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The synanthropic flora of kurgans within three steppe zones in southern Ukraine

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Abstract. The aim of the studies conducted in 2004-2008 was to estimate and compare the diversity of synanthropic flora of the kurgans and their microhabitats in three steppe zones in southern Ukraine. Kurgans located among large fields and pastures are very characteristic element of the Ukrainian landscape. Among the 400 visited kurgans, 81 were investigated within an area of about 20 000 km^2 in the desert steppe, Pontic grass steppe and herb-grass steppe zones. The total number of species (613), as well as percentage of synanthropic species (55%) was estimated. The number of species on the kurgans in each zone increased along a south-north gradient. However, the percentage of groups of synanthropic species on the kurgans was comparable. Differences between microhabitats (within kurgans) with regard to the proportion of synanthropes were smaller in the case of the desert steppe zone. Contrasts between the microhabitats were more significant in the case of the steppe zones further to the north. The flora of kurgans is determined by the climate conditions of a particular zone and by the form of utilization of the area.

Key words: floristic diversity within kurgans, synanthropes on kurgans, microhabitats within kurgans, desert steppe zone, Pontic grass steppe zone

1. Introduction

The true steppe is the most transformed vegetation type in Europe. It is estimated that from 82 to 90 per cent of the steppe area in Ukraine, whose territory lies mainly within the steppe and forest steppe zones, has been converted into arable land

In the south of Ukraine, kurgans used to be a characteristic element of the landscape. The oldest kurgans were built over 5000 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 and Nogays (Smirnov 1974; Kubczak 1978). Nowadays they play an important role as refugia of the steppe flora in the agricultural landscape. Two hundred years ago there were about 500000 kurgans in Ukraine. However, their number has been reduced to 100000 or even 50000 (about 4000-5000 kurgans have been reported from the Kherson region only!). They are about 1-10 (0.5-12) m high and range in size from 8 to 100 (180) m in diameter (Artemenko *et al*. 1975-1985). Most of the small kurgans have been ploughed up but those higher than 3-4 m are easily recognizable in the landscape of southern Ukraine.

The first archaeological field explorations were conducted in the middle of the 18th century. In the 19th century and at the beginning of the 20th century numerous archaeologists were involved in site excavations. An initial review of literature shows that very few botanical studies of kurgans, which have yielded insufficient data regarding the flora of the barrows, have been made so far in southern Ukraine (e.g. Yanata 1913; Paczoski 1914; Kondratyuk & Chuprina 1992; Andrienko *et. al*. 1999; Melnik 2001), as well as in other European countries, where kurgans are less numerous, e.g. in Hungary (Barczi & Joo 2000; Barczi 2003), Bulgaria (Paczoski 1933), and Poland (Cwener 2004, 2005;

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Cwener & Towpasz 2003). Specimens of plants collected by various authors from the kurgans have been deposited in Ukrainian herbaria (e.g. *Ephedra distachya* L. – I. Paczoski [KHEM], *Limonium platyphyllum* Lincz. – M. Kotov [KW], A. Kuzmichev [KW], K. Zaleski [KW]).

The aim of the study was to estimate and compare the diversity of synanthropic flora of the kurgans and their microhabitats in three steppe zones in southern Ukraine.

2. Study area

In the years 2004-2008, floristic studies were carried out on the kurgans in southern Ukraine within an area of about 20000 km^2, in the Black Sea Lowland and Dnieper Upland, within the Kherson, Mykolaiv and Kirovograd regions in three steppe zones (Fig. 1). The classification below is based on the scheme used in the *"Map of the Natural Vegetation of Europe"* (Bohn *et al*. 2000). The classification scheme developed by Russian and Ukrainian authors (e.g. Bilyk *et al*. 1973; Lavrenko *et al*. 1991) is given in square brackets; [the following symbols: D, P, R are used to designate different types of steppes in the text and figures]:

D – west and central Pontic desert steppe (M16), usually occurs in combination with halophyte vegetation (solonchak, solonetz); [wormwood/sod-grass or desert steppe; Russian: polynnaya step];

P – west Pontic grass steppe (M12); [forb-poor fescue/feather-grass steppe; Russian: tipchakovo-kovylnaya step – biednoje raznotravie];

R – west and central Pontic herb-grass steppe (M5) and west and central Pontic herb-rich grass steppe (M1); [forb-rich fescue/feather-grass steppe; Russian: tipchakovo-kovylnaya step – bogatoje raznotravie].

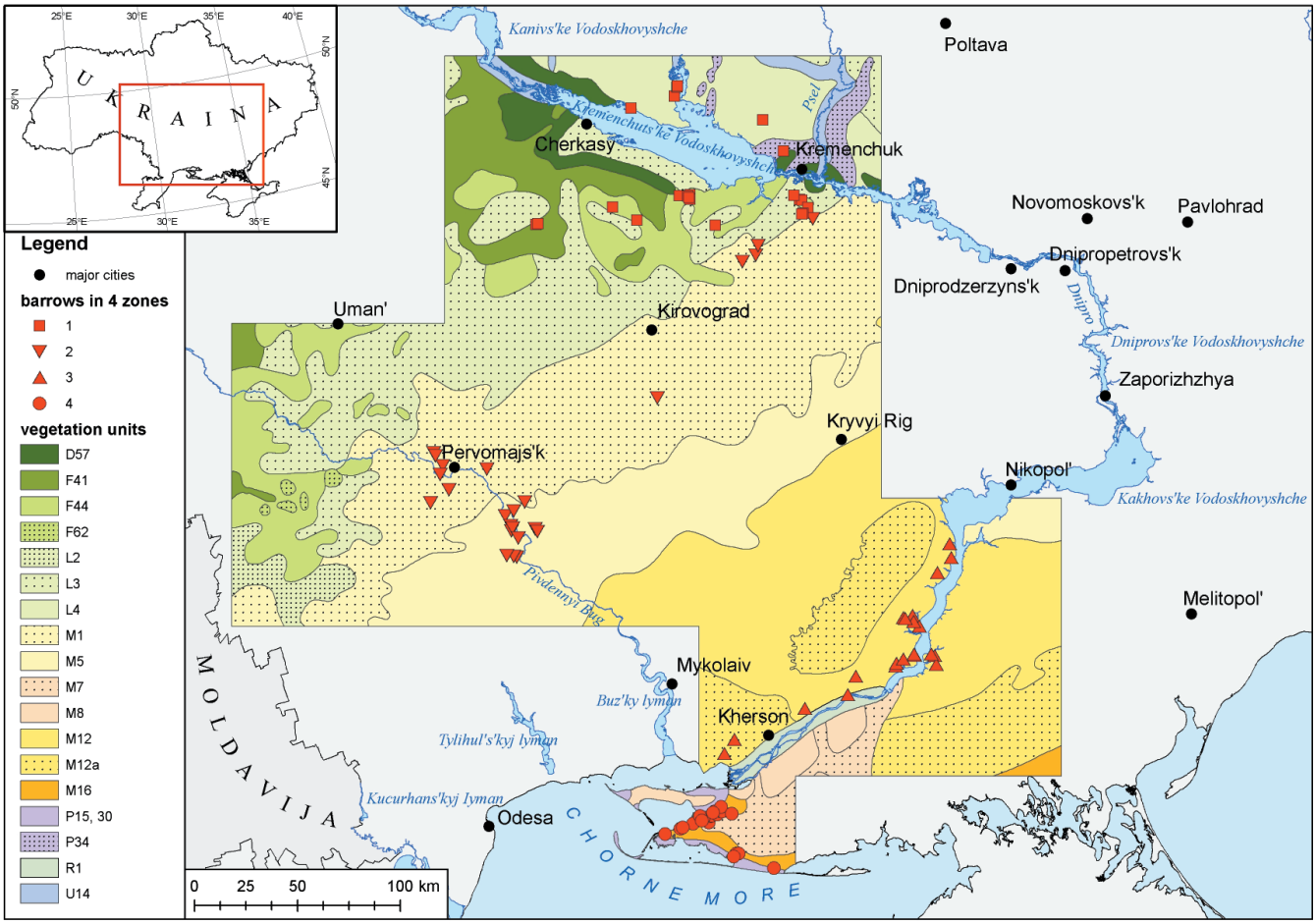

Fig. 1. Distribution of the kurgans investigated in the steppe zones in southern Ukraine

Explanations: ○ – kurgans in the desert steppe zone; △ – kurgans in the west Pontic grass steppe zone; ▽ – kurgans in the west and central Pontic herb-grass steppe and west and central Pontic herb-rich grass steppe zone; □ – kurgans in the forest-steppe zone (not considered in the present study)

Designations (according to Bohn *et al*. 2000): D57 – southeast European herb- and grass-rich xerophytic pine and oak pine forests, F41 – east Polish-Ukrainian lime-pedunculate oak-hornbeam forests, F44 – Podolian-Moldavian thermophilous hornbeam-pedunculate oak forests; F62 – east pre-Carpathian-Moldavian sessile oak-hornbeam forests; L2 – Vohlyn-Podolian meadow steppes; L3 – Moldavian-Ukrainian meadow steppes; L4 – south Sarmatian meadow steppes; M1 – west and central Pontic herb-rich grass steppes; M5 – west and central Pontic herb-grass steppes; M7 – Pontic hemi-psammophytic herb grass steppes; M8 – Pontic psammophytic herb grass steppes; M12 – west Pontic grass steppes; M12a – west Pontic grass steppes in combination with halophyte vegetation (solonchak); M16 – west and central Pontic desert steppes in combination with halophyte vegetation (solonchak, solonetz); P15 – west and central Pontic sand-dune vegetation, P30 – west Pontic halophytic vegetation; P34 – west and east Pontic salt meadows; R1 – freshwater tall reed swamps; U14 – Pontic hardwood alluvial forests

As mentioned earlier, about 82-90% of the steppe area is agriculturally utilized; grazing dominates in the south whilst arable cultivation – in the north. A more detailed description of the area surveyed within the three steppe zones is given below (Logvinov & Shcherban 1984; Marynych *et al*. 1985; Vernander & Tyutyunnik 1986):

• Desert steppe zone (D)

An area with low total annual precipitation below 350 mm, mean annual temperature is: 9-10^{O}C. Chestnut soils occur in combination with solonetz-solonchak soils. The surface of the territory is almost flat. Soil erosion is, therefore, less pronounced. Area with low population density. Extensively and, more rarely, intensively managed and utilized pastures dominate in the zone. Large-scale sheep farming has been replaced by smaller herds of cattle. Arable fields occupy a smaller area and are usually watered artificially (irrigation channels are a characteristic element of the landscape). The main crops grown are: *Triticum durum* Desf., *Brassica napus* L., *Helianthus annuus* L., *Citrulus lanatus* (Thunb.) Matsum et Nakai, *Lycopersicon esculentum* L. and, locally, *Oryza sativa* L. Many of the fields have been abandoned due to increased soil salinity.

• Grass steppe zone (P)

A territory with southern chernozem soil, the annual rainfall is 350-400 mm, and the mean annual temperature: 9-11^{O}C. Topographic heterogeneity is greater in this habitat type than in the desert steppe zone. Limestone outcrops occur in some places. Erosion is more pronounced. Water is sometimes supplied by artificial watering. A greater variety of crops are grown than in the desert steppe. The major crops are: *Triticum durum* Desf., *Zea mays* L., *Helianthus annuus* L., *Brassica napus* L., *Citrullus lanatus* (Thunb.) Matsum et Nakai, *Lycopersicon esculentum* L., *Panicum miliaceum*, *Sorghum sp*. and *Cucumis melo* L.. Orchards and vineyards occur throughout the area. Some of the agricultural fields have been abandoned.

• Herb-grass steppe and herb-rich grass steppe zone (R):

the soil of the area is a typical chernozem. The annual rainfall is 400-450 mm; and the mean annual temperature is about 7-9^{O}C. Topographic heterogeneity is greater in this zone than in the other two zones. Erosion is more pronounced. Granite and limestone outcrops occur locally. Forests frequently appear in balkas. The area is more built-up and densely populated, and has been utilized for hundreds of years. Agricultural fields are intensively used and managed. A greater variety of crops is grown than in zone P. The major crops are: *Triticum durum* Desf., *T. aestivum* L., *Hordeum vulgare* L., *Brassica napus* L., *Helianthus annuus* L., *Fagopyrum esculentum* Moench, *Linum usitatissimum* L. and *Beta vulgaris* L. var. *altissima* Döll. Watering the fields is not necessary. Arable fields have rarely been abandoned from agriculture.

3. Material and methods

Floristic investigations were conducted on 81 kurgans (26, 26 and 29 barrows in the 3 zones respectively) during the growing season in spring, summer and autumn. At the same time, analogous studies are being carried out in the forest-steppe zone in the regions: Kirovograd, Cherkasy and Poltava. These investigations are expected to be completed in 2009.

The following criteria were used to select the kurgans to be studied: (*i*) the height of kurgans; those less than 3 m in height were not considered; (*ii*) 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; (*iii*) the state of preservation of the plant cover; it was assumed that the presence of typical steppe species, such tuft grasses as *Festuca valesiaca* Schleich. ex Gaudin, *Koeleria macrantha* (Ledeb.) Schult. and *Stipa capillata* L. (or *S. lessingiana* Trin. et Rupr. and *S. ucrainica* P. Smirn.), was indicative of a relatively good condition of the plant cover.

It should be noted that among the 400 kurgans we visited in the steppe in the years 2004-8, only one-fifth of the barrows met all the above criteria.

Floristic lists were compiled for each of the 5 microhabitats (Fig. 2) identified within the kurgans (top – T, northern and southern slope – Sn, Ss, northern and southern foot – Bn, Bs). In each microhabitat the abundance of each species was estimated according to a 3-point scale: 1 – sporadic, 1-2 specimens; 2 – infrequent (about 3-20 specimens); 3 – abundant (the species occupies most of the microhabitat). The floristic richness and the role of synanthropic species on kurgans and their microhabitats was analyzed in the 3 steppe zones. Groups of synanthropic species were distinguished based on the historical-geographical classification of plants proposed by Kornaś (1968). The species nomenclature follows Mosyakin & Fedoronchuk (1999).

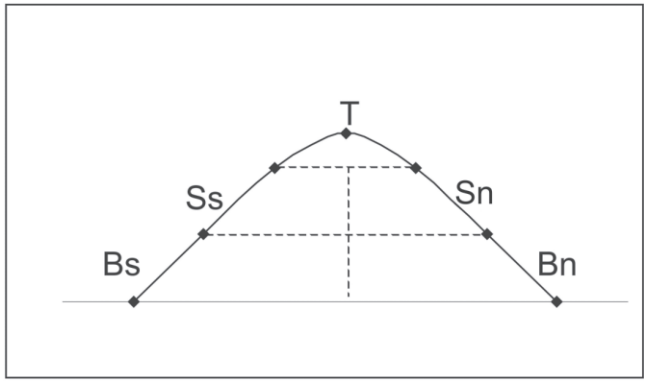

Fig. 2. The location of microhabitats within the kurgan
Explanations: T – top of kurgan; Sn, Ss – northern and southern slope; Bn, Bs – northern and southern foot

4. Results

A total of 613 species were reported from 81 kurgans in all the three steppe zones investigated. The number of species on particular kurgans ranged from 48 to 171, 107 on average. Synanthropic species (337) constituted 55% of the flora of kurgans. Native species (188) prevailed among this group of species, including: 56 apophytes, 125 hemiapophytes and 7 oekiophytes. The total number of aliens amounted to 149, including 73 archaeophytes, 61 kenophytes and 15 ergasiophygophytes. Table 1 includes data on the flora of kurgans in the particular steppe zones. Special attention was paid to the synanthropic flora.

The species richness increased along a geographic gradient from the south to the north. This trend is attributed to the gradually milder climate towards the south and higher habitat diversity (e.g. granite and limestone outcrops). However, the number of halophyte species declined gradually towards the north due to a decrease in soil salinity levels. At the same time, a higher number of steppe and tree species was recorded in the northern regions.

The present study showed that the lowest species diversity was noted on the kurgans located in the desert steppe zone (D), being higher in the grass steppe (P), and the highest in the herb-grass steppe and herb-rich grass steppe zone (R). A similar trend was determined in the case of the total and mean abundance values of species (Table 1).

- apophytes: *Consolida paniculata* (Host) Schur, *Elytrigia repens* (L.) Gould;
- hemiapophytes: *Achillea setacea* Waldst. & Kit., *Agropyron pectinatum* (M. Bieb.) P. Beauv., *Artemisia austriaca* Jacq., *Eryngium campestre* L., *Euphorbia agraria* M. Bieb., *Poa angustifolia* L., *Potentilla argentea* L.;
- archaeophytes: *Buglossoides arvensis* (L.) I. M. Johnst, *Capsella bursa-pastoris* (L.) Medik., *Sisymbrium loeselii* L.;
- kenophytes: *Conyza canadensis* (L.) Cronq.

The most abundant synanthropes recorded during the survey were: *Elytrigia repens* (L.) Gould, *Lamium amplexicaule* L., *Lactuca serriola* L. and *Sisymbrium loeselii* L.

A specific group of synanthropic species was associated with each of the three steppe zones, e.g. 32 species occurred only in the desert steppe zone, 22 in the grass steppe zone, and 76 in the herb-grass steppe and herb-rich grass steppe. Thus kurgans located in the "transitional" zone (grass steppe) supported the lowest number of their "own" synanthropes.

The percentage of native and alien synanthropes in the flora of kurgans was similar in the three steppe zones investigated and reached 60%. However, a lower proportion of anthropophytes was noted in the desert steppe zone (22.8%; Table 1). Their absolute number increased considerably from the south to the north (70, 105 and 112 alien species).

Table 1. Characteristics of the flora of kurgans in the three steppe zones

Characteristics of the flora of kurgans in the steppe zones	Steppe zone		
	desert steppe (D)	grass steppe (P)	herb-grass steppe and herb-rich grass steppe (R)
Total number of species	305	355	435
% of total described flora of kurgans in steppe zone (613 species)	49.8	58.0	71.1
The average number of species per kurgan	82.3	110.0	125.5
Minimum and maximum number of species on a kurgan	48-103	72-141	89-171
The total abundance of species on a kurgan	8275	10682	14023
The average abundance of species on a kurgan	318.3	410.9	483.6
Number of native species in kurgan flora	235	249	323
% of native species in kurgan flora	77.2	70.4	74.2
Number of nonsynanthropic species in kurgan flora	121	138	179
% of nonsynanthropic species in kurgan flora	39.6	38.9	41.2
Number of apophytes in kurgan flora	117	112	144
% of apophytes in kurgan flora	38.3	31.5	33.0
Number of alien species (anthropophytes) in kurgan flora	70	105	112
% of alien species (anthropophytes) in kurgan flora	22.8	29.6	25.8

A high proportion of nonsynanthropic species (about 40%) was noted on the kurgans in all the three steppe zones. It should be noted that in the native flora of kurgans nonsynanthropes prevailed over apophytes (native synanthropes).

The flora of kurgans in the three steppe zones shared 113 common synanthropic species. Among this group the following species occurred with the highest frequency:

The proportion of the particular groups of alien species from the geographical-historical categories were more or less the same in the three steppe zones (Fig. 3). Archeophytes prevailed over kenophytes in the case of all the zones investigated. The lowest proportion of kenophytes was recorded in the desert steppe zone.

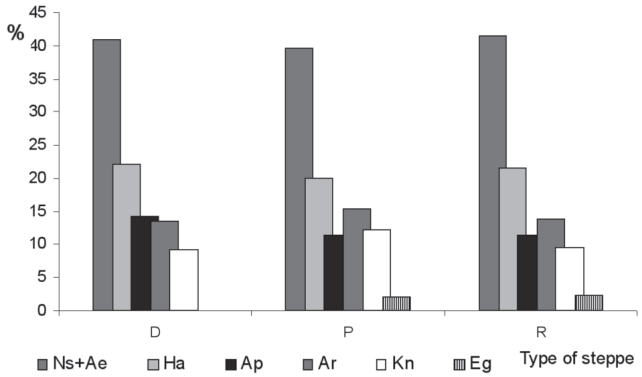

Fig. 3. Groups of the historical-geographical classification of plants – spectrum in the flora of kurgans in the three steppe zones
Explanations: Ns + Ae – native species + oekiophytes; He – hemiapophytes; Ap – apophytes; Ar – archaeophytes; Kn – kenophytes; Eg – ergasiophygophytes; D – west and central Pontic desert steppe; P – west Pontic grass steppe; R – west and central Pontic herb-rich grass steppe and west and central Pontic herb-grass steppe; T, Ss, Sn, Bs, Bn – see Fig. 2.

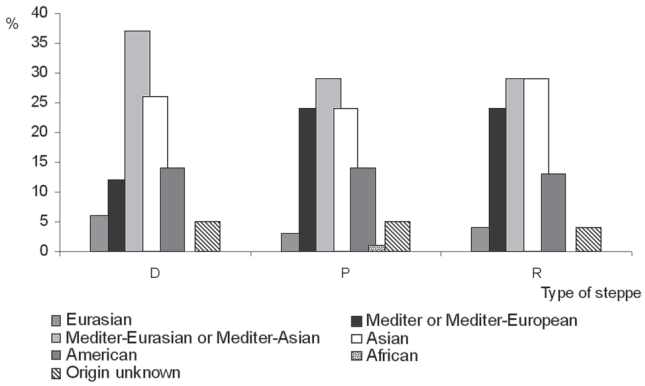

Fig. 4. The origin of anthropophytes in the flora of kurgans within the three steppe zones
Explanations: see Fig. 3

The geographical origin of the species was also analyzed. The proportion of species with a wide Mediterranean-Eurasian range decreased towards the north, whereas the proportion of Mediterranean-European and Asian species increased (Fig. 4). The percentage of American species in the flora of kurgans was similar in the case of all the three zones investigated although their absolute number was lower in the south.

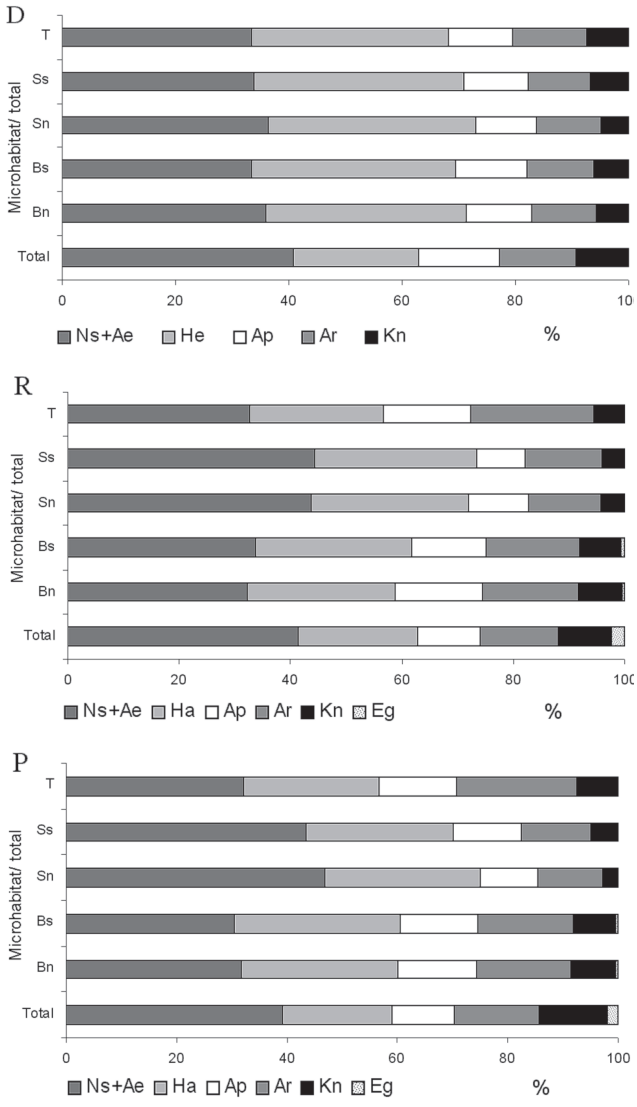

Fig. 5. The percentage share of particular groups of synanthropes in the total flora of kurgans and in the flora of microhabitats in the three steppe zones
Explanations: see Fig. 2 and 3

As stated earlier, the proportion of synanthropic species in the flora of kurgans was more or less the same in all the three zones. Differences in the contribution of synanthropes were found in the case of microhabitats identified within the kurgans (Fig. 5). In the desert steppe zone there was a similar percentage of native and alien species in all the five microhabitats studied. In the remaining two zones contrasts between the microhabitats were more significant. The slopes of the kurgans, which were only slightly altered by human activity, supported a higher number of nonsynanthropes and hemiapophytes, whereas the foot and top of the barrows were distinguished by a higher number of anthropophytes.

5. Discussion

As already mentioned, kurgans have been an anthropogenic element of the steppe landscape for ages. Kurgans located in the south of Ukraine are mostly of Scythian and Sarmatian origin and are about 2000-2500 years old. They constitute a relict of the ancient nomad culture in the landscape and had existed even before the steppes were ploughed up. Our earlier studies (Moysiyenko & Sudnik-Wójcikowska 2006a, 2006b; Sudnik-Wójcikowska & Moysiyenko 2006) indicated that steppe species were able to persist on the kurgans although the steppe was gradually converted to agriculture land. The above process has intensified over the past 200 years. At present arable fields, pastures and built-up areas dominate in the steppe zone. Therefore, some of the kurgans provide refuge for steppe species. At the same time, the flora of particular kurgans is more complex due to the influence of the surrounding area. In addition to native species of high floristic value, synanthropic species are noted. The state of preservation of the plant cover of kurgans varies as well. In the desert steppe zone most of the kurgans are surrounded by extensively used pastures containing a high share of halophyte species. The above zone is subject to weaker anthropogenic pressures (cultivated fields) than the grass steppe zone. Therefore, the contribution of alien species, particularly kenophytes (synanthropic newcomers), is lower than in the other two zones. The absence of ergasiophygophytes (species escaping from cultivation) is also noted.

Some interesting patterns of floristic differentiation of microhabitats within the kurgans were determined for the particular zones. Contrasts between the microhabitats were more significant in the case of the steppe zones further to the north. In both grass steppe zones there was a higher proportion of native species on the slopes of the kurgans, whereas the top and foot supported a higher number of synanthropic species. The top of the barrows has been strongly altered by human activities. Kurgans, which are visible from a long distance away across the plains, have served as landmarks (orientation points) for a considerable period of time and the tops were used to erect triangulation towers and monuments. Some barrows were damaged during the wars. They served as observation posts and trenches were dug by troops. In addition there are signs of illegal activities of archaeological looters which have occurred for hundreds of years. Kurgans which are located among cultivated fields are mainly damaged during intensive farming operations. The foot of the barrows is regularly disturbed due to ploughing.

A lower share of synanthropes in the flora of the foot and top of the barrows was recorded in the case of the desert steppe zone. Small differences between the microhabitats within the above zone with respect to the spectrum of geographical-historical groups of species may be attributed to the small size of the kurgans and dominance of extensively used pastures in the surrounding area (where usually alien species are less numerous than in the fields), as well as to the grazing activities on the barrows.

A completely different scenario was observed in the case of the grass steppe, where kurgans have been surrounded by cultivated fields for ages. In the 1970's a "campaign against kurgans" was waged. It was believed that they were a refuge for crop weeds which eventually expanded to the fields. Smaller kurgans were destroyed and ploughed (kurgans 1-3m high are rarely found nowadays). Our studies confirmed the presence of weeds on top and at the foot of the barrows. However, in the early stages of agricultural utilization of the steppe, weeds spread from the fields to the kurgans, persisting mainly at the foot, where they were not eliminated. Thus this part of the kurgan could have been a source of weed species.

It should be noted that, paradoxically, the vast agricultural fields can "protect" kurgans from the impact of human activities (e.g. treading, burning, plant collecting), with the exception of farming operations. Kurgans are spatially isolated and become accessible after crop harvest (as well as after seed and fruit production of steppe species).

During our investigations we took into account the flora of well-preserved kurgans only. A total of 400 barrows were explored. The trends presented in the analysis were determined based on the studies conducted on 81 selected kurgans (which constitutes 20% of all the barrows investigated), where the flora had not changed significantly. If 80 random kurgans were investigated and no selection was made (i.e. small kurgans, destroyed, damaged, partly ploughed up and etc. were taken into account), perhaps the degree of synanthropization of the flora would be higher and the kurgan flora poorer in species.

There is a surprisingly small number of publications dealing with the flora of kurgans. It is difficult, therefore, to compare our findings with data in the literature. J. Paczoski, who initiated pioneer studies in such specific habitats as the Balcan kurgans, indicated that overgrazing and increasing human interference had a significant negative impact on the native flora of kurgans.

A small number of kurgans are also found in Poland, whose territory lies in the temperate zone of mesophytic deciduous broad-leaved forests. Like most barrows in Ukraine, they are surrounded by cultivated fields. Studies conducted on 14 kurgans in Poland (Cwener 2004, 2005; Cwener & Towpasz 2003) indicated that the total flora of the barrows was estimated at 217 species, but the number of species per kurgan was smaller and ranged from 52 to 81. Anthropophytes comprised 23% of the total flora of kurgans, but their percentage share varied within a wider range (4-35%). As in the case of the Ukrainian kurgans, the slopes supported some of the most valuable species. The top and foot of the barrows were mainly inhabited by anthropophytes. Tree species, including anthropophytes, played a more significant role in the flora of this zone than in the steppe zone.

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References

Andrienko T. L. (ed.). 1999. Zapovidni kutochki Kirovogradskoi zemli. 240 pp. Arktur, Kyiv.

Artemenko I. I., Baran V. D., Bibikov S. M., Dobzhenok V. J., Leskov O. M., Telegin D. Ja. & Terenozhkin O. I. (eds.). 1975-1985. Archeologija Ukrainskoj SSSR. Vol. 2, 3. 500+502 pp. Naukova Dumka Press, Kyiv.

Barczi A. 2003. Data for the botanical and pedological surveys of the Hungarian kurgans (Great Hungarian Plain, Hortobagy). Thaiszia, J. Bot. 13: 113-126.

Barczi A. & Joó K. 2000. Kurgans: Historical and ecological heritage of the Hungarian Plane. Előadás. International Conference on Multifunctional Landscapes. Roskilde, Dánia, 2000. október 18-21. Conference Material, p. 199-200.

Bilyk G. I., Osychnyuk V. V., Tkachenko V. S., Gryn F. O. & Kosets M. I. 1973. Roslynnist URSR. Stepy, kam'yanysti vidslonennya, pisky. 428 pp. Naukova Dumka, Kyiv.

Bohn U., Gollub G., Hettwer C., Neuhäuslová Z., Raus T., Schlüter H. & Weber H. (eds.). 2000. Karte der natürlichen Vegetation Europas, Maßstab 1:2 500 000. Bundesamt für Naturschutz, Bonn.

Cwener A. 2004. Rośliny naczyniowe kurhanów w dorzeczu dolnej Szreniawy i Nidzicy (Wyżyna Małopolska, południowa Polska). Fragm. Flor. Geobot. Polonica 11: 27-40.

Cwener A. 2005. Różnorodność flory roślin naczyniowych kurhanów w dorzeczu Szreniawy i Nidzicy (Wyżyna Małopolska, południowa Polska). In: K. Wasylikowa, M. Lityńska-Zając & A. Bieniek (eds.). Roślinne ślady człowieka. Botanical Guidebooks 28: 297-304.

Cwener A. & Towpasz K. 2003. Kurhany jako ostoje różnorodności gatunkowej w rolniczym krajobrazie Płaskowyżu Proszowickiego. Chrońmy Przyr. Ojcz. 59(6): 57-65.

Kondratyuk E. N. & Chuprina T. T. 1992. Kovylnye stepi Donbassa. 172 pp. Naukova Dumka, Kyiv.

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

Kubczak J. 1978. Kurhany arystokracji scytyjskiej. Wyd. Uniwersytetu A. Mickiewicza w Poznaniu, Ser. Historia Sztuki 9: 7-167.

Lavrenko E. M., Karamysheva Z. V. & Nikulina R. I. 1991. Stepi Eurazji, pp. 5-143. Izdat. Nauka, Leningrad.

Logvinov K. T. & Shcherban M. G. (eds.). 1984. Priroda Ukrainskoi SSR. Klimat. 232 pp. Naukova Dumka, Kyiv.

Marynych A. M., Pashchenko V. M., Shishchenko P. G. 1985. Priroda Ukrainskoi SSR. Landshafty i fiziko-geograficheskoe raionirovanie. 224 pp. Naukova Dumka, Kyiv.

Melnik V. I. 2001. Luchni stepi lisostepu Ukraini. Botaniko-geografichnyi narys. Visti Biosfernogo Zapovidnika Askania Nova 3: 7-14.

Mosyakin S. L. & Fedoronchuk M. M. 1999. Vascular plants of Ukraine: A nomenclatural checklist. xxiv + 346 pp. M. G. Kholodny Institute of Botany, National Academy of Sciences of Ukraine, Kiev.

Moysiyenko I. I. & Sudnik-Wójcikowska B. 2006a. The flora of kurgans in the steppe zone of southern Ukraine – phytogeographical and ecological aspects. Polish Bot. Studies 22: 387-398.

Moysiyenko I. I. & Sudnik-Wójcikowska B. 2006b. The flora of kurgans in the desert steppe zone of southern Ukraine. Chornomorski Bot. Journ. 2(1): 5-35.

Paczoski J. K. 1914. Khersonskaya flora: Kherson. Vol. 1, 514 pp. Kherson.

Paczoski J. 1933. Szata roślinna kurhanu króla Władysława Warneńczyka. PTPN, Prace Komisji Mat.-Przyr., Ser. B, 6: 157-172.

Smirnov A. 1974. Scytowie. 217 pp. PIW,Warszawa.

Sudnik-Wójcikowska B. & Moysiyenko I. I. 2006. The flora of kurgans in the west Pontic grass steppe zone of southern Ukraine. Chornomorski Bot. Journ. 2(2): 14-44.

Vernander M. B. & Tyutyunnik D. A. (eds.). 1986. Priroda Ukrainskoi SSR. Pochvy, 214 pp. Naukova Dumka, Kyiv.

Yanata A. A. 1913. Flora stepi Melitopolskogo i jugo-zapadnoi chasti Dnieprovskogo uezdov Tavricheskoi gubernii. 250 pp. Tipografia Tavricheskogo gubernskogo zemstva. Simferopol.