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СООБЩЕНИЯ

FLORA OF THE DESNA PLATEAU: COMPREHENSIVE ANALYSIS AND GENESIS

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In modern conditions of the catastrophic climate changes, increasing human impact on natural surroundings, monitoring studies of phytodiversity as a basic component of biodiversity become of particular relevance. The article presents the results of the comprehensive analysis of the flora of the Desna Plateau (DP), as well as information on its origin and forming process. The location of the study area near the border of the geographical zones of Novhorod-Sivers'ky Polissya and Sumy forest-steppe, low-lying and high forms of relief with close occurrence of the chalk rock, the diversity nature of the soil cover give the features of the flora of the region. The stated species composition of the flora includes 920 species of higher vascular plants, which are related to 464 genera, 112 families, 6 classes, and 5 divisions. Analysis of parameters of flora, leading spectra of families Asteraceae, Poaceae, Cyperaceae, Fabaceae, Lamiaceae, Rosaceae, Caryophyllaceae, Brassicaceae, Apiaceae, Scrophulariaceae and genus *Carex*, *Veronica*, *Campanula*, *Salix*, *Ranunculus*, *Potentilla*, *Galium*, *Viola*, *Poa*, *Trifolium* suggest that the basis of the flora of the region is made up by the moderateholarctic and boreal elements with the significant proportion of the southern, in particular, the Mediterranean elements, which indicate the region's links with the Mediterranean. Using the coefficient of rank correlation of Kendel, the levels of similarity of the flora of the Desna Plateau with the some regional floras of Ukraine and the Central Russian Upland are determined. It was defined that the basis of the biomorphological structure of the flora is made by herbaceous summer-green perennials species with fibrous root system. Among types of life forms according to K. Raunkier's classification hemicryptophytes dominate. The distribution of species in the ecological spectrum by the type of humidity corresponds to the location of region in ecotone conditions. With the domination of mesophytes and hygrophytes, which indicates the favorable hydrological regime of the region, the parts of xeromesophytes and xerophytes, which indicate about arid habitats, are quite significant. The coherence of the ecological spectrum according to the humidity regime with the ecocoenotic structure of DP flora is revealed, where the species of forest, meadow and ruderal-segetal ecocoenotic groups are most represented.

The geographic structure indicates the heterogeneous nature of the flora of the Desna Plateau. Generally the Desna Plateau flora has palearctic character with the significant share of European-Mediterranean elements. A significant proportion of plurieregional species is partly due to the anthropogenic impact.

Almost complete lack of endemic species and a small number of relict elements of the interpostglacial age, spore-poll analysis data show the young post-glacial age and predominantly migratory nature of the Desna Plateau flora.

Keywords: phytodiversity, flora, floristic analysis, relict species, endemic species

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INTRODUCTION

In order to build the society of sustainable development, the key task of humanity is the conservation of biodiversity as a pillar of bio-ecosystem resilience (Convention on Biological Diversity, 2012, 2019; Angelstam et al., 2013). That is why inventory, monitoring of biodiversity are now among the main priorities of scientific research (Strategic Plan., 2010; Corlett, 2016). Biodiversity is seen as a multi-dimensional design covering landscape, taxonomic, functional, phylogenetic, genetic and other elements of the variability of life on the Earth (Naeem, Prager et al, 2016). It is known that the basic component of biosystems is phytodiversity, whose biosystem services are critical to the survival of all living organisms and their groups, including human society (Corlett, 2016; Mudrak et al., 2018). On the other hand, the impact of anthroinfluence on phytodiversity contributes to dangerous changes in the composition of the natural vegetation cover: by the disappearance of natural species, appearing introducts species, quarantine invasive species into natural plant communities (Foxcroft et al., 2013; Heywood & Sharrock, 2013; Protopopova & Shevera, 2015; Mosyakin, 2016).

Fluctuating and successional changes in the plant cover are also due to the climatic fluctuations (Svenning & Sandel, 2013; Buse et al., 2015; Chu et al., 2019). There have been cases of extinction of certain species, narrowing or distribution of habitats of some plant species, determined by the climatic pulsations (Rydsaa et al., 2015; Bachman et al., 2016; Wiens, 2016; Giesecke et al., 2017). Thus, researching the flora diversity at both the global and local levels is a priority, especially for the densely populated areas of the European continent. The need for monitoring regional flora, methods for monitoring natural habitats in Europe, and their conservation are the subject of broad discussion (Schmeller, 2008). Ukraine as a part of the European continent with an area of 5.7% of its territory has a rather high level of phytodiversity, accounting for 37% of higher vascular plants of Europe, of which 9% are endemic (Melnic, 2015).

To solve the mentioned global problems the necessary condition is studying the dynamic changes of flora and vegetation condition both in Ukraine as a whole and in it separate territorial areas (Shelyag-Sosonko et al., 2004; Onyshchenko et al., 2017).

The territory of Desna Plateau is situated in the north east part of Ukraine at the border line of Polissya (the forest-covered territory) and forest-steppes physical and geographical zones. Its geographical position is N 51°21'–51°55', E 33°10'–34°15'.

In the orographic aspect the territory is made up by the western spurs of the Central Russian Upland with the dismembered forms of the relief. According to geobotanical zonning it is Krolevet's-Hlukhiv geobotanical district (Andrienko et al., 1977). The area under study consists of about 4 thousand square kilometers.

The studied territory belongs to Hlukhiv, Krolevets, Putyvl administrative districts Sumy administrative region of Ukraine (Marynych et al., 1988). Hlukhiv, Krolevets, Putyvl are among the oldest small towns of Ukraine where agriculture is developed.

The remoteness of the region from administrative and research centers led to its fragmented, episodic studying as part of the Polissya flora and Forest-Steppe of Ukraine while the surrounding areas have been studied for several last decades (Poluyanov, 1997; Karpenko, 1999; Lukash, 1999; Honcharenko, 2001; Kozyr, 2015).

The climate of the region is temperate-continental with average temperatures +19.5°C in July and –7.5°C in January. Precipitation is 550–600 mm/year. The soils are mainly gray and dark gray forest, sod-podzolic under broadleaf oak-maple-linden forests; sandy soils under pine forests. Under the influence of high erosion chalk outcrop can be seen. The river Seim and tributaries are proceeding by the research territory.

MATERIAL AND METHODS

The floristic research of the territory of Desna Plateau was carried out in 2002–2006. Floristic research was executed with the field research method and the complex of accepted

Table 1. Quantitative distribution of taxonomic units and major proportions of the Desna Plateau flora
Таблица 1. Количественное распределение таксономических групп и главные пропорции флоры Придеснянского плато

Division, class	Number of families		Number of genera		Number of species		Family : genus : species ratio	Generic coefficient
		%		%		%		
Lycopodiophyta	2	1.79	2	0.43	3	0.32	1 : 1 : 1.5	1.5
Equisetophyta	1	0.89	1	0.22	6	0.65	1 : 1 : 6	6.0
Polypodiophyta	6	5.35	8	1.72	11	1.19	1 : 1.3 : 1.8	1.4
Pinophyta	2	1.79	3	0.65	3	0.32	1 : 1.5 : 1.5	1.0
Magnoliophyta	101	90.18	450	96.9	897	97.5	1 : 4.5 : 8.88	2.0
Magnoliopsida	78	69.64	361	77.9	700	76.1	1 : 4.6 : 8.97	19
Liliopsida	23	20.53	89	19.2	197	21.4	1 : 3.9 : 8.6	2.2
Total	112	100	464	100	920	100	1 : 4.1 : 8.2	1.98

methods of comparative floristry. The list of species of vascular plants includes all species spontaneously growing in a region. The other sources of data were also additionally used: literature and herbarium materials (KW), we consulted with prof. Serhiy L. Mosyakin, prof. Vira V. Protopopova, prof. Mykola M. Fedoronchuk, doctor Myroslav V. Shevera and with the other experts in various taxonomic groups.

Taxonomic structure of the studied flora was analyzed (Tolmachev, 1974). In the process of comparative research of systematic structure we used Kendall's tau rank correlation coefficient.

We used the linear system of life forms (Holubev, 1978) and the system of Raunkiaer's biotypes (Raunkiaer, 1934) for the study of biomorphological structure. Species were divided into the ecological groups relative to humidity for ecological analysis (Didukh et al., 2000).

Ecocoenotic groups are given according to the "Ecoflora of Ukraine" (Didukh et al., 2000). The geographical analysis is based on the regionalization identified by A.L. Takhtajan (Takhtajan, 1978).

The species names are given according to "Vascular plants of Ukraine. A nomenclatural checklist" (Mosyakin & Fedoronchuk, 1999).

RESULTS

Taxonomical analysis. According to our data the flora of the Desna Plateau includes 920 species of vascular plants belonging to 464 genera, 112 families, 6 classes and 5 divisions (Table 1).

The leading families according to species richness are Asteraceae (120 species; 12.97%), Poaceae (79; 8.54%), Cyperaceae (43; 4.64%), Fabaceae (43; 4.67%), Lamiaceae (40; 4.32%), Rosaceae (41; 4.43%), Caryophyllaceae (40; 4.32%), Brassicaceae (39; 4.23%), Apiaceae (33; 3.59%), Scrophulariaceae (35; 3.78%). In general they consist of 518 species (55.76%). The leading genera according to species richness are *Carex* (29; 3.13%), *Veronica* (14; 1.51%), *Campanula* (11; 1.19%), *Salix*, *Ranunculus*, *Potentilla*, *Galium*, *Viola*, *Poa*, *Trifolium* (Table 2).

Higher position in the spectrum of leading families Asteraceae, Poaceae, Cyperaceae and of leading genera *Carex*, *Veronica*, *Potentilla*, *Viola*, *Poa*, *Trifolium*, *Ranunculus* indicate that the flora of the region has got boreal character. High position *of Fabaceae*, *Lamiaceae*, *Brassicaceae*, *Apiaceae* witnesses about the considerable influence of thermophilic elements and aridity, which are conditioned with features of the area relief, the composition of soil and the anthropogenic impact.

Table 2. Leading families and genera of the Desna Plateau flora
Таблица 2. Ведущие по числу видов семейства и роды флоры Придеснянского плато

Family	Number of species	%	Genus	Number of species	%
Asteraceae	120	12.97	*Carex*	29	3.13
Poaceae	79	8.54	*Veronica*	14	1.51
Cyperaceae	43	4.64	*Campanula*	11	1.19
Fabaceae	43	4.64	*Potentilla*	11	1.19
Rosaceae	41	4.43	*Galium*	11	1.19
Lamiaceae	40	4.32	*Salix*	10	1.08
Caryophyllaceae	40	4.32	*Viola*	10	1.08
Brassicaceae	39	4.21	*Poa*	10	1.08
Apiaceae	38	4.1	*Trifolium*	9	0.97
Scrophulariaceae	35	3.78	*Ranunculus*	9	0.97
Total	518	56	Total	124	13.4

Table 3. Comparing the richness of the Desna Plateau flora species with some other Ukrainian floras and the Central Russian Upland floras
Таблица 3. Сравнение показателей флористического богатства флоры Придеснянского плато и некоторых флор Украины и Среднерусской возвышенности

Region	Area [km^2]	Number of			Floristic indexes	Species/genera
		families	genera	species		
DP	4000	112	464	920	1 : 4.1 : 8.2	1.98
DSI	1200	105	425	786	1 : 4 : 7.48	1.84
DOI	5000	109	421	836	1 : 3.8 : 7.6	1.98
SGR	8600	114	482	1160	1 : 4.2 : 10	2.4
LP	70000	127	577	1613	1 : 4.5 : 12.7	2.7
KR	48000	121	550	1338	1 : 4.5 : 11	2.43
KP	40000	118	542	1375	1 : 4.6 : 11.7	2.53
KT	2000	111	505	1120	1 : 4.4 : 9.9	2.21

The floristic indexes of taxonomic diversity (genus/family = 4.1), (species/family = 8.2), (species/genus = 1.98) are typically for Central-European floristic region.

For comparison of the Desna Plateau (DP) flora's parameters with some other Ukrainian floras and Central Russian Upland flora seven territorial separations were selected, which had been studied in the past decades. They are adjacent areas of the lower reaches of Desna-Seym interfluves (DSI), Desna-Oster interfluves (DOI), Sumy geobotanic region (SGR), Left Bank Prydniprovya (LP), Kursk region (KR) of Russia, and the territory of Kyiv Polissia (KP) and Kamyanets' Transnistria (KT) (Table 3).

Thus, the flora of the Desna Plateau according to the species and genera number is poorer than Kamyanets Transnistria's and it is close to local surroundings' floras, in particular Desna-Seim interfluves and Desna-Oster interfluves and Sumy geobotanic region. Compared with floras of larger areas, including Kursk region, Kyiv Polissya, Left Bank Prydniprovya, the proportional prevalence of their taxonomic categories as for the Desna Plateau flora was observed.

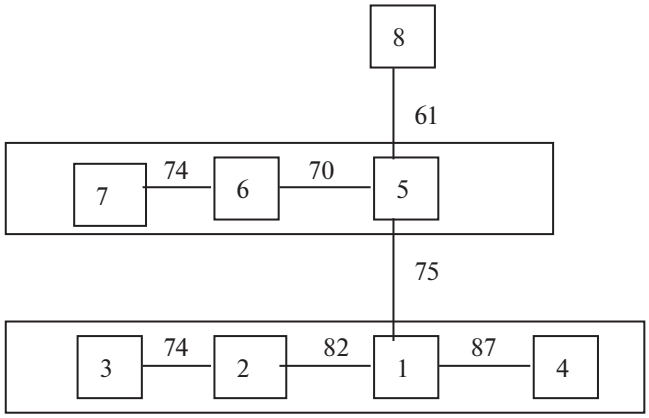

Fig. 1. The dendrite and correlation pleiades of the leading families in the floras of Ukraine and Central Russian Upland measured by Kendall coefficient. Explanations: 1– DP, 2 – DSI, 3 – DOI, 4 – SGR, 5 – LP, 6 – KR, 7 – KP, 8 – KT.

Рис. 1. Дендрит и корреляционные плеяды, отображающие степень сходства десяти ведущих по числу видов семейств во флорах Украины и Среднерусской возвышенности. Условные обозначения: 1 – Придеснянское плато, 2 – Междуречье Десна–Сейм, 3 – Междуречье Десна–Остер, 4 – Сумской геоботанический район, 5 – Левобережное Приднепровье, 6 – Курская область, 7 – Киевское Полесье, 8 – Каменецкое Приднестровье.

Structural comparison of the family spectra of different Ukrainian floras and Central Russian Upland, using the correlation rank coefficient by Kendall, made it possible to build a dendrite (fig. 1) and select correlation pleiades, reflecting the degree of similarity of the floral spectra of the leading families according to the number of species in the floras of Ukraine and the Central Russian Upland. (tab. 4). In the figure the dendrite is shown and the correlation pleiades that indicate a close relationship between DP and SGR, DSI floras are marked; the degree of similarity between them is 87 and 82. DSI and DOI floras associated with the degree of similarity 74. The degree of similarity 75 links DP flora with LP flora, which, although being adjacent to the investigated region, but has 17 times larger area and extends to the southwestern direction from the region of study. LP is launching its own galaxy of floras of great local areas KP and KR with such degrees of similarity: 70 and 74. KT flora, linked with LP by the degree of similarity 61, occupies an isolated position on these two pleiades.

Biomorphological analysis. In the spectrum of the biomorphological structure in the studied flora the majority of plants is herbaceous – 833 (90.55%). Among them the herbaceous polycarpics make up 584 (63.4%), monocarps – 165 (17.90%), biennial monocarps – 54 (5.385%), mono-biennial monocarps – 33(3.58%). Woody polycarpics together account for 84 (9.01%) and consist of the following forms: trees – 27 (2.93%), shrubs – 45 (4.80%), semishrubs – 7 (0.76%), bushes and semi-bushes – 5 (0.54%).

According to the types of root system the fibrous root type is prevailing – 462 (50.21%), the rest have taproot – 411 (44.67%).

Among the types of underground shoots prevail plants without rhizome structure (322; 35%), short rhizomatous (242; 26%), caudex (144; 16%) and long rhizomatous (137; 15%).

The results of biomorphological analysis of the studied flora with domination of the herbaceous perennials with fibrous root system denotes its affiliation to the zonal flora of Forest and Forest-Steppe.

According to Raunkiaer's forms in the flora of the Desna Plateau hemicryptophytes prevail – 485 (52.70%), the other forms have: phanerophytes – 71 (7.71%), chamaephytes – 25 (2.71%),

Table 4. Comparison of the structures of the family spectra in different floras of Ukraine and the Central Russian Upland
Таблица 4. Сравнение структур ведущих по числу видов семейств в некоторых флорах Украины и Среднерусской возвышенности

Leading families	DP	DSI	DOI	SGR	LP	KR	KP	KT
Asteraceae	1	1	1	1	1	1	1	1
Poaceae	2	2	2	2	2	2	2	2
Cyperaceae	3	4	5	3	5	6	3	(11)
Fabaceae	4	5	6	4	3	8	9	4
Rosaceae	5	3	3	5	7	4	6	6
Lamiaceae	6	6	4	7	6	5	8	5
Caryophyllaceae	7	7	8	8	8	7	5	8
Brassicaceae	8	11	10	9	4	3	4	3
Scrophulariaceae	9	8	7	6	9	9	7	10
Apiaceae	10	9	9	(11)	(11)	10	10	9
Ranunculaceae	11	10	(11)	10	10	(11)	(11)	7
Kendall index		0.82	0.72	0.87	0.75	0.63	0.54	0.42

cryptophytes (geophytes) – 115 (12.50%), helophytes – 33 (3.58%), hydrophytes – 26 (2.82%), terophytes – 165 (17.90%).

The type of vegetating plant is a very important indicator in the comprehensive analysis of floras. This indicator depends on the historical, ecological, coenotic features of the region. The summer-green plants dominate in the Desna Plateau flora – 813 (88.36%). The number of summer-winter-green plants make up fewer species – 80 (8.69%). The number of evergreen species – 16 (1.74%), as well as ephemerals and ephemeroids – 12 (1.30%) is insignificant. This is due to the boreal climate of the region: a long winter period. This fact is confirmed by comparison with the analogical indicators in the flora with the Mediterranean type of vegetating plant – Kerch-Taman region, where the summer-greens species make only 42.50%, but the summer-winter green species – 24.50%, ephemerals and ephemeroids – 25.30%.

Thus, generally the results of biomorphological analysis of the studied flora denotes its affiliation to the moderate Holarctic region flora. It is characterized by boreal character with the considerable influence of the thermophilic and aridity features, which are conditioned with features of the area relief, the compound of soil formed species and the anthropogenic impact.

Ecological and ecocoenotical analysis. Among the native conditions for the vegetation the factor of the humidity plays a considerable role. According to our research the ecological spectrum of humidity of species of the studied flora is divided into 11 groups. The first place is occupied by mesophytes (404; 43.90%). The other groups consist of: hygrophytes (123; 13.26%), xeromesophytes (120; 13.04%), mesoxerophytes (78; 8.47%) hygromesophytes (57; 6.20%), xerophytes (55; 5.97%), mesohygrophytes (29; 3.15%), hydrophytes (19; 2.06%), hygrohydrophytes (10; 1.08%), aerogidatophytes (17; 1.84%), gidatophytes (8; 0.86%).

The considerable part of xerophytes (55; 5.97%), xeromesophytes (120; 13.04%) and mesoxerophytes (78; 8.47%) can be found on the chalk outcrops in the relief of territory and considerable anthropogenic pressure.

On the territory of the Desna Plateau 16 ecocoenotic groups with plant species in their composition are noticed. The species are distributed among such groups as: coniferous forest (45; 4.80%), deciduous forest (133; 14.45%), mixed forest (25; 2.70%), forest edge (144; 15.70%), meadow (108; 11.70%), marsh (36; 3.90%), meadow-marsh (41; 4.45%), meadow-steppe (29; 3.15%), steppe (50; 5.43%), coastal (63; 6.84%), coastal-psammophytic (8; 0.86%), aquatic (46; 5.00%), psammophytic (22; 2.39%), ruderal-segetal (39; 4.67%), ruderal (113; 12.30%), segetal (18; 1.95%).

The distribution of species of the studied flora on ecological groups according to humidity and to ecocoenotic complexes are fairly typical of moderate to Holarctic floras.

However, the location of the Desna Plateau on the border of the forest and forest-steppe zones, favorable hydrological conditions associated with the close occurrence of Cretaceous sediments and, consequently, groundwater, the presence of Cretaceous outcrops in the relief structure give specificity to the flora of the region.

Geographycal analysis. The geographical spectrum of species areas of the studied flora is divided into 5 types including 38 groups. The species with palearctic 320 (34.9%) and holarctic – 245 (26.73%) types dominate. The other types are made up by: European – 151 (16.7%), plurieregional – 114 (12.39%), European-Mediterranean – 90 (9.7%). Among the divided groups the next are prevailing: Eurasian – 151 (16.41%), Eurasian-Northern American – 106 (11.52%), European – 75 (98.2%), hemicosmopolites – 66 (7.17%), cosmopolites – 48 (5.21%), European-Western Siberien – 42 (4.56%), European-Siberien – 27 (2.93%), Eastern-European – 22(2.39%), European-Caucasian – 22 (2.39%). The following groups testify to the influence of the ancient Mediterranean: Euro-Mediterranean – 23 (2.50%), European-Ancient Mediterranean – 18 (1.95%), European-Mediterranean-Minor Asian – 12 (1.30%), European-Minor Asian – 15 (1.63%), European-Mediterranean-Iran-Turanien – 8 (0.86%). Boreal elements are represented in the flora of the region in groups: euro-boreal – 12 (1.30%), paleoboreal – 7 (0.76%), circumboreal – 6 (0.64%).

Generally the Desna Plateau flora has palearctic character with the significant share of European-Mediterranean elements.

DISCUSSION

In the territory of the Desna Plateau there is one euendemic species – *Gagea praeciosa* L. and also 19 subendemic species: *Carduus thoermeri* Weinm., *Centaurea sumensis* Kalen, *C. pseudomaculosa* Dobrocz., *Jurinea calcarea* Klok., *J. pseudomollis* Klok., *Dianthus pseudosquarrosus* (Novak) Klok., *D. pineticola* Kleopow, *D. eugeniae* Kleopow, *Syrenia cana* L., *Taraxacum klokovii* Litvinenko, *Pilosella piloselliflora* (Naeg. & Peter) Sojak, *Thymus tschernjajevii* Klok. & Des.-Shost., *Urtica galeopsifolia* Wiersb. ex Opiz, *Polygala cretacea* Kotov, *Gladiolus tenuis* M. Bieb., *Iris pineticola* Klok., *Euphorbia stepposa* Zoz ex Prokh.

It is known that in the Quaternary Period Desna Plateau area was under the Riss and Wurm glaciation masses. Therefore, the pre-glacial flora elements are unlikely to have been preserved here, including the Tertiary period. Thus, low level of endemism testifies about the post-glacial young age of Desna Plateau flora.

We have identified the genesis elements of the Desna Plateau flora.

1. The most ancient relict elements are as follows:

– Riss-Wurm relicts (mountain ferns): *Matteuccia struthiopteris*, *Cystopteris fragilis*, water fern *Salvinia natans*; ferns of the genus *Dryopteris*, *Athyrium*; hydrophytes *Ceratophyllum demersum*, *Nuphar luteum*, *Stratiotes aloides*, *Nymphaea alba;*

– glacial relicts *Betula humilis*, *Salix mirsinifolia*, *Polytrichum commune*, *Lycopodium annotinum*, *L. clavatum*. Relicts of the Central Russian Upland *Vaccinium vitis-idaea*, *Ledum palustre*.

– xerothermic relicts of the post-glacial era: *Stipa pennata*, *Clematis recta*, *Veronica spicata*, *Koeleria cristata* – confined to meadow-steppe areas in places close to Cretaceous deposits. *Cerasus fruticosa* rarely occurs on the meadow-steppe slopes. *Allium ursinum*, *Acer tataricum* – species of deciduous and mixed dark and light forests.

– Atlantic relict *Anemone nemorosa* happens under the tents of the forest.

2. Elements of the preserved boreal palearctic flora: for example, *Pinus sylvestris* L., which grows on chalk outcrops and sandy soils. Obviously, it was preserved in the glacial periods on elevated areas, then occupied the liberated sandy terraces of the rivers.

3. Migratory elements of the boreal-nemoral group that penetrated the territory liberated from the glacial territory later from different centers of origin.

E. Lavrenko defined the centers of plant migration for the territory of Ukraine (Lavrenko, 1930). Boreal center: *Pyrola rotundifolia*, *Chimaphylla umbellata*, *Nardus stricta*, *Maianthemum bifolium* – these species are located on the territory of the Desna Plateau on the extreme southern border of distribution.

Central European and Carpatho-Balkan centers, probably, gave a number of Central European species, in particular, oak. From the Caucasian center during the interglacial and postglacial periods *Malus sylvestris*, *Vinca minor* migrated. The Mediterranean Center: through the mountain bridges of the Balkans and the Great Caucasus Range gave a large number of species of Ancient Mideterranian. These species inhabited wet meadow, forest edge and dry arid steppe ecotops, took part in ruderal-segetal plant communities: *Trifolium pratense*, *Salvia viridis*, *S. verticillata*, *Lactuca serriola*.

The Dzhungaro-Altai Center, probably, gave the widespread forest-forming species of the dendroflora of the region (*Tilia cordata*), which are part of the oak-lime-maple forests of the Left-Bank Ukraine. Species of the Pannonian-Pontic center are usually located on the extreme northern border of distribution (*Salvia nutans*). Significant anthropogenic impact was experienced by the Desna Plateau flora in late Holocene.

Thus, settling the liberated from the glacial cover of the territory of the Desna Plateau occurred in several stages – migration waves. The first wave includes species that could populate the territory of the Desna Plateau during the Riss-Wurm Interglacial Stage. These are relict species of the boreal and water-coastal (alluvial) floristic complexes. The long-standing of these species within the forest zone was pointed out by S.L. Mosyakin (Mosyakin, 1990). These include the mountain ferns *Matteuccia struthiopteris*, *Cystoptheris fragilis*, which could have been preserved in elevated sections of the refugios (Podilskyi Upland, Donetsk ridge, etc.) that were not affected by the glacial masses of the previous Mindel and Riss ice epoch.

These species survived the severe glacial conditions of the Wurm (Valdai) glacial era in the kryo-xerophilic phase, grow in narrow-ecological niches, and are recognized as relict forms that require protection.

The second migration wave on the Desna Plateau is represented by the boreal-forest species spread from the northern territories during the Wurm (Valdai) glacial. Those species constitute a group of glacial relicts in the territory of the Desna Plateau. In our time they are on the extreme southern boundary of distribution and grow on the sandy substrate of pine forests (*Lycopodium annotinum*, *L. clavatum*), river terraces and marsh ecotopes (*Betula humilis*).

The third – the Holocene – the remigration wave has been widely deployed on the study area after its release from the glacial waters of the last Wurm (Valdai) glacier. This wave is the result of complex combinations of periodic fluctuations in air temperature, humidity, type of soil-forming rocks and soils, and so on. For the territory of the Desna Plateau, a pre-boreal phase was possible – the most ancient phase of the Holocene, when here a short time was spreading spruce. Later in the boreal phase of the early Holocene formed pine-birch, birch forests, which spread from the composition of the migratory boreal northern and Siberian birch flora. The forest landscapes were interrupted by steppes in the migration of the Siberian-steppe flora and, probably, migrants from the southern Pannonian-Pontic territories.

At that time the formation of a number of xerothermic relicts on the investigated area included: *Gagea praeciosa*, *Stipa pennata*, *Allium ursinum*, *Acer tataricum*, *Koeleria cristata*. Probably, during the arid warm period, steppe landscapes were represented by plant communities consisted different grass, fescue (*Festuca*), feather-grass (*Stipa*).

The climate optimum of the Middle Holocene contributed to the migration of *Quercus* and the formation of mixed oak-pine and oak forests. Their distribution is indicated by the findings of *Anemone nemorosa* – a sub-Atlantic relict both in the study area and much more north, in the zone of coniferous forests. The first half of the late Holocene is associated with migratory processes aimed at the spread of water-loving species *Tilia*, *Acer*, *Ulmus*, *Alnus* and the formation of broad-leaved forests with herbaceous cover among the species distributed from the Middle European, Carpathian, Caucasian, Altaic refugios (Giesecke et al., 2017).

The driving force of the fourth migration wave is human activity in the second half of the late Holocene. Deforestation, drainage of marshes in the forest and forest-steppe zones contributed to the change of hydrological regime, xerophytisation of growth conditions. These factors combined with the violation of natural vegetation cover due to the formation of agrocenoses, introduction and acclimatization of plants contributed to the general synanthropization of the Desna Plateau flora.

Transformative phenomena and trends of the flora of the region will be presented separately.

Thus, the Desna Plateau flora is characterized by high species diversity and richness, which is explained by the ecoton location of the region, the presence of intrazonal types of vegetation – marshes, meadow-steppe areas, peculiarities of the composition of soil-forming rocks (loess loam, sandstones, chalky deposits), as well as historical development. The results of the taxonomic analysis indicate that the basis of the Desna Plateau flora consist temperate arctic and boreal elements. The systematic structure of the flora reflects its boreal-nemoral character with significant influence of the southern, in particular, Mediterranean elements, indicating the ties of the region with the Ancient Mediterranean.

The results of the analysis of flora parameters confirm its affiliation with the Central European floristic region (Malyshev, 1972; Shmidt, 1974), and in the system of floristic zoning of Ukraine – to the Eastern European province of the European floristic region. In addition, the near boundary nature of the location of the studied region within the two floristic subprovinces is reflected: the Polissya (in the South Polissya county) and the Dnipro-Central Russian (in the Left-bank Dnipro county).

The geographic analysis shows that the flora of the Desna Plateau is a vivid example of the heterogeneous, mostly alochtone (migration) flora. The core of the flora forms palearctic and Holarctic elements. The boreal features of the flora are followed by the presence of a number of circumboreal and palaeoboreal elements. A significant proportion of European species, in particular, Eastern European, Eastern European-Central Asiatic, European-Western Siberia species, bring it closer to the Eastern European floras. Migration relations with the territories of the Caucasus, Asia Minor, Mediterranean are indicated by a rather large number of those geographic elements. A significant proportion of pluri-regional species is due to the influence of anthropogenic impact.

This is in perfect agreement with the location of the region near the two physical and geographical zones – the Novhorod-Sivers'ky Polissya and the Sumy Forest-steppe, as well as near the border of two geomorphological structures – the Dnieper Lowlands in the west and the Central Russian Upland in the east. The almost complete lack of endemic and insignificant amounts of subendemic confinite species suggests that the region is located at the peri-pheral boundary of several autochthonous floristic nuclei: boreal, forest-steppe and low alpine.

The results of the biomorphological analysis of the Desna Plateau flora and comparison with other regional floras of Ukraine indicate the affiliation of the studied flora to temperate arctic type, emphasizing its boreal character with a significant influence of thermophilic and arid elements due to the features of the relief of the territory, the composition of soil-forming rocks and the influence of anthropogenic factors.

The ecological structure of the Desna Plateau flora relative to humidity indicates that in the general background of the moderately humid habitats (forest, meadow) in the region there are more humid forest-marsh and meadow-marsh ecotopes. Besides there are arid meadow-steppe areas associated with elevated forms of relief and chalk outcrops. Also there are arid ruderal ecotopes due significant spread of processes of denaturalization of landscapes.

For the ecocoenotic structure in the flora of the Desna Plateau the most widely presents species of forest edge and deciduous forest which fully corresponds to the zonal location of this region in the northern part of the Sumy forest-steppe. The participation boreal species as well as species of intrazonal types of vegetation – marshes, meadows, steppe areas associates on its ecoton location, forms of relief and as a result promote transitional nature. A rather significant proportion of species of hygrophilic group indicates favorable hydrological conditions in the region.

CONCLUSION

Generally according to the taxonomic, biomorphological, ecological and ecocoenotic analysis of Desna Plateau is typical of the moderate Holarctic floras. It is characterized by species richness (920 species belonging to 464 genera and 112 families), by diversity of floristic complexes.

Higher position in the spectrum of the leading families Asteraceae, Poaceae, Cyperaceae and of leading genera *Carex*, *Veronica*, *Potentilla*, *Viola*, *Poa*, *Trifolium*, *Ranunculus* indicate that the flora of the region is of boreal character. High position of Fabaceae, Lamiaceae, Brassicaceae, Apiaceae witnesses about the considerable influence of thermophilic elements and aridity, which are conditioned with features of the area relief, the composition of soil and the anthropogenic impact.

The results of the biomorphological analysis of the studied flora with domination of the herbaceous perennials with fibrous root system denotes its affiliation to the zonal flora of Forest and Forest-Steppe.

The results of the ecological analysis of Desna Plateau flora species according to relation to humidity demonstrate the higher position are occupied by mesophytes (46.24%), submesophytes (13.04%), hygrophytes (13.26%) that fully answers by physical-geographycal position of region. The considerable part of xerophytes (5.97%) and mesoxerophytes (8.47%) denote on the chalk outcrops in the relief of territory and considerable anthropogenic pressure. The consistency of the ecological spectrum with relative to the humidity regime with the ecocoenotic structure of the Desna Plateau flora was revealed.

According to the geographic structure the Desna Plateau flora is closer to floras of the Eastern European type.

The almost complete lack of endemic species and a small number of relict elements of the inter- and postglacial age indicate a young post-glacial age and, mainly, the migratory nature of the Desna Plateau flora. Forming the vegetation cover was carried out through several migratory waves, settled the territory of the Desna Plateau freed from the Riss and Wurm (Valdai) glaciation. The modern species composition of the flora is formed mainly under the influence of Holocene climatic pulsations and migrations.

Climate change and the increasing influence of human activities indicate the need for continuous monitoring the flora of the Desna Plateau in order to preserve its ecoton nature character (Koval et al., 2018).

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ФЛОРА ПРИДЕСНЯНСКОГО ПЛАТО: КОМПЛЕКСНЫЙ АНАЛИЗ И ГЕНЕЗИС

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В современных условиях катастрофических изменений климата и усиления антропогенного воздействия на природную среду мониторинговые исследования фиторазнообразия как базового компонента биоразнообразия становятся особенно актуальными. В статье представлены результаты комплексного анализа флоры Придеснянского плато (ПП), а также сведения о ее происхождении и процессе формирования. Расположение района исследований вблизи границы географических зон Новгород-Северского Полесья и Сумской лесостепи, сочетание низменных и возвышенных форм рельефа с близким залеганием меловых пород, а также достаточно разнообразный характер почвенного покрова территории придают флоре региона целый ряд особенностей. Видовой состав флоры включает 920 видов высших сосудистых растений, которые относятся к 464 родам, 112 семействам, 6 классам и 5 отделам. Анализ параметров флоры, спектры ведущих семейств Asteraceae, Poaceae, Cyperaceae, Fabaceae, Lamiaceae, Rosaceae, Caryophyllaceae, Brassicaceae, Apiaceae, Scrophulariaceae и родов *Carex*, *Veronica*, *Campanula*, *Salix, Ranunculus*, *Potentilla*, *Galium*, *Viola*, *Poa*, *Trifolium* свидетельствуют, что основу флоры региона составляют умеренно-голарктические и бореальные элементы со значительной долей южных, в частности, средиземноморских элементов, указывающих на связи со Средиземноморским регионом.

Используя коэффициент ранговой корреляции Кендела, определены уровни сходства флоры Придеснянского плато с некоторыми региональными флорами Украины и Среднерусской возвышенности. Установлено, что основу биоморфологической структуры флоры составляют травянистые многолетние летне-зеленые виды с мочковатой корневой системой. Среди жизненных форм растений согласно классификации К. Раункиера доминируют гемикриптофиты. Распределение видов в экологическом спектре по типу влажности вполне соответствует расположению региона в экотонных условиях. Так, на фоне доминирования мезофитов и гигрофитов, что в целом указывает на благоприятный гидрологический режим территории, значительное количество ксеромезофитов и ксерофитов свидетельствуют о наличии и аридных мест обитания. Выявлена взаимосвязь экологического спектра по режиму влажности с экоценотической структурой флоры ПП, где наиболее представлены виды лесных, луговых и рудерально-сегетальных экоценотических групп.

Географический анализ флоры ПП вскрывает ее неоднородное происхождение. В целом флора ПП имеет палеарктический характер со значительной долей европейско-средиземноморских элементов. Значительная доля плюрирегиональных видов частично обусловлена антропогенным воздействием. Почти полное отсутствие эндемичных видов и небольшое количество реликтовых элементов межледникового и послеледникового периодов, данные споро-пыльцевого анализа свидетельствуют о молодом послеледниковом возрасте и преимущественно миграционном происхождении флоры ПП.

Ключевые слова: фиторазнообразие, флора, флористический анализ, реликтовые виды, эндемичные виды