Теоретичні та прикладні питання

The Flora of Kurgans in the Desert Steppe Zone of Southern Ukraine

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Abstract: Results of the studies on biodiversity of the kurgan flora in the desert steppe of the Black Sea Lowland (the southern part of Kherson Region) are presented. Twenty-six of about 130 kurgans higher than 3 m, distributed over an area of approx. 1500 km^2, were surveyed. The kurgan flora was estimated at 305 species; the number of species on particular kurgans ranged from 48 to 103, 82 on average. The species of particularly high floristic value were: *Allium regelianum*, *Anacamptis picta* (= *Orchis picta*), *Cerastium ucrainicum*, *Dianthus lanceolatus*, *Linaria biebersteinii, Muscari neglectum, Senecio borysthenicus, Stipa capillata,* and *Tulipa schrenkii*. The spectrum of life forms of the kurgans flora generally corresponded to the spectrum for the desert steppe zone (almost a half of the flora consisted of therophytes and short-living perennials). Species of alien origin constituted 23% of the kurgans flora, which does not indicate significant anthropogenic influence. Species with wide Mediterranean-Eurasian ranges predominated among anthropophytes. Only 9 species were the synanthropic newcomers, i.e. kenophytes. The phytosociological range of the kurgans flora was quite wide. Species of two classes, *Festuco-Brometea* and *Stellarietea mediae* were predominant, which also confirmed the semi-natural character of the kurgan flora.
The kurgans constitute a distinctive element of the southern Ukraine landscape. The state of preservation of their plant cover varies. Floristic richness, a share of rare and protected species, as well as shares of non-synanthropic (steppe and halophilous) species can be assumed as the criteria for its assessment. The recommendations regarding kurgans that should be under protection, not only as archaeological sites but also as nature monuments, was based on these assessment criteria.

Key words: kurgans` flora, barrows, refugia of steppe flora, floristic diversity, Pontic desert steppe, protection of kurgans, Kherson Region.

Ключові слова: флора курганів, кургани, рефугіум степової флори, флористичне різноманіття, Понтичний пустельний степ, охорона курганів, Херсонська область.

Introduction

Barrows, or burial mounds, are found throughout the temperate zone in Eurasia, in particular in Great Britain, the Netherlands, France, Germany, Poland, Hungary, Ukraine, Russia, Kazakhstan, and Mongolia. The oldest kurgans were built over 5500 years ago and the most recent ones are over 700 years old (dating from the Eneolithic Age, the Bronze Age, the early Iron Age, Pre-Roman and Roman Times, the Migration Period, and the Middle Ages). They were constructed by the nomadic communities of Cimmerians, Scythians, Sarmatians, Huns, Bulgarians, Magyars, Polovtsians (Kumans), Nogays (Nogay Tatars) and other peoples [АРХЕОЛОГІЯ…, 1971]. These conical or dome-shaped burial mounds, with a wooden (where wood was available), stone or wood-stone construction, usually contain one or several urn graves or skeleton graves. Many of the kurgans have also been used as cemeteries up to the present time.

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Over 50,000 kurgans are recorded in Ukraine; most of them are located in the steppe zone in the southern part of the country [Оленковський, 1997; Оленковський, personal communication]. More than 5,000 kurgans have been reported from Kherson Region. The oldest of them date back over 5500 years (Skelanska culture) [Давня історія…, 1997]. Kurgans are a characteristic and unique element of the Ukrainian landscape, especially of the steppe plains. They are about 1-10 (0.5-12) m high and range in size from 8 to 100 (180) m in diameter [Археологія…, 1971]. Most of the small kurgans have been ploughed down but those higher than 3-4 m are easily recognizable in the agricultural landscape of Ukraine.

During our field trips we noted that the kurgans were more or less floristically distinct from adjacent areas. Moreover, the proportion of steppe species in the flora of kurgans seemed to be higher.

The aim of this study was to assess the richness and specific character of the flora of kurgans within the desert steppe (= wormwood/sod-grass steppe) zone and to answer the question about their role as refugia of the steppe flora. The differentiation of kurgans' microhabitats will be the subject of another article. The data obtained will be used to compare the floristic lists of kurgans from various steppe subzones (*western Pontic grass steppe* = fescue/feather-grass, poor forbs steppe = "tipczakovo-kovylnaja step – biednoje raznotravie" and *western and central Pontic herb-rich grass and herb-grass steppe* = fescue/feather-grass, rich forbs steppe = "tipczakovo-kovylnaja step – bogatoje raznotravje") and the forest-steppe zone.

Characteristics of the study area

The studied area is located within the desert steppe zone (*Pontic desert steppe =Artemisia steppe* = "polynnaya step") (fig. 1), which continues a narrow strip in the south of Ukraine, along the coast of the Black Sea and the Sea of Azov; the most connected steppe belt developed along the northern and southern Syvash coast. Isolated areas are found on the Kerchens`ki (Kerch) Peninsula, the eastern part of Crimea [Рослинність..., 1973, Bohn et al., 2000, Лавренко та ін., 1991].

The survey was carried out in the southern part of the Black Sea Lowland and the south-western part of Kherson Region (Gola Prystan' and the western part of Skadovs`k Districts), in the weakly structured plains along the northern coast of the Black Sea. The study area was limited on the north by Dniprovs`ki Liman (the Dnieper Estuary), on the west by Jagorlytski Bay, on the south by Tendra Bay, and on the east by the road from Gola Prystan' to Lazurne. The investigated kurgans were located over an area estimated at around 1500 km^2.

The area lies within the southern part of the temperate continental climate zone with hot summers and short, mild, snow-poor winters and with prolonged precipitation-free periods. The total annual precipitation is below 350 mm; total summer rainfall is greater than total winter rainfall; maximum rainfall occurs in June and July. Mean July temperature is $+23^0$C, mean temperature for January – not greater than -3^0C; extreme temperatures: $+39^0$C in summer, -31^0C in winter [Природа…, 1998].

The surface of the territory is almost flat. There are no rivers. The waters of saline lakes evaporate completely in summer, and the dry bottoms of lakes are covered with crust salt in the central part and with obligatory halophytes in the peripheral part.

The soils vary within the area investigated. The northern part of the area (adjoining the left bank of the Dnieper) is dominated by sandy soils, the central part – by solonetz-like dark chestnut soils, the eastern and southern part – by a combination of chestnut soils with a complex of solonetz-solonchak soils [Природа…, 1998; Скляр, Хільченко, 1969].

The plant cover also varies due to the diversity of substrata [Природа..., 1998, Лавренко та ін., 1991]. In accordance with the classification scheme adopted in the *Map of the Natural Vegetation of Europe* [Bohn et al., 2000] some units of steppe vegetation can be distinguished in this area: *west and central Pontic desert steppe* (M16) is the dominant part of

the desert steppe, in the eastern part *Pontic hemi-psammophytic herb-grass steppe* (M7) is noted, in the north – *Pontic psammophytic herb-grass steppe* (M8), which occurs in combination with *kolka*-forest (small forested areas within the steppe area). The *west Pontic halophytic vegetation* (P30) dominates on the coast, which represents a combination of desert steppe, solonchak, sand and littoral vegetation.

In this part of Kherson Region much of the area is not agriculturally utilized. In addition, many of the fields have been abandoned due to increased soil salinity. The rest of the steppe was used mainly as pasture. Twenty to thirty years ago most of the area belonged to *kolkhozes* (collective farms) and there were thousands of sheep. The structure of animal breeding has changed significantly since then. Large-scale sheep farming has been replaced by smaller herds of cattle. Nowadays the pastures are used only extensively.

Part of this area is under protection within Black Sea Biosphere Reserve, which was established in 1927 to preserve the bird life of this area.

In the study area there are estimated 130 kurgans higher than 3 m. Some of the low kurgans located within the cultivated fields had been ploughed up or completely destroyed. The contact zone between the kurgans and the surrounding pastures is slightly visible. Sometimes small depressions develop at the edge of the kurgans as a result of the piling up of earth used to make the barrows (these places were characterized by somewhat different species composition patterns). The slopes of kurgans are gentle and the top is almost undisturbed. Triangulation towers are rarely built in these plain territories and signs of archaeological activities are infrequently seen. Some of the kurgans are still used as cemeteries.

A total of 26 kurgans were investigated (fig. 1). The criteria used for selecting the barrows are introduced in the *Material and Methods* section. Due to problems in establishing the location of the kurgans on archaeological and geo-physical maps, GPS was used to locate the barrows (tabl. 1).

Material and methods

Floristic studies were carried out during the growing seasons of 2004 and 2005 (in spring, summer and autumn). Of the 26 kurgans selected for this study, only a few were situated among cultivated fields. Most of the barrows were located in previously intensively grazed areas and abandoned fields where the desert steppe was recovering. Nowadays these areas are mainly used for extensive cattle-rearing. The following criteria were used to select the 26 kurgans:

- the height of kurgans; those less than 3 m in height were not considered;
- the state of preservation of kurgans; barrows destroyed or severely altered by man (e.g. due to the extraction of earth, strong disturbance of the upper part of the kurgan, presence of trenches or water tanks on the top, intensive use of barrows as cemeteries) were rejected;
- the state of preservation of the plant cover; it was assumed that the presence of typical steppe species, such tuft grasses as *Festuca valesiaca, Koeleria cristata* and *Stipa capillata*, was indicative of a relatively good condition of the plant cover.

The following microhabitats within the kurgan were identified:

T – top of the barrow;
Ss – southern slope;
Sn – northern slope;
Bs – southern foot;
Bn – northern foot.

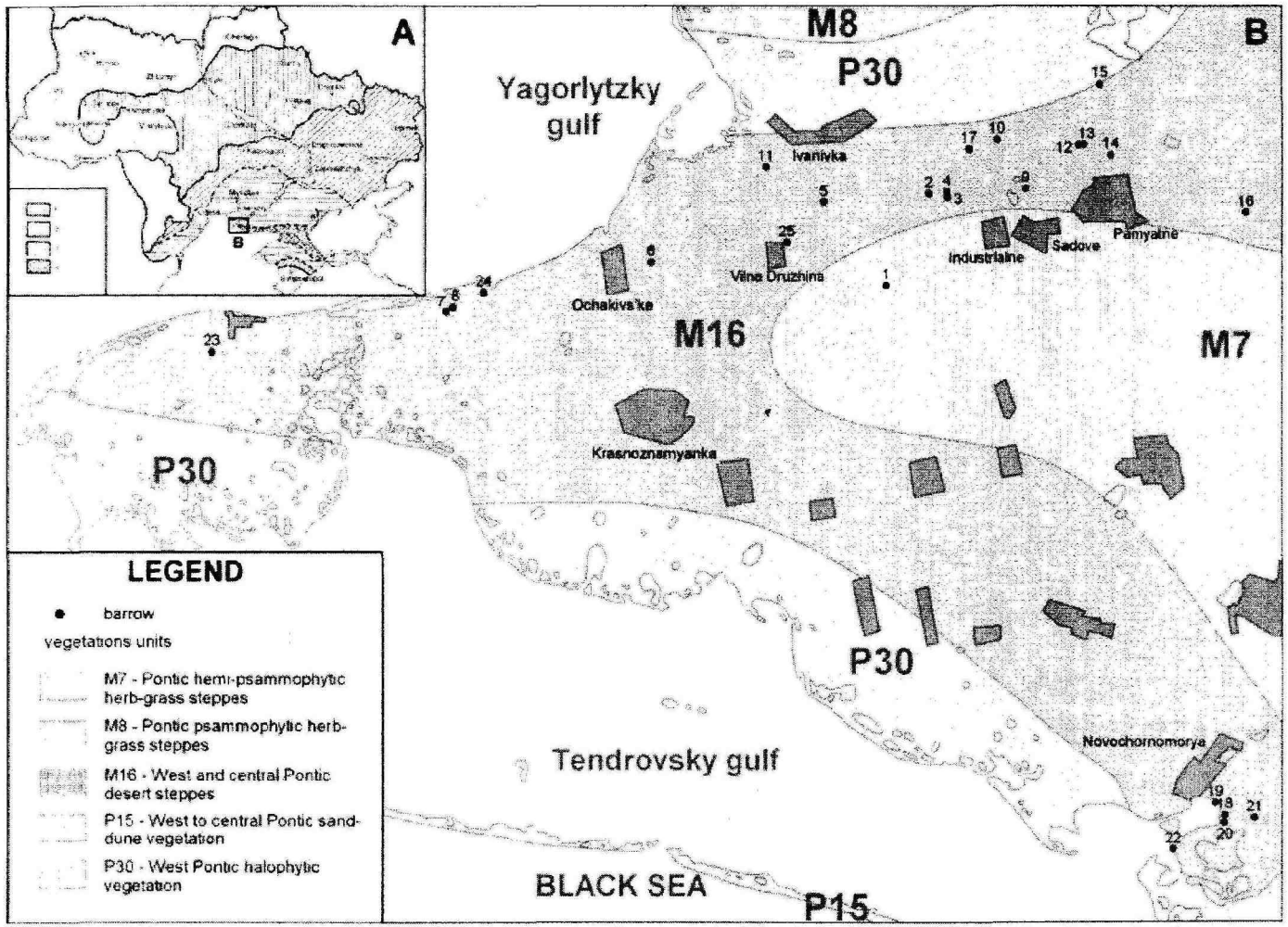

Fig. 1. A) The location of the investigated area and the various types of steppes in Ukraine: 1– forest-steppe; 2 – fescue/feather-grass, rich forbs steppe; 3 – fescue/feather-grass, poor forbs steppe; 4 – wormwood/sod-grass steppe.
B) The investigated area and location of the 26 chosen kurgans against a background of the vegetation units based on the *Map of the Natural Vegetation of Europe* [BOHN et al., 2000].

Рис. 1. А) Розміщення території дослідження відносно різних типів степів в Україні: 1 – Лісостеп; 2 – багаторізнотравні типчаково-ковилові степи; 3 – біднорізнотравні типчаково-ковилові степи; 4 – полиново-злакові степи.
В) Територія дослідження та розташування 26 вибраних курганів відносно одиниць рослинності прийнятих в *Map of the Natural Vegetation of Europe* [BOHN et al., 2000].

Table 1

The location and size of the investigated kurgans in the desert steppe zone in the southern part of the Kherson Region

Табиця 1

Локалізація та розміри досліджених курганів в пустельностеповій зоні на півдні Херсонської області

Code of the kurgan	Location (nearest village)	Longitude (E)	Latitude (N)	Height of kurhan (m)	Diameter of kurgan (m)
D1	Industrial`ne	$32^0$07’26.9”	$46^0$20’29.7”	10	90
D2	Ivanivka	$32^0$08’31.6”	$46^0$22’08.4”	8	80
D3	Ivanivka	$32^0$09’00.2”	$46^0$22’03.9”	4,5	45
D4	Ivanivka	$32^0$08’59.1”	$46^0$22’10.1”	4	35
D5	Ivanivka	$32^0$05’53.0”	$46^0$21’59.0”	5,5	60
D6	Ochakivs`ke	$32^0$01’30.5”	$46^0$20’54.3”	6	55
D7	Krasnoznamyanka	$31^0$56’20.0”	$46^0$20’02.6”	3,5	40
D8	Krasnoznamyanka	$31^0$56”30.2”	$46^0$20’06.8”	4	45
D9	Sadove	$32^0$10’59.0”	$46^0$22’13.3”	6	50
D10	Ivanivka	$32^0$10’15.8”	$46^0$23’05.1”	8	90
D11	Ivanivka	$32^0$04’25.0”	$46^0$22’36.8”	5	40
D12	Pamyatne	$32^0$12’19.0”	$46^0$23’00.0”	6	60
D13	Pamyatne	$32^0$12’27.1”	$46^0$23’00.3”	4,5	40
D14	Pamyatne	$32^0$13’08.1”	$46^0$22’49.5”	6	55
D15	Pamyatne	$32^0$12’52.4”	$46^0$24’01.9”	3	25 x 40
D16	Chulakivka and Pamyatne	$32^0$16’31.6”	$46^0$21’48.5”	7	80
D17	Ivanivka	$32^0$09’33.0”	$46^0$22’55.4”	3,5	35
D18	Novochornomorya	$32^0$16’00.1”	$46^0$11’14.1”	6	65
D19	Novochornomorya	$32^0$15’45.6”	$46^0$11’27.6”	7	80
D20	Novochornomorya	$32^0$15’58.9”	$46^0$11’05.9”	4,5	50
D21	Novochornomorya	$32^0$16’44.1”	$46^0$11’11.5”	9	80
D22	Novochornomorya (“Lysyachi mogyly”)	$32^0$14’41.5”	$46^0$10’37.3”	4	45
D23	Ochakivs`ke, Black Sea Biosphere Reserve	$31^0$50’24.0”	$46^0$19’20.5”	4,5	65
D24	Ochakivs`ke	$31^0$57’16.9”	$46^0$20’22.6”	3	40
D25	Vil`na Druzhyna	$32^0$04’56.8”	$46^0$21’15.7”	6	75
D26	Lazurne	$32^0$29’01.9”	$46^0$05’52.4”	3	35

In each microhabitat a floristic list was made and the abundance of each species was estimated according to a 3-point scale (1 – sporadic, 2 – infrequent, 3 – common).

All the floristic data were compiled into one table (Appendix 1). The following parameters were determined:

- occurrence and abundance of the species on all kurgans and in particular microhabitats;
- life forms;
- socio-ecological group: syntaxa to which particular species are connected in the studied area (phytosociological range) are listed in Table; the syntaxon to which connection is the strongest is always listed in the first place. The spectrum of socio-

ecological groups was analysed, with both the whole range – all syntaxa for all the species, and also only the first one taken into account.

- status of the species in a geographical-historical classification [KORNAŚ 1981], including the form of protection for some native plants and determining the origin of aliens.

Floristic analysis was conducted in which such selected elements as floristic richness in species and spectra of selected species groups were assessed, i.e. life forms, socio-ecological groups, and synanthropic groups. The specificity of the kurgan flora was determined.

The following scale was used to assess the frequency category of the species:

I – sporadic, occasional (< 5% i.e. 1-2 kurgans);
II – rare (6-25% i.e. 3-6 kurgans);
III – relatively frequent (26-50% i.e. 7-13 kurgans);
IV – frequent (51-75% i.e. 14-20 kurgans)
V – common (75-100% i.e. 20-26 kurgans)

Barrows which were of high floristic value were chosen. The species nomenclature follows MOSYAKIN, FEDORONCHUK [1999], Latin names of syntaxa are given according to СОЛОМАХА [1996], МІРКІН, НАУМОВА [1998], and MATUSZKIEWICZ [2001].

Results

1. Biodiversity of the kurgan flora

The results of our floristic investigations are presented in Appendix 1. A total of 305 species of vascular plants were recorded on 26 kurgans in the desert steppe zone. The species belonged to 192 genera and 48 families. The following families were represented by the greatest number of taxa: *Asteraceae, Poaceae, Fabaceae, Chenopodiaceae, Caryophyllaceae, Brassicaceae, Lamiaceae, Scrophulariaceae, Rosaceae, Apiaceae,* and *Boraginaceae* (fig. 2).

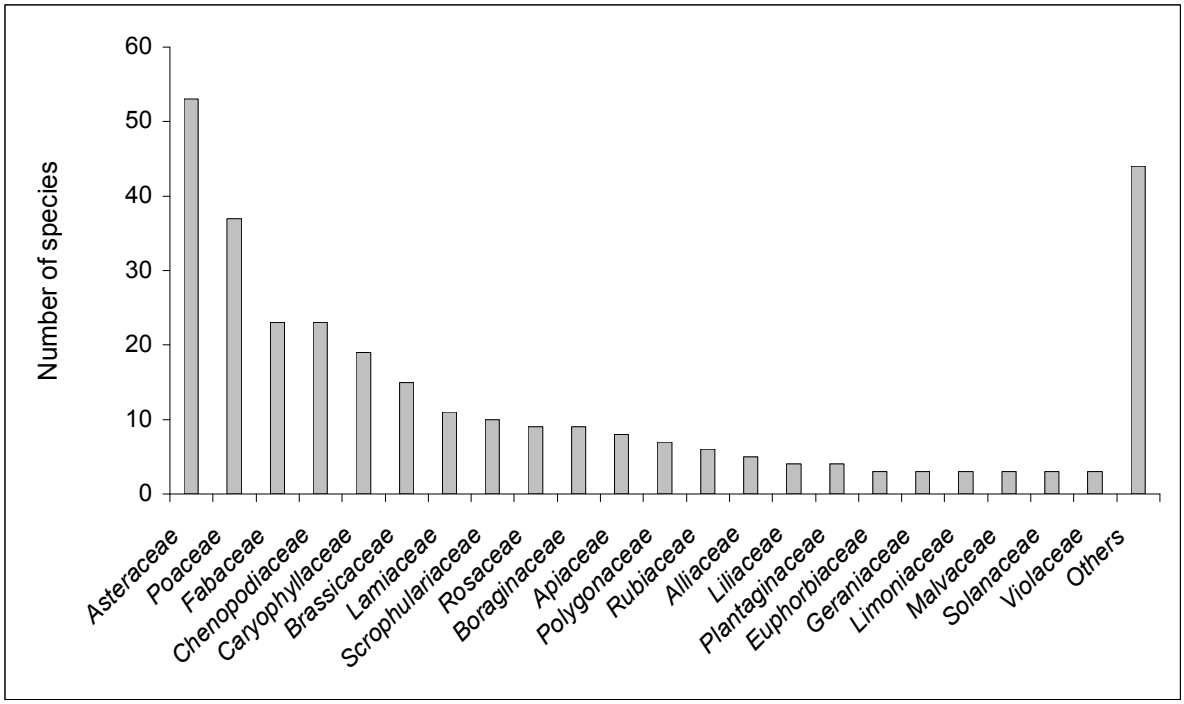

Fig. 2. The best represented families (in terms of species number) in the total flora of kurgans.

Рис. 2. Найбільш представлені у флорі курганів родини.

Most of the species (116 i.e. 38% of the kurgans flora) were considered sporadic or accidental (on 1-2 kurgans only) and are included in the first (I) frequency class (fig. 3). The group of common species is much smaller: the species recorded on 20-26 of the studied kurgans comprise only 6% of the flora: *Agropyron pectinatum* (26 kurgans), *Artemisia austriaca* (26), *Festuca valesiaca* (26), *Elytrigia repens* (25), *Holosteum umbellatum* (25), *Kochia prostrata* (25), *Poa bulbosa* (25), *Stipa capillata* (25), *Taraxacum erythrospermum* (25), *Eryngium campestre* (24), *Myosotis micrantha* (24), *Veronica verna* (24), *Vicia lathyroides* (24), *Erophila verna* (23), *Limonium meyeri* (23), *Anisantha tectorum* (22), *Ficaria stepporum* (22), *Galium humifusum* (22), and *Lamium amplexicaule* (21).

The abundance of species occurring on the kurgans theoretically ranges from 0 up to 390 (with a 3-grade scale of abundance and 5 microhabitats on 26 kurgans taken into account: 3 x 5 x 26 = 390). In fact, the abundance of only a few species exceeds 200, i.e. *Agropyron pectinatum* (242), *Artemisia austriaca* (240), *Holosteum umbellatum* (236), *Festuca valesiaca* (230), and *Poa bulbosa* (214). At the same time, the above taxa are the most frequently encountered species.

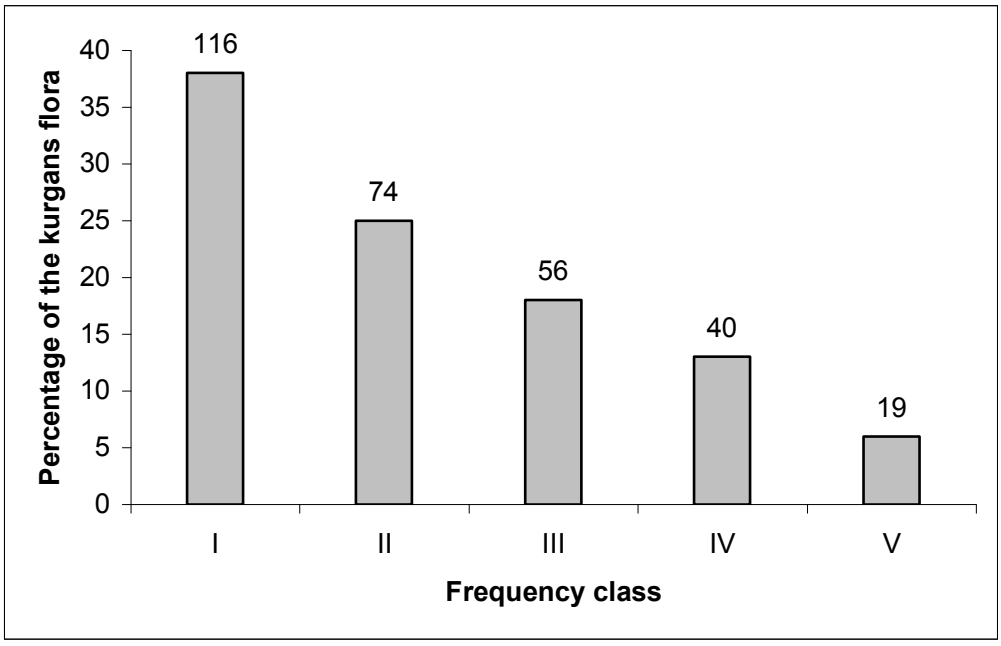

Fig. 3. Subdivision of the total flora of kurgans based on frequency class (absolute number of species in each category is indicated at the top of the bar). Frequency classes: see *Material and Methods*.

Рис. 3. Розподіл флори курганів за класами частоти трапляння (на верхівці стовпчика вказана абсолютна кількість видів у кожній категорії). Класи частоти трапляння: дивись *Матеріали та методи*.

2. Life forms spectrum

The spectrum of life forms in the flora of kurgans corresponds basically to that of the flora of the desert steppe zone. Short-living plants: one, two or three years old are predominant (fig. 4). Hemicryptophytes prevailing in the proper steppe zone comprise about 31.4% of the kurgans flora. They are less numerous and occupy smaller areas.

The high number of therophytes in the flora of the desert steppe zone is due to the less favourable geo-physical conditions (lower annual rainfall, higher insolation and soil salinity level) and less compact plant cover, on kurgans in this zone – also due to anthropogenic influences. On the kurgans, in places disturbed by animals and man, ecological niches are

formed which are filled first by therophytes. About 40% of the short-living plants are anthropophytes. It indicates that the flora of kurgans is, to some extent, the subject of anthropogenic transformation.

As in the case of the flora of the desert steppe zone, xerophilous chamaephytes contribute significantly to the flora of kurgans, the number of species is not as important (there are 12 on the kurgans, which constitutes 4%), as their abundance. Four of the species are among the 20 most abundant and most dispersed: *Artemisia austriaca* (240), *Kochia prostrata* (173)*, Artemisia santonica* (154)*,* and *Camphorosma monspeliaca* (132). Unlike the flora of typical desert steppe, the flora of kurgans consists of phanerophytes (4% of the flora – 12 species). Most of them were found at the foot of the kurgans. They were very rarely noted on the slopes (kurgan D16 located in an old park). It is likely that only one species of phanerophyte, i.e. *Tamarix ramosissima,* became established spontaneously, while others (including *Quercus robur* listed in the "Red Data List of Kherson Region" [БОЙКО, ПОДГАЙНИЙ, 2002]) escaped from windbreaks and parks. We have included them in the anthropophytes or oekiophytes group.

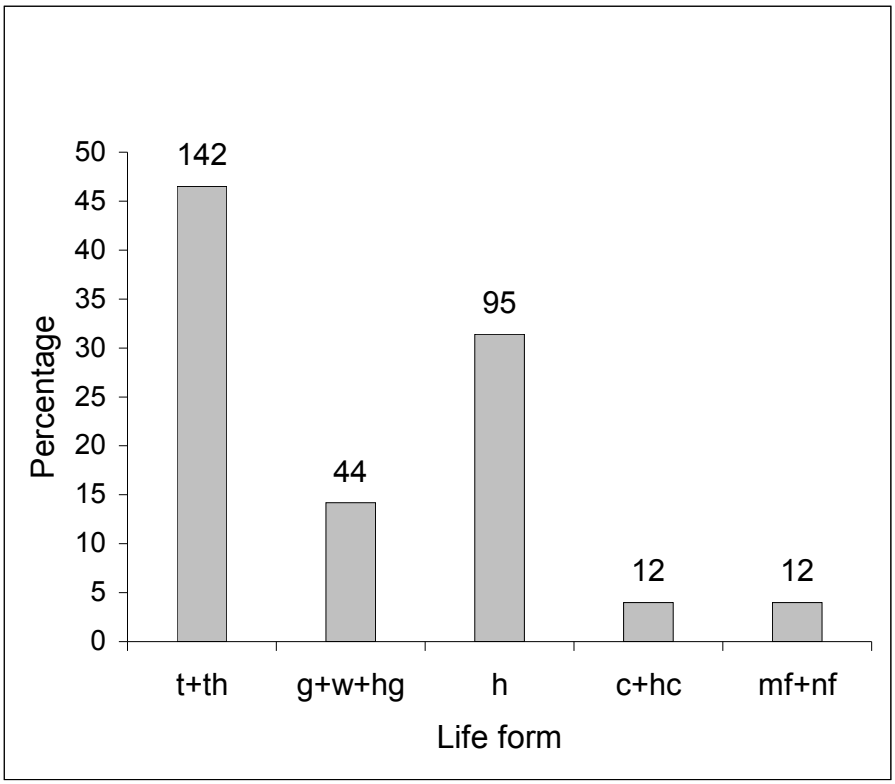

Fig. 4. Spectrum of life forms in the total flora of kurgans (for abbreviations see Appendix 1). The absolute number of species in each category is indicated at the top of the bar.

Рис. 4. Спектр життєвих форм флори курганів (прийняті скорочення дивись в Додатку 1). На верхівці стовпчика вказана абсолютна кількість видів у кожній категорії.

3. Spectrum of socio-ecological groups

The flora of kurgans is distinguished by a wide sociological range. It includes the representatives of at least 25 syntaxa of higher ranks (fig. 5). Species related to two classes, *Festuco-Brometea* and *Stellarietea mediae*, have the biggest share concerning complex groups of steppe grasslands and synanthropic communities, 82 i.e. 27%, and 63 i.e. 21% respectively. Such domination demonstrates the character of the kurgan flora.

Besides the *Festuco-Brometea* class, other commonly accepted steppe syntaxa are represented, such as *Galietalia veri*, *Festucetalia vaginatae,* and *Polygono-Artemisietea*. In total, the species connected with these syntaxa comprise as much as 41% of the kurgan flora. Species connected with syntaxa including the synanthropic communities, except *Stellarietea mediae*, are also found in great numbers and belong to such classes as *Artemisietea, Agropyretea intermedio-repentis* and order *Plantaginetalia majori,* constituting in total 29% of the kurgan flora. Arborescent (trees and shrubs) vegetation is obviously represented poorly on the kurgans (5%). As already mentioned, these are mainly plants brought from the windbreak forest belts and parks, and connected with the communities *Robinietea, Prunetalia*, and *Nerio-Tamaricetea*. The share of species from "halophilous" and "sub-halophilous" syntaxa, such as *Thero-Salicornietea, Salicornietea fruticosae, Asteretea tripolium, Festuco-Puccinellietea, Juncetea maritimi*, and *Althaetalia officinalis*, slightly exceeds 14%, but also reflects the specificity of the kurgans from the desert steppe zone well.

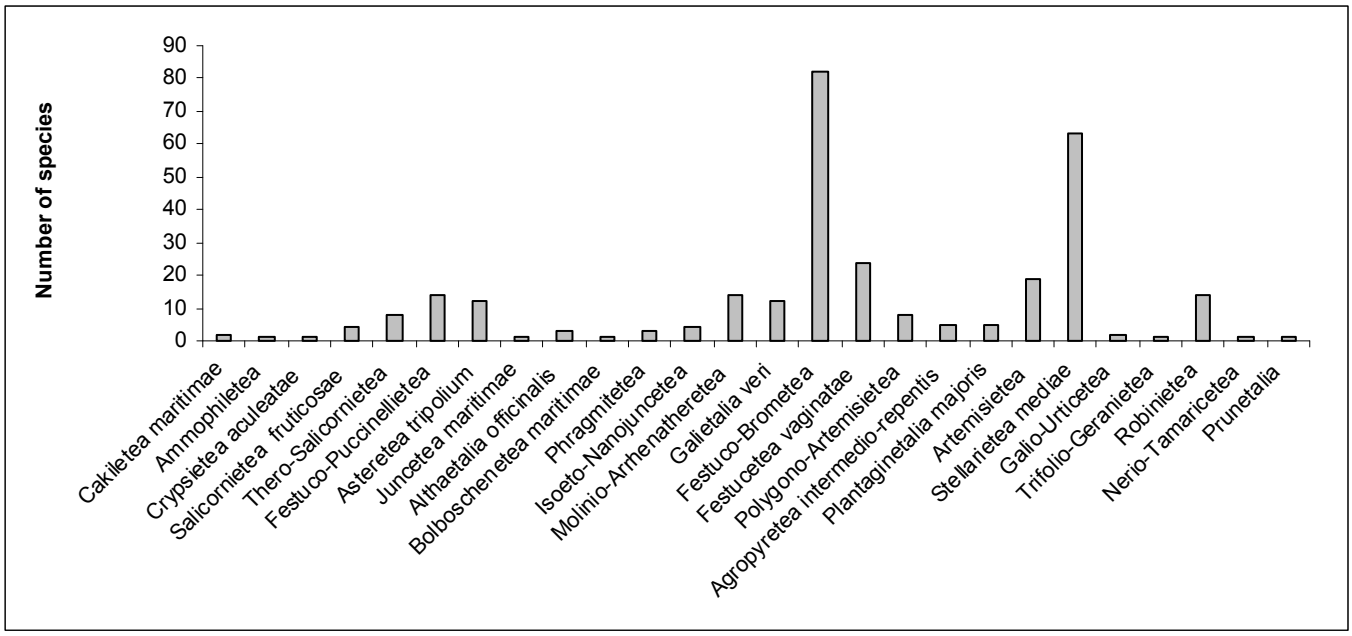

Fig. 5. The number of species from the syntaxa represented in the kurgans flora (order of syntaxa is not random – syntaxa given in a gradient from more to less halophilous, and from natural to synanthropic).

Рис. 5. Кількість видів в синтаксонах представлених на курганах (порядок синтаксонів не випадковий – в градієнті від більш до менш галофільних і від натуральних до синантропних).

4. Spectrum of species groups in the geographical-historical classification

The majority of species of the kurgan flora of the desert steppe zone are native plants (236, i.e. about 77% of flora). A half of this group (120) – 39 % of the total number of species (tab. 2, fig. 6), are the plants not entering the habitats altered by man, i.e. non-synanthropic, represented on the kurgans mostly by steppe plants and halophytes. Non-synanthropes occurring with the highest frequency are *Festuca valesiaca, Ficaria stepporum, Kochia prostrata, Limonium meyeri, Stipa capillata, Taraxacum erythrospermum*, and *Vicia lathyroides.*

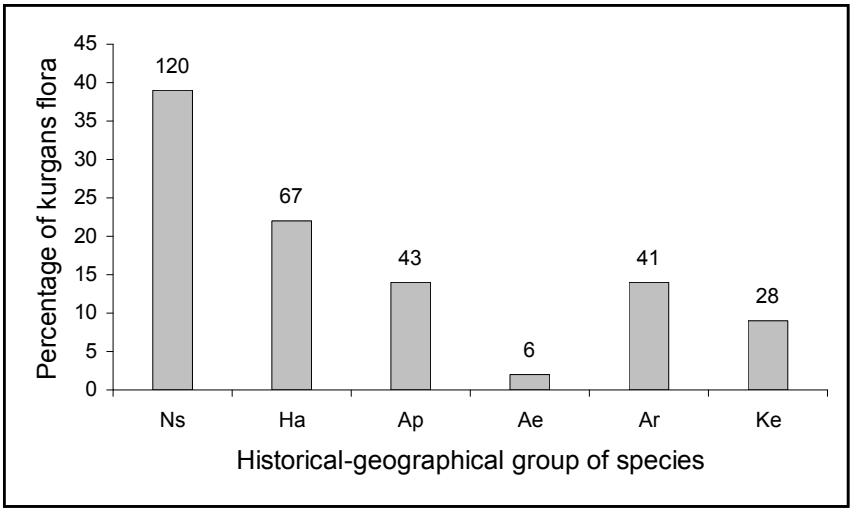

Fig. 6. Geographical-historical classification of the total flora of kurgans (for abbreviations see Appendix 1). The absolute number of species in each category is indicated at the top of the bar.

Рис. 6. Географічно-історична класифікація флори курганів (прийняті скорочення дивись в Додатку 1). На верхівці стовпчика вказана абсолютна кількість видів у кожній категорії).

Table 2

The number and abundance of species in groups of geographical-historical classification of the flora of kurgans

Таблиця 2

Кількість і рясність видів в групах географічно-історичної класифікації флори курганів

Geographical- historical group	Species in geographical-historical group		Total abundance of species in geographical-historical group	
	Number	%	Number	%
Indigenous species:	236	77	7023	85
Non-synanthropes	120	39	2906	35
Apophytes:	116	38	4117	50
- Hemiapophytes	67	22	3263	40
- Euapophytes	43	14	845	10
- Oekiophytes	6	2	9	0,1
Anthropophytes:	69	23	1257	15
Archaeophytes	41	14	855	10
Kenophytes	28	9	402	5
Total flora	**305**	**100**	**8280**	**100**

Apophytes, depending on the level of transformation of the microhabitats into which they penetrate, can be subdivided into 2 groups, hemiapophytes (22%) and euapophytes (14%) (fig. 6). With respect to frequency, hemiapophytes distinctly predominate over euapophytes, for example 10 hemiapophytes belong to frequency class V (A*gropyron pectinatum, Artemisia austriaca, Erophila verna, Eryngium campestre, Falcaria vulgaris, Galium humifusum, Holosteum umbellatum, Myosotis micrantha, Poa bulbos* and *Veronica verna*), but only 1 euapophyte (*Elytrigia repens).* The predominance of hemiapophytes is even clearer than that assessed on the basis of the species number and frequency, when the

total abundance of these groups is considered. It can be estimated for apophytes on the kurgans at 4117, which includes 3263 (40%) of hemiapophytes and 845 (10%) of euapophytes. The predominance of hemiapophytes over other groups of geographical-historical classification (non-synanthropes, anthropophytes) is also significant when, besides the number of species and frequency, abundance is also taken into consideration.

In both these groups, sporadic and single species are present on the kurgans, such as some non-synanthropes rare by nature (*Tulipa schrenkii, Dianthus lanceolatus*) or becoming extinct due to increased salinity (for example, *Onosma tinctoria, Allium inaequale, Serratula erucifolia*) or overdrying (for example *Althaea officinalis, Lotus corniculatus, Rumex stenophyllus*). Random and single anthropophytes found on kurgans, such as common crop weeds, are also be numbered among these groups (*Ambrosia artemisiifolia* or *Kochia scoparia*).

On all the kurgans, to a smaller or greater extent, alien species were found i.e. anthropophytes (fig. 6) numbering about 23% of the kurgans flora [Мойсієнко, Суднік-Войциковська, 2006]. They belong mainly to such families as *Asteraceae, Poaceae, Brassicaceae, Chenopodiaceae, Fabaceae* and *Boraginaceae*; other families are represented by 1-3 species each.

The number of anthropophytes per kurgan ranges from 4 to 29 species, 16 on average. Among anthropophytes the species of wide Mediterranean-Eurasian ranges, groups of Mediterranean-Eurasian and Mediterranean-Asian species, predominate (49%). The lower place is taken by the Asian species (26%). American species constitute only 14% (fig. 7).

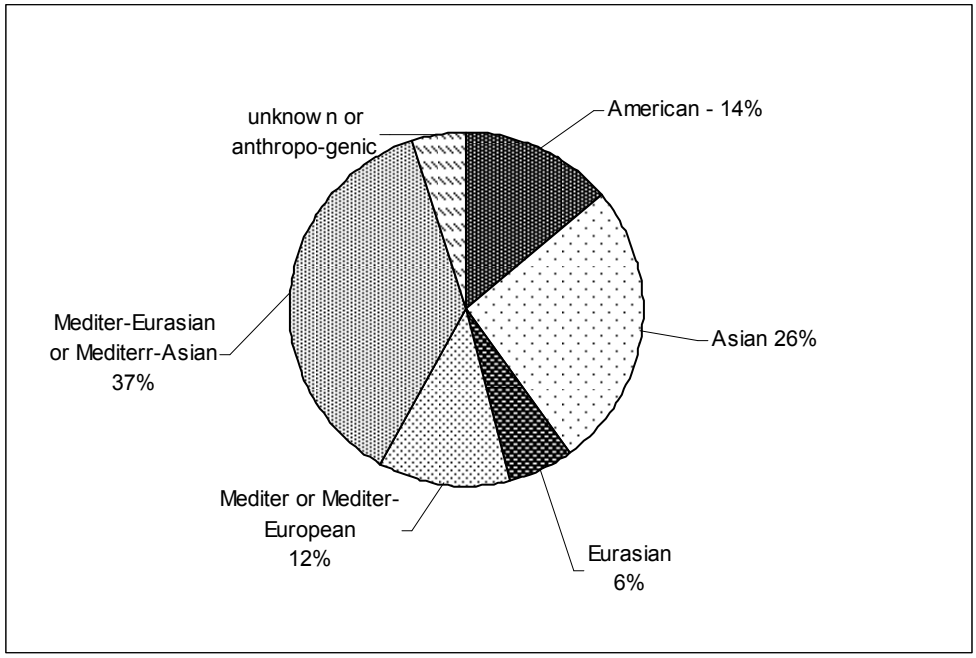

Fig. 7. Origin of the alien flora of kurgans.

Рис. 7. Походження адвентивного елементу флори курганів.

The number of archaeophytes is 1.5 higher than the number of kenophytes. The total abundance of anthropophytes on the kurgans numbers up to 1257 (855 archaeophytes and 402 kenophytes). Among the common anthropophytes there are only 2 species (indicated as archaeophytes), *Anisantha tectorum* and *Lamium amplexicaule*; among the more frequent are

archaeophytes (*Bromus squarrosus, Capsella bursa-pastoris*, *Veronica arvenis, V. triphyllos* and *Vicia hirsuta*) and kenophytes (*Centaurea diffusa, Conyza canadensis, Eragrostis minor*).

However, with respect to both frequency and abundance, the predomination of native species from 2 groups, i.e. non-synanthropes and hemiapophytes, can be observed on the kurgans. It clearly indicates the semi-natural character of the habitat.

Floristic values and the problem of protection of the plant cover of kurgans

The specificity of the flora of barrows is determined by their origin, history, and use. It is an artificial geomorphologic form built by people using natural materials (upper layers of soil) hundreds of years ago (from 3000 BC to 700 AD). Before mass ploughing, the kurgans of southern Ukraine were surrounded by virgin steppe vegetation that promoted formation on them of the plant cover similar to the natural steppe vegetation. During the development of steppes on the majority of barrows (especially smaller ones), the steppe vegetation was destroyed, basically by ploughing, or the kurgans themselves were completely destroyed. However, some of the barrows, especially large ones, were never ploughed, and on them steppe vegetation which clearly differs from that surrounding them, in most cases segetal vegetation, was preserved. In seaside conditions of the desert steppe zone some of the kurgans appeared among salty soils unsuitable for plant cultivation; now these areas are used as pastures. Thus, an essential distinction of the flora of kurgans in this zone is observed: it combines the steppe species and halophytes. All of the investigated kurgans, to a greater or lesser extent, keep a natural vegetative cover and at today's stage of transformation of nature of the south of Ukraine could play an essential role in restoration of desert steppes. Occupying a very small area (10 hectares in total), the 26 researched barrows represent a significant part of the biological and landscape diversity of the region. The richness of their flora is only 1,0-2,4 times less than the floristic richness of the large protected objects located in the Kherson Region area (Askania-Nova Biosphere Reserve – 515 species [Веденьков, 1989; Природно-заповідний фонд…, 1999], Black Sea Biosphere Reserve – 728 species, and Azov-Sivash National Park – 308 species [Природно-заповідний фонд..., 1999]).

Protected species and a significant number of non-synanthropes and steppe species of a different status in the geographical-historical classification have their refugia in the desert steppe zone. Regarding protection of the plant cover, the comparative criteria of kurgans are essential, most of all the assessment of the function of these groups on the particular kurgans, which allows identification of the most floristically valuable sites.

The factor indicating the level of plant cover preservation on the kurgans is on the one hand the floristic biodiversity of the particular objects as well as the contribution of rare and protected species into the flora, and on the other hand – a limited contribution of synanthropic species that indicate anthropogenic disturbances.

The minimum number of species found on an individual kurgan amounts to 48, the maximum – 103, on average – 82. The highest kurgans with the most diversified surrounding, marked as D1, D10, D14, D16, D19 (see Appendix 1) belong mostly to the objects of the most abundant (over 100 species) and most interesting flora among all investigated kurgans.

Among the 305 species listed (Appendix 1), the majority – over 77% – are native plants, of which at least 10 shall be considered as particularly interesting: *Allium regelianum*, *Dianthus lanceolatus*, *Linaria biebersteinii* listed in "Plants of Ukraine in the 1997 IUCN – Red List of Threatened Plants" [Mosyakin 1999], *Senecio borysthenicus* from the "Europeaen Red List" [Червона книга…, 1996], *Anacamptis picta* (= *Orchis picta*), *Stipa capillata* and *Tulipa schrenkii* – the "Red Data Book of Ukraine" [Червона книга…, 1996], *Cerastium ucrainicum*, *Muscari neglectum*, *Quercus robur* – the "Red Data List of Kherson Region" [Бойко, Подгайний, 2002]. All these species are protected. From 1 to 6 plants of these species were found on one kurgan. The greatest number of protected species (6) was recorded on a 10-meter kurgan D1, in the surroundings of the village of Industrialnoye.

Relatively rich kurgans with respect to protected species are D2, D3, D4, D5, D11, D20, and D25. Four protected species were recorded on each of them. On the other 7 kurgans, 3 protected species were recorded, and on the following 8 sites, 2 on each, and on 3, one species. Distribution patterns of rare species on the kurgans vary. The majority are present at a low frequency and low number. Two taxa are exceptional, *Cerastium ucrainicum* (IV frequency class) and *Stipa capillata* (V class).

As shown in Table 2, 120 (39%) of species recorded on kurgans shall be considered as non-synanthropic plants. The majority of them are steppe plants and halophytes. The maximum number of non-synanthropes on a kurgan ranges up to 44 species, minimum – 14, and average – 28. The contribution of non-synanthropes on particular kurgans ranges from 12% to 57%. They are most prevalent (over 40%) on the kurgans surrounded with halophilous plants (D2, D4, D10, D11, D12, D15, D17, D18, D20, D26). The lowest (under 25%) contribution of non-synanthropes was recorded on the kurgans located between fields (D1, D6, D25), in the desert steppe (D7, D23, D24), the park (D 16), and among abandoned land (D21).

One of the tasks undertaken by the researchers was the evaluation of the function of the kurgans of the southern Ukraine as the refugia of steppe flora. This required a detailed analysis of the species group in the flora of particular kurgans. In total, on the kurgans of the desert steppe zone, 124 steppe species were recorded widely comprehended as the plants naturally present in communities of syntaxa *Festuco-Brometea, Festuco vaginetea, Galietalia veri* and *Polygono-Artemisietea* (also including apophytes of steppe origin). It jointly constitutes about 14% of the total abundance of the steppe flora in Ukraine [ПОРІВНЯЛЬНА ОЦІНКА…, 1998]. To summarize, kurgans appear to be a suitable type of habitat enabling the survival of steppe plants. With the exception of one kurgan (D10), the flora of which consisted of 48% steppe species, the contribution of this species group exceeds 50% (maximum 75%). Forty-eight steppe species (minimum 25, maximum 64) were recorded on average on each kurgan. The kurgans D1, D5, D9, D11, D14, D16, D18, D19, D21, and D25 were identified as sites of the most abundant steppe flora, amounting over 50 species. The majority of them are large kurgans located in low saline areas.

Though kurgans in Ukraine are considered monuments of archaeology and are under the legal protection of the state, the vegetative cover on kurgans remains unprotected. Although the content of kurgans is appreciated, among both professionals (archaeologists, historians and heritage conservators) and the local people, there is no awareness of the great natural value of these places. All over the country the vegetation cover of most kurgans, even the large ones, is disrupted. Owing to that, development of methods for the protection of the kurgans' vegetation cover, wherever it survives in good condition, for example, through granting them the natural monument status, seems to be exceptionally urgent and topical. The analysis of presence of rare, non-synanthropic and steppe species on kurgans conducted by the researchers allowed them to identify the most valuable objects which should be subject to protection. These are D1, D2, D4, D5, D11, D12, D18, D20, and D25 kurgans.

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References

АРХЕОЛОГІЯ Української РСР / Гол. ред. Бібіков С.М. – Київ: 1971. - Т. 1. – 504 с; Т. 2. – 502 с.

БОЙКО М.Ф., ПОДГАЙНИЙ М.М. Червоний список Херсонської області. – Херсон: Айлант, 2002. – 32 с.

ВЕДЕНЬКОВ Е.П. Флора заповедника “Аскания-Нова” (аннотированный список цветковых растений заповедной степи). – Москва, 1989. – 52 с.

ДАВНЯ ІСТОРІЯ України. Первісне суспільство / В.Н. Станко (відп. ред.) та ін. – Київ: Наукова думка, 1997. – 558 С.

ЛАВРЕНКО Е.Н., КАРАМЫШЕВА З.В., НИКУЛИНА Р.И. Степи Евразии. – Ленинград: Из-во «Наука», 1991. – 146 с.

ПОРІВНЯЛЬНА ОЦІНКА фіторізноманітності заповідних степових екосистем України з метою оптимізації режимів їх охорони / Дідух Я.П., Ткаченко В.С., Плюта П.Г. та ін. / Під. заг. ред. Я.П. Дідуха. – Київ: Інститут ботаніки ім. М.Г. Холодного НАН України, 1998. – 75 с.

ПРИРОДА Херсонської області. Фізико-географічний нарис / Відп. ред. М.Ф. Бойко. – Київ: Фітосоціоцентр, 1998. – 120 с.

РОСЛИННІСТЬ УРСР. Степи, кам'янисті відслонення, піски / Г.І. Білик, В.В. Осичнюк, В.С. Ткаченко та ін. - Київ: Наукова думка, 1973. – 428 с.

ПРИРОДНО-ЗАПОВІДНИЙ ФОНД України загальнодержавного значення. Довідник / Ред. В.Б. Леоненко та ін. - Київ, 1999. – 240 с.

МИРКИН Б.М., НАУМОВА Л.Г. Наука о растительности. – Уфа: Гилем, 1998. – 412 с.

МОСЯКІН С.Л. Рослини України у Світовому Червоному списку // Укр. ботан. журн. – 1999. – 56 (1). – С. 79-88.

МОЙСІЄНКО І., СУДНІК-ВОЙЦИКОВСЬКА Б. Адвентивні рослини на курганах в пустельних степах півдня України // Синантропізація рослинного покриву України (м. Переяслав-Хмельницький, 27-28 квітня 2006). – Тези наукових доповідей. – Київ, Переяслав-Хмельницький, 2006. – С. 142-144.

ОЛЕНКОВСЬКИЙ М. Розкриті і не розкриті таємниці історії та природи південної України. – Херсон: Лілея, 1997. – 80 с.

СОЛОМАХА В.А. Синтаксономія рослинності України // Укр. фітоцен. зб. – Фітосоціоцентр. – Київ, 1996. - Сер. А, вип. 4 (5). – 120 с.

ЧЕРВОНА КНИГА України / Ю.Р.Шеляг-Сосонко (відп. ред.) та ін. – К.: Вид-во Укр. енцикл., 1996. – 608 с.

СКЛЯР О.С., ХІЛЬЧЕНКО П.О. Грунти Херсонської області.- Одеса: Маяк, 1969. – 60 с.

KARTE der natürlichen Vegetation Europas, Maßstab 1:2 500 000. [Map of the Natural vegetation of Europe. Scale 1: 2 500 000] / Bohn U., Gollub G., Hettwer C. & al. – Bonn: Bundesamt für Naturschutz, 2000. – Maps: 9 sheets. – Legend: 153 p.

KORNAŚ J. Oddziaływanie człowieka na florę: mechanizmy i konsekwencje // Wiad. Bot. - 1981. – 25. - 165-182.

MATUSZKIEWICZ W. Przewodnik do oznaczania zbiorowisk roślinnych Polski. – Warszawa: Wydawnictwo Naukowe PWN, 2001. – 537 s.

MOSYAKIN S. L., FEDORONCHUK M. M. Vascular plants of Ukraine. A nomenclatural checklist. – Kiev: M. G. Kholodny Institute of Botany National Academy of Sciences of Ukraine, 1999. – 346 pp.

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APPENDIX 1. Flora of the kurgans in desert steppe zone and their microhabitats

Abbreviations applied in Table A:

Microhabitats:

T – the top of the barrow;
Ss – the southern slopes;
Sn – the northern slopes;
Bs – the southern foot;
Bn – the northern foot.

Data regarding the occurrence of species in particular microhabitats are presented in the following order:

T	
Ss	Sn
Bs	Bn

Life forms:

t – therophytes;
th – short-living perennials (2,3,4 years old);
g – geophytes;
w – hydrophytes;
h – hemicryptophytes;
hg – geophytes-hemicryptophytes – perennials, some of whose perennating buds (shoot system) remain on the soil surface and underground;
hc – hemicryptophytes-chamaephytes – perennials whose perennating buds remain on or above (within 0.25 m) the soil surface;
c – chamaephytes;
mf – megaphanerophytes;
nf – nanophanerophytes;

Syntaxa:

Agro int-rep – Agropyretea intermedio-repentis (Oberd. et al. 1967) Müller et Görs 1969)
Alth offi – Althaetalia officinalis V. Golub et Mirkin in V. Golub 1995 {*Molinio-Arrhenatheretea* T. Tx 1937}
Artemi – Artemisietea Lohm., Prsg et R. Tx. in R. Tx. 1950
Aste trip – Asteretea tripolium Westh. et Beeft. ap Beeft. 1962
Bolb mari – Bolboschoenetalia maritimi Hejny in Holub et al. 1967 {*Phragmitetea* R. Tx. et Prsg 1942 = *Phragmito-Magnocaricetea* Klika in Klika et Novak 1941} or *Bolboschoenetea maritimae* Vicherek et R. Tx. 1968 em. R. Tx. et Hulb. 1971
Caki mari – Cakiletea maritimae R. Tx. et Prsg. 1950
Cryp acul – Crypsietea aculeatae Vicherek 1973
Fest vagi – Festucetea vaginatae Soó 1968 em. Vicherek 1972 or *Festucetalia vaginatae* Soó{*Festuco-Brometea* Br.-Bl. et R. Tx. 1943}
Fest-Brom – Festuco-Brometea Br.-Bl. et R. Tx. 1943
Fest-Pucc – Festuco-Puccinellietea Soó (incl. *Festuco-Limonietea* Karpov et Mirkin 1985)
Gali-Urti – Galio-Urticetea Passarge 1967 or *Galio-Urticenea* (Passarge 1967) {*Artemisietea* Lohm., Prsg. Et R. Tx. in R. Tx. 1950}
Gali veri – Galietalia veri Mirkin et Naumova 1986 {*Molinio-Arrhenatheretea* T. Tx. 1937}
Isoe-Nano – Isoëto-Nanojuncetea Br.-Bl. et R. Tx. 1943
Junc mari – Juncetea maritimi Br.-Bl. 1931
Moli-Arrh – Molinio-Arrhenatheretea R. Tx. 1937
Neri-Tama – Nerio-Tamaricetea Br.-Bl. et Bolos 1957
Phragm – Phragmitetea R. Tx. et Prsg 1942 (syn. *Phragmito-Magnocaricetea* Klika in Klika et Novak 1941)
Planta – Plantaginetea majoris T. Tx. et Prsg. 1950 *or Plantaginetalia majoris* R. Tx. (1943) 1950 {*Molinio-Arrhenatheretea* R. Tx. 1937}

Poly-Arte – Polygono-Artemisietea austriacae Mirkin, Sakhapov et Solomeshch in Mirkin et al. 1986
Prunet – Prunetalia {*Querco-Fagetea* Br.-Bl. et Vlieg. 1937or *Rhamno-Prunetea* Rivas, Goday et Garb. 1961}
Robin – Robinietea Jurko ex Hadac et Sofron 1980
Sali frut – Salicornietea fruticosae (Br.-Bl. et R. Tx. 1943) R. Tx. et Oberd. 1985 em. Golub et V. Solomakha 1988
Stel medi – Stellarietea mediae T. Tx. , Lohm., et Prsg. 1950 (incl. *Chenopodietea* Br.-Bl. 1952 em. Lohm., J. et R. Tx. 1961 ex Matuszk.1962 & *Secalietea* Br.-Bl. 1951)
Ther-Sali – Thero-Salicornietea R. Tx. 1954 in R. Tx. et Oberd. 1958 (incl. *Thero-Suaedetalia* Br.-Bl. et de Bolos 1957 or *Thero-Suadetetea maritimae* Vicherek 1973)
Trif-Gera – Trifolio-Geranietea sanguinnei Th. Müller 1962

[ ] – indicates that the introduced species were established in the particular plant community types (see Table);
{ } – indicates that the syntaxon belongs to a given class (see above list of syntaxa abbreviations).

Geographical-historical classification of species:

Native species:
Ns – native species, not established in anthropogenic habitats;
Ap – apophytes, natives established in anthropogenic habitats;
He – hemiapophytes, natives established only in semi-natural habitats;
Ae – oekiophytes, natives grown (e.g. in plantations or in windbreaks) and recorded in anthropogenic habitats.

Aliens:
Ar – archaeophytes, aliens that immigrated before the year 1500;
Ke – kenophytes, aliens introduced after the year 1500;
Ef – ephemerophytes, aliens not established in the new territory, appearing only temporarily.

Origin of alien species – groups and abbreviations:

- Mediterr (= Mediterranean), sub-Mediterr (= sub-Mediterranean);
- European, Atlantic, sub-Atlantic;
- Eurasian, Eurosiberian, boreal-Eurasian, continent. (= continental) , subcontinent (= subcontinental);
- W-Asian (=Western-Asian), Middle-Asian, C-Asian (=Central Asian), Irano-Turanian, Indian, Malay;
- North American, Central American, South American.

Status of the protected species:

* – World Red List
** – European Red List
*** – Red Data Book of Ukraine
**** – Red List of Kherson Region

At the bottom of the Table the flora of each kurgan is described taking into account:

- the number of species;
- the number of species in all of its microhabitats.