VEGETATION SCIENCE, ECOLOGY, CONSERVATION
ГЕОБОТАНІКА, ЕКОЛОГІЯ, ОХОРОНА РОСЛИННОГО СВІТУ

https://doi.org/10.15407/ukrbotj80.05.409
RESEARCH ARTICLE

Ruderal vegetation of Kyiv City. II. Class *Artemisietea vulgaris*

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Abstract. The article is a continuation of the study on ruderal vegetation of Kyiv City and provides summarized results of syntaxonomic research of the class *Artemisietea vulgaris*. We identified 14 associations and one derivative community belonging to three orders and four alliances. Using ordination and phytoindication analyses, the synmorphology of the communities, their ecological requirements, and habitat preferences were described. It has been shown that the vegetation of *Artemisietea vulgaris* is distributed throughout all districts of the city. According to ecological requirements, we found that main environmental gradients that determine the ordination of different types of stands of *Artemisietea vulgaris* within Kyiv City are thermoregime and light. The diversity of man-made habitats and regional environmental conditions appeared as the most important factors affecting the territorial differentiation of this vegetation type within the city. The contributed data can be used for strategic planning and practical implementation of measures for sustainable urban development and optimization of the urban environment.

Keywords: ordination, phytoindication, syntaxonomy, Ukraine, urboecosystem

Introduction

The article is a continuation of the series of publications on syntaxonomy of the ruderal vegetation of the city of Kyiv, Ukraine. In the previous article, we addressed a detailed description and characterization of the class *Stellarietea mediae* Tx. et al. in Tx. 1950 (Dubyna et al., 2021a). We also provided detailed information about the study area and made a review of the history of investigation of the ruderal vegetation of cities in Ukraine, including the Kyiv urban area. The present article summarizes the results of our syntaxonomic research of the class *Artemisietea vulgaris* Lohmeyer et al. in Tx. ex von Rochow 1951.

The class *Artemisietea vulgaris* unites thermophilous ruderal plant communities composed of biennial and perennial species (Dengler et al., 2003). They prefer mostly man-made habitats or semi-natural sites within urban areas or human settlements and are associated with well-lit nutrient-rich soils, different regarding their moisture and mechanical structure. The coenoses of the class are widely distributed within Europe, mostly in the temperate and sub-Mediterranean regions (Mucina et al., 2016).

ARTICLE HISTORY. Submitted 21 November 2022. Revised 07 September 2023. Published 27 November 2023

CITATION. Dubyna D.V., Iemelianova S.M., Dziuba T.P., Tymoshenko P.A. 2023. Ruderal vegetation of Kyiv City. II. Class *Artemisietea vulgaris*. *Ukrainian Botanical Journal*, 80(5): 409–430. https://doi.org/10.15407/ukrbotj80.05.409

Vegetation of the class *Artemisietea vulgaris* has some specific features determining the classification process and obtained results. In particular, the heterogeneous composition and floristic structure of plant communities, as well as a wide range of their habitat preferences, make syntaxonomical identification of such phytocoenoses quite a difficult task. It also depends on syntaxonomical concepts of the class used by various scientists. The syntaxonomic structure and circumscription of the class have been repeatedly reviewed by European and Ukrainian phytosociologists (Tüxen, 1950; Rochow, 1951; Oberdorfer, 1957; Braun-Blanquet, 1967; Rivas-Martínez et al., 2001; Borhidi, 2003; Dengler et al., 2003; Bardat et al., 2004; Matuszkiewicz, 2008; Sanda et al., 2008; Solomakha, 2008; Láníková et al., 2009; Tzonev et al., 2009; Biondi et al., 2014; Dubyna et al., 2019, 2022). Thus, some authors included in *Artemisietea vulgaris* only coenoses of hemicryptophytes in anthropogenic and semi-natural habitats, while ruderal plant communities of rhizomatous grasses were considered within a separate class of vegetation, namely *Agropyretea repentis* Oberdorfer, T. Müller et Görs in Oberdorfer et al. 1967 (Moravec et al., 1983; Theurillat et al., 1995). Other researchers, on the contrary, supported another concept of *Artemisietea vulgaris*, including in this class nitrophilous perennial vegetation of the class *Galio-Urticetea* Passarge ex Kopecký 1969 (currently considered as a synonym of the class *Epilobietea angustigolii* Tx. et Preising ex von Rochow 1951) (Dengler, Wollert, 2004; Matuszkiewicz, 2008).

In recent syntaxonomical surveys of European countries, the content and structure of the class *Artemisietea vulgaris* are generally similar. However, the hierarchical rank of nitrophilous biennial plant communities on mesic soils, which considers the alliance *Arction lappae* Tx. 1937, is still controversial. These phytocoenoses occupy a position transitional towards the plant communities of the class *Epilobietea angustifolii* and therefore are considered in both mentioned classes, depending on the syntaxonomical concept adopted by the researchers. The modern syntaxonomic structure of the class *Artemisietea vulgaris* on the pan-European scale was presented by Mucina et al. (2016). The results of syntaxonomic studies of this class in Ukraine were summarized by Dubyna et al. (2019, 2022).

Within the Kyiv urban area, the plant communities of the *Artemisietea vulgaris* were recorded mainly for some parts of the city or for certain habitats. Thus, on the islands of the Dnipro River within Kyiv, Tsukanova (2005) reported three associations of the class: *Balloto nigrae-Leonuretum cardiacae*, *Tanaceto-Artemisietum vulgaris*, and *Artemisietum absinthii*. Chokha (2005) described coenoses of other seven associations and one rankless community on the lawns of the city. Phytosociological aspects of the vegetation of Kyiv railways have been studied by Dziuba et al. (2019, 2022). According to these authors, it is represented by 2 orders, 4 alliances, 11 associations, and 4 derivative communities. Didukh and Alyoshkina (2012), having studied various habitats of the city of Kyiv, mentioned some plant communities with the dominance of diagnostic species of *Artemisietea vulgaris*. It is obvious that phytocoenotic investigations of the class within the Kyiv urban area remain rather fragmentary. Thus establishing the syntaxonomical diversity of *Artemisietea vulgaris* is very important regarding the necessity of further monitoring and management of vegetation in a large urboecosystem of Kyiv City.

The main aims of this study were: (1) to present a classification of vegetation of the class *Artemisietea vulgaris* at the association level within Kyiv City and (2) to evaluate ecological requirements and distribution of the defined associations in the study area.

Materials and methods

Data preparing

Initially, we collected 1164 phytosociological vegetation plot records (relevés) of ruderal vegetation in the territory of Kyiv City in 2016–2020. These relevés were sampled using the Braun-Blanquet approach (Braun-Blanquet, 1964) on plots of 10–25 m^2. We also used geobotanical materials provided by O. Melezhyk (Chokha, 2005). All relevés were stored in the Turboveg for Windows 2.92 database (Hennekens, Schaminée, 2001) and integrated into the database *Anthropogenic vegetation of Ukraine*, registered in the Global Index of Vegetation-Plot Databases (Dengler et al., 2011) with the code EU-UA-11 and included in the European Vegetation Archive (Chytrý et al., 2016). All vegetation layers were combined into one. As bryophytes and lichens were not recorded in the majority of plots and have limited ecological importance in ruderal vegetation, they were excluded from the dataset. We also removed all records of juvenile trees and

shrubs as well as records of vascular plant species that were not identified to the species level.

We harmonized nomenclature according to the *Euro+MedBase* (2022).

Data analysis

To build the classification, we used both agglomerative and divisive classification algorithms. In the first step, we made an analysis of all vegetation plots sampled across the Kyiv urban area (1164 relevés) and distinguished the large groups of relevés which are quite different from each other by their species composition. For this purpose, we used a modified TWINSPAN algorithm (Roleček et al., 2009), with three pseudospecies cut levels (0, 5, 25%) and with Sørensen coefficient (Sørensen, 1948) as a measure of cluster heterogeneity. Thereafter we selected those clusters, which corresponded to the class *Artemisietea vulgaris* according to the list of diagnostic species provided by Mucina et al. (2016). After such filtering, our resulting dataset included 270 vegetation plots, which we used for further analysis. We processed selected data using beta-flexible clustering (beta = –0.25, Bray-Curtis dissimilarity, log-transformed percentage abundances) in PC-ORD software (McCune, Mefford, 2011) and distinguished vegetation units corresponding to the associations and their groups (alliances). The optimal number of clusters was selected using the OptimClass test on both stages of the classification procedure (Tichý et al., 2010).

The content of clusters was analyzed by diagnostic (D. sp.), constant (C. sp.), and dominant species in JUICE (Tichý, 2002). The diagnostic value of the species was assessed using the phi coefficient based on the fidelity concept (Chytrý et al., 2002). The threshold values are taken at the level of 0.25. Highly diagnostic species have a phi-coefficient that exceeds 0.5. Species with a non-significant diagnostic value based on Fisher's exact test ($P < 0{,}001$) were excluded. Species with a frequency of more than 25% were defined as constant. Highly diagnostic and highly constant species are bolded in the text. Means of phi coefficient for all diagnostic species are presented in Table 1. Syntaxa in the synoptic table are ordered according to the syntaxonomy scheme presented in the Results section.

To identify the vegetation units at different hierarchical ranks, we used the lists of diagnostic species presented in European and Ukrainian phytosociological publications (Chytrý, Tichý, 2003; Jarolímek, Šibík, 2008; Kącki et al., 2013; Mucina et al., 2016; Dubyna et al., 2019). Wherever it was possible, we involved type relevés of syntaxa, basically nomenclatural types of associations described from the territory of Ukraine. To distinguish the rankless (derivative) communities, we used the Kopecký and Hejný approach (Kopecký, Hejný, 1974).

The structure of the class *Artemisietea vulgaris* at the high-rank syntaxonomic level, as well as names of associations, are given according to Dubyna et al. (2019, 2022). Names of orders and alliances follow Mucina et al. (2016). The nomenclature of syntaxa was checked for compliance with the *International Code of Phytosociological Nomenclature* (Theurillat et al., 2021).

Ecological differentiation was conducted using DCA-ordination (Hill, Gauch, 1980) in the R program (William, 2008) operated from JUICE. Indicator values were adopted from Didukh (2011). We also used Didukh's (2011) ecological scales to provide an overview of the ecological requirements of individual associations. We did this analysis in R 4.0.2 (R Core Team, 2022) using the library *ggplot2* (Wickham, 2016) to visualize the results presenting them as box-and-whiskers plots. Boxes reflect the interquartile range (25–75% of observed values), and whiskers 5–95% observed values for each association.

Results

Vegetation classification

A classification dendrogram of the class *Artemisietea vulgaris* within the city of Kyiv is presented in Fig. 1, where four hierarchical groups of clusters are clearly separated. Group 1 (clusters 1–3) represents vegetation plots dominated by tall perennial, nutrient-demanding dicots which are traditionally considered to be the alliance *Arction lappae*. Group 2 (clusters 4–10) we identified as alliance *Dauco-Melilotion* which unites xero-mesophytic vegetation dominated by biennial species on anthropogenic stony and gravelly substrates. Vegetation plots that united thermophilous anthropogenic vegetation on dry soils and were comprised within cluster group 3 (clusters 11–14) we recognized as the *Onopordion acanthii* alliance. The last group 4 (clusters 15–20) includes semi-natural and ruderal vegetation with a high incidence of perennial grasses which we assigned to the alliance *Convolvulo*

Table 1. **Synoptic table with percentage frequency and modified fidelity index phi coefficient**
Shortened synoptic table of the class *Artemisietea vulgaris* in Kyiv. Percentage frequency and modified fidelity index (phi coefficient × 100) superscripted are shown. Only species with frequency more than 25 % and phi coefficient more than 0.25 in at least one column are included and shaded in grey (with phi> 50 in dark grey; with phi< 50 in light grey). Species within clusters are arranged in descending order of fidelity index.

Number of association	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**
Number of plots	**61**	**22**	**5**	**14**	**22**	**5**	**15**	**17**	**3**	**15**	**11**	**17**	**23**	**19**	**21**
Convolvulus arvensis	**68**$^{48.1}$	17$^{4.7}$	·	·	27$^{13.6}$	·	18$^{5.9}$	14$^{2.6}$	·	·	18$^{5.9}$	·	·	5	·
Amaranthus albus	12$^{25.9}$	·	·	·	·	·	·	·	·	·	·	·	·	·	·
Plantago lanceolata	43$^{25.6}$	33$^{17.7}$	·	28$^{10.8}$	9	·	27$^{12.7}$	·	·	·	36$^{20.2}$	·	4	·	**62**
Medicago lupulina	4	**100**$^{89.9}$	·	·	·	20	·	·	·	·	·	·	·	·	·
Trifolium repens	·	**75**$^{80.6}$	·	·	·	·	9	·	·	·	·	·	·	·	·
Rumex confertus	·	**58**$^{75.3}$	·	·	·	·	·	·	·	·	·	·	·	·	·
Cerastium arvense	·	**58**$^{75.3}$	·	·	·	·	·	·	·	·	·	·	·	·	·
Lotus corniculatus	·	**58**$^{75.3}$	·	·	·	·	·	·	·	·	·	·	·	·	·
Poa pratensis	18$^{12.3}$	**75**$^{74.3}$	·	·	5	·	·	·	·	·	·	·	·	·	·
Agrostis capillaris	4	**58**$^{72.8}$	·	·	·	·	·	·	·	·	·	·	·	·	·
Festuca rubra	4	**58**$^{72.8}$	·	·	·	·	·	·	·	·	·	·	·	·	·
Trifolium pratense	·	**67**$^{64.3}$	·	·	·	20	·	·	·	·	·	·	·	·	·
Centaurea jacea	·	33$^{56.4}$	·	·	·	·	·	·	·	·	·	·	·	·	·
Potentilla reptans	4$^{1.9}$	33$^{53.3}$	·	·	·	·	·	·	·	·	·	·	·	·	·
Glechoma hederacea	4$^{1.9}$	33$^{53.3}$	·	·	·	·	·	·	·	·	·	·	·	·	·
Bromus hordeaceus	·	25$^{48.7}$	·	·	·	·	·	·	·	·	·	·	·	·	·
Eragrostis minor	·	33$^{46.3}$	·	·	5	·	·	·	·	·	9	·	·	·	·
Achillea millefolium	7	**75**$^{44.3}$	·	**64**$^{44.3}$	9	·	·	·	33$^{13.4}$	·	·	·	9	31$^{4.3}$	·
Phleum pratense	·	27$^{39.7}$	·	·	·	·	·	·	·	·	·	·	·	·	·
Cirsium arvense	·	27$^{39.7}$	·	·	·	·	·	·	·	·	·	·	·	·	·
Galium verum	·	27$^{39.7}$	·	·	·	·	·	·	·	·	·	·	·	·	·
Malva thuringiaca	·	27$^{39.7}$	·	·	·	·	·	·	·	·	·	·	·	·	·
Fragaria vesca	·	27$^{39.7}$	·	·	·	·	·	·	·	·	·	·	·	·	·
Argentina anserina	·	27$^{39.7}$	·	·	·	·	·	·	·	·	·	·	·	·	·
Rumex acetosella	·	27$^{39.7}$	·	·	·	·	·	·	·	·	·	·	·	·	·

Lolium perenne	7	**58**$^{36.3}$	20	·	9	·	·	·	·	·	9$^{18.7}$	·	32	11	·
Schedonorus pratensis	·	25$^{33.1}$	·	·	·	·	·	·	·	·	9	·	9	5$^{14.5}$	
Arctium tomentosum	·	27^{31}	·	·	·	·	·	·	·	·	·	·	·	·	·
Veronica chamaedrys	·	18^{28}	·	·	·	·	·	·	·	·	·	·	·	·	·
Artemisia austriaca	·	·	**100**$^{100.0}$	·	·	·	·	·	·	·	·	·	·	·	·
Setaria pumila	4	8	**100**$^{70.8}$	·	·	·	18$^{4.6}$	·	·	·	·	29^{13}	·	16$^{2.7}$	12
Diplotaxis tenuifolia	4	·	**60**$^{49.5}$	·	·	·	18$^{13.7}$	·	·	·	27$^{13.7}$	·	·	·	·
Bromopsis inermis	·	·	·	**100**$^{91.1}$	5	·	·	14	·	·	·	·	·	·	·
Salsola tragus	·	·	·	45$^{48.7}$	·	·	·	·	·	·	·	·	·	·	·
Atriplex prostrata	·	·	·	28$^{40.4}$	·	·	·	·	·	·	·	·	4	5	·
Calamagrostis epigejos	11	·	·	31$^{4.3}$	**100**$^{55.6}$	**60**$^{32.8}$	·	29$^{6.7}$	33^{10}	·	·	·	17	·	·
Anisantha sterilis	·	·	·	·	28$^{29.2}$	·	·	·	·	·	·	·	·	·	·
Aristolochia clematitis	·	·	·	·	·	**100**$^{97.7}$	·	·	·	·	·	·	4	·	·
Artemisia campestris	·	·	·	·	·	**60**$^{72.5}$	·	14$^{10.5}$	·	·	·	·	·	·	·
Poa angustifolia	·	·	·	21^{8}	5	**100**$^{64.9}$	·	23$^{21.5}$	·	20$^{4.2}$	9	·	·	16	·
Verbascum thapsus	·	·	·	·	14$^{5.8}$	40$^{58.6}$	9	·	·	·	9$^{1.3}$	14$^{6.5}$	4	·	·
Odontites vulgaris	·	·	·	·	·	**80**$^{56.4}$	·	·	·	·	·	·	·	·	·
Rumex acetosa	·	17$^{18.7}$	·	·	·	**60**$^{42.5}$	·	·	·	·	·	·	4	·	·
Chondrilla juncea	·	·	·	·	·	20$^{39.8}$	9	·	·	·	18$^{19.2}$	·	·	·	·
Berteroa incana	28	·	·	28	14	20	**100**$^{42.2}$	29	33	26	**55**$^{15.4}$	43$^{8.4}$	26	21	12
Poa compressa	·	·	·	·	·	·	28$^{37.4}$	·	·	·	·	·	·	·	·
Silene latifolia	·	·	·	·	·	·	28$^{33.6}$	·	·	·	·	·	·	·	·
Anthemis ruthenica	·	·	·	·	·	·	28$^{29.2}$	·	·	·	·	·	·	·	·
Asclepias syriaca	·	·	·	·	·	40$^{47.2}$	·	**100**$^{75.6}$	·	·	·	·	·	·	·
Melampyrum arvense	·	·	·	·	·	·	·	29$^{52.1}$	·	·	·	·	·	·	·
Fallopia convolvulus	7$^{5.8}$	·	·	·	·	·	·	29^{38}	·	·	9	·	4	·	·
Verbascum phlomoides	·	·	·	·	·	·	·	34$^{36.7}$	·	·	·	·	·	·	·
Tragopogon dubius subsp. *major*	·	·	·	·	14	·	17	·	**67**$^{61.6}$	·	·	·	·	·	·
Equisetum arvense	·	·	·	·	5	·	·	29$^{19.6}$	**67**$^{56.5}$	·	·	·	·	·	25
Picris hieracioides	·	·	·	·	·	**60**$^{21.7}$	·	·	**67**^{52}	·	·	·	·	5	18

Table 1 (continued)

Number of association	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**
Number of plots	**61**	**22**	**5**	**14**	**22**	**5**	**15**	**17**	**3**	**15**	**11**	**17**	**23**	**19**	**21**
Plantago arenaria	·	·	·	·	·	·	$9^{10.1}$	·	$33^{49.2}$	·	·	·	·	·	·
Verbascum lychnitis	·	·	·	·	5	·	$9^{7.5}$	·	$33^{41.7}$	·	$9^{7.5}$	·	·	·	·
Melilotus albus	7	·	·	·	5	·	27^{11}	·	·	$\mathbf{100}^{\mathbf{68.1}}$	27^{11}	29^{12}	·	5	·
Linaria genistifolia	·	·	·	·	·	·	·	·	·	$33^{43.5}$	·	·	·	·	·
Achillea setacea	·	·	·	·	·	$\mathbf{60}^{\mathbf{53.7}}$	·	·	·	$\mathbf{60}^{47.5}$	9	·	·	·	·
Artemisia absinthium	4	·	20	·	9	·	9	14	·	$47^{27.9}$	$\mathbf{100}^{\mathbf{55.2}}$	14	9	16	·
Medicago sativa subsp. *falcata*	·	·	·	·	14	**60**	9	19	·	·	$\mathbf{55}^{40.7}$	·	·	5	·
Poa bulbosa	·	·	·	·	·	·	·	·	·	·	$36^{29.2}$	·	·	·	·
Hypericum perforatum	·	·	·	·	·	·	·	·	·	·	$36^{29.2}$	·	·	·	·
Consolida regalis	·	·	·	·	·	·	·	·	·	·	$36^{29.2}$	·	·	·	·
Elytrigia intermedia	·	·	·	·	·	·	·	·	·	·	$36^{29.2}$	·	·	·	·
Anthemis arvensis	·	·	·	·	·	·	$18^{11.8}$	·	·	·	·	$\mathbf{86}^{\mathbf{82.9}}$		·	·
Medicago sativa	·	·	·	·	9		·	·	·	20^{10}	$18^{8.3}$	$\mathbf{86}^{\mathbf{70.7}}$	·	5	·
Grindelia squarrosa	15	·	·	·	9	·	·	·	·	$\mathbf{67}^{22.1}$	9	$\mathbf{100}^{\mathbf{70.5}}$	·	5	·
Anisantha tectorum	7	·	·	·	·	·	$45^{14.8}$	14		$\mathbf{80}^{36.9}$	$\mathbf{45}^{14.8}$	$\mathbf{100}^{49.7}$	17	16	·
Lepidium ruderale	·	·	·	·	·	·	·	·	·	$20^{19.8}$	·	$43^{49.2}$	·	5	·
Echium vulgare	·	·	·	·	18	·	$27^{7.3}$	·	$\mathbf{100}^{\mathbf{59}}$	$47^{2.1}$	·	$\mathbf{71}^{38.7}$	13	5	·
Ballota nigra	7	·	·	·	18	·	·	$29^{12.4}$	·	·	18	·	$\mathbf{100}^{\mathbf{69.1}}$	11	12
Conium maculatum	·	·	·	·	·	·	·	·	·	·	·	·	$27^{40.5}$	·	·
Leonurus cardiaca	·	·	·	·	·	·	·	·	·	·	·	·	$34^{32.2}$	·	·
Sisymbrium officinale	·	·	·	·	·	·	·	·	·	·	·	·	$39^{28.6}$	·	·
Galinsoga parviflora	·	·	·	·	·	·	·	·	·	·	·	·	$\mathbf{52}^{25.2}$	·	·
Alliaria petiolata	·	·	·	·	·	·	·	·	·	·	·	·	$43^{25.2}$	·	·
Chenopodium album	18	·	·	$28^{\mathbf{50.6}}$	$34^{11.4}$	·	18	·	33	·	·	·	$35^{45.0}$	16^{10}	·
Urtica dioica	·	·	·	·	9	·	·	$29^{27.5}$	·	·	·	·	$30^{29.7}$	·	12
Artemisia vulgaris	·	8	·	$21^{18.1}$	18	·	18	$\mathbf{86}^{41.2}$	·	·	27	·	$39^{21.6}$	$\mathbf{100}^{\mathbf{50.4}}$	·
Artemisia annua	·	·	·	·	·	·	·	·	·	·	·	·	·	$35^{31.5}$	·

Arctium lappa	·	·	·	·	·	·	·	·	·	·	·	·	·	$41^{27.6}$	·
Iva xanthiifolia	·	·	·	·	·	·	·	·	·	·	·	·	·	$35^{25.7}$	·
Arrhenatherum elatius	·	·	·	21	·	·	·	·	·	·	·	·	4	5	**100**
Taraxacum sect. *Taraxacum*	$28^{24.8}$	$\mathbf{100}^{49.4}$	·	15	5	·	18	14	·	·	18	·	4	16	**88**
Erigeron canadensis	28	·	$\mathbf{60}^{8.2}$	21	14	·	$\mathbf{64}^{15.9}$	14	$\mathbf{67}^{17.6}$	$\mathbf{100}^{36.2}$	18	$\mathbf{71}^{20.2}$	17	32	**50**
Elytrigia repens	$\mathbf{93}^{25.6}$	$\mathbf{100}^{25.4}$	·	$\mathbf{64}^{12}$	$\mathbf{77}^{13.2}$	$\mathbf{100}^{25.4}$	$\mathbf{91}^{20.5}$	$\mathbf{86}^{17.8}$	·	·	45	·	**61**	$47^{4.5}$	**62**
Oenothera biennis	·	·	·	·	9	40^{31}	·	·	·	·	9	$29^{25.7}$	9	·	·
Potentilla argentea	18	25	40	18	·	·	27	·	·	47	$\mathbf{55}^{29.2}$	43	4	·	25
Anchusa officinalis	11	·	·	·	5	·	·	·	33^{27}		$36^{30.2}$	·	·	11	12
Ambrosia artemisiifolia	4	·	$\mathbf{60}^{6.1}$	$\mathbf{78}^{19.8}$	22	·	$\mathbf{64}^{13.5}$	·	33	$\mathbf{87}^{33.5}$	$\mathbf{55}^{8.6}$	$\mathbf{86}^{25.6}$	39	47	**75**
Lactuca serriola	14	·	·	·	9	·	$45^{24.5}$	14	·	$\mathbf{60}^{35.8}$	27	·	17	16	12
Euphorbia cyparissias	11	8	·	·	5	40	9	$\mathbf{57}^{34.4}$	33	·	9	·	4	·	12
Daucus carota	·	8	·	·	9	·	$27^{13.8}$	·	$\mathbf{67}^{47.3}$	·	18	·	9	16	12
Plantago major	4	$33^{38.3}$	·	·	14	·		·		·	·	·	$13^{11.7}$	·	·
Portulaca oleracea	$18^{9.7}$	·	·	·	5	·	$45^{36.9}$	·		·	9	$43^{34.4}$	·	·	·
Lamium purpureum	·	·	·	·		·		·	$33^{25.1}$	·	·	·	·	$16^{18.8}$	·
Erigeron annuus	14	8	·	$\mathbf{50}^{14.4}$	32	$\mathbf{100}^{44.8}$	$\mathbf{55}^{17.2}$	·	$\mathbf{67}^{24.6}$	·	9	14	13	$32^{3.2}$	·
Setaria viridis	7	·	·	$\mathbf{75}^{61.2}$	5	·	9	·	·	·	9	·	9	11	12
Polygonum aviculare	39	·	40	28	9	·	18	·	·	47	27	·	39	26	**62**
Dactylis glomerata	11	$42^{26.5}$	·	18	5	·	·	$43^{27.5}$	·	·	·	·	4	32	12
Sisymbrium loeselii	11	·	·	28	·	·	9	·	·	·	18	·	9	5	
Achillea collina	18	8	·	36	14	·	18	43	33	·	18	·	13	5	12
Cichorium intybus	11	17	·	36	14	·	9	·	·	·	9	·	4		
Centaurea borysthenica	·	·	·	·	·	40	·	·	·	·	18	·	·	·	·
Solidago canadensis	4	·	·	·	32	·	·	14	33	·	·	·	17	21	25
Carex hirta	11	17	·	14	5	·	·	·	·	·	·	·	·	5	25
Sonchus oleraceus	·	·	·	·	·	·	·	·	·	·	·	·	9	11	38

Number marks the associations: 1 — *Convolvulo arvensis-Agropyretum repentis*; 2 — *Medicagini lupulinae-Agropyretum repentis*; 3 — *Anisantho-Artemisietum austriacae*; 4 — *Convolvulo-Brometum inermis*; 5 — *Calamagrostietum epigei*; 6 — *Aristolochio-Convolvuletum arvensis*; 7 — *Berteroetum incanae*; 8 — *Asclepiadetum syriacae*; 9 — *Echio-Verbascetum*; 10 — *Melilotetum albo-officinalis*; 11 — *Potentillo argenteae-Artemisietum absinthii*; 12 — *Achilleo millefoliae-Grindelietum squarrosae*; 13 — *Leonuro cardiacae-Ballotetum nigrae*; 14 — *Arctio lappae-Artemisietum vulgaris*; 15 — DC *Arrhenatherum elatius*.

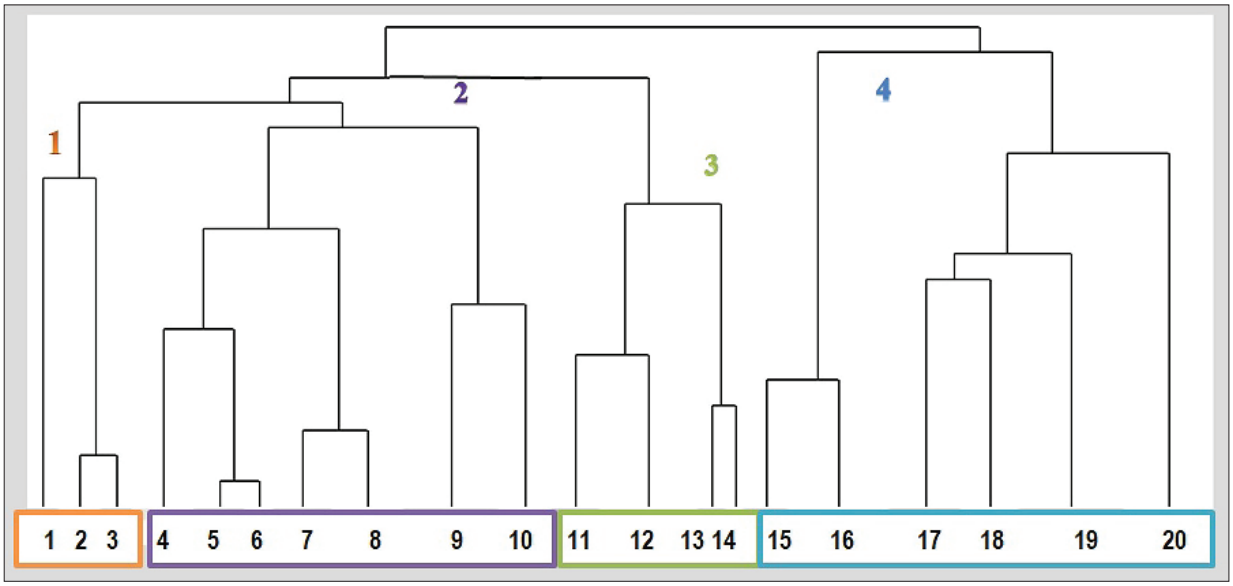

Fig. 1. Dendrogram of the hierarchical classification. Groups: 1 — alliance *Arction lappae*; 2 — alliance *Dauco-Melilotion*; 3 — alliance *Onopordion acanthii*; 4 — alliance *Convolvulo arvensis-Agropyrion repentis*. The numbers of clusters correspond to the vegetation associations detailed below

arvensis-Agropyrion repentis. Within the obtained 20 clusters, we recognized and interpreted 14 vegetation units. In some cases, we considered two clusters as one association. In particular, these were the cases when the dividing of relevés occurred by the dominance of one of diagnostic species.

Description of plant communities

Here we present a brief phytocoenotic characteristics of the associations, taking into account differentiating species and preferred habitats. We do not provide here the definitions of high-rank syntaxa and accept them in accordance with Mucina et al. (2016).

CLUSTER 1. **Ass. *Leonuro cardiacae-Ballotetum nigrae.***

D. sp.: *Alliaria petiolata* (M. Bieb.) Cavara & Grande, ***Ballota nigra*** L. *Chenopodium album* L., *Conium maculatum* L., *Galinsoga parviflora* Cav., *Leonurus cardiaca* L., *Sisymbrium officinale* (L.) Scop., *Urtica dioica* L.

C. sp.: *Ambrosia artemisiifolia* L., *Artemisia vulgaris* L., *Berteroa incana* (L.) DC., *Elytrigia repens* (L.) Nevski, *Lolium perenne* L., *Polygonum aviculare* L.

Phytocoenoses of this association are quite common in all administrative districts of the city and cover various ruderal areas — garbage landfills, lawns, roadsides, strips along walls and fences, areas adjacent to railways, sites near construction grounds, etc. In most cases, habitats are slightly shaded with wet to dry loamy nutrient-rich soils, often with admixtures of building wastes or various organic materials. The stands are usually species-rich (number per relevé varies from 10 to 21, with a total of 79 species), dense (total cover to 90–100%) and two- or three-layered. The dominant species is *Ballota nigra*, while *Elytrigia repens*, *Ambrosia artemisiifolia*, *Conium maculatum*, *Urtica dioica*, *Lolium perenne*, and *Galinsoga parviflora* occur as subdominants in some vegetation plots. An abundant occurrence of other nutrient-demanding species (*Artemisia vulgaris*, *Chelidonium majus* L., *Chenopodium album*, *Oxybasis rubra* (L.) S. Fuentes & al. (*Chenopodium rubrum* L.), *Atriplex prostrata* DC., *Scorzoneroides autumnalis* (L.) Moench (*Leontodon autumnalis* L.), *Alliaria petiolata*, *Arctium tomentosum* Mill., *A. lappa* L., *Taraxacum* F.H. Wigg sect. *Taraxacum*) is also characteristic of this community. Species of dry grasslands (*Achillea collina* (Wirtg.) Heimerl, *A. millefolium* L., *Viola hirta* L., *Oenothera biennis* L., *Artemisia campestris* L., *Euphorbia cyparissias* L., *Bromus squarrosus* L., *Secale sylvestre* Host) are more frequent in stands of phytocoenoses on dry open habitats.

CLUSTERS 2–3. **Ass. *Arctio lappae-Artemisietum vulgaris*.**

D. sp.: *Arctium lappa*, *Artemisia annua* L., ***Artemisia vulgaris***, *Iva xanthiifolia* Nutt.

C. sp.: *Achillea millefolium*, *Ambrosia artemisiifolia*, *Dactylis glomerata* L., ***Elytrigia repens***, *Erigeron annuus* (L.) Desf., *Erigeron canadensis* L., *Polygonum aviculare*.

This community is one of the most common within the territory of Kyiv. It inhabits quite diverse habitats: landfills, edges of fences, roadsides and sidewalks, lawns, abandoned sport grounds, areas near buildings, and industrial sites of the city. We also found these phytocoenoses along railways on the north and west-facing moderate slopes (mean 30–35°). The soils are nutrient-rich clay and chornozems with admixtures of gravel or stones. As a rule, stands are two-layered and reach 120–180 (200) cm in height with total coverage of 80–100%. The upper layer is characterized by the dominance of diagnostic species: tall perennial herbaceous plants of *Artemisia vulgaris* and *Arctium lappa*, sometimes together with *A. tomentosum*. Representatives of *Artemisietea vulgaris* (*Tanacetum vulgare* L., *Daucus carota* L., *Ambrosia artemisiifolia*, *Berteroa incana*, *Artemisia absinthium* L., *Echium vulgare* L., *Melilotus albus* Medik., *Ballota nigra*) and *Stellarietea mediae* (*Erigeron canadensis*, *Iva xanthiifolia*, *Setaria pumila* (Poir.) Roem. & Schult., *Chenopodium album*) included in the middle layer are accompanied by nitrophilous herbs which are characteristic of *Epilobietea angustifolii* class (*Lamium purpureum* L., *Solidago canadensis* L., *Urtica dioica*, *Anthriscus sylvestris* (L.) Hoffm., *Helianthus tuberosus* L.). Within the dense stands, the bottom layer usually is not developed due to shadow of burdock's broad leaves. In semi-closed stands, the lowest layer consists of climbing plants (*Convolvulus arvensis* L.) and some low-growing herbs (*Polygonum aviculare*, *Taraxacum* sect. *Taraxacum*, *Plantago major* L.). In total, the floristic structure of the association is formed by 66 species (from 5 to 15 in some plots).

CLUSTER 4. **DC *Arrhenatherum elatius*.**

Dominant species: *Arrhenatherum elatius*

C. sp.: ***Ambrosia artemisiifolia***, ***Arrhenatherum elatius*** (L.) J. Presl & C. Presl, *Carex hirta* L., ***Elytrigia repens***, *Erigeron canadensis*, *Equisetum arvense* L., ***Plantago lanceolata*** L., ***Polygonum aviculare***, *Potentilla argentea* L., *Solidago canadensis*, *Sonchus oleraceus* L., *Taraxacum* sect. *Taraxacum*.

We observed these stands near the railway stations Karavayevi Dachi and Kyiv Volynskyi on flat areas with humid chornozems mixed with gravel. False oat-grass (*Arrhenatherum elatius*) is a native species in the western part of Ukraine where it forms mesic meadows of the class *Molinio-Arrhenatheretea* (Protopopova et al., 2014). Within the territory of Kyiv, *Arrhenatherum elatius* appears like an alien species and spreads actively in the eastern direction. This process is especially successful due to the permanent mowing of the sites on railway slopes and embankments. It makes the dissemination of *Arrhenatherum elatius* very efficient and causes forming of dense stands with a high dominance ability of the mentioned grass. Stands of the community are usually dense with total coverage of 70–80% reaching in height of 100–120 cm. Among the companions, species characteristic of *Artemisietea vulgaris* (*Ballota nigra*, *Elytrigia repens*, *Daucus carota*) and *Molinio-Arrhenatheretea* (*Equisetum arvense*, *Agrostis stolonifera* L., *Carex hirta*, *Vicia cracca* L., *Trifolium hybridum* L.) are noticed.

CLUSTERS 5–6. **Ass. *Melilotetum albo-officinalis*.**

D. sp.: *Achillea setacea* Waldst. & Kit., *Ambrosia artemisiifolia*, *Anisantha tectorum* (L.) Nevski (*Bromus tectorum* L.), *Artemisia absinthium*, *Erigeron canadensis*, *Lactuca serriola* L., *Linaria genistifolia* (L.) Mill., ***Melilotus albus***

C. sp.: *Berteroa incana*, *Echium vulgare*, ***Grindelia squarrosa*** (Pursh) Dunal, *Polygonum aviculare*, *Potentilla argentea*

This community is locally distributed within Kyiv City, mainly in Darnytskyi and Dniprovskyi districts. It inhabits anthropogenic areas (around industrial sites, along roads and railways) on shallow well-drained sandy soils with high gravel and stone content. In total, the floristic structure of the association is formed by 23 species (from 8 to 10 in some plots). The two-layered stands reach 80–110 cm in height and have a total cover of 40–50%. The herb layer is usually dominated by *Melilotus albus*. The most characteristic components of the phytocoenoses are xerophilous light-demanding species, such as *Ambrosia artemisiifolia*, *Anisantha tectorum*, *Bromus squarrosus*, *Achillea setacea*, *Capsella bursa-pastoris* (L.) Medik., *Linaria genistifolia*, *Lepidium ruderale* L., *Erigeron canadensis*. Common species of the class *Artemisietea vulgaris* (e.g., *Grindelia squarrosa*, *Echium vulgare*, *Artemisia absinthium*, *Berteroa incana*) are also well-represented.

CLUSTERS 7–8. **Ass. *Berteroetum incanae.***

D. sp.: *Anthemis ruthenica* M. Bieb., *Berteroa incana*, *Poa compressa* L., *Portulaca oleracea* L., *Silene latifolia* Poir.

C. sp.: ***Ambrosia artemiisifolia***, *Anisantha tectorum*, *Daucus carota*, ***Elytrigia repens***, *Echium vulgare*, ***Erigeron annuus***, ***Erigeron canadensis***, *Lactuca serriola*, *Melilotus albus*, *Plantago lanceolata*, *Potentilla argentea*.

This community, dominated by the biennial herb *Berteroa incana*, colonizes well-drained, warm sandy to loamy soils with a high proportion of gravel or stones. We found phytocoenoses along railway tracks, highways, roads, and sidewalks. Chokha (2005) also mentioned them as occurring on abandoned lawns. The association was represented by 15 relevés sampled in all districts of the city. In total, the coenoflora of this association is composed of 48 taxa. A number of species in the vegetation plots is between 6 and 12. The stands are low, two-layered, reaching on average 40–60 cm. The bottom layer is formed by diagnostically important *Berteroa incana*, *Portulaca oleracea*, and species of higher syntaxa, both anthropogenic and natural vegetation, e.g. *Stellarietea mediae* (*Ambrosia artemisiifolia*, *Erigeron canadensis*, *Anisantha tectorum*, *Setaria viridis* (L.) P. Beauv., *Sisymbrium loeselii* L.), *Artemisietea vulgaris* (*Echium vulgare*, *Artemisia vulgaris*, *A. absinthium*, *Daucus carota*, *Melilotus albus*), *Koelerio-Corynephoretea canescentis* (*Plantago arenaria* Waldst. & Kit., *Oenothera biennis*, *Artemisia campestris*). In the lower layer, *Poa compressa*, *Polygonum aviculare*, *Convolvulus arvensis*, and *Medicago lupulina* L. are concentrated. Some grasses (*Elytrigia repens*, *Arrhenatherum elatius*), which overtop the stands, locally form another, third rather loose layer.

CLUSTER 9. **Ass. *Asclepiadetum syriacae.***

D. sp.: *Artemisia vulgaris*, ***Asclepias syriaca*** L., *Dactylis glomerata*, *Euphorbia cyparissias*, *Fallopia convolvulus* (L.) Á. Löve, ***Melampyrum arvense*** L., *Urtica dioica*, *Verbascum phlomoides* L.

C. sp.: *Achillea collina*, *Ballota nigra*, *Berteroa incana*, *Calamagrostis epigejos* (L.) Roth, ***Elytrigia repens***, *Equisetum arvense*

This vegetation type is dominated by the tall herb *Asclepias syriaca*, an invasive plant species of North American origin. Within the Kyiv urban area, this species-poor community occurs on railway slopes (usually of the southern exposure) and roadsides. Soils are often dry, ranging from chornozem to stony. The floristic structure comprised 33 plant species (6–13 per relevé). Stands are usually one- or two-layered, reaching on average 80–100 cm and having a total cover of 60 to 90%. The upper layer consists of the dominant *Asclepias syriaca*, broad-leaved ruderal herbs (*Artemisia vulgaris*, *Urtica dioica*, *Ballota nigra*, *Berteroa incana*, *Chelidonium majus*), and grasses (*Calamagrostis epigejos*, *Elytrigia repens*, *Bromopsis inermis*, *Anisantha tectorum*, *Dactylis glomerata*). In the bottom layer, the most common species are *Equisetum arvense*, *Achillea collina*, *Melampyrum arvense*, *Taraxacum* sect. *Taraxacum*, as well as climbing plants (*Fallopia convolvulus*, *Convolvulus arvensis*).

CLUSTER 10. **Ass. *Echio-Verbascetum.***

D. sp.: *Daucus carota*, ***Echium vulgare***, ***Equisetum arvense***, *Lamium purpureum*, ***Picris hieracioides*** L., *Plantago arenaria*, ***Tragopogon dubius* subsp. *major*** (Jacq.) Vollm., *Verbascum lychnitis* L.

C. sp.: *Achillea millefolium*, *Ambrosia artemisiifolia*, *Anchusa officinalis* L., *Berteroa incana*,*Calamagrostis epigejos*, *Chenopodium album*, ***Erigeron annuus***, ***Erigeron canadensis***, *Euphorbia cyparissias*, *Solidago canadensis.*

This community has a local distribution within Kyiv and was documented by five relevés sampled in Svyatoshynskyi and Holosiyivskyi districts on railway slopes and abandoned building sites. All habitats are associated with open sunny places on sandy soils, sometimes with an admixture of gravel and stones. Stands are not dense (to 60–70% total cover) and are only slightly stratified. The total number of species in the phytocoenoses reaches 40, in some relevés — 10–13. The aspect of communities is determined by a diagnostic species, *Echium vulgare*, with quite conspicuous blue flowers. Ruderal species (e.g., *Humulus lupulus* L., *Picris hieracioides*, *Daucus carota*, *Erigeron canadensis*, *Ambrosia artemisiifolia*, *Erigeron annuus*, *Berteroa incana*), as well as representatives of the psammophytic floristic coenocomplex (*Artemisia campestris*, *Oenothera biennis*, *Plantago arenaria*), are frequent in the species composition.

CLUSTERS 11–12. **Ass. *Achilleo millefoliae-Grindelietum squarrosae.***

D. sp.: *Ambrosia artemisiifolia*, ***Anthemis arvensis*** L., *Anisantha tectorum*, *Echium vulgare*, ***Grindelia squarrosa***, *Lepidium ruderale*, ***Medicago sativa*** L., *Oenothera biennis*, *Portulaca oleracea*

C. sp.: *Berteroa incana*, ***Erigeron canadensis***, *Melilotus albus*, *Potentilla argentea*, *Setaria pumila*

This community was found on railway slopes and waste places on sandy soils with high content of gravel or pebbles. It occurs mainly in Holosiyivskyi, Svyatoshynskyi, and Darnytskyi districts. Stands are normally 50–60 cm tall with a total cover of 60–70%, of which *Grindelia squarrosa* makes up 40–50%. Differentiation into layers is indistinct, but some plants, such as *Echium vulgare*, *Melilotus albus*, *Artemisia absinthium*, sometimes overtop the herb layer. Drought-tolerant heliophilous species (*Anisantha tectorum*, *Ambrosia artemisiifolia*, *Berteroa incana*, *Anthemis arvensis*, *Erigeron canadensis*, *Potentilla argentea*) usually prevail together with herbs characteristic of *Koelerio-Corynephoretea canescentis* class (*Festuca beckeri* (Hack.) Trautv., *Oenothera biennis*, *Artemisia campestris*). The number of species varies from 8 to 12 (the total count is 20).

CLUSTERS 13–14. **Ass. *Potentillo argenteae-Artemisietum absinthii.***

D. sp.: *Anchusa officinalis*, ***Artemisia absinthium***, *Consolida regalis* Gray, *Elytrigia intermedia* (Host) Nevski, *Hypericum perforatum* L., *Medicago sativa* subsp. *falcata* (L.) Arcang., *Melilotus albus*, *Poa bulbosa* L., *Potentilla argentea.*

C. sp.: ***Ambrosia artemisiifolia***, *Anisantha tectorum*, *Artemisia vulgaris*, ***Berteroa incana***, *Diplotaxis tenuifolia* (L.) DC., *Elytrigia repens*, *Lactuca serriola*, *Plantago lanceolata*, *Polygonum aviculare*

This association includes species-rich thermophilous vegetation growing on sunny and dry ruderal sites. In most cases, soils are loamy, mostly with an admixture of gravel and stones, rich in nutrient compounds. We documented this plant community in all districts of the city on building rubble, railway slopes (usually moderate, sun-exposed with south and southwest orientations), along roads, and sidewalks. Stands are not dense (total cover of 40–70%) and quite variable in both their abundance and number of species, but species-rich stands prevail. The number of species per relevé can vary from 9 to 19. In total, 68 taxa were recorded for this association in the study area. Stands reach up to 70–80 cm and are three-layered, of which the upper layer consists of the dominant *Artemisia absinthium* (with a cover of 40–60%) together with other tall ruderal herbs (*Elytrigia repens*, *Artemisia vulgaris*, *Portulaca oleracea*, *Lactuca serriola*, *Daucus carota*). The middle layer frequently consists of herbs characteristic of the class *Artemisietea vulgaris* (*Potentilla argentea*, *Berteroa incana*, *Melilotus albus*, *Grindelia squarrosa*), together with representatives of *Stellarietea mediae* (*Anisantha tectorum*, *Diplotaxis tenuifolia*, *Ambrosia artemisiifolia*, *Eragrostis minor* Host, *Setaria viridis*, *Erigeron canadensis*, *Sisymbrium loeselii*). The most frequent dominants of the bottom layer are climbing plants *Convolvulus arvensis* and *Fallopia convolvulus*. In habitats affected by trampling, the floristic composition of phytocoenoses is characterized by constant participation of *Polygonum aviculare*, *Cichorium intybus* L., *Plantago major*, and *Taraxacum* sect. *Taraxacum*. The occurrence of some species diagnostic for *Koelerio-Corynephoretea canescentis* class (e.g. *Centaurea borysthenica* Gruner, *Artemisia campestris*, *Poa bulbosa*, *Secale sylvestre*, *Scabiosa ochroleuca* L., *Medicago sativa* subsp. *falcata*) is also remarkable.

CLUSTER 15. **Ass. *Convolvulo arvensis-Elytrigietum repentis*** (incl. *Agropyretum repentis*).

D. sp.: *Amaranthus albus* L., *Convolvulus arvensis*, *Elytrigia repens*, *Plantago lanceolata*.

C. sp.: *Berteroa incana*, *Erigeron canadensis*, *Polygonum aviculare*, *Taraxacum* sect. *Taraxacum.*

This association is the most widespread in the territory of Kyiv. It is found along roads, fences, transport routes, park alleys, near buildings, garbage dumps and landfills, and other anthropogenic areas. It is represented by 58 relevés that were sampled from all districts of the city. In most cases, soils are loamy to clayey, often with high calcium content. It also could be found on different anthropogenic substrates with admixtures of sand or stones. The habitats are dry, warm, and well-lit.

The association includes phytocoenoses with the dominance of *Elytrigia repens*, which forms dense, sometimes monodominant stands. *Convolvulus arvensis* is a constant species, with different cover values in various vegetation plots. The association is made of 157 species in total, and their number per relevé varies from 5 to 19. The floristic composition of plant communities is formed by typical ruderal plants (*Berteroa incana*, *Artemisia vulgaris*, *Erigeron canadensis*, *Chenopodium album*, *Lactuca serriola*, *Daucus carota*, *Portulaca oleracea*, *Ambrosia artemisiifolia*, *Erigeron annuus*, *Ballota nigra*) and meadow grasses (*Lolium perenne*, *Poa pratensis* L., *Taraxacum* sect. *Taraxacum*, *Trifolium pratense* L., *Dactylis glomerata*, *Carex hirta*, *Schedonorus pratensis* (Huds.) P. Beauv.). Stands are two- or three-layered, reaching 80–120 cm in height, with dense coverage to 90–100%. The upper layer is characterized by the diagnostic species *Elytrigia repens* usually accompanied by *Chenopodium album*,

Erigeron canadensis, *Dactylis glomerata*, *Artemisia absinthium*, and *Portulaca oleracea*. The middle layer is made up of *Setaria viridis*, *Digitaria sanguinalis* (L.) Scop., *Potentilla argentea*, *Grindelia squarrosa*, *Berteroa incana*, *Glechoma hederacea* L., *Taraxacum* sect. *Taraxacum*, *Tripleurospermum inodorum* (L.) Sch. Bip., and *Capsella bursa-pastoris*. In the lower layer, mainly *Polygonum aviculare*, *Plantago lanceolata*, and *P. major* frequently occur.

There are two variants distinguished within the association, which differ by their species composition and habitat affiliation. Phytocoenoses of *Convolvulo arvensis-Elytrigietum repentis* var. *Berteroa incana* grows along roads and railways on dry soils with an admixture of sand or stones. This variant is characterized by the predominance of thermophilous plant species which represent classes *Festuco-Brometea* (*Achillea collina*, *Euphorbia cyparissias*, *Festuca valesiaca* Gaudin, *Medicago sativa* subsp. *falcata*, *Viola hirta*) and *Koelerio-Corynephoretea canescentis* (*Centaurea borysthenica*, *Oenothera biennis*, *Chondrilla juncea* L., *Secale sylvestre*).

Plant communities of *Convolvulo arvensis-Elytrigietum repentis* var. *Polygonum aviculare* are typical for lawns, park alleys, and various trampled areas. Well-developed stands consist of representatives of the classes *Stellarietea mediae* (*Lactuca serriola*, *Erigeron canadensis*, *Digitaria sanguinalis*, *Eragrostis minor*, *Galinsoga parviflora*, *Amaranthus albus*) and *Polygono-Poetea annuae* (*Polygonum aviculare*, *Taraxacum* sect. *Taraxacum*, *Plantago lanceolata*, *Lolium perenne*).

CLUSTER 16. **Ass. *Medicagini lupulinae-Agropyretum repentis.***

D. sp.: *Achillea millefolium*, ***Agrostis capillaris*** L., *Arctium tomentosum*, *Argentina anserina* (L.) Rydb., *Bromus hordeaceus* L., ***Centaurea jacea*** L., ***Cerastium arvense*** L., *Cirsium arvense* (L.) Scop., *Dactylis glomerata*, *Elytrigia repens*, *Eragrostis minor*, ***Festuca rubra*** L., *Fragaria vesca* L., *Galium verum* L., ***Glechoma hederacea***, *Lolium perenne*, ***Lotus corniculatus*** L., *Malva thuringiaca* (L.) Vis., ***Medicago lupulina***, *Phleum pratense* L., *Plantago major*, ***Poa pratensis***, ***Potentilla reptans*** L., *Rumex acetosella* L., ***R. confertus*** Willd., *Schedonorus pratensis*, *Taraxacum* sect. *Taraxacum*, ***Trifolium pratense***, ***T. repens*** L., *Veronica chamaedrys* L.

C. sp.: *Plantago lanceolata*, *Potentilla argentea*.

This vegetation type was recorded on the lawns of the city. It is represented by 12 relevés sampled in Shevchenkivskyi, Holosiyivskyi, Pecherskyi, and Solomyanskyi districts. Coenoses are confined to the open well-lit habitats with chornozem or sandy chornozem soils. Plant communities are characterized by high species richness (16–22 species in the relevé with a total taxa number of 54), high density (total cover 80–100%), and height of 80–100 cm of stands. The vertical structure is two-layered. The taller plants are concentrated in the upper layer; of them the most important is a diagnostic species *Elytrigia repens* and several other dominant species (*Schedonorus pratensis*, *Festuca rubra*, *Poa pratensis*, *Dactylis glomerata*). Included in the middle layer usually are *Medicago lupulina*, *Taraxacum* sect. *Taraxacum*, *Trifolium pratense*, *Achillea millefolium*, *Potentilla reptans*, *Plantago lanceolata*. A high frequency of diagnostic species for *Molinio-Arrhenatheretea* class is a characteristic feature of this association.

CLUSTER 17. **Ass. *Convolvulo-Brometum inermis.***

D. sp.: *Achillea millefolium*, *Atriplex prostrata* DC., ***Bromopsis inermis*** (Leyss.) Holub (*Bromus inermis* Leyss.), ***Chenopodium album***, *Salsola tragus* L., ***Setaria viridis***

C. sp.: ***Ambrosia artemisiifolia***, *Berteroa incana*, *Calamagrostis epigejos*, *Cichorium intybus*, ***Elytrigia repens***, ***Erigeron annuus***, *Plantago lanceolata*, *Polygonum aviculare*, *Sisymbrium loeselii.*

Association includes stands of *Bromopsis inermis* that inhabit areas along roads and railways on dry loamy soils with an admixture of sand. It is distributed sporadically in Svyatoshynskyi and Darnytskyi districts. The number of species per plot varies between 8 and 14 species (in total 26 species have been recorded). The herb coverage is usually dense, with total coverage of 90 to 100%. Well-developed two-layer stands reach up to 70–90 cm. They consist of the dominant *Bromopsis inermis*, other grasses (e.g., *Dactylis glomerata*, *Elytrigia repens*, *Setaria viridis*, *Calamagrostis epigejos*, *Poa angustifolia* L., *Arrhenatherum elatius*), and perennial ruderal species (*Artemisia vulgaris*, *Potentilla argentea*). The occurrence of annual plants (*Chenopodium album*, *Ambrosia artemisiifolia*, *Erigeron canadensis*, *Sisymbrium loeselii*, *Atriplex prostrata*, etc.) is also remarkable.

CLUSTER 18. **Ass. *Aristolochio-Convolvuletum arvensis.***

D. sp.: ***Achillea setacea***, ***Aristolochia clematitis*** L., ***Artemisia campestris*** L., *Asclepias syriaca*, *Calamagrostis epigejos*, *Chondrilla juncea*, *Elytrigia repens*, *Erigeron annuus*, ***Odontites***

vulgaris Moench, *Oenothera biennis*, ***Poa angustifolia***, *Rumex acetosa* L., ***Verbascum thapsus*** L.

C. sp.: *Centaurea borysthenica*, *Euphorbia cyparissias*, ***Medicago sativa* subsp. *falcata***, ***Picris hieracioides.***

The communities of the association are sporadically distributed in the study area. We found stands mainly in Desnianskyi District on lower sections of railway slopes with sandy chornozem soils. Phytocoenoses had low species richness (the species number varied from 9 to 13 per relevé). Stands are normally 60–80 (100) cm tall, with a total cover of 60 to 80%. They are usually differentiated into two layers. The upper layer consists of the diagnostic species *Elytrigia repens*, *Poa angustifolia*, *Calamagrostis epigejos*, *Verbascum thapsus*, *Asclepias syriaca*. The bottom layer is made up of several diagnostic species (*Achillea setacea*, *Aristolochia clematitis*, *Erigeron annuus*, *Trifolium arvense* L.) along with *Medicago sativa* subsp. *falcata*, *Rumex acetosa*, *Chondrilla juncea*, *Centaurea borysthenica*, *Picris hieracioides*, etc.

CLUSTER 19. **Ass. *Anisantho-Artemisietum austriacae.***

D. sp.: ***Artemisia austriaca* Jacq.**, *Diplotaxis tenuifolia*, ***Setaria pumila***

C. sp.: ***Ambrosia artemisiifolia***, ***Erigeron canadensis***, *Polygonum aviculare*, *Potentilla argentea*

It is a rare association within the city of Kyiv. Phytocoenoses were recorded only in one locality, between the railway stations Livoberezhna and Darnytsia. It occurs in sunny open dry habitats, e.g. railway slopes with a steepness of 35°. The soils are sandy with a small admixture of pebbles. These plant communities are dominated by *Artemisia austriaca*. Among other species, there are typical xerophytes, such as *Bromus squarrosus*, *Achillea millefolium*, *Grindelia squarrosa*. In total, 13 species were found in the phytocoenoses, on average 7–13 per relevé. The total cover of communities is 40–60%. Stands 50–60 cm tall are one or two-layered. The upper layer (40–60 cm) consists of diagnostically important *Artemisia austriaca*, *Setaria pumila*, together with tall plants of *Ambrosia artemisiifolia*, *Artemisia absinthium*, and *Erigeron canadensis*. The bottom layer (5–15 cm) is made up of *Polygonum aviculare*, *Potentilla argentea*, *Diplotaxis tenuifolia*.

CLUSTER 20. **Ass. *Calamagrostietum epigei.***

D. sp.: *Anisantha sterilis* (L.) Nevski, ***Calamagrostis epigejos***

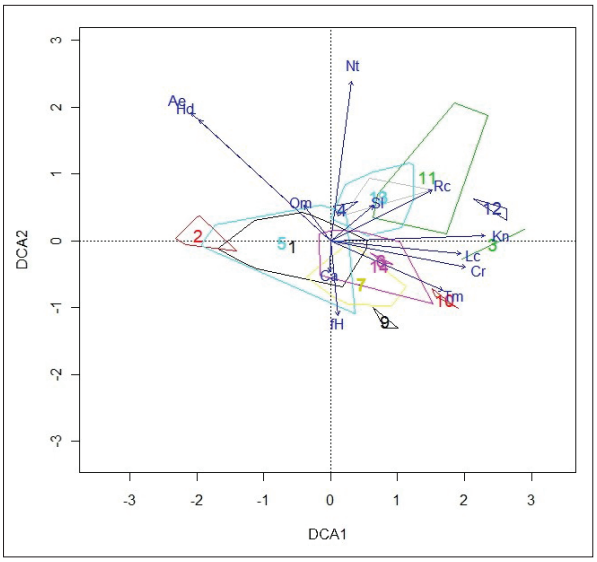

Fig. 2. Results of DCA-ordination of plant communities of the class *Artemisietea vulgaris* by ecological factors: Hd — soil humidity, fH — fluctuating of water level, Rc — soil acidity, Sl — salt regime, Ca — carbonate content, Nt — nitrogen content, Ae — soil aeration, Tm — termoregime, Om — ombroregime, Kn — continentality of climate, Cr — cryoregime, Lc — light regime. The numbers indicate syntaxa that correspond to those given in the classification scheme

C. sp.: *Chenopodium album*, *Convolvulus arvensis*, ***Elytrigia repens***, *Erigeron annuus*, *Solidago canadensis*

The plant communities of the association are widely distributed within the Kyiv urban area. In most cases, habitats are roadsides, lawns, and abandoned sites near buildings. Stands are usually dense, with a total cover of up to 80–100% and a height of 120–150 cm. A total of 94 species were recorded in the plant communities (5–16 per relevé). The vertical structure of phytocoenoses is normally two-layered. In the upper layer, *Elytrigia repens* and *Poa pratensis* were recorded together with the diagnostic *Calamagrostis epigejos*. In the lower layer, *Vicia cracca*, *Polygonum aviculare*, *Plantago lanceolata*, and *Convolvulus arvensis* are frequently concentrated.

Depending on habitat conditions and floristic composition, the following two variants may be distinguished: (a) containing meadow plant species – the variant with *Dactylis glomerata*; (b) consisting of typical ruderal plants — the variant with *Elytrigia repens*. Phytocoenoses of *Calamagrostietum epigei* var. *Dactylis glomerata* occur

***Artemisietea vulgaris* Lohmeyer et al. in Tx. ex von Rochow 1951**
Agropyretalia intermedio-repentis T. Müller et Görs 1969
Convolvulo arvensis-Agropyrion repentis Görs 1967
1. *Convolvulo arvensis-Agropyretum repentis* Felföldy 1943
var. *Berteroa incana*
var. *Polygonum aviculare*
2. *Medicagini lupulinae-Agropyretum repentis* Popescu et al. 1980
3. *Anisantho-Artemisietum austriacae* Kostylev 1985
4. *Convolvulo-Brometum inermis* Eliáš 1979
5. *Calamagrostietum epigei* Kostylev in Solomakha et al. 1992
var. *Dactylis glomerata*
var. *Elymus repens*
6. *Aristolochio-Convolvuletum arvensis* Ubrizsy 1967
Onopordetalia acanthii Br.-Bl. et Tx. ex Klika et Hadač 1944
Dauco-Melilotion Görs et Rostanski et Gutte 1967
7. *Berteroetum incanae* Sissingh et Tideman ex Sissingh 1950
8. *Asclepiadetum syriacae* Láníková in Chytrý 2009
9. *Echio-Verbascetum* Sissingh 1950
10. *Melilotetum albo-officinalis* Sissingh 1950
Onopordion acanthii Br.-Bl. et al. 1936
11. *Potentillo argenteae-Artemisietum absinthii* Faliński 1965
12. *Achilleo millefoliae-Grindelietum squarrosae* Kostylev in Solomakha et al. 1992
Arction lappae Tx. 1937
13. *Leonuro cardiacae-Ballotetum nigrae* Slavnić 1951
14. *Arctio lappae-Artemisietum vulgaris* Oberd. ex Seybold et T. Müller 1972
DC *Arrhenatherum elatius* [*Artemisietea vulgaris-Molinio-Arrhenatheretea*]

along fences, as well as in lawns, park sites, and different abandoned areas. This vegetation develops on slightly shaded habitats with mesic to dry soils rich in nutrients. The species diagnostic for *Molinio-Arrhenatheretea* class (e.g., *Poa pratensis*, *Dactylis glomerata*, *Trifolium pratense*, *T. repens*, *Taraxacum* sect. *Taraxacum*, *Lotus corniculatus*, *Equisetum arvense*) are typical for the species composition of these plant communities. On the contrary, the phytocoenoses of *Calamagrostietum epigei* var. *Elytrigia repens* prefer open well-lit habitats with sandy soils. Plant communities were found on roadsides, railway slopes, and the surroundings of parking slots. Stands are characterized by the dominance of typical ruderal plants, such as *Daucus carota*, *Solidago canadensis*, *Erigeron annuus*, *Ambrosia artemisiifolia*, *Artemisia vulgaris*, *Ballota nigra*, *Echium vulgare*, *Erigeron canadensis*, *Melilotus albus*, and *Chenopodium album*. The participation of representatives of the class *Koelerio-Corynephoretea canescentis* (e.g., *Artemisia campestris*, *Oenothera biennis*, *Medicago sativa* subsp. *falcata*) is also notable.

Thus, the classification scheme of the class *Artemisietea vulgaris* within the city of Kyiv in accordance with our results is as follows:

Ecological preferences of the vegetation

The DCA-diagram (Fig. 2) reveals that the main environmental gradients of ecological ordination of the class *Artemisietea vulgaris* in the Kyiv urban area are thermoregime and light. The first axis reflects the division between relevés of open thermophilous and drought-adapted stands and vegetation of slightly shaded areas on quite moist soils.

According to ecological requirements, it has been found that within the Kyiv City the stands of *Artemisietea vulgaris* inhabit areas with insufficient moisture supply (Fig. 3A). Only *Medicagini lupulinae-Agropyretum repentis* tends to mesic conditions. The mentioned plant communities are also different in relation to other closely correlated edaphic factors, including soil aeration (Fig. 3B) and fluctuating water level (Fig. 3C). All phytocoenses of the class in the territory of Kyiv City prefer neutral soils (Fig. 3D) with a minimum content of mineral salts (Fig. 3E) and carbonate compounds (Fig. 3F). In

Table 2. **Values of Jaccard similarity coefficients for associations of the class *Artemisietea vulgaris* in the territory of Kyiv compared with other cities and regions of Ukraine**

Association	KR*	Chk	Mel	NBS	R
Convolvulo arvensis-Agropyretum repentis	0.05	0.23	0.16	0.09	0.23
Medicagini lupulinae-Agropyretum repentis	-	-	-	0.07	-
Anisantho-Artemisietum austriacae	0.33	0.02	0.05	0.09	-
Convolvulo-Brometum inermis	0.18	-	-	0.15	-
Calamagrostietum epigei	-	0.27	0.09	0.11	0.25
Berteroetum incanae	0.14	-	-	0.24	0.22
Melilotetum albo-officinalis	0.13	0.17	-	0.15	0.08
Potentillo argenteae-Artemisietum absinthii	0.10	-	-	-	0.19
Achilleo millefoliae-Grindelietum squarrosae	0.07	-	-	0.09	-
Arctio lappae-Artemisietum vulgaris	0.09	0.30	-	0.05	0.21

*KR — Kryvyi Rih (Yeremenko, 2017); Chk — Cherkasy (Osypenko, Shevchyk, 2001); Mel — Melitopol (Bredikhina, 2015); NBS — Northern Black Sea Region (Dubyna et al., 2004); R — Roztochya (Soroka, 2008).

terms of nitrogen content (Fig. 3G), it was observed that the stands belonging to the associations of the alliance *Arction lappae* are more demanding on such compounds compared to other communities of the *Artemisietea vulgaris*.

Differentiation of plant communities is not so pronounced according to climatic indicators. In relation to the thermal regime, stands of *Artemisietea vulgaris* are mainly submesothermic (Fig. 3H), subaridophytic according to the aridity-humidity of the climate (Fig. 3I), hemicontinental by its continentality degree (Fig. 3J), and hemicryophilic by cryoregime (Fig. 3K). It has been also found that phytocoenoses of the class are mostly distributed in open well-lit habitats (Fig. 3L).

Discussion

Based on the data analysis, we identified three orders, four alliances, 14 associations, and one derivative community within the class *Artemisietea vulgaris* in Kyiv City. In the territory of Kyiv, almost all types of phytocoenoses of the class *Artemisietea vulgaris* at the level of alliances are represented, except those described and distributed in Ukraine only in Crimea or in the adjacent continental southern part of the country (*Medicagini falcatae-Diplotaxion tenuifoliae* Levon 1997 and *Rorippo austriacae-Falcarion vulgaris* Levon 1997). It is necessary to emphasize that we have also included the alliance *Arction lappae* into the class *Artemisietea vulgaris*, despite its still debatable status. Our decision was based on the argument that the species composition of *Arction lappae* does not differ significantly from the vegetation of *Artemisietea vulgaris* class by prevailing in stands of its representatives, species of dry habitats and alien plants (both archaeophytes and neophytes). Since *Epilobietea angustifolii* (incl. *Galio-Urticetea*) vegetation is mesophilic and consists mainly of native species, we followed other European phytosociologists (Jarolímek et al., 1997; Borhidi, 2003; Matuszkiewicz, 2007; Chytrý et al., 2017) who classified nitrophilous biennial plant communities on mesic soils within the *Artemisietea vulgaris* class.

At the association level, vegetation diversity in the city of Kyiv represents 30.5% of the total diversity of the class *Artemisietea vulgaris* in the territory of Ukraine (Dubyna et al., 2019, 2022). Such significant syntaxonomic representation and comparison of this vegetation type with that in other large cities (Kucheryavyi et al., 1991; Yeremenko, 2017) allow us to conclude that within the study area the class *Artemisietea vulgaris* is characterized by high coenotic diversity. The diversity of man-made habitats as well as regional environmental conditions appeared as the most important factors affecting the variation in this vegetation type. Peculiarities of its vertical structure in the study area are manifested by dense species-rich stands, indistinct layer differentiation, and the high dominance ability of some diagnostic species. The coenotaxonomic specificity was manifested at the level of frequent species, which are characteristic of *Molinio-Arrhenatheretea*, *Koelerio-Corynephoretea canescentis*, and *Plantaginetea majoris*.

The species composition of most widespread associations is most similar to those reported for Central and Western Ukraine (Table 2), as well

Fig. 3. Distribution of associations of the class *Artemisietea vulgaris* by soil humidity (A), soil aeration (B), fluctuating of water level (C), soil acidity(D), salt regime of soil (E), carbonate content in soil (F), nitrogen content in soil (G), thermoregime of climate (H), ombroregime of climate (I), continentality degree of climate (J), cryoregime of climate (K), light regime of habitats (L). Numbers on the horizontal (x, abscissa) axis correspond to the number of syntaxa in the classification scheme, the values of environmental factors are indicated on the vertical (y, ordinate) axis, colours of boxplots indicate different vegetation alliances.

Continuation of **Fig. 3.**

as their habitat preferences. Primarily, due to the ruderal plants and typical species for neighboring grassland vegetation types of classes *Molinio-Arrhenatheretea*, *Koelerio-Corynephoretea canescentis*, and *Trifolio-Geranietea sanguinei*, those are more characteristic for the forest-steppe zone. At the same time, the species composition of the associations that are mainly distributed in the southern part of Ukraine in the study area includes more thermophilous plants than the same phytocoenoses in Central and Western Ukraine, if they were found there.

In the study area, vegetation of *Artemisietea vulgaris* follows and replaces the plant communities of annual ruderal vegetation of the class *Stellarietea mediae*. When further human impact is absent or insignificant, stands of *Artemisietea vulgaris* could be replaced by different types of herb or scrub vegetation depending on the initial environmental conditions. However, because of permanent human pressure within the territory of Kyiv City, stands of the class for a long time remain at the serial stage, without proceeding to the next stages of succession.

The leading factors of territorial differentiation of *Artemisietea vulgaris* within Kyiv City are the soil type and its structure, as well as the intensity of diverse human impact and habitat disturbances. We demonstrated that the vegetation of *Artemisietea vulgaris* is distributed throughout the entire city. It is typical for disturbed natural habitats, lawns, railway slopes, roadsides, waste places, industrial sites, and abandoned sports grounds. The most widespread stands within the territory of Kyiv City belong to the associations *Convolvulo arvensis-Agropyretum repentis*, *Medicagini lupulinae-Agropyretum repentis*, *Calamagrostietum epigei*, *Berteroetum incanae*, *Leonuro cardiacae-Ballotetum nigrae*, and *Arctio lappae-Artemisietum vulgaris*. We also observed active spread of some other plant communities. In particular, during our observation period the number of stands dominated by *Asclepias syriaca* has apparently increased. The plant is native to North America and within its native range it grows in well-drained sandy, clayey, or rocky calcareous soils along the banks of lakes, ponds, and waterways, in prairies, and at forest margins (Bhowmik, 1994; Hartzler, Buhler, 2000; Gudžinskas et al., 2021). In the study area, it most often occurs in dry habitats, particularly along roads and railways. We also found this species accompanied in the stands of unmanaged xeric and mesic grasslands of the city. Its tolerance to a wide range of soil humidity (from dry to moist soils), high potential ability to invade different habitats, as well as factors of climate changes, may facilitate its further spread over larger areas in the future (Gudžinskas et al., 2021). Climate changes also affected the appearance within the city of some plant communities typical for southern regions, e.g., *Anisantho-Artemisietum austriacae* and *Convolvulo-Brometum inermis*, which in the previous survey of the vegetation of Ukraine (Dubyna et al., 2019) were reported only for the steppe zone. The most habitable (suitable) areas for these plant communities in the study area are the open and driest sites near railway tracks and large roads. In such places, microclimatic indices correspond to those characteristic of the habitats of these stands.

Further research of the vegetation of the class in the territory of Kyiv City is desirable. There are some associations belonging to the class *Artemisietea vulgaris* that we expect to appear in Kyiv; first of all, those with the diagnostic participation of thermophilous species, as well as some alien ones. The presence of non-native plants in urban areas increases over time and now it causes significant changes in the composition and structure of the flora and plant communities of the city. It is therefore really important to contribute to the research on the trends of occurrence and spreading of alien species in various types of the *Artemisietea vulgaris* coenoses and, depending on the obtained data, start to develop the appropriate management measures to prevent biodiversity losses in neighboring natural vegetation types. In addition, habitats of *Artemisietea vulgaris* within Kyiv and other urban environments may be important for protection of certain endangered plant species.

Conclusions

The vegetation of the class *Artemesietea vulgaris* in Kyiv is characterized by high coenotic diversity. Based on the analysis of the representative dataset, we identified three orders, four alliances, 14 associations, and one derivative community. They prefer mostly man-made habitats and semi-natural sites with well-lit nutrient-rich soils, different regarding humidity and mechanical structure. Our ecological analysis reveals that the main environmental gradients of the ordination of the class *Artemisietea vulgaris* in the Kyiv urban area are thermoregime

and light. According to ecological requirements, it has been found that the stands of *Artemisietea vulgaris* inhabit areas with insufficient moisture supply, neutral nutrient-rich soils with a minimum content of mineral salts and carbonate compounds. Peculiarities of the vertical structure of plant communities in the study area are manifested by dense species-rich stands, indistinct layer differentiation, and high dominance ability of some diagnostic species. The coenoses of the associations *Convolvulo arvensis-Agropyretum repentis*, *Medicagini lupulinae-Agropyretum repentis*, *Calamagrostietum epigei*, *Berteroetum incanae*, *Potentillo argenteae-Artemisietum absinthii*, *Leonuro cardiacae-Ballotetum nigrae*, and *Arctio lappae-Artemisietum vulgaris* are most widespread within the Kyiv urban area. The studies of the class in the territory of Kyiv should be continued, especially with regard to contributed data about introduction and further spreading of alien plant species in various types of *Artemisietea vulgaris* habitats and appearance of new vegetation associations, for developing the appropriate management measures.

Ethics Declaration

The authors declare no conflict of interest.

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REFERENCES

Bardat J., Bioret F., Botineau M., Boullet V., Delpech R., Géhu J.-M., Haury J., Lacoste A., Rameau J.-C., Royer J.-M., Roux G., Touffet J. 2004. *Prodrome des végétations de France*. Paris: Muséum national d'Histoire naturelle, 180 pp.

Bhowmik P.C. 1994. Biology and control of common milkweed (*Asclepias syriaca*). *Review of Weed Science*, 6: 227–250.

Biondi E., Blasi C., Allegrezza M., Anzellotti I., Azzella M.M., Carli E., Casavecchia S., Copiz R., Del Vico E., Facioni L., Galdenzi D., Gasparri R., Lasen C., Pesaresi S., Poldini L., Sburlino G., Taffetani F., Vagge I., Zitti S., Zivkovic L. 2014. Plant communities of Italy: The Vegetation Prodrome. *Plant Biosystems*, 148(4): 728–814. https://doi.org/10.1080/11263504.2014.948527

Borhidi A. 2003. *Magyarorszag növćnytársulásai*. Budapest, 610 pp.

Braun-Blanquet J. 1967. Vegetationsskizzen aus dem Baskenland mit Ausblicken auf das weitere Ibero-Atlantikum. II. Teil. *Vegetatio*, 14: 1–126.

Bredikhina Yu.L. 2015. *Spontanna roslynnist m. Melitopolya: syntaksonomiya, fitomelioratyvne znachennya i shchlyakhy optymizatsii*. Cand. Sci. Diss. Abstract. Lviv, 18 pp. [Бредіхіна Ю.Л. 2015. *Спонтанна рослинність м. Мелітополя: синтаксономія, фітомеліоративне значення і шляхи оптимізації*. Автореф. дис. … канд. сільськогосп. наук: спец. 06.03.01 "Лісові культури та фітомеліорація". Львів, Національний лісотехнічний університет України, 18 с.].

Chokha O.V. 2005. *Hazonni pokryttya m. Kyeva*. Kyiv: Phytosociocenter, 82 pp. [Чоха О.В. *Газонні покриття м. Києва*. Київ: Фітосоціоцентр, 82 с.].

Chytrý M., Tichý L. 2003. Diagnostic, constant and dominant species of vegetation classes and alliances of the Czech Republic: a statistical revision. *Folia Facultatis Scientiarum Naturalium Universitatis Masarykianae Brunensis*, 108: 1–231.

Chytrý M., Tichý L., Holt J., Botta-Dukát Z. 2002. Determination of diagnostic species with statistical fidelity measures. *Journal of Vegetation Science*, 13: 79–90. https://doi.org/10.1111/j.1654–1103.2002.tb02025.x

Chytrý M., Danihelka J., Kaplan Z., Pyšek P. 2017. *Flora and vegetation of the Czech Republic* [*Plant and Vegetation*, vol. 14]. Cham: Springer, 466 pp.

Chytrý M., Hennekens S.M., Jiménez-Alfaro B., Knollová I., Dengler J., Jansen F., Landucci F., Schaminée J.H.J., Aćić S., Agrillo E., Ambarlı D., Angelini P., Apostolova I., Attorre F., Berg C., Bergmeier E., Biurrun I., Botta-Dukát Z., Brisse H., Campos J.A., Carlón L., Čarni A., Casella L., Csiky J., Ćušterevska R., Dajić Stevanović Z., Danihelka J., De Bie E., de Ruffray P., De Sanctis M., Dickoré W.B., Dimopoulos P., Dubyna D., Dziuba T., Ejrnæs R., Ermakov N., Ewald J., Fanelli G., Fernández-González F., FitzPatrick Ú., Font X., García-Mijangos I., Gavilán R.G., Golub V., Guarino R., Haveman R., Indreica A., Işık Gürsoy D., Jandt U., Janssen J.A.M., Jiroušek M., Kącki Z., Kavgacı A., Kleikamp M., Kolomiychuk V., Krstivojević Ćuk M., Krstonošić D., Kuzemko A., Lenoir J., Lysenko T., Marcenò C., Martynenko V., Michalcová D., Moeslund J.E., Onyshchenko V., Pedashenko H., Pérez-Haase A., Peterka T., Prokhorov V., Rašomavičius V., Rodríguez-Rojo M.P., Rodwell J.S., Rogova T., Ruprecht E., Rūsiņa S., Seidler G., Šibík J., Šilc U., Škvorc Ž., Sopotlieva D., Stančić Z., Svenning J.-C., Swacha G., Tsiripidis I., Turtureanu P.D., Uğurlu E., Uogintas D., Valachovič M., Vashenyak Y., Vassilev K., Venanzoni R., Virtanen R., Weekes L., Willner W., Wohlgemuth T., Yamalov S. 2016. European Vegetation Archive (EVA): an integrated database of European vegetation plots. *Applied Vegetation Science*, 19: 173–180. https://doi.org/10.1111/avsc.12191

Dengler J., Wollert H. 2004. *Artemisietea vulgaris* — Ausdauemde Ruderalgesellschaften und Saume frischer bistrockener, stickstoffreicher Standorte. In: *Die Pflanzengesellschaften Mecklenburg-Vorpommerns und ihre Gefährdung. Textband*. Eds. C. Berg, J. Dengler, A. Abdank, M. Isermann. Jena: Weissdorn-Verlag, pp. 380–411.

Dengler J., Berg C., Eisenberg M., Isermann M., Jansen F., Koska I., Löbel S., Manthey M., Päzolt J., Spangenberg A., Timmermann T., Wollert H. 2003. New descriptions and typifications of syntax within the project "Plant communities of Mecklenburg-Vorpommern and their vulnerability" — Part I. *Feddes Repertorium*, 114(7–8): 587–631. https://doi.org/10.1002/fedr.200311017

Dengler J., Jansen F., Glöckler F., Peet R.K., De Cáceres M., Chytrý M., Ewald J., Oldeland J., Lopez-Gonzalez G., Finckh M., Mucina L., Rodwell J.S., Schaminée J.H.J., Spencer N. 2011. The Global Index of Vegetation-Plot Databases (GIVD): a new resource for vegetation science. *Journal of Vegetation Science*, 22: 582–597. https://doi.org/10.1111/j.1654-1103.2011.01265.x

Didukh Ya.P. 2011. *The ecological scales for the species of Ukrainian flora and their use in synphytoindication*. Kyiv: Phytosociocentre, 176 pp.

Didukh Ya.P., Alyoshkina U.M. 2012. *Biotopy mista Kyyeva*. Kyiv: NaUKMA, Ahrar Media Hrup, 163 pp. [Дідух Я.П., Альошкіна У.М. 2012. *Біотопи міста Києва*. Київ: НаУКМА, Аграр Медіа Груп, 163 с.].

Dubyna D.V., Neuhäyslova Z., Dziuba T.P., Shelyag-Sosonko Yu.R. 2004. *Klasyfikatsiya ta prodromus roslynnosti vodoym, perezvolozhenykh terytoriy ta aren Pivnichnoho Prychornomor'ya*. Kyiv: Phytosociocenter, 200 pp. [Дубина Д.В., Нойгойзлова З., Дзюба Т.П., Шеляг-Сосонко Ю.Р. 2004. *Класифікація та продромус рослинності водойм, перезволожених територій та арен Північного Причорномор'я*. Київ: Фітосоціоцентр, 200 с.].

Dubyna D.V., Iemelianova S.M., Dziuba T.P., Yeremenko N.S., Tymoshenko P.A. 2021a. Ruderal vegetation of Kyiv City. I. Class *Stellarietea mediae* Tx. et al. in Tx. 1950. *Ukrainian Botanical Journal*, 78(3): 176–200. https://doi.org/10.15407/ukrbotj78.03.176

Dubyna D.V., Iemelianova S.M., Dziuba T.P., Ustymenko P.M., Felbaba-Klushyna L.M., Davydova A.O., Davydov D.A., Tymoshenko P.A., Baranovski B.O., Borsukevych L.M., Vakarenko L.P., Vynokurov D.S., Datsyuk V.V., Yeremenko N.S., Ivanko I.A., Lysohor L.P., Kazarinova H.O., Karmyzova L.O., Makhynia L.M., Pashkevych N.A., Fitsailo T.V., Shevera M.V., Shyriaieva D.V. 2021b. Ruderal vegetation of Ukraine: syntaxonomical diversity and territorial differentiation. *Chornomorski Botanical Journal*, 17(3): 253–275. [Дубина Д.В., Ємельянова С.М., Дзюба Т.П., Устименко П.М., Фельбаба-Клушина Л.М., Давидова А.О., Давидов Д.А., Тимошенко П.А., Барановський Б.О., Борсукевич Л.М., Вакаренко Л.П., Винокуров Д.С., Дацюк В.В., Єременко Н.С., Іванько І.А., Лисогор Л.П., Казарінова Г.О., Кармизова Л.О., Махиня Л.М., Пашкевич Н.А., Фіцайло Т.В., Шевера М.В., Ширяєва Д.В. 2021b. Рудеральна рослинність України:синтаксономічна різноманітність і територіальна диференціація. *Чорноморський ботанічний журнал*, 17(3): 253–275]. https://doi.org/10.32999/ksu1990-553X/2021-17-3-5

Dubyna D.V., Dziuba T.P., Iemelianova S.M., Bagrikova N.O., Borysova O.V., Borsukevych L.M., Vynokurov D.S., Gapon S.V., Gapon Yu.V., Davydov D.A., Dvoretskyi T.V., Didukh Ya.P., Zhmud O.I., Kozyr M.S., Konishchuk V.V., Kuzemko A.A., Pashkevych N.A., Ryff L.E., Solomakha V.A., Felbaba-Klushyna L.M., Fitsailo T.V., Chorna H.A., Chorney I.I., Shelyag-Sosonko Yu.R., Iakushenko D.M. 2019. *Prodrome of the Vegetation of Ukraine*. Eds D.V. Dubyna, T.P. Dziuba. Kyiv: Naukova Dumka, 782 pp. [Дубина Д.В., Дзюба Т.П., Ємельянова С.М., Багрікова Н.О., Борисова О.В., Борсукевич Л.М., Винокуров Д.С., Гапон С.В., Гапон Ю.В., Давидов Д.А., Дворецький Т.В., Дідух Я.П., Жмуд О.І., Козир М.С., Коніщук В.В., Куземко А.А., Пашкевич Н.А., Рифф Л.Е., Соломаха В.А., Фельбаба-Клушина Л.М., Фіцайло Т.В., Чорна Г.А., Чорней І.І., Шеляг-Сосонко Ю.Р., Якушенко Д.М. 2019. *Продромус рослинності України*. Відп. ред. Д.В. Дубина, Т.П. Дзюба. Київ: Наукова думка, 782 с.].

Dziuba T.P., Dubyna D.V., Tymoshenko P.A., Iemelianova S.M. 2019. In: *Synanthropization of the vegetation cover of Ukraine: III All-Ukrainian Scientific Conference*: *book of scientific articles*. Kyiv, pp. 42–47. [Дзюба Т.П., Дубина Д.В., Тимошенко П.А., Ємельянова С.М. 2019. Рудеральна рослинність залізничних шляхів міста Києва. В зб.: *Синантропізація рослинного покриву України: ІІІ Всеукраїнська наукова конференція: збірник наукових статей*. Київ, с. 42–47].

Dziuba T.P., Dubyna D.V., Iemelianova S.M., Tymoshenko P.A. 2022. Vegetation of the railways of the Kyiv urban area (Ukraine). *Biologia* (*Bratislava*), 77: 931–952. https://doi.org/10.1007/s11756-021-00961-0

Euro+Med 2006+ [continuously updated]: Euro+Med PlantBase — the information resource for Euro-Mediterranean plant diversity. Available at: http://www.europlusmed.org (Accessed 15 May 2022).

Görs S., Müller T. 1969. Beitrag zur Kenntnis der nitrophilen Saumgesellschaften Südwestdeutschlands. *Mitteilungen der Floristisch-soziologischen Arbeitsgemeinschaft*, 14: 153–168.

Gudžinskas Z., Petrulaitis L., Taura L. 2021. *Asclepias syriaca* L. (*Apocynaceae*) and its invasiveness in the southern part of the Boreal region of Europe — evidence from Lithuania. *BioInvasions Records*, 10(2): 436–452. https://doi.org/10.3391/bir.2021.10.2.22

Hartzler R.G., Buhler D.D. 2000. Occurrence of common milkweed *Asclepias syriaca* in cropland and adjacent areas. *Crop Protection*, 19: 363–366. https://doi.org/10.1016/S0261–2194(00)00024–7

Hennekens S.M., Schaminée J. 2001. TURBOVEG, a comprehensive data base management system for vegetation data. *Journal of Vegetation Science*, 12: 589–591. https://doi.org/10.2307/3237010

Hill M.O., Gauch H. 1980. Detrended correspondence analysis, an improved ordination technique. *Vegetatio*, 42: 47–58. https://doi.org/10.1007/BF00048870

Jarolímek I., Šibík J. 2008. *Diagnostic, constant and dominant species of the higher vegetation units of Slovakia*. Bratislava: Veda, 332 pp.

Jarolímek I., Zaliberová M., Mucina L., Mochnacký S. 1997. *Rastlinné spoločenstvá Slovenska 2. Synantropná vegetácia*. Bratislava: Veda, 416 pp.

Kopecký K., Hejný S. 1974. A new approach to the classification of anthropogenic plant communities. *Vegetatio*, 29: 17–20. https://doi.org/10.1007/BF02390892

Kącki Z., Czarniecka M., Swacha G. 2013. *Statistical determination of diagnostic, constant and dominant species of the higher vegetation units of Poland*. Monographiae Botanicae.103. Warszawa: Polish Botanical Society, 274 pp. https://doi.org/10.5586/mb.2013.001

Kucheryavyi V.O., Solomakha V.A., Solomakha T.D., Shelyag-Sosonko Yu.R., Kramarets V.O. 1991. Syntaxonomy of ruderal vegetation of the city of Lviv. *Ukrainian Botanical Journal*, 48(3): 48–55. [Кучерявий В.О., Соломаха В.А., Соломаха Т.Д., Шеляг-Сосонко Ю.Р., Крамарець В.О. 1991. Синтаксономія рудеральної рослинності м. Львова. *Український ботанічний журнал*, 48(3): 48–55].

Matuszkiewicz W. 2008. *Przewodnik do oznaczania zbiorowisk roślinnych Polski*. Warszawa: Wydawnictwo Naukowe PWN, 540 pp.

McCune B., Mefford M.J. 2011. *PC–ORD. Multivariate analysis of ecological data. Version 5*. Gleneden Beach, Oregon, U.S.A.: MjM Software, 24 pp.

Moravec J., Balátová-Tuláčková E., Hadač K., Hejný S., Jeník J., Kolbek J., Kopecký K., Neuhäusl R., Rybníček K., Vicherek J. 1983. Přehled vyšších vegetačních jednotek České socialistické republiky. *Preslia*, 55: 97–122.

Láníková D., Chytrý M., Lososová Z. 2009. Suchomilná ruderální vegetace s dvouletými a vytrvalými druhy. In: *Vegetace České republiky. 2: Ruderální, plevelová, skalní a suťová vegetace*. Ed. M. Chytrý. Praha: Academia, pp. 207–288.

Matuszkiewicz W. 2007. *Przewodnik do oznaczania zbiorovisk roślinnych Polski*. Ed 3. Warszawa: Wydawnictwo Naukowe PWN, 376 pp.

Mucina L., Bültmann H., Dierβen K., Theurillat J.-P., Raus T., Čarni A., Šumberová K., Willner W., Dengler J., Gavilán García R., Chytrý M., Hájek M., Di Pietro R., Iakushenko D., Pallas J., Daniëls F., Bergmeier E., Santos Guerra A., Ermakov N., Valachovič M., Schaminée J., Lysenko T., Didukh Y., Pignatti S., Rodwell J., Capelo J., Weber H., Solomeshch A., Dimopoulos P., Aguiar C., Hennekens S., Tichý L. 2016. Vegetation of Europe: hierarchical floristic classification system of vascular plant, bryophyte, lichen, and algal communities. *Applied Vegetation Science*, 19(S1): 3–264. https://doi.org/10.1111/avsc.12257

Oberdorfer E. 1957. *Süddeusche Pflazengesellschaften*. Jena: Gustav Ficher Verlag, 564 pp.

Osypenko V.V., Shevchyk V.L. 2001. Spontaneous vegetation of Cherkasy. 6. Ruderal vegetation of the coastal part of Cherkasy. *Ukrainian Phytosociological Collection. Series A*, 1(17): 104–121. [Осипенко В.В., Шевчик В.Л. 2001. Спонтанна рослинність м. Черкаси. 6. Рудеральна рослинність прибережної частини м. Черкаси. *Український фітоценотичний збірник. Серія А*, 1(17): 104–121].

Protopopova V.V., Shevera M.V., Fedoronchuk M.M., Shevchyk V.L. 2014. Transformer species in the flora of the Middle Dnipro Region. *Ukrainian Botanical Journal*, 71(5): 563–572 [Протопопова В.В., Шевера М.В., Федорончук М.М., Шевчик В.Л. Види-трансформери у флорі Середнього Придніпров'я. *Український ботанічний журнал*, 71(5): 563–572]. https://doi.org/10.15407/ukrbotj71.05.563

R Core Team. 2020. R: a language and environment for statistical computing. Vienna: R Foundation for Statistical Computing. Available at: http://www.R-project.org (Accessed 20 April 2023).

Rivas-Martínez S., Fernández-González F., Loidi J., Lousã M., Penas A. 2001. Syntaxonomical checklist of vascular plant communities of Spain and Portugal to association level. *Itinera Geobotanica*, 14: 5–341.

Rochow von M. 1951. *Die Pflanzengesellschaften des Kaiserstuhls. Pflanzensoziologie*. Vol. 8. Jena: Fischer, 160 pp.

Roleček J., Tichý L., Zelený D., Chytrý M. 2009. Modified TWINSPAN classification in which the hierarchy respects cluster heterogeneity. *Journal of Vegetation Science*, 20: 596–602. https://doi.org/10.1111/j.1654–1103.2009.01062.x

Sanda V., Öllerer K., Burescu P. 2008. *Fitocenozele din România. Sintaxonomia, structură, dinamică şi evoluţie*. Bucureşti: Universitatea din Bucureşti, 576 pp.

Solomakha V.A. 2008. *Syntaksonomiya roslynnosti Ukrainy. Tretye nablyzhennya*. Kyiv: Fitosotsiotsentr, 296 pp. [Соломаха В.А. 2008. *Синтаксономія рослинності України*. Третє наближення. Київ: Фітосоціоцентр, 296 с.].

Soroka M.I. 2008. *Roslynnist Ukrainskoho Roztochchya*. Lviv: Svit, 434 pp. [Сорока М.І. 2008. *Рослинність Українського Розточчя*. Львів: Світ, 434 с.].

Sørensen T.J. 1948. A method of establishing groups of equal amplitude in plant sociology based on similarity of species content and its application to analyses of the vegetation of Danish commons. *Kongelige Danske Videnskabernes Selskab, Biologiske Skrifter*, 5(4): 1–34.

Theurillat J.P., Aeschimann D., Küpfer P., Spichiger R. 1995. The higher vegetation units of the Alps. *Colloques Phytosociologiques*, 23: 189–239.

Theurillat J.-P., Willner W., Fernández-González F., Bültmann H., Čarni A., Gigante D., Mucina L., Weber H. 2021. International Code of Phytosociological Nomenclature. 4th edition. *Applied Vegetation Science*, 24: e12491. https://doi.org/10.1111/avsc.1249

Tichý L. 2002. JUICE, software for vegetation classification. *Journal of Vegetation Science*, 13: 451–453. https://doi.org/10.1111/j.1654–1103.2002.tb02069.x

Tichý L., Chytrý M., Hájek M., Talbot S.S., Botta-Dukát Z. 2010. OptimClass: Using species-to-cluster fidelity to determine the optimal partition in classification of ecological communities. *Journal of Vegetation Science*, 21: 287–299. https://doi.org/10.1111/j.1654-1103.2009.01143.x

Tsukanova G.O. 2005. *Floristic and coenotic diversity of the Dnieper islands within Kyiv and its protection*. Cand. Sci. Diss. Abstract. Kyiv, M.G. Kholodny Institute of Botany NAS of Ukraine, 20 pp. [Цуканова Г.О. 2005. *Флористичне та ценотичне різноманіття островів Дніпра в межах м. Києва та його охорона*. Автореф. дис. ... канд. біол. наук: спец. 03.00.05 "Ботаніка". Київ, Інститут ботаніки ім. М.Г. Холодного НАН України, 20 с.].

Tüxen J. 1950. Grundriß einer Systematik der nitrophilen Unkrautgesellschaften in der Eurosibirischen Region Europas. *Mitteilungen der Floristisch-soziologischen Arbeitsgemeinschaft*, 2: 94–175.

Tzonev R.T., Dimitrov M.A., Roussakova V.H. 2009. Syntaxa according to the Braun-Blanquet approach in Bulgaria. *Phytologia Balcanica*, 15(2): 209–233.

Venables W.N., Smith D.M., R Development Core Team. 2008. *An Introduction to R: Notes on R, A Programming Environment for Data Analysis and Graphics* (electronic edition, 2008). Available at: https://cran.r-project.org/doc/manuals/R-intro.pdf

Yeremenko N.S. 2017. Ruderal vegetation of Kryvyi Rih. I. Class *Artemisietea vulgaris*. *Ukrainian Botanical Journal*, 74(5): 449–468. [Єременко Н.С. 2017. Рудеральна рослинність міста Кривий Ріг. І. Клас *Artemisietea vulgaris*. *Український ботанічний журнал*, 74(5): 449–468]. https://doi.org/10.15407/ukrbotj74.05.449

Wickham H. 2016. *ggplot2: Elegant Graphics for Data Analysis*. New York: Springer-Verlag. https://doi.org/10.1007/978-0-387-98141-3

Рудеральна рослинність міста Київ. І. Клас *Artemisietea vulgaris*

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Реферат. У статті, яка є продовженням серії публікацій з дослідження рудеральної рослинності м. Києва, представлено результати синтаксономічного вивчення рослинних угруповань класу *Artemisietea vulgaris*. Встановлено, що синтаксономічне різноманіття класу на території міста представлено 14 асоціаціями та одним деривативним угрупованням, які належать до 3 порядків та 4 союзів. Подані результати екологічного та ординаційного аналізів рослинності *Artemisietea vulgaris*, наведені синморфологічні особливості угруповань та охарактеризовані умови їхніх місцезростань. Встановлено, що рослинність класу *Artemisietea vulgaris* поширена на території всього міста. З'ясовано, що основними факторами екологічної диференціації угруповань класу *Artemisietea vulgaris* є терморежим та освітленість біотопів. Різноманіття антропогенних екотопів, а також особливості кліматичних умов регіону є визначальними у територіальному поширенні угруповань класу в межах міста. Проведені дослідження та їхні результати є важливими для стратегічного планування та практичного впровадження заходів зі збалансованого розвитку міста та оптимізації екологічних умов у межах міської агломерації.

Ключові слова: ординація, синтаксономія, Україна, урбоекосистема, фітоіндикація