Oak forests of the class *Quercetea pubescentis* in Central-Eastern Ukraine

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Abstract: The article is devoted to the phytosociological study and vegetation classification of the dry-mesic oak forests in the central and eastern regions of Ukraine. We showed that oak forests of the *Quercetea pubescentis* class have specific northern features in the region and their syntaxonomic position at the level of alliances was not assigned. Syntaxa formed three distinct geographical groups eastward from the Dnieper lowland to the Middle Russian Upland. Ordination, phytoindication, and comparative floristic analysis with other syntaxa from adjacent regions were performed. New associations (*Digitali grandiflorae-Quercetum roboris* ass. nova and *Carici praecocis-Quercetum roboris* ass. nova) were reported. Two edaphic subtypes of dry-mesic oak forests (terrace and ravine oak forests) were distinguished and their floristic features were discussed.

Keywords: forest-steppe zone, *Quercetea pubescentis,* syntaxonomy, thermophilous oak forests, Ukraine.

Introduction

Thermophilous oak forests attracted attention of botanists due to the high level of biodiversity and a number of rare species. The centre of diversity of the *Quercetea pubescentis* class is located in southern Europe, the Mediterranean, and Asia Minor (Mucina et al. 2016). The origin of these forests is associated with the postglacial climatic optimum, and the current reduction of their area is

considered to be a consequence of a human impact (Faliński & Falińska 1986). In Europe, the range of thermophilous oak forests covers many countries: e.g. Poland (Jakubowska-Gabara 2000; Matuszkiewicz 2007; Kasprowicz 2010), Germany (Oberdorfer 1992), Austria (Mucina et al. 1993), Czech Republic (Chytrý & Horák 1997; Chytrý 1997), Slovak Republic (Roleček 2004; Roleček 2005; Roleček 2007), Hungary (Zólyomi 1957; Zólyomi et al. 2013; Lendvai et al. 2014; Horváth et al. 2017), Serbia, Croatia (Čarni et al. 2009; Purger et al. 2014), Romania (Indreica 2011), Bulgaria (Tzonev et al. 2009), Bosnia and Herzegovina (Stupar et al. 2015).

Syntaxonomic position of thermophilous oak forest remains controversial in cool temperate regions, where there are significant floristic differences from the core (typical) sub-Mediterranean type. European authors emphasize the need for a pan-European revision of *Quercetea pubescentis* class (Mucina et al. 2016). In Eastern Europe, and especially in northern localities, the syntaxonomy of dry-mesic oak forests (in the region of research the term "dry-mesic" will be used hereinafter instead of the "thermophilous" forests) is even more unclear because these territories are very poorly explored. Authors who have studied dry-mesic oak forests in Western Russia in detail emphasize the differences from the related syntaxa from Central Europe (Semenishchenkov 2012; Bulokhov & Semenishchenkov 2013). But, despite this, syntaxa from this territory have been controversially included by the authors in the *Quercion petraeae* Issler 1931, which is Central European alliance (Mucina et al. 2016). In Ukrainian publications, data on dry-mesic oak forests are not only incomplete, but also need to be synthesized. They are scattered over 5 alliances (*Aceri tatarici-Quercion* Zólyomi 1957, *Quercion petraeae*, *Pino-Quercion* Medwecka-Kornaś et al. in Szafer 1959, *Genisto germanicae-Quercion* Neuhäusl et Neuhäuslová-Novotná 1967, *Convallario majalis-Quercion roboris* Shevchyk et Solomakha 1996) and within three classes of vegetation – *Carpino-Fagetea, Quercetea pubescentis, Quercetea robori-petraeae*. Moving eastward, on the vast territory of the East European Plain, dry-mesic oak forests have not been studied with a large gap until the Southern Urals, where the easternmost locations are likely found and the alliance *Lathyro pisiformis-Quercion roboris* Solomeshch et Grigoriev in Willner et al. 2016 has been described (Martynenko et al. 2008; Mirkin et al. 2010; Willner et al. 2016). The issue is even more complicated, given that until the 80s of the last century, forests of this type were overlooked due to the use of the dominant classification approach in the Soviet geobotanical school for a long time.

The aim of the study is to perform syntaxonomic and numerical analysis of the dry-mesic oak forests of the central and eastern parts of Ukraine, that is, in the territories from which still little actual data are available. Whether the dry-mesic forest of this territory belongs to a separate alliance remains an issue and cannot be resolved in this study. We will show the specifics of the communities of the class of *Quercetea pubescentis* in the remote northern location of its distribution range.The floristic comparative analysis will reveal the floristic features of the studied syntaxa and differences from other similar associations. Environmental factors affecting the floristic differentiation will be studied by superposition of the model of unconstrained ordination and data obtained by the phytoindication method.

Material and methods

Study region

The study region (Fig. 1) is located in the central and eastern parts of Ukraine from the Dnieper valley in the west to the Middle Russian Upland in the east. It encompasses mainly the northern part of the forest-steppe zone and partially the southern part of the forest zone in Ukraine.
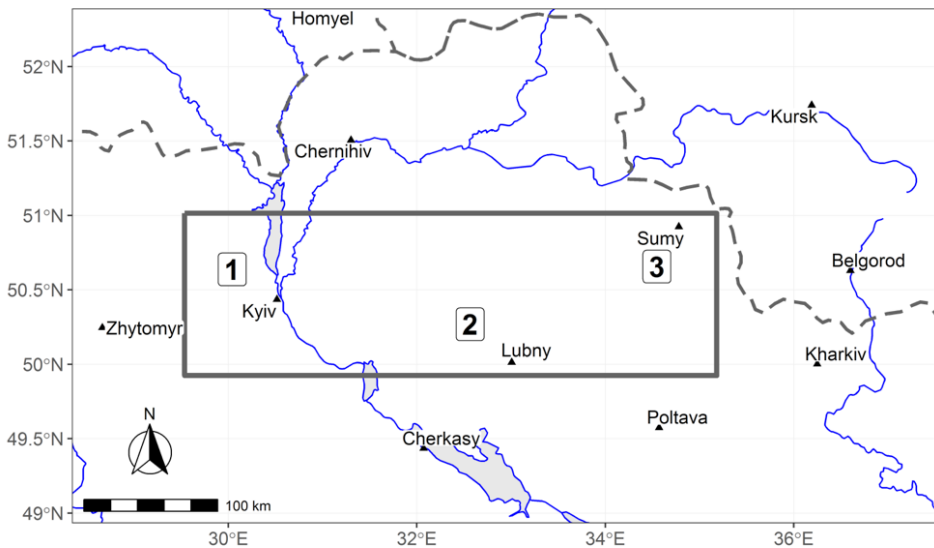

Fig. 1. **Study region in central-eastern Ukraine (rectangle). Associations of dry-mesic oak forests: 1 – ass.** *Digitali grandiflorae-Quercetum roboris*, **2 – ass.** *Carici praecocis-Quercetum roboris*, **3 – ass.** *Galio tinctoriae-Quercetum roboris*

The climate of the territory is subcontinental. According to the Köppen-Geiger climate classification it is of *Dfb* type, namely warm-summer humid continental climate (Kottek et al. 2006). In Kyiv's location, the annual average temperature is 7.7°C; the period of the temperatures above +10°C continues 155–175 days, the year's total rainfall is 640 mm (Osadchy et al. 2010). The climatic conditions are not significantly different throughout the region of research: maximal difference in annual temperatures in any direction within the study region does not exceed 1°C, and the maximal difference in year's rainfalls is below 80 mm.

Relief of the western part of the region, in the Kyiv Polissya, are embodied by sand-moraine terraced complexes with sod-podzolic soils on which pine and pine-oak forests developed. The main river is the Dnieper with its smaller tributaries – Prypiat, Uzh, Teteriv, Zdvyzh and Irpin rivers. The central part of the research area (Poltava region) is located in the northern part of the forest-

steppe zone within the limits of the Dnieper Lowland. The relief of the territory is plain-wavy rugged by river valleys (the main ones are the left tributaries of the Dnieper – Vorskla, Sula and Psel' rivers).There, the main vegetation types are deciduous forests, meadow-steppes, meadows (floodplain meadows, neutral hay meadows, swampy meadows) and wetlands in lowlands. The eastern part of the region is located on the south-western spurs of the Middle Russian Upland. The Psel' and Vorskla rivers shape landscape of this territory. On watersheds, low-humus deep chernozem is a main type of soils formed from the loamy loess bedrock. Steep slopes of river valleys are covered with deciduous forests. On the river terraces, the prevailing type of soils is sod-podzolic on which pine and pine-oak forests were formed.

Data collection and analyses

The phytosociological dataset of 123 relevés sampled by the authors was used for vegetation classification. Plots size equalled 400 m^2. Species abundances were recorded using the six-point Braun-Blanquet cover-abundance scale. Taxonomic concept in the article follows *The Plant List* (http://www.theplantlist. org, ver. 1.1). The names and authorship of the syntaxa are in accordance with the *EuroVegChecklist* (Mucina et al. 2016).

The method of vegetation classification of DRSA, Distance-Ranked Sorting Algorithm, (Goncharenko 2015a, b) was applied for obtaining primary phytocoenotic clusters. Differential species were determined by the concept of fidelity (Bruelheide 2000; Chytrý et al. 2002). The species-to-cluster fidelities were calculated by the Ochiai index (De Cáceres et al. 2008; Cáceres & Legendre 2009).

The DCA (Hill & Gauch 1980) was used for ordination because of high heterogeneity of the phytocoenotic data. Calculations were performed using R software (https://cran.r-project.org) with the *decorana* function from *vegan* package (Oksanen et al. 2018). In order to identify gradients and explain them by environmental variables, we applied the ecological indication (phytoindication) method with the use of Didukh's ecological scales for Ukrainian flora (Didukh 2011). Phytoindicational variables were supplementary (passive) so they did not affect the DCA results.

In addition to phytoindicational variables, the phytosociological analysis was also applied. It is an approach of measuring and comparing amounts (fractions) of the species diagnostic of different classes of vegetation in the species composition of the syntaxa. We followed the species-to-class classification adopted in Mucina et al. (2016). Ratios of species from different classes constitute the phytosociological spectrum (Goncharenko et al. 2013) and yield the additional phytosociological variables, which were used together with phytoindicational ones to explain the axes of ordination.

Results and Discussion

Syntaxonomic scheme of dry-mesic oak forests of the region of research includes 1 class, 1 order, 3 associations, 2 subassociations and 1 variant.

Syntaxonomic scheme of the studied vegetation

Quercetea pubescentis Doing-Kraft ex Scamoni et Passarge 1959
    Quercetalia pubescenti-petraeae Klika 1933
        Alliance: ???
        1. *Digitali grandiflorae-Quercetum roboris* ass. nova hoc loco
            Carici praecocis-Quercetum roboris ass. nova hoc loco
        2.   *Carici praecocis-Quercetum roboris* typicum
        3.   *Carici praecocis-Quercetum roboris* var. *Agrostis vineali*s
            Galio tinctoriae-Quercetum roboris Goncharenko 2003
        4.   *Galio tinctoriae-Quercetum roboris violetosum mirabilis* subass.
            nova hoc loco
        5.   *Galio tinctoriae-Quercetum roboris dianthetosum fisheri*
            subass. nova hoc loco

The synoptic table is provided in Table 1 and the relevé table is placed in the electronic supplement (Table S1).

In the syntaxonomic scheme the syntaxa were not assigned at the alliance level. As mentioned, in Ukraine and Russia dry-mesic oak forests are most often classified into two alliances: *Aceri tatarici-Quercion* and *Quercion petraeae* (incl. *Potentillo albae-Quercion petraeae* Jakucs in Zólyomi 1967). In our opinion, apparently the distribution areas of these alliances do not reach Ukraine and Western Russia. The *Quercion petraeae* is Central European alliance and the *Aceri tatarici-Quercion* is the Pannonian-Pontic alliance (Mucina et al. 2016). The study region, that is in the Sarmatian floristic province (Meusel et al. 1965), lies outside of both – the more western *Quercion petraeae* and the more southern – *Aceri tatarici-Quercion*. Some historical notes may clarify the issue. H. Zólyomi introduced the *Aceri tatarici-Quercion* alliance (Zólyomi 1957), and, obviously, at that time the author simply did not have complete information from Ukraine since he relied on the data from F. Greenj (Greenj 1940) and M. Kotov (Kotov & Karnaukh 1940). We support the understanding of the *Aceri tatarici-Quercion* alliance in its narrow sense as oak forests mainly in the Pannonian region of Hungary. The *Potentillo albae-Quercion petraeae* alliance is based on the association from Germany (Libbert 1933). The differences between the East and Central European dry-mesic oak forests, with particular attention to the alliances *Quercion petraeae* / *Potentillo albae-Quercion petraeae*, have been shown and discussed (Semenishchenkov 2012; Bulokhov & Semenishchenkov 2013). We refrained from placing the syntaxa from the north-eastern part of Ukraine in the mentioned alliances until more comparative material is obtained from these territories.

Ordination analysis

Syntaxa are distinctive in the ordination space with syntaxa 3 and 4 stretched along the first ordination axis and syntaxa 1 and 2 – along the second axis (Fig. 2). First axis captures 6.8% of total variation, and first two axes together – 12.8% of total variation.

Tab. 1. Synoptic table with species percentage constancies. Values above 40 % marked in bold. Only species with at least 20 % constancy in any syntaxon are shown. For full species composition see Table S1

ID syntaxon	1	2	3	4	5
Number of relevés	**15**	**26**	**11**	**12**	**8**
D.s. *Digitali grandiflorae-Quercetum roboris* ass. nova					
Teucrium chamaedrys	**87**				
Galium boreale	**80**			8	12
Serratula tinctoria	**60**				
Digitalis grandiflora	**67**	8	9		
D.s. *Carici praecocis-Quercetum roboris typicum*					
Fragaria viridis		**77**	9	8	
Viola suavis		**42**			
Carex michelii		**73**		8	25
D.s. *Carici praecocis-Quercetum roboris* var. *Agrostis vinealis*					
Agrostis vinealis	7		**100**		
Crepis tectorum			**55**		
Lactuca quercina			36		
D.s. *Carici praecocis-Quercetum roboris* ass. nova					
Allium oleraceum	27	**46**	**55**	17	
Carex montana	7	**65**	27	25	
Carex praecox	7	**85**	36		
Crataegus rhipidophylla	27	**58**	18	8	
Agrimonia eupatoria	20	**50**	9		
Acer campestre		**46**	18		
D.s. *Galio tinctoriae-Quercetum roboris violetosum mirabilis* subass. nova					
Viola mirabilis				**100**	
Vicia sepium		8		**92**	
Lathyrus vernus		8		**67**	
D.s. *Galio tinctoriae-Quercetum roboris dianthetosum fisheri* subass. nova					
Dianthus fischeri	7				**100**
Pilosella officinarum		8			38
Veronica spicata	13				38
D.s. cl. *Quercetea pubescentis*					
Acer tataricum	**47**	**81**	36	**75**	25
Melampyrum nemorosum	27	**77**	9	**75**	**75**
Chamaecytisus ruthenicus	**60**	**46**	**45**	8	**75**
Anthericum ramosum	**87**	**46**	**55**	8	38
Campanula persicifolia	27	35	**45**	33	25
Pyrus pyraster	**67**	**50**	27	8	
Hylotelephium maximum	**67**	35	9	8	25
Clematis recta	33	27	36	25	12
Asperula tinctoria	**40**	35	9	25	25
Potentilla alba	**47**	31		25	
Tanacetum corymbosum	27	38	9	25	

Tab. 1. – cont.

ID syntaxon	1	2	3	4	5
Number of relevés	**15**	**26**	**11**	**12**	**8**
Viola hirta	13	38	9	17	12
Campanula bononiensis	**47**	23	18		
Lathyrus niger	20	12	18		
Iris arenaria		19	27		
Lathyrus sylvestris		31	9		
D.s. cl. *Trifolio-Geranietea*					
Betonica officinalis	**73**	**65**	**55**	**67**	**62**
Veronica chamaedrys	**73**	**77**		**83**	**62**
Polygonatum odoratum	**67**	**62**		**92**	**88**
Peucedanum oreoselinum	**67**	**65**	27	33	**88**
Clinopodium vulgare	**60**	**54**	36	**67**	25
Silene nutans	**60**	**58**		8	**88**
Securigera varia	**60**	**65**	27	17	**50**
Genista tinctoria	**67**	23	36		**75**
Trifolium alpestre	**67**	**65**	27	25	25
Geranium sanguineum	**60**	**54**	27	**42**	12
Hypericum perforatum	**73**	**50**	9	33	25
Fragaria vesca	**80**		45	17	38
Vincetoxicum hirundinaria	**53**	**62**	18	8	12
Solidago virgaurea	**47**	19	18	17	**50**
Astragalus glycyphyllos	**47**	35	18	8	12
Origanum vulgare	**53**	38			25
Ajuga genevensis	13	**46**	18	8	12
Filipendula vulgaris	7	**46**	9	25	
Knautia arvensis	20	15	27	8	12
Trifolium medium	13	35			
Centaurea phrygia	7	23	9		
Campanula rapunculoides		23	9		
D.s. cl. *Carpino-Fagetea*					
Quercus robur	**100**	**100**	**100**	**100**	**75**
Melica nutans	**67**	**42**		**92**	**75**
Poa nemoralis	**53**	**65**		**67**	**75**
Stellaria holostea		**77**	27	**83**	12
Euonymus verrucosus	**47**	**42**	45	**42**	12
Corylus avellana	13	35	36	**50**	25
Asarum europaeum	7	12	27	**75**	25
Carex digitata	**60**			25	38
Tilia cordata	13	38	9	**67**	
Festuca gigantea	**60**	15		33	
Milium effusum		19		**58**	25
Euonymus europaeus	13	**46**	27	8	
Brachypodium sylvaticum	27	8	9	33	
Ranunculus auricomus		23		33	

Tab. 1. – cont.

ID syntaxon	1	2	3	4	5
Number of relevés	**15**	**26**	**11**	**12**	**8**
Acer platanoides		**42**	9		
Carex pilosa		15		25	
Carpinus betulus	20				
D.s. cl. *Quercetea robori-petraeae*					
Convallaria majalis	**80**	27	**73**	**83**	**62**
Pinus sylvestris	**53**	**54**	**82**	25	**62**
Pteridium aquilinum	**80**	23	**100**	**50**	12
Frangula alnus	33	19	**73**	33	**75**
Sorbus aucuparia	**53**	12	18	33	**50**
Betula pendula	20	31	**45**	17	12
Dryopteris carthusiana		4	**82**	17	12
Rubus saxatilis	7			**100**	
Hieracium umbellatum	**47**			17	38
Rubus idaeus	7	31	55		
Veronica officinalis	**53**	12	9		
Calamagrostis arundinacea	**47**			17	
Melampyrum pratense	**40**			17	
Maianthemum bifolium			27	17	12
Molinia caerulea		4	27	8	
Prunus serotina	33				
D.s. cl. *Festuco-Brometea*					
Poa angustifolia	**60**	**92**	**73**	8	38
Galium verum	20	**73**	27		**62**
Euphorbia cyparissias	**73**	27	**45**		
Carex caryophyllea		27	18		25
Bromus inermis	**40**			8	
Verbascum lychnitis		**54**			
Anthyllis macrocephala			36		
Thymus pannonicus					25
Salvia nemorosa		23			
D.s. cl. *Molinio-Arrhenatheretea*					
Dactylis glomerata	**53**	**81**	55	**75**	25
Calamagrostis epigejos	13	**50**	**82**		**62**
Elymus repens	**47**	12	27	8	**100**
Agrostis capillaris	**60**	35	9		**88**
Galium mollugo	**73**			58	38
Achillea millefolium	**73**	31	18		**50**
Ranunculus polyanthemos	**40**	**92**		17	
Viscaria vulgaris	13	**42**	27	8	12
Stellaria graminea		38			**50**
Festuca rubra	20				25
Prunella vulgaris	27				
Leucanthemum vulgare		23			

Tab. 1. – cont.

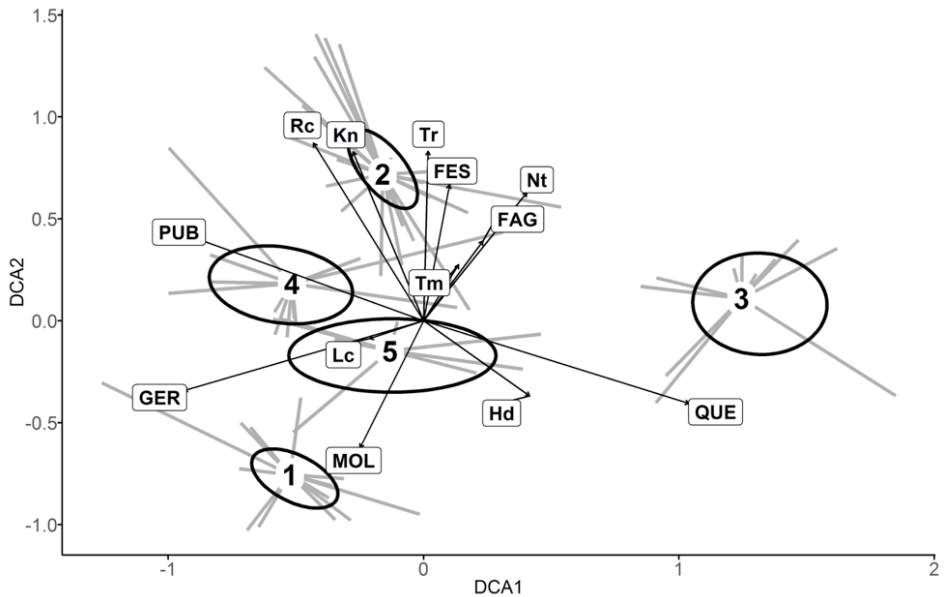| ID syntaxon	1	2	3	4	5
Number of relevés	**15**	**26**	**11**	**12**	**8**
D.s. cl. *Epilobietea angustifolii*					
Geum urbanum	33	**54**	36	**42**	12
Glechoma hederacea	20	**50**	**45**	33	25
Scrophularia nodosa	33	35	18	25	12
Geranium robertianum	20		**64**	8	12
Chelidonium majus	13	4	**45**	17	12
Lactuca muralis	13	19	**45**		
Torilis japonica	**40**			25	
Impatiens parviflora	33		18	8	
Urtica dioica		4		25	
Fallopia dumetorum	13		27		
Galeopsis bifida				8	25
Galeopsis pubescens			27		
D.s. cl. *Artemisietea vulgaris*					
Linaria vulgaris	20	12	9		12
Rumex thyrsiflorus					25
D.s. cl. *Crataego-Prunetea*					
Rosa sp.	27	27	9		
Crataegus ucrainica		19	18		
Prunus spinosa		23			
D.s. cl. *Alno-Populetea albae*					
Prunus padus	20			25	
Humulus lupulus		12	**45**		
Populus tremula	20	8	9		
Ulmus laevis	7		36		
Sambucus nigra		8	36		
D.s. cl. *Nardetea strictae*					
Campanula rotundifolia	**60**	23	18		**62**
Carex pallescens	33			25	
Rumex acetosella					25
Festuca ovina	20				
Other species					
Epipactis helleborine	27				
Hypericum hirsutum			27		
Carex ericetorum		31	36		
Acer negundo			27		
Adoxa moschatellina				25	
Brachypodium pinnatum	7			33	
Lamium maculatum				25	
Heracleum sibiricum	7			25	12
Bromus benekenii					25
Scorzoneroides autumnalis	7				25

Fig. 2. DCA ordination plot. Numbers indicate syntaxa (see syntaxonomic scheme). Vegan's standard errors ellipses were drawn at 0.95 confidence level. Phytoindicational variables: Hd – moisture, Lc – light value, Rc – soil reaction Nt – nitrogen, Tm – temperature Kn – continentality, Tr – salt regime. Classes of vegetation: FAG – *Carpino-Fagetea*, FES – *Festuco-Brometea*, GER – *Trifolio-Geranietea*, MOL – *Molinio-Arrhenatheretea*, PUB – *Quercetea pubescentis*, QUE – *Quercetea robori-petraeae*

In Table 2 all variables that are passively projected onto the ordination space were sorted by determination coefficient r^2 of multiple regression tested by the *envfit* function, which is a measure of the relations between variables and ordination scores.

Two phytosociological variables QUE (*Quercetea robori-petraeae*) and GER (*Trifolio-Geranietea*) have the greatest contribution to the floristic differentiation of the studied vegetation, being both mostly correlated with the first axis of ordination (Table 2). Among the environmental factors, *Rc* and *Kn* were the largest contributors. The length of the vectors in Fig. 2 and the r^2 values in the Table 2 are not related to the extent to which the factor is critical (important) for the growth of forests of the studied type, but reflects to what extent and in which syntaxa it plays a differentiating role. For example, the vector *Lc* is the shortest because all the studied forest stands are light with closeness of tree canopy ranges 0.5–0.6. At the same time, soil reaction differs much with the long *Rc* vector that is directed to syntaxon 2 (neutral or basiphilous soils). As can be seen from Fig. 2, types of other classes of vegetation, including forest (*Quercetea robori-petraeae*, *Carpino-Fagetea*) and herbaceous (*Trifolio-Geranietea, Festuco-Brometea, Molinio-Arrhenatheretea*) types take a significant part in the species composition of syntaxa. This is important given the controversial syntaxonomy of

Tab. 2. Summarized outputs of the multiple regression analysis showing relations of 13 supplementary (passive) variables to the first two ordination axes

Notations	Supplementary variables	DCA1	DCA2	r^2	r^2.ranked
QUE	*Quercetea robori-petraeae*	0.693	−0.271	0.553	1
GER	*Trifolio-Geranietea*	−0.626	−0.228	0.444	2
Rc	soil reaction	−0.288	0.581	0.421	3
PUB	*Quercetea pubescentis*	−0.580	0.264	0.406	4
Kn	continentality value	−0.184	0.553	0.339	5
Tr	total salt regime	0.012	0.555	0.308	6
Nt	nitrogen value	0.269	0.419	0.248	7
FES	*Festuco-Brometea*	0.068	0.445	0.203	8
MOL	*Molinio-Arrhenatheretea*	−0.166	−0.415	0.200	9
Hd	moisture value	0.277	−0.246	0.137	10
FAG	*Carpino-Fagetea*	0.155	0.261	0.092	11
Tm	temperature value	0.092	0.183	0.042	12
Lc	lightness value	−0.141	−0.059	0.023	13
Eigenvalues of axes		0.44	0.39		
Variation explained, %		6.80	6.00		
Axis lengths		3.11	2.43		

dry-mesic forests in the northeastern regions. Species composition of the studied vegetation is ecotonic and there are gradual series from typical communities to the communities of other mentioned classes since they are usually located near forest edges and in light (open-canopy) stands and may be bordered by different types of vegetation – meadow-steppes, broad-leaved forests, xeric scrub vegetation and pine forests.

General description

Habitat. In the studied region, dry-mesic oak forests occupy two different habitat types. First type («terrace» forests) is connected with sandy soils and the gentle relief of river terraces, where oak forests are usually concentrated on the second (boreal) terrace and are surrounded by xeric pine forests, which prevail in areas. Here, unlike pine forests, fragments of pure oak stands, or at least with a pronounced predominance of oak over pine in the tree layer, usually occupy various lowering of the boreal terraces, where heavier water-resistant clay strata are necessarily included in sandy sediments. This also affects soil fertility and humidity, which is higher than that of the surrounding pine forests. Terrace oak forests are more northern, located mainly in the southern part of the forest zone and gradually become rarer in the south, in the forest-steppe zone. The second type of oak forests ("ravine" forests) confined to elevated and eroded areas – on the steep slopes of river valleys, ravines on watersheds (called

"bayracks" in the forest-steppe landscape) and sometimes on the high (third – fourth) river terraces, where the soils are heavier and more similar to those on the watersheds. Soils are fertile on loam-loess bedrocks, usually gray forest soils, and podzolized chernozems as well in the south.

Tree layer. Dry-mesic oak forests have a sparse tree layer and are mainly formed by the late form of oak (*Quercus robur* var. *tardiflora*). Unlike the Central-Southern Europe, where many *Quercus* species grow (*Quercus petraea, Q. pubescens, Q. cerris, Q. frainetto*), only *Quercus robur* goes so far to the east. The participation of other tree species does not exceed 30%, varies from region to region. Boreal tree species, like *Pinus sylvestris* and *Betula pendula,* often come from the surrounding pine forests which prevail on boreal terraces of rivers in the region. In the western part of the study region, *Carpinus betulus* still occurs and disappears gradually eastward. In the eastern locales of the region, *Tilia cordata* and *Acer platanoides* become main oak companions. To the south, *Fraxinus excelsior* and *Pyrus pyraster* also become more frequent**.**

Shrub layer. The shrub layer is species-rich and its composition depends. In the terrace oak forests there are many species that are common with the pine forests (*Chamaecytisus ruthenicus, Genista tinctoria, Frangula alnus, Sorbus aucuparia*). The ravine oak forests are more characterized by the species of the *Crataego-Prunetea* class (*Prunus spinosa, Acer tataricum, Crataegus rhipidophylla* etc.).

Herbaceous layer. Like the shrub layer, herbaceous layer is species-rich with the average number of species per relevé varies from 30 to 60, increasing in the light stands. Total coverage of the layer ranges from 70 to 90%. There is a mixture of grasses (*Poa angustifolia*, *Calamagrostis epigeios*, *Festuca rubra*, *Agrostis capillaris*, *A. giganthea*) with light-demanding forest-edge species (*Geranium sanguineum*, *Betonica officinalis*, *Trifolium alpestre*, *Securigera varia*). On sandy soils oak forests have more common species with the surrounding xeric pine forests (*Solidago virgaurea*, *Hypericum perforatum*, *Peucedanum oreoselinum*, *Calamagrostis arundinacea*). The ravine type of oak forests is bordering broad-leaved forests and meadow-steppe communities, and therefore includes more floristic elements of steppe vegetation in light stands and of fagetalic forests in shady conditions.

Correspondence to the units of dominant classification. According to the former dominant classification, which was the main classification approach for a long time in the USSR¸ the dry-mesic oak forests were attributed to two different groups: the terrace oak forests were mainly reported as *Querceta roboris convallariosa, Querceta roboris pteridiosa* from many locations throughout Ukraine, except for the south (steppe part) of the country, and the ravine oak forests type were mentioned as *Querceta roboris violosa hirtae*, *Querceta roboris caricosa montanae, Querceta roboris lithospermosa, Querceta roboris melicosa pictae* (Bradis 1971). The last two are not distributed within the region of research.

Conservation value. In dry-mesic oak forests many threatened species occur: *Digitalis grandiflora, Potentilla alba, Epipactis helleborine, Dianthus fisheri, Lilium martagon* etc. High naturalness, floristic richness, and limited distribution, all they evidence for the needs of protection of communities.

Description of syntaxa

Quantitative data calculated by the header data of relevés (average number of species, coverage of each layer) and derived from species composition of synoptic columns (homotoneity coefficient, Moravec 1973) were aggregated for each syntaxon (Table 3). Synantropization and adventization indices (Sudnik-Wójcikowska 1991) and the ratios of species of Raunkier's life forms were added to characteristics. Common features of all studied syntaxa are: high floristic richness; similar layer structure; low synantropization indices (ISyn, IAd) and quantities of terophytes (T %); high fraction of nanophanerophytes to phanerophytes (nPh / Ph).

Tab. 3. Descriptive statistics and the structure of syntaxa

ID synt.	N	floristic richness			Ht, const. species,%		M_c, coverage of layers			ISyn	IAd	Raunkier's life forms, %				
		S	R	ΔR	K_{20}	K_{40}	trees	shrubs	herbs			Ph	nPh	G	H	T
1	15	164	47	30 – 60	51	32	55	11	71	18	1	11	7	13	63	6
2	11	128	35	38 – 60	45	20	77	12	89	29	2	12	10	16	56	6
3	26	146	44	27 – 40	53	30	62	7	70	14	0	9	7	13	70	1
4	12	116	33	26 – 37	46	22	66	6	79	13	0	11	8	15	63	3
5	8	84	31	35 – 56	55	37	57	11	58	13	0	9	11	12	63	5

Legend: *ID* – syntaxon number, the same as in the syntaxonomic scheme, *N* – number of relevés in the cluster; *S* – total number of species in joint species list of syntaxon; *R* – average number of species per relevé; *ΔR* – min-max ranges of number of species in the relevés of the cluster; *Ht* –the homotoneity coefficient, the number of species with constancies higher than 20%(40%) divided by the average number of species in the relevés; *M_c* – average of the relevé header data on coverage of tree, shrub, herb layers; *ISyn* – the synantropization index; Raunkier's life forms (*Ph*– phanerophytes, *nPh* – nanophanerophytes, *G* – geophytes, *H* – hemicryptophytes, *T* – therophytes)

Synanthropic indices are low and most synanthropic species are apophytes which do not transform natural communities. For alien species¸ the adventization index is negligible (0-2%). There is a decrease in floristic richness from syntaxon 1 to 5. For example, communities in Polissya are richer than in Forest-Steppe (47 and 31 species per relevé in average). In the biomorph structure, hemicryptophytes are the most numerous, both in quantities (H%, 56-70%) and in coverage in the herbaceous layer which is mainly formed by them (M_c, 58-89%). The closeness of the trees varies from 55 to 77%. In most cases these forests are light and warm which promotes the richness of herbs and shrubs. In contrast to high alpha-diversity, the beta-diversity is quite low. The average similarity of communities can be judged by the *Ht* index. Species with constancies above 40% make up to 37% and above 20% – up to 55% of species lists considering the average number of species in relevés.

Association *Digitali grandiflorae-Quercetum roboris* ass. nova

Holotypus: relevé 76 (Table S1). Author of the relevé: I. Goncharenko. Date: 27.05.2017. Coordinates: 50.5702°N, 30.3224°E. Location: Ukraine, Kyiv region, near the village Horenka. Habitat: dry-mesic pine-oak forest on sandy (boreal) terrace of the Irpin' river. Coverage of layers: trees − 80%, shrubs − 15%, herbs − 75%; mosses − less than 1% (not identified). Number of species: 43. Tree layer: *Quercus robur* 3, *Pinus sylvestris* 1, *Pyrus pyraster* +. Shrub layer: *Chamaecytisus ruthenicus* 2, *Genista tinctoria* 2, *Euonymus verrucosus* +, *Prunus serotina* +, *Rosa sp.* +. Herbaceous layer: *Pteridium aquilinum* 3, *Anthericum ramosum* 2, *Betonica officinalis* 2, *Campanula rotundifolia* 2, *Carex digitata* 2, *Clinopodium vulgare* 2, *Convallaria majalis* 2, *Euphorbia cyparissias* 2, *Festuca gigantea* 2, *Fragaria vesca* 2, *Galium boreale* 2, *Peucedanum oreoselinum* 2, *Poa angustifolia* 2, *Polygonatum odoratum* 2, *Potentilla alba* 2, *Serratula tinctoria* 2, *Silene nutans* 2, *Agrostis capillaris* 1, *Carex muricata* 1, *Digitalis grandiflora* 1, *Geranium sanguineum* 1, *Luzula multiflora* 1, *Melica nutans* 1, *Poa nemoralis* 1, *Teucrium chamaedrys* 1, *Veronica chamaedrys* 1, *V. officinalis* 1, *Vincetoxicum hirundinaria* 1, *Achillea millefolium* +, *Calamagrostis arundinacea* +, *Galium mollugo* +, *Hypericum perforatum* +, *Hypochaeris radicata* +, *Linaria vulgaris* +, *Viscaria vulgaris* +.

Communities develop on boreal terrace of the Irpin' river, but the expected range of association is wider, covering the southern part of the forest zone within Kyiv and other eastern regions in Polissya. Absolute heights range from 143 to 147 m a.s.l.; mesorelief is hilly; soils are sod-podzolic and slightly acidic. Pure oak stands are confined to lower parts of the terrace and mixed pine-oak stands occur on gentle slopes (5–10° inclination) of dunes of the boreal terrace, mainly of south-facing expositions. In the tree layer, the late oak *Quercus robur* var. *tardiflora* is dominated. An admixture of *Pinus sylvestris* is not exceeding 20% with both species in the same tree layer. Other tree species (*Betula pendula*, *Populus tremula*, *Carpinus betulus*, *Tilia cordata* etc.) are less frequent. The total coverage of shrub layer is 5–30%. Unlike the monotypic tree layer, the shrub layer is species-rich (*Acer tataricum*, *Berberis vulgaris*, *Chamaecytisus ruthenicus*, *Clematis recta*, *Euonymus verrucosa*, *Frangula alnus*, *Genista tinctoria*, *Padus serotina*, *Sorbus aucuparia*). Herb layer is composed of grasses and light-demanding and xeromesophytic dicots. Among grasses, several groups are combined: meadow (*Dactylis glomerata*, *Agrostis capillaris*, *Festuca rubra*), meadow-steppe (*Poa angustifolia*, *Bromus inermis*) and nemoral grasses (*Festuca gigantea*, *Melica nutans*). An interesting fact indicating a connection with thermophilous forests is a high constancy of sub-Mediterranean species *Teucrium chamaedrys*, which is found here on the northern distribution border. Like Central European forests of similar type, thermophilous species (*Serratula tinctoria*, *Anthericum ramosum*, *Potentilla alba* etc.) are present as well as some East-European (*Chamaecytisus ruthenicus*, *Acer tataricum*) and species of wide distribution range, especially in the northern regions (*Calamagrostis arundinacea*, *Galium boreale*, *Hieracium umbellatum*, *Melampyrum pratense*, *Pinus sylvestris*, *Veronica officinalis*).

Association *Carici praecocis-Quercetum roboris* ass. nova

Holotypus: relevé 82 (Table S1). Author of the relevé: O. Kovalenko. Date: 16.06.2013. Coordinates: 50.2687°N, 32.5658°E. Location: Ukraine, Poltava region, Piryatin district, near the village Kharkivtsi. Habitat: dry-mesic oak forest in the outer part of forest massif bordering open areas covering with psammophytic meadows of *Agrostion vinealis* alliance. Coverage of layers: trees – 50%, shrubs – 20%, herbs – 60%; mosses – 0%. Number of species: 36. Tree layer: *Quercus robur* 5, *Ulmus minor* 2. Shrub layer: *Chamaecytisus ruthenicus* 1. Herbaceous layer: *Carex michelii* 2, *Hylotelephium maximum* 2, *Agrostis capillaris* 1, *Ajuga genevensis* 1, *Asarum europaeum* 1, *Carex ericetorum* 1, *Euphorbia virgata* 1, *Fragaria viridis* 1, *Galium verum* 1, *Geranium sanguineum* 1, *Melica nutans* 1, *Origanum vulgare* 1, *Peucedanum oreoselinum* 1, *Poa angustifolia* 1, *P. nemoralis* 1, *Polygonatum odoratum* 1, *Silene nutans* 1, *Agrimonia eupatoria* +, *Anthericum ramosum* +, *Asperula tinctoria* +, *Astragalus glycyphyllos* +, *Campanula persicifolia* +, *Carex pilosa* +, *C. praecox* +, *Clematis recta* +, *Melampyrum nemorosum* +, *Milium effusum* +, *Ranunculus polyanthemos* +, *Stellaria holostea* +, *Tanacetum corymbosum* +, *Veronica chamaedrys* +, *Viola hirta* +, *V. suavis* +.

Communities occupy warm and well-drained slopes and uplands. Soils are sod-podzolic from slightly acidic to neutral (pH from 6.5 to 7). They have often scattered distribution in drier conditions and are surrounded by xeric pine forests. This vegetation unit represents oak and pine-oak forests with two-layered tree structure. In the first tree layer, *Quercus robur* is dominated. *Pinus sylvestris* plays a co-dominating role in the first layer. Second tree layer are formed by various accompanying species like *Acer platanoides, Pyrus pyraster* and *Tilia cordata.* The shrub layer is species-rich and composed of *Frangula alnus, Crataegus rhipidophylla, Acer tataricum, Prunus spinosa, Euonymus verrucosa, Crataegus ucrainica* etc*.* The herbaceous layer (coverage of 50–80%) is dominated by *Carex praecox, Poa angustifolia, Calamagrostis epigeios.*

Association *Galio tinctoriae-Quercetum roboris* Goncharenko 2003

The association was described in the northern part of the forest-steppe zone, on the south-western spurs of the Middle Russian Upland in Ukraine (Goncharenko 2003, p. 102). It is the easternmost association within the studied region (Fig. 1). It unites dry-mesic species-rich oak forests in the forest-steppe zone. Using this association as an example, we will demonstrate floristic differences between the two types of previously mentioned oak forests – the terrace type on sandy soils and the ravine type on loamy soils, since this can be especially well traced in the forest-steppe zone-ecotone. Table 4 summarizes the most valuable floristic features of both types (two subassociations in this case).

Subassociation *Galio tinctoriae-Quercetum roboris violetosum mirabilis* subass. *nova* (ravine forests)

Holotypus: relevé 6 (Table S1). Author of the relevé: I. Goncharenko. Date: 09.05.2000. Coordinates: 50.6560° N, 34.5478° E. Location: Ukraine, Sumy

Tab. 4. Differentiating table of two edaphic subtypes of dry-mesic oak forests (1 – ravine type, *Galio-Quercetum* subass. *violetosum mirabilis*, 2 – terrace type, *Galio-Quercetum* subass. *dianthetosum fisheri*)

Type of oak forests	1	2	Type of oak forests	1	2
Common species			**Differential species of the type #2**		
Quercus robur	V	IV	Pinus sylvestris	II	V
Polygonatum odoratum	V	V	Dianthus fisheri	.	V
Melica nutans	V	IV	Silene nutans	.	V
Acer tataricum	IV	III	Galium verum	.	V
Poa nemoralis	IV	V	Genista tinctoria	.	V
Melampyrum nemorosum	IV	IV	Chamaecytisus ruthenicus	.	V
Veronica chamaedrys	V	III	Agrostis capillaris	.	V
Convallaria majalis	V	III	Campanula rotundifolia	.	IV
Betonica officinalis	IV	III	Calamagrostis epigejos	.	IV
Differential species of the type #1			Veronica spicata	.	III
Viola mirabilis	V	.	Hieracium umbellatum	.	III
Vicia sepium	V	.	Solidago virgaurea	.	III
Asarum europaeum	IV	.	Pilosella officinarum	.	III
Tilia cordata	IV	.			
Lathyrus vernus	IV	.			
Clinopodium vulgare	IV	.			
Galium mollugo	III	.			
Corylus avellana	III	.			
Euonymus verrucosus	III	.			

region, Lebedyn district, near the village Mezhirich. Habitat: pure oak stands on the upper part of steep (20°) SW-exposed slope of the Psel' river valley. Coverage of layers: trees – 60%, shrubs – 5%, herbs – 80%, mosses are absent. Number of species: 38. Tree layer: *Quercus robur* 3. Shrub layer: *Acer tataricum* 2, *Clematis recta* 1, *Chamaecytisus ruthenicus* +. Herbaceous layer: *Convallaria majalis* 2, *Poa nemoralis* 2, *Asperula tinctoria* 1, *Betonica officinalis* 1, *Dactylis glomerata* 1, *Fragaria vesca* 1, *Geranium sanguineum* 1, *Lathyrus vernus* 1, *Melampyrum nemorosum* 1, *Melica nutans* 1, *Peucedanum oreoselinum* 1, *Polygonatum odoratum* 1, *Rubus saxatilis* 1, *Stellaria holostea* 1, *Veronica chamaedrys* 1, *Vicia sepium* 1, *Brachypodium sylvaticum* +, *Campanula persicifolia* +, *Carex montana* +, , *Dracocephalum ruyschiana* +, *Galium mollugo* +, *Heracleum sibiricum* +, *Hieracium umbellatum* +, *Hypericum perforatum* +, *Iris aphylla* +, *Milium effusum* +, *Pteridium aquilinum* +, *Ranunculus polyanthemos* +, *Securigera varia* +, *Silene nutans* +, *Tanacetum corymbosum* +, *Vincetoxicum hirundinaria* +, *Viola mirabilis* +, *Viscaria vulgaris* +.

The subassociation is confined to the gray and dark-gray soils on loess loams and unites forests on slopes of gullies and highest parts of water catchment areas

of long branched ravines typical of forest-steppe landscape. It is alternating with the fagetalic forests of the alliance *Scillo sibericae-Quercion roboris* (Onyshchenko 2009) in the lower parts of shady slopes. There are common species between them, and the subassociation is differentiated by megatrophic and nemoral species (Table 4). In the previous dominant classification, communities were usually classified as the sociation *Querceta roboris caricosum montanae* and reported for locations in the Left-Bank Forest-Steppe of Ukraine. According to its characteristics: "oak groves on dark gray forest loams ... which in the past occupied an intermediate position between the maple-lime-oak forests and meadow steppes in the watersheds" (Bradis 1971, p. 288).

Subassociation *Galio tinctoriae-Quercetum roboris dianthetosum fisheri* subass. *nova* (terrace forests)

Holotypus: relevé 1 (Table S1). Author of the relevé: I. Goncharenko. Date: 14.06.2000. Coordinates: 50.7255° N, 34.7041° E. Location: Ukraine, Sumy region, near the village Patriotivka. Habitat: oak forest on lowered area of second river terrace of Psel' river. Coverage of layers: trees – 60%, shrubs – 10%, herbs – 80%, mosses are absent. Number of species: 30. Tree layer: *Quercus robur* 3, *Pinus sylvestris* +. Shrub layer: *Chamaecytisus ruthenicus* 2, *Acer tataricum* 1, *Genista tinctoria* +, *Sorbus aucuparia* +. Herbaceous layer: *Melampyrum nemorosum* 2, *Melica nutans* 2, *Betonica officinalis* 1, *Convallaria majalis* 1, *Dactylis glomerata* 1, *Peucedanum oreoselinum* 1, *Polygonatum odoratum* 1, *Stellaria holostea* 1, *Agrostis capillaris* +, *Anthoxanthum odoratum* +, *Asperula tinctoria* +, *Calamagrostis epigejos* +, *Campanula rotundifolia* +, *Carex digitata* +, *Dianthus fischeri* +, *Elymus repens* +, *Galium verum* +, *Geranium sanguineum* +, *Origanum vulgare* +, *Poa angustifolia* +, *P. nemoralis* +, *Silene nutans* +, *Veronica chamaedrys* +, *V. spicata* +.

The subassociation occurs on sandy soils, frequently on second (boreal) river terraces of Psel' and Vorskla rivers. Species composition includes many species that are common with the surrounding pine forests (*Genista tinctoria, Chamaecytisus ruthenicus, Hieracium umbellatum)* and psammophytes (*Veronica spicata, Pilosella officinarum*). In the previous dominant classification, such communities most often attributed to the sociation *Querceta roboris convallarioso-pteridiosa*. From its description: "oak forests on podzolic sandy soils ... where the dark-colored humus horizon of 10-20 cm includes yellow inclusions" (Bradis 1971, p. 290)*.

Comparative floristic analysis

In this section, we focus on comparative floristic analysis of the studied syntaxa with similar syntaxa from adjacent territories, thus going beyond the region we have studied. As for criteria for selection of syntaxa for comparison, they are based on floristic, geographic and ecological resemblance to our syntaxa. We were not guided by the similarity of the original syntaxonomic interpretation, since similar syntaxa were included by the authors in various alliances. These data are indicated in the legend of Table 5.

Tab. 5. Comparative floristic study of the associations of dry-mesic oak forests and related types

ID syntaxa[1]	classes of vegetation	1	2	3	4	5	6	7	8	9	10	11	12	13
Number of relevés		**15**	**11**	**26**	**12**	**8**	**6**	**14**	**76**	**44**	**5**	**7**	**9**	**5**
Common species														
Quercus robur	FAG;POP;QUE	V	V	V	V	IV	V	V	.	.	V	V	V	IV
Acer tataricum	PUB	III	II	V	IV	III	.	V	V	V	.	III	V	.
Euonymus verrucosus	FAG;PUB	III	III	III	III	.	IV	III	.	.	.	IV	V	.
Poa nemoralis	BRA;FAG;GER;PUB	III	.	IV	IV	V	.	IV	V	IV	.	.	IV	.
Stellaria holostea	FAG	.	II	IV	V	II	.	II	V	V	III	.	IV	.
Melica nutans	BRA;FAG	IV	.	III	V	IV	V	.	.	.	IV	IV	III	II
Betonica officinalis	BRA;EPI;GER	IV	III	IV	IV	III	.	.	.	.	IV	IV	II	II
Convallaria majalis	FAG;POP	V	IV	II	V	III	V	.	.	.	IV	V	V	V
Differential species of ass. 1-5														
Clematis recta	GER	II	II	II	II	.	.	.	.	.	V	.	.	.
Asperula tinctoria	FES	III	.	II	II	II	.	.	.	.	.	.	III	.
Poa angustifolia	FES	IV	IV	V	.	III	.	II	.	.	.	.	.	.
Securigera varia	FES;GER	IV	II	IV	.	II	.	.	.	.	.	.	.	.
Allium oleraceum	FES;GER	II	III	III	V	.	.	.	.	.	.	.	.	.
Differential species of ass. 6-13														
Carex muricata	EPI;FAG;GER	.	.	.	.	.	.	III	V	V	II	.	II	.
Fraxinus excelsior	FAG	.	.	.	.	.	.	II	IV	IV	.	.	II	.
Acer platanoides	FAG	.	.	III	.	.	IV	III	.	.	.	IV	V	.
Rubus saxatilis	BRA	.	.	.	V	.	IV	.	.	.	II	III	III	III
Differential species of each association														
Digitalis grandiflora	BRA;EPI	III	.	.	.	.	.	.	.	.	III	.	.	.
Galium boreale	BRA;FES;MOL	V	.	.	.	.	IV	.	.	.	.	.	.	.
Serratula tinctoria	MOL;QUE	IV	.	.	.	.	.	.	.	.	.	.	.	III

Tab. 5 – cont.

ID syntaxa[1]	classes of vegetation	1	2	3	4	5	6	7	8	9	10	11	12	13
Number of relevés		**15**	**11**	**26**	**12**	**8**	**6**	**14**	**76**	**44**	**5**	**7**	**9**	**5**
Teucrium chamaedrys	FES;GER	V	.	.	.	.	.	.	.	.	.	.	.	.
Agrostis vinealis	COR	.	V	.	.	.	.	.	.	.	.	.	.	.
Carex praecox	FES	.	II	V	.	.	.	.	.	.	.	.	.	.
Fragaria viridis	FES	.	.	IV	.	.	.	.	.	.	.	.	.	.
Viola suavis	FAG;PUB	.	.	III	.	.	.	.	.	.	.	.	.	.
Carex michelii	FES;PUB	.	.	IV	.	.	.	.	IV	III	.	.	.	.
Viola mirabilis	BRA;FAG;PUB	.	.	.	V	.	.	.	II	II	II	.	.	.
Lathyrus vernus	BRA;FAG	.	.	.	IV	.	.	.	.	.	.	.	.	.
Vicia sepium	BRA;GER;MOL	.	.	.	V	.	.	.	.	.	.	.	.	.
Veronica spicata	FES;GER	.	.	.	.	III	.	.	.	.	.	.	.	.
Pilosella officinarum	COR;SED	.	.	.	.	III	.	.	.	.	.	.	.	.
Agrostis gigantea	MOL	.	.	.	.	.	V	.	.	.	.	.	.	.
Carex leporina	MOL	.	.	.	.	.	V	.	.	.	.	.	.	.
Leucanthemum vulgare	MOL	.	.	II	.	.	IV	.	.	.	II	.	.	.
Luzula pilosa	BRA;FAG	.	.	.	.	.	V	.	.	.	.	.	.	.
Melampyrum pratense	GER;PIC;QUE	III	.	.	.	.	V	.	.	.	.	.	.	.
Pimpinella saxifraga	FES	.	.	.	.	.	IV	.	.	.	.	.	.	.
Rubus nessensis	QUE;PIC	.	.	.	.	.	IV	.	.	.	.	.	.	.
Phlomoides tuberosa	BRA;FES	.	.	.	.	.	.	.	IV	.	.	.	.	.
Buglossoides purpuro-caerulea	GER;PUB	.	.	.	.	.	.	.	II	II	.	.	.	.
Fallopia convolvulus	EPI	.	.	.	.	.	.	.	V	V	.	.	.	.
Carex pilosa	FAG	.	.	.	II	.	.	.	.	.	III	.	.	.
Lysimachia nummularia	MOL	.	.	.	.	.	.	.	.	.	V	.	.	.

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Tab. 5 – cont.

ID syntaxa[1]	classes of vegetation	1	2	3	4	5	6	7	8	9	10	11	12	13
Number of relevés		**15**	**11**	**26**	**12**	**8**	**6**	**14**	**76**	**44**	**5**	**7**	**9**	**5**
Platanthera bifolia	NAR;MOL	.	.	.	.	.	.	.	.	.	.	.	.	.
Cruciata glabra	FES;GER	.	.	.	.	.	.	.	.	.	III	III	.	.
Rubus caesius	POP	.	.	.	.	.	.	.	.	.	.	III	.	.
Vaccinium vitis-idaea	PIC	.	.	.	.	.	.	.	.	.	.	III	.	.
Antennaria dioica	NAR	.	.	.	.	.	.	.	.	.	.	.	.	III
Asparagus officinalis	FES;PUB	.	.	.	.	.	.	.	.	.	.	.	.	III
Moehringia trinervia	FAG	.	.	.	.	.	.	.	.	.	.	.	.	III

Note: original syntaxonomic interpretation (alliance), biblioreferences and locations of the syntaxa: 1–5 – syntaxa of the studied vegetation, numbers correspond to the syntaxonomic scheme; 6 – *Lathyro nigri-Quercetum roboris* Bulokhov et Solomeshch 2003 (all. *Quercion petraeae*), Ukraine, Sumy region, Seredina-Buda district (Panchenko 2013, p. 232, tab. 17, relevés 1-6); 7 – *Viola hirtae-Quercetum roboris* Vorobyov et al. 2017 (all. *Aceri tatarici-Quercion*), Ukraine, Poltava region, Zolotonosha district, lower basin of the Sula river (Vorobyov et al. 2017, p. 30, tab. 1, relevés 1-14); 8 – *Caragano fruticis-Aceretum tatarici* Nazarenko & Kuzemko 2011, Dnieper region, Novomoskovsk district (all. *Fraxino excelsioris-Acerion tatarici*) (Nazarenko & Kuzemko 2011, tab. 1, syntaxon 12); 9 – *Fraxino excelsioris-Aceretum tatarici* Nazarenko & Kuzemko 2011; the same as in the previous case, syntaxon 13; 10 – *Pteridio aquilini-Quercetum roboris* Bajrak 1996 (alliance was not specified), Ukraine, Chernihiv region, Ichnya district (Bajrak 1996, p. 62, tab. 3, relevés 1-5); 11 – *Clinopodio vulgare-Quercetum roboris* Solomakha et al. 1996 (all. *Genisto germanicae-Quercion*), Ukraine, Kyiv region, Kyiv-Svyatoshin district (Solomakha et al. 1996, p. 72, tab. 2, relevés 1-7); 12 – *Convallario majali-Quercetum roboris* Shevchyk et al. 1996 (all. *Convallario majali-Quercion roboris*), Ukraine, Cherkassy region, Kaniv Nature Reserve (Shevchyk et al. 1996 p. 48, tab. 9, relevés 1-15); 13 – *Convallario-Pinetum* Bajrak 1997 (all. *Pino-Quercion*), Poltava region, Gadyach district (Bajrak 1997, p. 88, tab. 1, relevés 10-14).

As can be seen from Table 5, syntaxa from the region of research demonstrate floristic differences sufficient to recognize some of them as new ones. Differential species of our syntaxa (1–5) did not change much or disappear after adding associations from a wider region. Two subgroups may be distinguished (1–5 and 6–13), but they are not sufficient for assigning to two different vegetation units of higher ranks. Given the number of common species with high constancy, the number of alliances reported by the authors (5 alliances, as can be seen from the legend) is likely overestimated. The role of differentiating species in the syntaxa of the southern Ukrainian territories is played by such species as *Buglossoides purpurocaerulea, Carex michelii, Fragaria viridis, Phlomoides tuberosa* and nemoral species (*Lathyrus vernus, Viola mirabilis, Carex pilosa*), the proportion of which increases markedly in the ravine forests as well. In contrast, in more northern regions, differentiating species are boreal (*Rubus nessensis*, *Vaccinium vitis-idaea*), as well as psamophytic (*Pilosella officinarum, Veronica spicata*) due to sandy soils, and meadow species (*Leucanthemum vulgare, Lysimachia nummularia*).

Conclusion

We presented the results of the floristic-sociological classification of dry-mesic oak forests, although the coenotic diversity of forests of this type is probably not limited to three established associations, which is connected with still incomplete data on comparative material from other neighboring regions. Communities were found both in the southern part of the forest zone on flat relief of river terraces on sandy soils, and in the forest-steppe zone, where they are confined to the most elevated areas of the eroded relief and south-facing steep slopes. The terrace and ravine types are separated by soil conditions and not being adjacent to each other bordering the vegetation of other types – meadow-steppes, broad-leaved forests, scrub vegetation and xeric pine forests. Soil reaction and climate continentality were identified as the main contributors to the floristic differentiation of the studied vegetation.The syntaxa of dry-mesic oak forests from the central and eastern parts of Ukraine cannot be placed in any of known alliances in the class *Quercetea pubescentis*. In contrast to sub-Mediterranean type which is considered a class of zonal vegetation, in the remote northern part of the range of the class these communities occupy azonal habitats and descend to river terraces. As a whole, it is obvious that dry-mesic forests require a larger syntaxonomic revision in the eastern regions of Ukraine, Russia and Belarus.

Electronical supplementary material

Table S1. Table of relevés (available at https://www.upjs.sk/pracoviska/botanicka-zahrada/ odborne-aktivity/volume-29-2019-abstracts/)

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