteristics of this principal species are presented in Table 2. Most *Quercus robur* trees (more than 75–80%) are healthy, possessing dense green crowns and exhibiting normal growth. However, a small proportion of trees (up to 5–7%) are slightly weakened, with isolated dead branches in the upper part of the crown and signs of insect damage.

A B

Fig. 4. Typical herbaceous plants of the dryish oak forest: A – Gagea minima, B – Hypericum perforatum

Source: developed by the authors

No accompanying tree species were recorded in the stands on the surveyed trial areas within the "Zhucha Balka" tract. The only exception was TA2, where, as noted above, *Gleditsia triacanthos* occurred with a minor proportion of less than 5%.

The aesthetic evaluation class is 2, the pedestrian accessibility class is 3, the stability class is 2, and the stand is at the first stage of recreational digression.

The herbaceous layer contains a higher proportion of mesophytic species than the dryish oak forest. The spring synusia is represented mainly by *Corydalis solida*, *C. marschalliana*, *Scilla bifolia*, *Gagea lutea*, *G. minima*, *Anemonoides ranunculoides*, *Ficaria verna*, *Viola odorata*, while *Pulmonaria obscura* occurs locally. The core of the summer synusia is formed by *Polygonatum odoratum*, *Asparagus officinalis* (Fig. 5), *Poa angustifolia*, *Carex pilosa*. In some places, *Aegopodium podagraria*, *Galium odoratum*, *Fragaria vesca*, *Viola odorata* are present; *Hypericum perforatum* and *Origanum vulgare* occur on certain parts of the slope, whereas *Chelidonium majus* is found beneath the forest canopy.

The forest site conditions are classified as $CL_{1\text{-}2}$ (slightly fresh, xeromesophilic). Moisture is supplied primarily by atmospheric-transit precipitation.

A B

Fig. 5. Typical herbaceous plants of the slightly fresh oak forest: A – Polygonatum odoratum, B – Asparagus officinalis

Source: developed by the authors

2.2. "Domashnia Balka"

The fresh lime-ash-field maple-oak forest with *Aegopodium podagraria* (TA1) is located in the lower part of a north-facing slope adjacent to the thalweg. The *Quercus robur* trees are of vegetative origin. They are approximately 90–95 years old, and their mensurational characteristics are presented in Table 3, while those of the accompanying tree species are given in Table 4.

The average canopy closure of the stand is 0.80–0.85. The stand is characterized by a horizontally closed canopy. The aesthetic evaluation class is 2, the pedestrian accessibility class is 3, the stability class is 2, the stand is at the first stage of recreational digression.

The stand is somewhat weakened, with isolated signs of damage and stress, but overall it remains stable. Some trees exhibit slightly thinned crowns (5–10% defoliation), while dieback of individual branches is observed, particularly in the upper part of the crown. There are also isolated trees affected by fungal diseases or infested with stem-boring insects.

The herb layer is poorly developed and confined mainly to canopy gaps. The spring synusia is dominated by *Ficaria calthifolia*, *Corydalis solida*, *C. cava*, *Viola mirabilis*, *V. nemoralis*. The summer synusia is dominated by

Aegopodium podagraria, with a projective cover of 60–65%. Other species include *Galium aparine*, *Geranium robertianum*, *G. sylvaticum*, *Urtica dioica* (Fig. 6, A), *Glechoma hederacea* (Fig. 6, B), and *Carex pilosa*. *Pulmonaria obscura* occurs occasionally, whereas *Asarum europaeum* is encountered only rarely.

Table 3

Mensurational characteristics of the dominant species *Quercus robur* on trial areas in the "Domashnia Balka" tract

Parameters		Phytocoenoses	
		TA1	TA2
FST		CL_2	CL_2
Composition		6Qr2Ac1Fe1Tc	9Qr1Ap+Rp+Bp
Average	*H*, m	19.5	18.2
	D, cm	30.6	30.1
N, pcs/ha		186	239
M, m^3/ha		115.4	136.4
Bonitet		III–IV	IV

Notes: FST – forest site type; CL – clay-loam soil; Qr – Quercus robur; Ac – Acer campestre; Fe – Fraxinus excelsior; Tc – Tilia cordata; Ap – Acer platanoides; Rp – Robinia pseudoacacia; Bp – Betula pendula

The forest site conditions – CL_2 (fresh, mesophilic). Moisture regime is atmospheric-transitional.

A B

Fig. 6. Herb-layer species of the fresh oak forest: A – Urtica dioica, B – Glechoma hederacea

Source: developed by the authors

Table 4

Mensurational characteristics of associated tree species on trial areas in the "Domashnia Balka" tract

TAs	FST	Associated tree species	Average		*N*, pcs/ha	*M*, m^3/ha
			H, m	*D*, cm		
TA1	CL_2	Ac	18.3	28.1	77	38.3
		Fe	21.4	34.3	23	19.1
		Tc	19.2	28.3	120	19.1
TA2	CL_2	Ap	19.1	34.3	20	15.4
		Rp	14.8	19.6	2	0.15
		Bp	8.3	15.2	1	0.10

Note: tree species abbreviations as in Table 3

The fresh maple-oak forest with *Aegopodium podagraria* (TA2) occurs in the lower part of a north-facing slope. The common oak trees are of vegetative origin, with an average age of 85–90 years, while some individuals reach 100 years of age. The mensurational characteristics of *Quercus robur* are presented in Table 3, and those of associated tree species are given in Table 4. This oak forest contains individuals of *Robinia pseudoacacia* and *Betula pendula*. *Robinia pseudoacacia* has spread from adjacent forest stands where this species was established through forest plantations, in particular from stand 1 of the same forest compartment 16.

In the 1950s–1970s, large-scale experimental afforestation of gullies and ravines was carried out in the Dnipropetrovsk region. Researchers from the Institute of Forestry often included *Betula pendula* in mixed planting schemes as a buffer or temporary species[11]. Over time, during the process of species replacement, *Quercus robur* displaced most of its associated species; however, individual birch trees, especially under fresh and favourable conditions in the lower parts of slopes, have survived to the present day.

The average canopy closure of the stand is 0.75–0.8. It is characterized by horizontal canopy closure. The aesthetic evaluation class is 2, the recreational accessibility class is 3, the stability class is 2, the first stage of digression.

The shrub layer is formed by *Crataegus monogyna* and *Cornus sanguinea*, with a canopy closure of 0.40.

The main herbaceous species comprising the spring synusia of this phytocoenosis are *Corydalis solida*, *C. marschalliana*, *Ficaria verna*, *Gagea lutea*, *G. minima*, *Anemonoides ranunculoides*, *Viola odorata*, *V. hirta* (Fig. 7, A), with *Pulmonaria mollis* occurring locally. The summer synusia is composed

[11] Гордієнко М. І., Гойчук А. Ф., Гордієнко Н. М. Штучні ліси в дібровах / ред. М. І. Гордієнко. Житомир : Полісся, 1999. 592 с.

of *Aegopodium podagraria*, *Galium aparine*, *Glechoma hederacea*, *Chelidonium majus*, *Anthriscus sylvestris*, *Brachypodium sylvaticum* (Fig. 7, B), *Carex spicata*, *Elymus caninus*, *Viola hirta*, *Alliaria petiolata*, with *Ballota nigra* and *Carex muricata* occurring locally.

A B

Fig. 7. Herbaceous plants of the fresh maple-oak forest: A – Brachypodium sylvaticum, B – Viola hirta

Source: developed by the authors

The forest site conditions – CL_2 (fresh, mesophilic). Moisture regime is atmospheric-transitional.

2.3. "Rezynova Balka"

The slightly fresh field maple–tatar maple-oak forest with wild pear and *Poa angustifolia* (TA1) located on the middle part of a north-facing slope. Individual specimens of *Quercus robur* are up to 100 years old and are of seed origin. The main forest inventory characteristics of this species are presented in Table 5, while those of the associated tree species are given in Table 6.

The average canopy closure of the stand is 0.60–0.65, with the presence of semi-open areas. The stand is classified as aesthetic class 2, pedestrian accessibility class 3, stability class 2, the first stage of recreational digression.

The sparse shrub layer is composed of *Crataegus monogyna*, *Rosa canina*, *Euonymus europaea* (along the forest edge and in more open sites), as well as *E. verrucosa* (Fig. 8) beneath the forest canopy. In some places, the forest edge is formed by *Prunus spinosa*. Natural regeneration of *Acer tataricum* and *A. campestre* is present, together with occasional self-sown individuals of *Quercus robur*, which are confined to canopy gaps.

The herb layer of the spring synusia is primarily composed of *Corydalis solida*, *Gagea bulbifera*, *Anemone ranunculoides*, *Ficaria verna*, *Viola odorata*, *Iris pumila*, and others. The summer synusia is represented by *Poa nemoralis*, *Brachypodium sylvaticum*, *Melica picta*, *Stellaria holostea*, *Galium aparine*, *Viola hirta*, *Carex spicata*, *Anthriscus cerefolium*, *Chaerophyllum temulum*, *Alliaria petiolata*, and *Agrimonia eupatoria*. In more shaded and moist habitats, *Glechoma hederacea* and *Chelidonium majus* occur.

Table 5

Mensurational characteristics of the dominant species *Quercus robur* on trial areas in the "Rezynova Balka" tract

Parameters		Phytocoenoses			
		TA1	TA2	TA3	TA4
FST		CL_{1-2}	CL_1	CL_1	CL_{1-2}
Composi-tion		4Qr3At2Ac1Pc	8Qr2Ac+Pc	4Qr2Ac2Um2Pc	7Qr2Ac1Pc+Um
Average	*H*, m	17.5	17.2	16.5	17.7
	D, cm	26.6	29.8	30.3	28.6
N, pcs/ha		96	225	65	154
M, m^3/ha		40.8	123.0	36.0	78.8
Bonitet		IV	IV	IV	IV

Notes: FST – forest site type; CL – clay-loam soil; Qr – Quercus robur; At – Acer tataricum; Ac – Acer campestre; Pc – Pyrus communis; Um – Ulmus minor

Table 6

Mensurational characteristics of associated tree species on trial areas in the "Rezynova Balka" tract

TAs	FST	Associated tree species	Average		*N*, pcs/ha	*M*, m^3/ha
			H, m	*D*, cm		
TA1	CL_{1-2}	At	10.9	21.9	163	30,2
		Ac	16.9	25.8	50	20,0
		Pc	13.5	21.8	44	10,0
TA2	CL_1	Ac	14.2	27.8	80	30,6
		Pc	12.4	23.7	2	0,4
TA3	CL_1	Ac	15.4	27.6	45	18,4
		Um	15.1	22.1	69	18,3
		Pc	13.6	23.9	66	18,3
TA4	CL_{1-2}	Ac	15.6	24.3	74	22,2
		Pc	13.8	21.9	47	11,0
		Um	13.8	21.1	1	0,2

Note: tree species abbreviations as in Table 5

A

B

Fig. 8. Understory shrub species:
A – Euonymus europaea, B – E. Verrucose

Source: developed by the authors

The forest site conditions are classified as CL_{1-2} (slightly fresh, xeromesophilic). Moisture is supplied primarily by atmospheric-transit precipitation.

The dryish tatar maple–oak forest with pear and *Carex* (TA2) is located on the middle part of a south-facing slope.

The average canopy closure is 0.70–0.75. The stand is characterized by a horizontally closed canopy. The aesthetic value class is 2, the pedestrian accessibility class is 3, the stability class is 4, the stand is at the first stage of recreational degradation.

The trees are in a more weakened condition than those on the other sample plots described above. Some individuals exhibit sparse crowns, reduced annual growth, and dieback of individual branches. Standing dead trees are present, and damage caused by pests and diseases is also observed.

Fig. 9. Viola matutina and Veronica persica in the steppe-like section of the ravine

Source: developed by the authors

The spring synusia is dominated by *Gagea lutea*, *Corydalis solida*, *Anemonoides ranunculoides*, *Scilla bifolia*, *Viola odorata*, *Ficaria verna*, *Gagea minima*. The herb layer of the summer synusia is primarily composed of *Carex humilis*, *Melica picta*, *Poa angustifolia*, *Festuca valesiaca*, *Elytrigia intermedia*, *Polygonatum odoratum*, *Stellaria holostea*, *Galium aparine*, *Viola hirta*, *Veronica chamaedrys*, *Campanula bononiensis*, *Brachypodium pinnatum*, *Agrimonia eupatoria*, *Clinopodium vulgare*, *Origanum vulgare*, *Fragaria viridis*, *Asparagus officinalis*. On this trial area, *Viola matutina* and *Veronica persica* were also recorded (Fig. 9), although they are neither diagnostic (indicator) nor characteristic species of this type of oak forest. Their presence

does not reflect the ecological specificity of these oak forests, as *Viola matutina* is a relatively plastic species that occurs not only in oak forests but also along forest edges, in shrublands, open woodlands, and other semi-open habitats. Likewise, *Veronica persica* may occur locally in natural ravine oak forests but is not a component of the characteristic nemoral floristic assemblage.

The forest site conditions are classified as CL_1 (dryish, mesoxerophilic). Moisture is supplied primarily by atmospheric-transit precipitation.

The dryish elm–tatar maple–oak forest with wild pear and *Dactylis glomerata* (TA3) is located in the middle (closer to the upper) part of the north-facing slope in the main northern section of the gully.

The pedunculate oak trees are of vegetative origin. They are 85–88 years old. Their mensurational characteristics are presented in Table 5, while those of the associated tree species are given in Table 6.

These are semi-open stands. The average canopy closure is 0.60–0.65. The stand is assigned to aesthetic class 2, pedestrian accessibility class 3, and stability class 4, and is at the first stage of recreational digression. It provides good accessibility for recreational visitors.

The shrub layer consists of *Euonymus verrucosa* and *Crataegus monogyna*, with occasional *Rosa canina*, while *Prunus spinosa* occurs along the forest edge. Shrub canopy closure is 0.3, occasionally reaching 0.4.

The spring synusia includes *Ficaria verna* and, in more shaded sites, occasional *Corydalis solida*, *C. cava*, *C. marschalliana*, *Gagea lutea*, *G. minima*, *Viola odorata*, *V. hirta*, *Stellaria holostea*, *Iris pumila*. The summer synusia is represented mainly by *Dactylis glomerata*, *Poa nemoralis*, *Melica picta*, and *Brachypodium sylvaticum*, with occasional *Carex praecox*, *Elytrigia intermedia*, *Asparagus officinalis*.

The forest site conditions are classified as CL_1 (dryish, mesoxerophilic). Moisture is supplied primarily by atmospheric-transit precipitation.

The slightly fresh field maple–oak forest with wild pear and *Stellaria holostea* (TA4) occupies the middle section of the north-facing slope.

The mature pedunculate oak trees are of vegetative origin. They are 95–100 years old.

Semi-open stands have developed here. The average canopy closure is 0.60–0.65. The stand is assigned to aesthetic class 2, pedestrian accessibility class 3, and stability class 2, and is at the first stage of recreational digression.

The stand is sufficiently stable and in good physiological condition. Damage is minor, the tree crowns are generally well developed.

The species composition of the shrub layer is practically the same as in TA3; however, its canopy closure averages 0.4 and reaches 0.5 in some parts of the trial area.

A B

Fig. 10. Ornithogalum boucheanum (A) in the slightly fresh field maple–oak forest and Salvia nemorosa in the steppe patches of the tract

Source: developed by the authors

The main species of the spring synusia include *Corydalis solida*, *Anemone ranunculoides*, *Ficaria verna*, *Gagea pusilla*, *Viola odorata*, *Stellaria holostea*, *Ornithogalum boucheanum* (Fig. 10, A). The summer synusia is represented mainly by *Stellaria holostea*, *Melica picta*, *Poa nemoralis*, *Brachypodium sylvaticum*, *Geum urbanum*, *Carex muricata*, *Galium aparine*, *Agrimonia eupatoria*, *Hypericum perforatum*, *Campanula rapunculoides*, *Viola hirta*, *Anthriscus sylvestris*, *Chaerophyllum temulum*, *Ballota nigra*, *Alliaria petiolata*. In open, steppe-like habitat, *Salvia nemorosa* occurs (Fig. 10, B).

The forest site conditions are classified as $CL_{1\text{-}2}$ (slightly fresh, xeromesophilic). Moisture is supplied primarily by atmospheric-transit precipitation.

3. Characteristics of oak forest phytocoenoses in the Left-Bank tracts

3.1. "Yatsevo"

The fresh linden–field maple–oak forest with elm and *Stellaria holostea* (TA1) is located in the lower part of the north-facing slope and in the thalweg.

Some pedunculate oak trees within the trial area are about 100 years old. The mensurational characteristics of this species are presented in Table 7. The characteristics of the associated tree species in this ravine forest are given in Table 8.

Table 7

Mensurational characteristics of the dominant species *Quercus robur* on trial areas in the "Yatsevo" tract

Parameters		Phytocoenoses		
		TA1	**TA2**	**TA3**
FST		CL_2	CL_1	CL_2
Composition		7Qr2Ac1Tc+Um	10Qr	7Qr2Ac1Tc
Average	*H*, m	20.7	19.1	22.5
	D, cm	36.9	34.0	41.5
N, pcs/ha		98	130	97
M, m^3/ha		99.3	107.1	138.5
Bonitet		IV	IV	III

Note: tree species abbreviations as in Table 3 and 5

Figure 11 shows pedunculate oaks within the trial area, including a multi-stemmed individual.

The trees are relatively sparsely distributed, forming semi-open stands. Small glades occur in some places. The average canopy closure is 0.60–0.65. The stand is assigned to aesthetic class 2, pedestrian accessibility class 3, and stability class 2, and is at the first stage of recreational digression. The stand is in good condition, with well-developed trees and only a small proportion showing damage caused by insects or diseases (up to 5 % of all trees within the trial area).

Table 8

Mensurational characteristics of associated tree species on trial areas in the "Yatsevo" and "Dibrova" tracts

TAs	FST	Associated tree species	Average		*N*, pcs/ha	*M*, m^3/ha
			***H*, m**	***D*, cm**		
"Yatsevo" tract						
TA1	CL_2	Ac	18.5	29.7	48	28.4
		Tc	19.8	27.6	25	14.1
		Um	20.2	27.3	1	0.2
TA3	CL_2	Ac	20.0	38.1	38	39.5
		Tc	20.7	42.1	15	19.8
"Dibrova" tract						
TA	CL_{1-2}	Ac	13.9	27.8	30	12.3

Notes: Ac – Acer campestre; Tc – Tilia cordata; Um – Ulmus minor

The shrub layer consists mainly of *Frangula alnus* and *Euonymus europaeus*, while patches of *Prunus spinosa* occur along the forest edge. The shrub canopy closure is 0.6.

The characteristic herbaceous species of the spring synusia in this type of oak forest include *Corydalis solida*, *C. cava*, locally forming patches of *Anemone nemorosa*, *Ficaria verna*, *Gagea lutea*, *G. minima*, *Viola mirabilis*, *V. odorata*, and occasional *Pulmonaria obscura*. The summer synusia is dominated by *Stellaria holostea*, *Melica nutans*, *Pulmonaria obscura*, *Viola mirabilis*, with occasional *Geum urbanum*. Along the forest edge, *Alliaria petiolata* occurs, while the lower, more humid part of the site is characterized by *Asarum europaeum*, *Aegopodium podagraria*, *Glechoma hederacea*, and, locally, *Carex pilosa* and *Polygonatum multiflorum*.

The forest site conditions – CL_2 (fresh, mesophilic). Moisture regime is atmospheric-transitional.

A B

Fig. 11. Pedunculate oak trees within the trial area (A) and a multi-stemmed oak tree (B)

Source: developed by the authors

The dryish oak forest with *Carex* (TA2) is located on the middle part of the south-facing slope and is represented by a pure pedunculate oak stand. The average age of the oak trees is 95–98 years. Semi-open stands have developed

within the trial area. The average canopy closure is 0.55–0.60. The stand is assigned to aesthetic class 2, pedestrian accessibility class 3, stability class 2, is at the first stage of recreational digression.

The shrub layer consists of *Crataegus monogyna*, *Rosa canina*, *Euonymus verrucosa*, while patches of *Prunus spinosa* occur locally along the forest edge.

The herbaceous species are typical of this forest type. The spring synusia is represented by early-flowering spring ephemeroids and nemoral species, whereas the summer synusia is dominated by mesoxerophytic and forest-edge species characteristic of the middle parts of south-facing slopes.

The forest site conditions are classified as CL_1 (dryish, mesoxerophilic). Moisture is supplied primarily by atmospheric-transit precipitation.

The fresh linden–field maple–oak forest with *Carex pilosa* (TA3) occurs in the lower part of the north-facing slope. Some pedunculate oak trees are nearly 100 years old, while the average age is 90 years. The mensurational characteristics of the dominant tree species are presented in Table 7, and those of the associated tree species are given in Table 8. The trial area is characterized by a horizontally closed stand, with an average canopy closure of 0.70–0.75. The stand is assigned to aesthetic class 2, pedestrian accessibility class 3, stability class 2, is at the first stage of recreational digression. A few standing dead pedunculate oak trees occur near the trial area.

The shrub layer is composed of *Euonymus europaeus*, *E. verrucosus*, *Crataegus monogyna*, *Rosa canina*, *Sambucus nigra*, *Frangula alnus*, with occasional *Swida sanguinea*. The shrub canopy closure is 0.60–0.65.

The most characteristic herbaceous species of this type of oak forest are *Carex pilosa*, *Stellaria holostea*, *Asarum europaeum*, *Aegopodium podagraria*. The species composition of the herbaceous layer is similar to that recorded in TA1.

The forest site conditions – CL_2 (fresh, mesophilic). Moisture regime is atmospheric-transitional.

We investigated the mensurational characteristics of *Quercus robur* and calculated the vitality indices of its stands in the natural oak forests located in the mouth and middle sections of the Yatsevo tract[12]. The stand vitality index (Ln) indicates that the stands in the thalweg, both in the mouth and in the middle section of the ravine, are healthy, with values of 86.3 and 84.3, respectively. In contrast, the stand in the upper part of the slope is somewhat weakened, with an Ln value of 76.7. The analysis of the mensurational characteristics and vitality of the oak phytocoenoses indicates that more hygrophilous site conditions are

[12] Бессонова В. П., Яковлєва-Носарь С. О. Таксаційні показники та життєвий стан *Quercus robur* L. за різних лісорослинних умов гирла та середньої частини урочища Яцево (Дніпропетровська область). *Питання степового лісознавства та лісової рекультивації земель*. 2023. Т. 52. С. 3–17.

more favorable for the development of pedunculate oak stands than xerophilous conditions.

During the same period, the study in this ravine was expanded by establishing additional trial areas in the southern side ravine of the tract[13]. The mensurational characteristics of *Quercus robur* and the associated tree species were analyzed under hygromesophilous, xeromesophilous, and xerophilous conditions, corresponding to the distribution of the oak forests along the slope elevation gradient. The oak phytocoenoses also differed in stand density, expressed as the number of trees per hectare. The results showed that the mensurational characteristics and vitality of the trees are influenced not only by moisture conditions but also by stand density. Thus, under xerophilous conditions, the height and basal area of pedunculate oak were greater than under xeromesophilic conditions, where the number of trees per hectare, including associated species, was excessively high. A similar pattern was observed for tree vitality. The highest values of these parameters were recorded in oak forests under hygromesophilic conditions.

3.3. "Dibrova"

The slightly fresh field maple–oak forest with *Viola mirabilis* (TA) is located in the lower part of the north-facing slope, closer to the thalweg. The oak trees are of vegetative origin, with some individuals being 90–95 years old. The forest mensurational characteristics of the dominant tree species are presented in Table 9, while those of the accompanying species, field maple, are given in Table 8. The presence of a small number of the North American introduced species, green ash, may be attributed to the dispersal of its seeds from the surrounding erosion-control artificial forest plantations established around the ravine.

Semi-open spaces have formed within the sample plot. The aesthetic value class is 2, the pedestrian accessibility class is 3, the stability class is 2, the site is at the first stage of recreational digression.

The principal representatives of the herbaceous layer are similar to those of the slightly fresh field maple–oak forest in the previously described ravine, Yatsevo tract, but with the predominance of *Viola mirabilis*, which flowers from mid-April to mid-May and subsequently remains in the vegetative stage.

The forest site conditions are classified as CL_{1-2} (slightly fresh, xeromesophilic). Moisture is supplied primarily by atmospheric-transit precipitation.

[13] Яковлєва-Носарь С. О., Бессонова В. П. Таксаційні показники та життєвий стан *Quercus robur* L. за різних лісорослинних умов південного приярка урочища Яцево (Дніпропетровська область). *Наукові доповіді НУБіП України*. 2023. № 4(104).

Table 9

Mensurational characteristics of the dominant species *Quercus robur* on trial area in the "Dibrova" tract

Parameters		Phytocoenoses
		TA
FST		CL_{1-2}
Composition		8Qr2Ac+Fp
Ave-rage	*H*, m	13.7
	D, cm	32.3
N, pcs/ha		92
M, m^3/ha		48.8
Bonitet		V

Notes: Qr – Quercus robur; Ac – Acer campestre; Fp – Fraxinus pennsylvanica

In our previous publication[14], we described a study of vegetation on seven sample plots located in the central part of the Viyskovyi ravine, which also belongs to the southern variant of ravine forests. The tract is situated within the Mykilske Forestry. It was found that the tree species composition of the stands varies depending on the forest site conditions and the orographic features of the terrain. It should be noted that the elevation difference within the ravine is 50–55 m (thalweg – 50 m a.s.l.; upper edge of the slopes – 100 m a.s.l.). This ecotopic heterogeneity promotes the formation of a considerable diversity of oak forest phytocoenoses within the ravine, differing in their floristic composition. In this ravine, the following oak forest phytocoenoses were identified: slightly fresh oak forest with *Aegopodium podagraria*; slightly fresh field maple oak forest with linden and *Aegopodium podagraria*; fresh linden–field maple oak forest with wild pear and *Aegopodium podagraria*; tatar maple–field maple oak forest with linden, wild pear and *Aegopodium podagraria*; ash–elm–field maple oak forest with *Viola suavis*; slightly fresh oak forest with *Aegopodium podagraria* and *Geranium robertianum*; and dry field maple–tatar maple oak forest with wild pear and *Agropyron pectinatum*. It was established that an optimal proportion of the dominant and accompanying tree species is an important prerequisite for the stable functioning and high productivity of forest phytocoenoses. The obtained results indicate the high conservation value of the Viyskovyi ravine and provide grounds for recommending its inclusion in the network of protected areas of Ukraine.

[14] Яковлєва-Носарь С. О., Бессонова В. П. Різноманіття дібровних фітоценозів основної частини байраку Військовий (Дніпропетровська область). *Сільське господарство та лісництво*. 2025, т. 36, № 2. С. 189–204.

CONCLUSIONS

1. The species composition of the dendroflora and the herbaceous plants forming the core of the spring and summer synusiae was determined on trial areas in five tracts of the Dnipropetrovsk region: “Zhucha Balka”, “Domashnia Balka”, “Rezynova Balka”, “Yatsevo, and “Dibrova”. A forest inventory description of the investigated natural stands is provided, including forest site conditions, canopy closure, stand composition, and site quality class (bonitet). For the dominant and accompanying tree species, the main forest inventory characteristics were determined, including mean tree height and diameter, tree density, and stem wood volume per hectare. The aesthetic value, pedestrian accessibility, and stand stability classes, as well as the stage of recreational digression, were also determined.

2. A diversity of oak forest phytocoenoses growing under different forest site conditions was identified within the trial areas: fresh oak forest with *Aegopodium podagraria*, dryish oak forest with *Poa angustifolia*, slightly fresh oak forest with *Polygonatum odoratum*, fresh linden-ash-field maple-oak forest with *Aegopodium podagraria*, fresh Norway maple-oak forest with *Aegopodium podagraria*, slightly fresh field maple–tatar maple-oak forest with wild pear and *Poa angustifolia*, dryish tatar maple–oak forest with pear and *Carex*, dryish elm–tatar maple–oak forest with wild pear and *Dactylis glomerata*, slightly fresh field maple –oak forest with wild pear and *Stellaria holostea*, fresh linden–field maple–oak forest with elm and *Stellaria holostea*, dryish oak forest with *Carex*, fresh linden–field maple–oak forest with *Carex pilosa*, slightly fresh field maple–oak forest with *Viola mirabilis*.

3. Associated tree species are present in all studied phytocoenoses, except for the trial areas located in the “Zhucha Balka” tract and trial area 2 in the “Yatsevo” tract.

4. It was recorded on the trial areas that most pedunculate oak (*Quercus robur*) trees are 80–95 years old, with some individual specimens reaching 100 years of age. Their average height is approximately 19 m, and the average diameter is 30 cm. The stands are predominantly classified as site bonitet class IV, indicating moderate productivity of oak stands, which is typical of the forest-growing conditions of the steppe zone.

5. The vitality of oak stands is higher under conditions of better moisture availability, particularly in the thalweg and the lower part of the north-facing slope. In general, the analyzed natural oak forests are characterized by an aesthetic evaluation class of 2, a pedestrian accessibility class of 3, a stability class of 2, and the first stage of recreational digression.

6. The analysis of the floristic composition of the natural oak forest phytocoenoses in the surveyed ravines demonstrated that ravine forests in both

the right-bank and left-bank parts of the Dnipropetrovsk Region are important centers for the conservation of the natural phytodiversity of the steppe zone. Despite the long-term anthropogenic transformation of the surrounding landscapes, these forest ecosystems have retained a considerable number of characteristic nemoral species and provide habitats for many rare plant species, including those listed in regional conservation lists.

7. The species composition of the vegetation in the studied oak forests is shaped by a complex of ecological factors, among which slope aspect, slope steepness, the topographic position of the sample plots, hydrothermal regime, and soil conditions are of primary importance. The diversity of habitat types within the ravines results in the formation of a mosaic of plant communities, ranging from relatively dry oak forests on the upper parts of south-facing slopes to fresh oak forests in the lower parts of the slopes and thalwegs, thereby substantially increasing the overall floristic diversity of the ravine forests.

8. The ravine oak forests of the Dnipropetrovsk Region, located on both banks of the Dnipro River, form a unified regional complex of forest vegetation within the steppe zone. They support a high level of floristic diversity, contribute to the conservation of a wide range of ecological plant groups, and enhance the stability of forest ecosystems.

9. The obtained results confirm the important conservation role of the ravine oak forests of the Dnipropetrovsk Region as refugia of forest flora within the steppe zone. Their continued study, regular monitoring, and effective protection are essential for conserving the region's biodiversity, maintaining the ecological stability of landscapes, and preserving natural populations of native plant species.

SUMMARY

Natural oak phytocoenoses of five ravine forests located on the right and left banks of the Dnipro River were investigated. These forests belong to the Mykilske and Liubymivske Forestry of the Dnipro Forestry Enterprise. The studied tracts are ravine forests representing the southern variant of the Northern Steppe and form part of the forest-park section of the green belt surrounding the city of Dnipro.

The species composition of the dendroflora and herbaceous layer, which forms the basis of the spring and summer synusiae, was determined. Forest mensurational characteristics of the stands were assessed, including the forest site type, canopy closure, species composition, site quality class (bonitet). For the dominant and associated tree species, the main mensurational parameters were determined, including mean height, mean stem diameter, tree density, and stemwood volume per hectare. The aesthetic evaluation, pedestrian

accessibility, stability classes, and the stage of recreational digression were also established.

A variety of ecotopes are formed within the surveyed ravines, resulting in a high phytocoenotic diversity of vegetation. The investigation of the floristic composition of the natural oak phytocoenoses demonstrated the high conservation value of the ravine forests of the Dnipropetrovsk Region. These forests play an important role in preserving the phytodiversity of the steppe zone by maintaining populations of characteristic nemoral and rare plant species.

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