

THE FLORA OF KURGANS IN THE STEPPE ZONE OF SOUTHERN UKRAINE – PHYTOGEOGRAPHICAL AND ECOLOGICAL ASPECTS

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Abstract. The paper presents the results of preliminary studies on the flora of kurgans (barrows) in two steppe subzones (fescue/feather-grass and wormwood/sod-grass steppe) of the Kherson region in southern Ukraine. There are about 50,000 kurgans in Ukraine, forming a characteristic element of the landscape, with estimated ages ranging from 700 to 5000 years. The kurgans are distinguished from their surroundings by a considerable number of steppe species. They can therefore be regarded as enclaves of steppe flora in the anthropogenic landscape. The barrows of the two steppe subzones differ in size, and their upper parts represent different degrees of disturbance. In fescue/feather-grass steppe the kurgans are surrounded by cultivated fields, and more rarely by abandoned agricultural fields, whereas those located in the wormwood/sod-grass steppe subzone are surrounded by extensive pasture. This study covered 44 kurgans at least 4 m high and 50 m in diameter, subject to weak anthropogenic influences, with well-preserved steppe flora. It was found that the flora of the barrows differed from that of the surrounding area and between the different microhabitats (fringe, foot, slope and top of mound) and subzones (different proportions of weeds, halophytes, halomesophytes, shrubs). The floristic richness of the kurgans was estimated; 401 species were noted, including 209 steppe species. Barrows can play an important role in local restoration of steppe vegetation on abandoned agricultural fields.

Key words: climatic-vegetation zones, fescue/feather-grass steppe, wormwood/sod-grass steppe, kurgan microhabitats, refugia, steppe flora, Ukraine

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INTRODUCTION

A research expedition to Ukraine in 2003, which explored the most interesting steppe reserves in the southern part of the country, revealed that little of the natural flora of the area examined had been preserved, and that the plant cover was highly transformed by anthropogenic impacts. A number of factors were responsible for this: easy access to sites, the absence of large forest complexes and bogs, and rather uniform topography (little variation of relief). In addition, the high fertility of the soil facilitated human settlement in the area. As a result, the steppes are one of the most altered ecosystems in Ukraine. At present the area of the steppes is much reduced; 2000 years ago they covered about 40% of the present area of Ukraine. Nowadays they occupy only 0.63% of the area (Shelyag-Sosonko & Andrievskij 2001).

Southern Ukraine, where *Stipa-Festuca* grass-

lands used to dominate, has not been cultivated for as long as other regions of Europe. Previously the grasslands were used as pasture. After the Russo-Turkish war in the late 18th century the territory was annexed by Russia. About 200 years ago the land was extensively settled and cultivated. In the past 100 years, most of the steppes have been plowed; at present, agrocoenoses occupy about 82% of the area. Steppe vegetation was practically eliminated on the vast plains, but has survived in areas where farming cannot be done: river valley sides, ravines, canyons, balkas (long erosional canyons formed as a result of intensive spring rain showers), limestone and granite outcroppings and sea cliffs.

Initial field surveys have shown that small enclaves of steppe vegetation are still found on kurgans. It has been estimated that there are over

50,000 kurgans in Ukraine, of which most are located in the steppe zone in the south of the country (Olenkov'skyj 1997; Olenkov'skyj, personal communication). Over 5000 kurgans have been reported from the Kherson region. Kurgans (barrows) are a characteristic and unique element of the Ukrainian landscape, especially the steppe plains. These conical or dome-shaped burial mounds, with wooden (where wood was available), stone or wooden-stone construction, usually contain one or several urn graves or skeleton graves. In Ukraine the kurgans are 1–10 m high and range from 8 m to 180 m in diameter (Artemenko 1985). They date from Neolithic times to the early Middle Ages. Kurgans are found throughout the temperate zone in Eurasia (e.g., Great Britain, Poland, Russia, Mongolia) but the biggest and most numerous are in Ukraine. The oldest kurgans were built over 5000 years ago and the most recent ones are over 700 years old (dating from the Copper Age, Bronze Age, Early Iron Age, Pre-Roman and Roman Times, Migration Period and Middle Ages). They were constructed by the nomadic populations of Cimerians, Scythians, Sarmatians, Huns, Bulgarians, Magyars, Polovtsians, Nogays and others (Artemenko 1985).

Kurgans had been a characteristic element of southern Ukraine before the steppes were plowed up and extensively cultivated about 200 years ago. In consequence their natural vegetation cover was gradually destroyed by agriculture. The kurgans that survived today differ in their conditions of preservation. 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 plowed. Kurgans 1–3 m high are rarely found nowadays. Fortunately, the bigger burial mounds have remained and are now registered as archaeological monuments.

The study project initiated in 2003 in collaboration with Ukrainian and Polish researchers will continue until 2007. The current three-year part of the study aims at determining the role of kurgans in restoration of steppe vegetation. Since some of the fields in Ukraine as well as in Poland have

been abandoned, kurgans could be a starting point in local restoration of steppes.

Pioneer floristic studies in such specific habitats as the kurgans were initiated by a prominent Polish and Ukrainian geobotanist, Józef Paczoski. He conducted his research on the south coast of the Black Sea. In one of his publications (Paczoski 1933) he said, 'I have an idea to describe the plant cover of this kurgan, because this type of vegetation, as well as the vegetation of Ukrainian kurgans, can play an important role in restitution of the steppe, which on the plains was subjected to the strongest anthropogenic transformation.'

A review of the literature shows that most of the southern Ukrainian burial mounds have been explored by archaeologists (Artemenko 1985; Shilov 1991). However, very few botanical studies of kurgans have been made so far (e.g., Paczoski 1917; Kondratyuk & Chuprina 1992).

This study represents the first phase of a research project which includes investigations of 44 of 100 kurgans within two types of steppes (fescue/feather-grass and wormwood/sod-grass steppe) in the Kherson region in southern Ukraine.

The aim of the present preliminary study was to determine the floristic differences between the kurgans located in the two types of steppes and to show the main differences in the species distribution patterns in microhabitats on the barrows, taking into account the ecological groups and life forms. Special attention was paid to rare and protected species. A full list of species will be compiled after the studies have been completed.

Kurgans are much less frequent in Poland, but their flora is studied as well (e.g., Cwener 2004; Cwener & Towpasz 2003). Kurgans as well as the similarly shaped kame hillocks (Faliński 1972), earthworks (Celka 1999) and medieval fortified settlements (Kamiński 2004) should be recognized as habitat islands in the contemporary anthropogenic landscape.

STUDY AREA

The Kherson region is situated entirely in the steppe zone (Fig. 1) but is internally differentiated (Boiko *et al.* 1998; Sklyar & Khilchenko 1969).

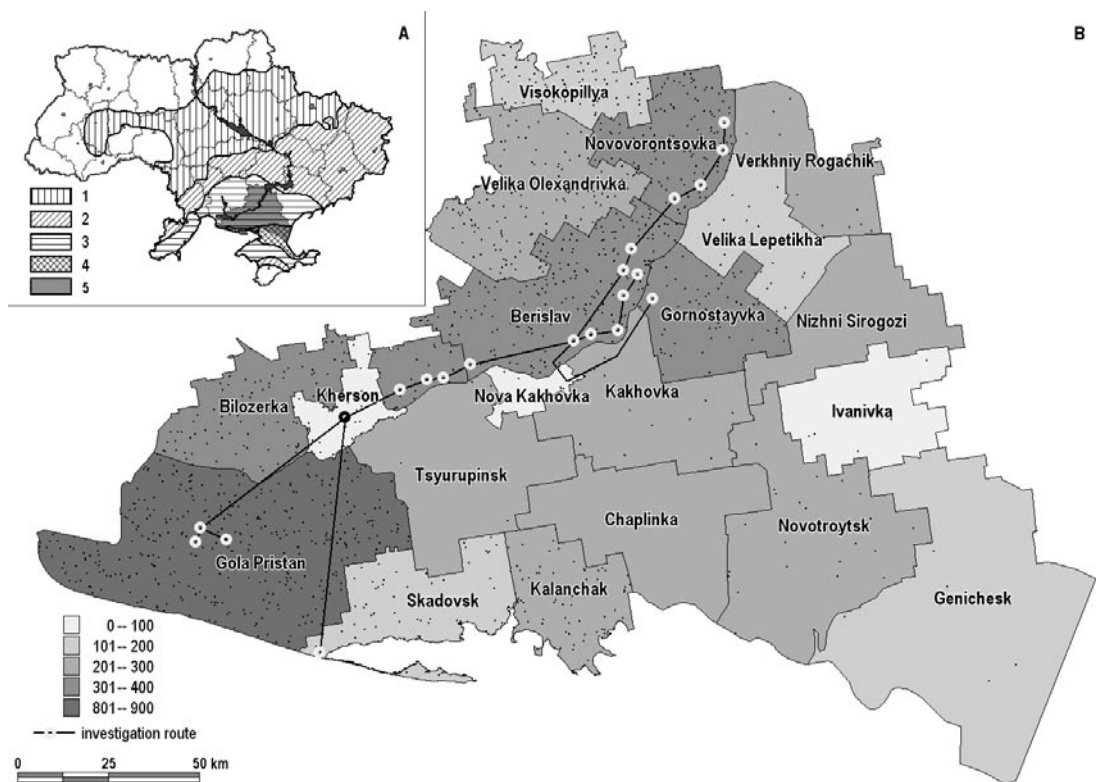


Fig. 1. A – Location of the Kherson region and the various types of steppes in Ukraine: 1 – forest-steppe; 2 – forb-rich fescue/feather-grass steppe; 3 – forb-poor fescue/feather-grass steppe; 4 – wormwood/sod-grass steppe; 5 – Kherson region. B – Distribution of kurgans in the Kherson region; grey shading indicates the number of kurgans in particular districts (see legend); black dots denote kurgans over 3 m high, white circles – localities of one or more (if neighboring) investigated kurgans.

The climate changes occurring in this area on the geological time scale (especially in the Pleistocene and Holocene) produced a variety of habitats and plant cover (Artyushenko 1970). In the Kherson region the steppe zone is differentiated according to climatic and soil conditions into two subzones (Berg 1962; Bilyk *et al.* 1973; Lavrenko 1991):

1. Fescue/feather-grass steppe, in the northern and central part of the Kherson region. At present nearly all the plain area of this subzone has been plowed up. Only small fragments of the steppe have remained and are protected (e.g., F. E. Falz-Fein Biosphere Reserve of Askania-Nova). Two edaphic variants of the typical steppe are distinguished: petricolous, on stone slopes (e.g., limestone outcroppings) of gullies and river terraces; and psammophilous, on sands of overflow terraces. These steppes have remained on the left bank of

the Dnieper. They are protected in the Black Sea Biosphere Reserve.

2. Wormwood/sod-grass steppe on saline soils, in the southern part of the Kherson region, where it stretches in a narrow streak along the coast of the Black Sea and the Sea of Azov. It is protected in the Black Sea Biosphere Reserve and Azovo-Syvasky National Nature Park.

Fescue/feather-grass (= typical) steppe occupies land with annual rainfall of 350–450 mm and with chernozem soil. Compared to meadow steppes in the north, this steppe has a less compact herb layer, with pronounced domination of xerophilous sod-grasses (*Stipa*, *Festuca*, *Koeleria*). This steppe has fewer floristic aspects, with poor flora (average up to 25 species per m²) and without mesophytes in most typical coenosis. There are two subtypes of fescue/feather-grass steppe, differing in the con-

tribution of forbs to the plant cover: (a) forb-rich fescue/feather-grass steppe – on land with typical chernozem soil and 400–450 mm annual rainfall; (b) forb-poor fescue/feather-grass steppe, on land with southern chernozem soil and 350–400 mm annual rainfall. The latter subtype is found in the Kherson region and is characterized by a less compact herb layer, greater shares of ephemers ?? ephemera ?? and ephemerooids, and a well-marked period of summer dormancy.

There are many kurgans in the typical steppe subzone, ranging in height from 0.5 m to 10 m. On the basis of archaeological maps (Olenkovs'kyj *et al.* 1979–2003, unpubl. materials), it is estimated that there are 5029 kurgans in the Kherson region. About 515 barrows are over 3 m high, and 263 are over 4 m (mainly 4.5–7 m). Usually burial mounds border agrocoenoses of cereals, sunflower, maize and turnip, as well as vineyards, orchards and sometimes abandoned fields. The land around the barrows forms slight depressions, the result of removal of soil for mound-building. Sometimes a small 'downcast' ?? THIS IS A MINING TERM. PLEASE USE A DIFFERENT TERM. ditch ?? is visible near the foot of the barrow as a result of plowing in the immediate vicinity. The upper parts of high kurgans are mostly altered as a result of erecting triangulation towers, monuments, information plaques, etc. Signs of animal activity are visible on the slopes of kurgans, including holes with underground tunnels which often collapse, making cavities on the slopes. Sometimes kurgans are used as cattle pasture. Signs of the activity of amateur archaeologists and penetration by local inhabitants are also evident. Occasionally there are recurring fires on the barrows.

Sand variants of typical steppes with psammophilous species are located on large areas of alluvial sand formed by the Dnieper River. The sand hills on the left bank of the Dnieper are covered with steppe vegetation. Low weeds ('kolok') untypical of steppe zone communities grow among the sand hills **in lower places where the upper soil layer is impermeable. ?? in lower places; this surface vegetation is impervious to invasion by other species. ??** There are no barrows in the sandy steppes.

Wormwood/sod-grass (= desert) steppes cover land with low total annual precipitation below 350 mm and with chestnut soil in complex with saline soil such as solonets ?? and solonchak. ?? ARE THESE STANDARD ENGLISH TERMS? The land surface is almost flat. These areas are usually not exploited for crop agriculture, and are used mainly as pasture. There are no rivers. The waters of saline lakes evaporate completely in the summer, and the dry lake bottoms are covered with salt crust in the center and obligatory halophytes on the periphery. The desert steppe vegetation has a large share of xerophilous subshrubs, mosses and lichens, and in the spring by ephemers ?? ephemera ?? and ephemerooids. The barrows in this area are usually lower than 4 m, except for those near the Dnieper, which are *ca* 10 m high. Deepened ditches and banks near the bases of the mounds are much more evident. The contact zone between the kurgans and surrounding pastures is barely apparent. The tops of the barrows are almost undisturbed. Triangulation towers are rarely built on these plains, and signs of archaeological activity are only sometimes visible.

MATERIAL AND METHODS

The area designated for surveying in 2003–2007 includes the Kherson region (28,500 km²) as well as nearby parts of the Dnieprovski, Nikolajevski and Zaporoski regions. The present study was carried out during the 2003 and 2004 growing seasons within two subzones of the steppe zone (fescue/feather-grass, poor-forb steppe and wormwood/sod-grass steppe) in part of Kherson region (investigated districts, covering *ca* 10,000 km²: Berislav, Novovorontsovka, Gornostayvka, Golaya Pristan, Skadovsk, Belozerka). The total route covered for surveying was over 2000 km.

Topographic and detailed maps prepared by archaeologists over more than two decades (Olenkovs'kyj *et al.* 1979–2003, unpubl. materials) were used to select the kurgans for study. The data were not always current, so the maps had to be verified and updated. In total, 53 kurgans were explored (32 in fescue/feather-grass steppe zone and 21 in wormwood/sod-grass steppe zone), but only 44 (28 and 16, respectively) were included in the research; the barrows selected for this study were at least 4 m high (mostly 4–7 m) and more than 50 m in

diameter (mostly 60–80 m). The kurgans were also characterized by the presence of at least one *Stipa* species. The barrows were situated among cultivated fields or pastures but only slightly disturbed by human activity. Those located in the immediate vicinity of human settlements and extensively penetrated by man were not considered in the study.

For each kurgan the heterogeneity of habitats was taken into account when floristic lists were compiled. The following microhabitats were distinguished: (I) fringe of kurgan, the border zone between the mound and the surrounding cultivated fields or pastures; (II) foot of southern and northern sides of kurgan; (III) southern and northern slope of barrow; (IV) upper part (top) of kurgan, usually very altered.

The floristic richness of 44 kurgans was estimated. Special attention was paid to species included in the 'Red Data Book of Ukraine' (Shelyag-Sosonko *et al.* 1996) and 'Red Data Book of the Kherson Region' (Boiko & Podgajnyj 2002).

Separate floristic lists were compiled for each microhabitat identified on the barrows, with special emphasis on species not recorded in the other microhabitats. The differences in distribution patterns of species on the kurgans were analyzed, and the specific character of the flora of the barrows located in the two steppe subzones was also determined.

The nomenclature of species follows Mosyakin & Fedoronchuk (1999). For species occurring in Poland, the checklist published by Mirek *et al.* (2002) was used. In case of differences in nomenclature, synonyms were given (in both publications the abbreviations identifying authors of plant names are based on Brummitt ?? Brummit ?? & Powell 1992).

RESULTS

GENERAL CHARACTERISTICS OF THE FLORA OF KURGANS

In total, 401 species were reported from 44 kurgans. Natives comprised *ca* 76.1% (305 taxa), including 209 steppe species of the flora of kurgans (Figs 2 & 3). Among them were *Dianthus lanceolatus* Steven ex Rchb, *Linaria bibersteinii* Besser, included in 1997 on the 'IUCN Red List of Threatened Plants' ?? PUT ITALICS INSTEAD OF QUOTES IF ORIGINAL TITLE (Mosyakin 1999); *Phlomis hybrida* Zelen. on the 'European Red List' (Shelyag-Sosonko *et al.* 1996); and *Orchis picta* Loisel., *Stipa capillata* L., *Stipa lessing-*

iana Trin. & Rupr., *Tulipa biebersteiniana* Schult. & Schult. F. and *Tulipa schrenkii* Regel. on the 'Red Data Book of Ukraine' (Shelyag-Sosonko *et al.* 1996). The following local species recorded on the kurgans were listed in the 'Red Data Book of the Kherson region' (Boiko & Podgajnyj 2002): *Cerastium ucrainicum* Pacz. ex Klokov, *Ephedra distachya* L., *Hyacinthella leucophaea* (K. Koch.) Schur, *Muscari neglectum* Guss. ex Ten. and *Ranunculus scythicus* Klokov. In addition, three identified plant communities belonged to the classes *Amygdaletea nanii*, *Stipetea capillatae* and *Stipetea lessingiana*, which were in the 'Green Data Book of Ukraine' (Shelyag-Sosonko 1987), containing a list of rare and endangered plant communities.

Most of the kurgans examined were more or less transformed by man. The presence of synanthropic species was therefore anticipated. Apophytes and anthropophytes (alien species) accounted for 31.7% and 23.9% of the flora of kurgans, respectively. Further studies are needed to determine the role of archaeophytes and newcomers (kenophytes), as well as ephemeral and permanently established species in the flora of the kurgans. A number of species regarded as archaeophytes in Central Europe (species introduced by the end of the 15th century) may have a different status in southern Ukraine. Some Central European archaeophytes no doubt will be classified as species native to southeastern Europe.

THE FLORA OF KURGAN MICROHABITATS

The zonation of the microhabitats and their vegetation on the kurgans in the fescue/feather-grass and wormwood/sod-grass steppes is shown in Figure 4. The flora of the microhabitats distinguished in this study are briefly described below.

Kurgans in fescue/feather-grass steppe

I. FRINGE OF KURGAN. This is the most peripheral part of the kurgan. It is defined as the border zone between the kurgans and cultivated or recently abandoned agricultural fields. This part of the kurgan is usually damaged during farming operations. It is characterized by a high propor-



a



b



c



d



e

Fig. 2. Southern Ukrainian kurgans (a, c) and recorded species: b – *Stipa capillata* L., d – *Iris pumila* L., e – *Tulipa bibersteiniana* Schult. & Schult.



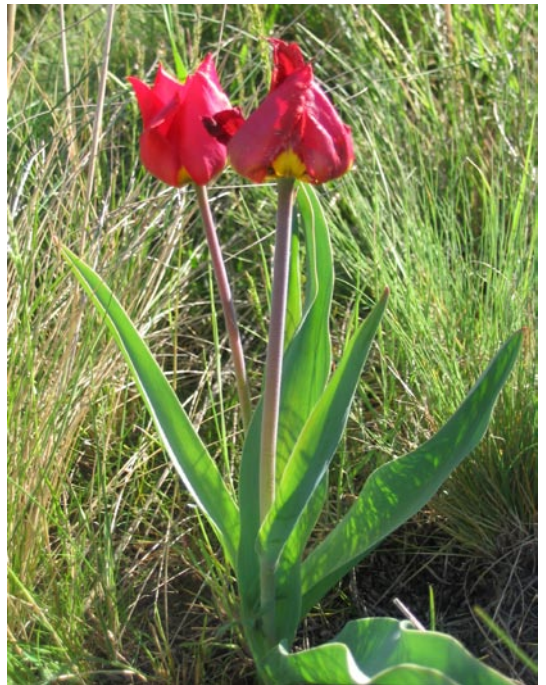
a



b



c



d

Fig. 3. Species noted on kurgans: a & b – *Amygdalus nana* L., c – *Muscari neglectum* Guss. ex Ten., d – *Tulipa schrenkii* Regel.

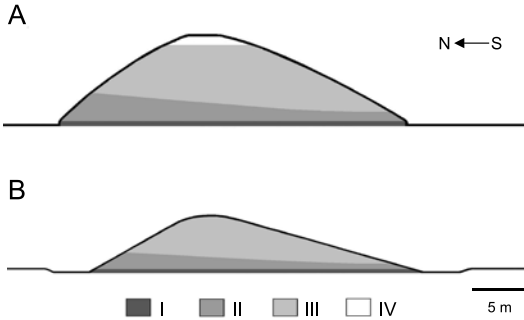


Fig. 4. Zonal distribution of microhabitats and their vegetation on kurgans located in the fescue/feather-grass steppe subzone (A) and wormwood/sod-grass subzone (B). Microhabitats: I – fringe, II – foot, III – slopes, IV – top.

tion of crop weeds, represented mainly by therophytes. The species composition varies with the growing season period. The following species are characteristic of this zone: *Erysimum repandum* L., *Cannabis sativa* L., *Cynoglossum officinale* L., *Setaria viridis* (L.) P. Beauv., *Chorispora tenella* (Pall.) DC., *Descurainia sophia* (L.) Webb ex Prantl and *Amaranthus retroflexus* L. In addition to these, a group of plants called tumbleweeds (in Russian, *perekatipole*), which are especially abundant in steppe regions, is also noted. Tumbleweeds are globe-shaped plants (ca 1 m in diameter) that break from their roots at maturity, dry to a rounded tangle of branches, and roll long distances with the wind, scattering seeds and fruit when they stop against the foot of the kurgans (e.g., *Salsola tragus*, *Kochia scoparia*, *Centaurea diffusa*).

II. FOOT OF KURGAN. The kurgan is usually surrounded by a small, shallow ditch. When water (heavy rains in May and June) runs off the sides of the burial mound, it remains for a considerable period of time in this depression, creating more favorable conditions for plant growth. As a result, xero-mesophilous species are found in addition to steppe species. In Central Europe these plants would be regarded as species typical of thermophilous grasslands. In the steppes of the Black Sea region, where the climate is very dry, they inhabit more mesic habitats than the typical steppe species.

The zone of xero-mesophytes is broader in the

case of higher and steeper kurgans. The width of the zone varies with the exposition of the slope. On the north-facing side of the mound, which is more shaded, the zone is wider and richer in species. The following species are restricted to this zone: *Festuca rupicola* Heuff., *Poa angustifolia* L., *Carex praecox* Schreb., *C. melanostachya* M. Bieb. ex Willd., ***Hierchoe?? repens*** (Host) P. Beauv., *Thalictrum minus* L., *Phlomis tuberosa* L., *Ficaria vaticana* Rchb. and *Gagea erubescens* (Besser) Schult. & Schult.f. Shrubs and small trees, if present on kurgans, are always restricted to this zone. They occur singly or in small groups. Among them are *Amygdalus nana* L., *Crataegus* sp., *Prunus stepposa* Kotov, *Rosa* sp. div., *Rhamnus cathartica* L. and *Pyrus communis* L. The presence of shrubs is indicative of the local process of ‘mesophytization’ of the flora; as in the steppes of the Black Sea region, shrubs usually find refuge in local terrain depressions such as balkas, canyons and river terraces. If the kurgan is quite small, the zone of xero-mesophytes is narrow and occupied by permanent communities of *Elymus repens* (L.) Gould = *Elytrygia repens* (L.) Nevsky, accompanied by such synanthropic species as *Euphorbia virgata* Waldst. & Kit., *Rumex patientia* L., *Artemisia vulgaris* L., *A. absinthium* L., *Verbascum densiflorum* Bertol., *V. phlomooides* L., *Lathyrus tuberosus* L. and *Galium humifusum* M. Bieb.

III. SLOPES OF KURGAN. The sides of kurgans have the highest number of steppe species. The north-facing slope is richer in species (less extreme environmental conditions), although the zone of xero-mesophilous vegetation is broader at the foot on the north side of kurgans. Tuft grasses typical of fescue/feather-grass steppe tend to dominate in different proportions: e.g., *Stipa capillata* L., *S. lessingiana* Trin. & Rupr., *Festuca valesiaca* Gaudin, *Koeleria macrantha* (Ledeb.) Schult. = *K. cristata* (L.) Pers. and *Agropyron pectinatum* (M. Bieb.) P. Beauv. They do not occur in dense stands, however. The species composition varies considerably with the season. Occupying gaps in the vegetation are therophyte spring ephemers ?? ephemera ?? *Erophila verna* (L.) Chevall., *Holosteum umbellatum* L., *A. turkestanicum* Regel

& Schmalh. = *A. desertorum* Stapf, *Veronica verna* L., *Trigonella monspeliaca* L., *Medicago minima* L. and *Androsace elongata* L. Also in gaps are ephemeroïds: *Hyacinthella leucophaea* (K. Koch.) Schur, *Tulipa biebersteiniana* Schult. & Schult. f., *Ornithogalum gussonei* Ten., *Gagea pusilla* (F.W.Schmidt) Schult. & Schult.f. and *G. bulbifera* (Pall.) Salisb. Tall perennial herbs flower in late spring and summer: e.g., *Tanacetum millefolium* (L.) Tzvelev, *Anthemis tinctoria* L., *Goniolimon tataricum* (L.) Boiss., *Ranunculus scythicus* Klokov, *Achillea nobilis* L. and *A. setacea* Waldst. & Kit. Hot dry summers create a period of steppe vegetation dormancy on kurgan slopes. Autumn rains stimulate plant growth again, but flowering is less intensive than in spring. The following plants flower: *Artemisia austriaca* Jacq., *Artemisia santonica* L., *Galatella villosa* (L.) Rchb.f., *Limonium bungeii* (Claus) Gamajun., *Kochia prostrata* (L.) Schrad. and *Xeranthemum annuum* L. Only plants of the genus *Stipa* (*Stipa capillata* L.) continue fruiting in autumn.

The slopes of the mounds have been penetrated by animals (e.g., burrowing by foxes, gophers, mice, field voles, hamsters) and disturbed by man. In recently altered places, weeds such as *Lamium amplexicaule* L., *Lithospermum arvense* L. = *Buglossoides arvense* (L.) I. M. Johnston., *Descurainia sophia* (L.) Webb ex Prantl and *Bromus tectorum* L. = *Anisantha tectorum* (L.) Nevski. are abundant. If the place was disturbed a few years ago, steppe species have encroached gradually. However, they usually grow in big aggregations (e.g., *Tanacetum millefolium* (L.) Tzvelev, *Artemisia austriaca* Jacq.).

IV. TOP OF KURGAN. The floristic composition indicates that the upper part of the barrow is more or less disturbed. The tendency is for annuals to be the first species to appear (see above), followed by perennials in big aggregations. The species characteristic of this microhabitat are *Poa bulbosa* L. or *Agropyron pectinatum* (M.Bieb.) P.Beauv.

Kurgans in wormwood/sod-grass steppe

I. FRINGE OF KURGAN. This part of the barrow is defined as the contact zone between the barrow and grazed areas (pasture) or unexploited communities of wormwood/sod-grass steppe and solonchaks, ?? where halophyte and subhalophyte vegetation dominates. Sometimes the border is not so readily distinguished, as grazing takes place on the kurgans themselves. The fringe of the barrow is not transformed by farming as the kurgans located in fescue/feather-grass steppe are. As a result, synanthropic therophytes, characteristic of the latter steppe, are absent from this part of the kurgan, but the halophytes encroach (e.g., *Aeluropus littoralis* (Gouan) Parl., *Halimione verucifera* (M. Bieb.) Aellen, *Limonium caspicum* (Willd.) Gams, *Puccinellia brachylepis* Klok., *P. bilykiana* Klok., *Salicornia prostrata* Pall.).

II. FOOT OF KURGAN. As in fescue/feather-grass steppe, this microhabitat is dominated by xero-mesophilous species, which usually tolerate soil salinity to some degree (e.g., *Carex praecox* Schreb., *Poa angustifolia* L., *Elymus repens* (L.) Gould, *Verbascum phoeniceum* L., *Potentilla argentea* L., *Achillea setacea* Waldst. & Kit., *Salvia nemorosa* L.). Some species are noted only in wormwood/sod-grass steppe: *Ficaria verna* P. Smirn., *Muscari neglectum* Guss. ex Ten. and *Orchis picta* Loisel. This part of the kurgan is also distinguished by a higher incidence of halomesophyte species, which are rare or absent from fescue/feather-grass steppe: *Limonium meyeri* (Boiss.) O. Kuntze, *Elytrigia elongata* (Host) Nevski, *Juncus gerardii* Loisel. and *Puccinellia cfr. distans* (Jacq.) Parl. Native shrubs were not recorded in this subzone. It is noteworthy that the Irano-Turanian species *Elaeagnus angustifolia* (shrub or small tree) invades the wormwood/sod-grass steppe even more than 20 km away from human settlements. Perhaps it is just a matter of time before the species invades the kurgans in this subzone. So far only one individual of this species was found on one of the barrows.

III. SLOPES OF KURGAN. Vegetation typical

of wormwood/sod-grass steppe is noted in this part of the kurgan. It is distinguished from that of fescue/feather-grass steppe by a higher share of xerophilous subshrubs and perennials that are facultative or obligatory halophytes (e.g., *Camphorosma monspeliaca* L., *Kochia prostrata* (L.) Schrad., *Limonium meyeri* (Boiss.) O. Kuntze) or halophytes (e.g., *Halimione verrucifera* (M. Bieb.) Aellen). Some salinity-intolerant steppe species occurred only on the kurgans and were absent from the area surrounding the mounds. The following species making up the communities of the fescue/feather-grass steppe were also recorded in this steppe subzone: *Stipa capillata* L., *Festuca valesiaca* Gaudin, *Agropyron pectinatum* (M. Bieb.) P. Beauv., and *K. macrantha* (Ledeb.) Schult. They were accompanied by therophytes (*Alyssum turkestanicum* Regel & Schmalh, *Herniaria euxina* Klokov, *Scleranthus syvaschicum* Kleopov, *geophytes: Gagea ucrainica* Klokov, *Iris pumila* L., *Ornithogalum collinum* Guss., *Tulipa schrenkii* Regel) and other perennial herb species (*Dianthus campestris* M. Bieb., *D. lanceolatus* Steven ex Rchb., *Taraxacum erythrospermum* Andrz., *Allium inequale* Janka, *Convolvulus lineatus* L., *Euphorbia sequierana* Neck., *Galatella villosa* (L.) Rchb.f., *Goniolimon tataricum* (L.) Boiss., *Marrubium praecox* Janka) and the biennial *Carduus uncinatus* (M. Bieb.).

IV. TOP OF KURGAN. This part of the kurgan usually remains undisturbed (no triangulation towers erected) or is only slightly altered by human activity (archaeology). Its flora is similar to that of the slopes. This feature distinguishes the kurgans of wormwood/sod-grass steppe from those of fescue/feather-grass steppe.

DISCUSSION

THE DIVERSITY OF KURGAN FLORA

Kurgans contain a range of microhabitats, in which different groups of species attain their optimum development. The variability of these habitats is associated with different light and temperature conditions (north- and south-facing slopes). Peri-

odically moister locations favor the development of xero-mesophilous species at the foot of mounds. Anthropogenic influences (especially at the top and fringe of the barrows) play an important role as well. The zonal distribution of the microhabitats corresponds to the distribution of vegetation, life forms and ecological groups of species. The differences in flora between microhabitats are striking in view of the relatively small size of the kurgans (4–7 m high).

THE FLORA OF KURGANS AND ADJACENT AREAS

The authors' field observations revealed that the flora of kurgans differed significantly from that of the surrounding areas. In the fescue/feather-grass steppe subzone, steppe species displaced from adjacent fields were more likely to survive on kurgans, where the slopes had not been plowed up.

The situation is much more complicated in the case of wormwood/sod-grass steppe. Although the steppe surrounding the kurgans has been only slightly altered by anthropogenic influences (pasturage), the flora of kurgans differs from that of the surrounding areas in having species typical of fescue/feather-grass steppe. This may be because the kurgans are very old and may have been erected when soil salinity levels were low, or lower than at present. Late Holocene transgressions such as changes of the Black Sea coastline may have affected the level of soil salinity. Human activities may have stimulated these changes as well. The wormwood/sod-grass steppe developed over time along with the solonchak ?? vegetation. Kurgans were the only elevations occurring in the flatlands and, therefore, had less risk of salinization; thus, steppe species typical of the fescue/feather-grass steppe would have survived on these sites.

KURGANS AS REFUGIA OF FESCUE/FEATHER-GRASS STEPPE FLORA

The kurgans of the two steppe subzones differ in size, are subject to different degrees of anthropopression, and are surrounded by different types of vegetation. It may be concluded, however, that kurgans provide refuge for steppe species typical

of fescue/feather-grass steppe in both investigated subzones. In plowed up fescue/feather-grass steppe the kurgans probably have played an important role in preserving steppe flora ever since the land began to be cultivated. In wormwood/sod-grass steppe the process of soil salinization may have started earlier, and the old kurgans probably have acted as a refuge for steppe flora for an even longer period.

The presence of steppe species typical of fescue/feather-grass steppe on the kurgans is a common feature of the two subzones investigated. On the other hand, halophytes and halo-mesophytes are absent from the fescue/feather-grass steppe subzone, which is associated with edaphic conditions. In the latter subzone, anthropogenic influences result in a higher incidence of weeds (especially on the fringe and top of the mounds), and sometimes shrubs are found growing at the foot of the barrows. The absence of shrubs on the kurgans located in the wormwood/sod-grass steppe is associated with local climatic conditions.

KURGANS AS POTENTIAL CENTERS FOR EXPANSION OF STEPPE SPECIES

It is estimated that the flora of Ukraine contains *ca* 900 steppe species (Didukh *et al.* 1998). At least 209 steppe species were reported from the 44 kurgans investigated in this study. This number may increase when further research is done. Kurgans as well as balkas and river terraces provide refuge for steppe species that survived in places not subject to strong anthropopression or salinization. Interestingly, in some areas steppe species expanded abundantly into fields abandoned a few years before. This confirms the important role kurgans play in the agricultural landscape of the steppe zone. However, the wormwood/sod-grass steppe species are less likely to expand from kurgans to adjacent areas, due to soil salinity.

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