Біологічний вісник МДПУ імені Богдана Хмельницького 6 (3), стор. 419–429 2016
Biological Bulletin of Bogdan Chmelnitskiy Melitopol State Pedagogical University, 6 (3), pp. 419–429, 2016

ARTICLE ***UDK 581.95(582)***

ANALYSIS OF THE ALIEN FLORA OF DNIPROPETROVSK PROVINCE

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Plant invasion in the Northern Steppe Dnieper has a long history complicated by excessive anthropogenic transformation of territory. Alien species status, origin areas, life history, and invasive tendency of alien species in Dnipropetrovsk region were investigated. The presence of 286 alien species of 61 families was registered. Some 7 families had the greatest species diversity (156 alien species that was 55% of total species number); 30 families were represented by 2–9 alien species, and 24 families contained only 1 alien species. So, the current proportion of the alien species was almost 17% in the regional flora. Archaeophytes consist of 40% of the total alien species, while neophytes had more than 60%. The proportion of naturalized species amounted 58% from alien species, whereas the share of casual species was 42%. The greatest abundance of alien species was typical for *Brassicaceae*, *Asterasea*, and *Poaceae* (14, 13, and 9% of the total species number). We proved invasive status of 28 species and positive trend regard alien species ratio for last years.
Key words: adventives species, archaeophytes, neophytes, casual species, naturalized species, invasiveness

АНАЛИЗ АДВЕНТИВНОЙ ФЛОРЫ ДНЕПРОПЕТРОВСКОЙ ОБЛАСТИ

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Инвазия растительных видов в Северном Степном Приднепровье имеет долгую историю, усложненную значительным антропогенным преобразованием территории. Исследованы статус чужеродных растений, их жизненные формы и тенденции развития инвазионности в Днепропетровской области. Установлено наличие 286 адвентивных видов, принадлежащих к 61 семейству. Среди них 7 семейств с наибольшим обилием чужеродных видов (156 видов или 55% от общего количества); 30 семейств представлены 2–9 видами, а 24 содержали только по одному адвентивному виду. Таким образом, на долю чужеродных видов во флоре региона приходится почти 17%. В общем количестве адвентивных видов археофиты составляют 40%, неофиты – 60%. Доля натурализованных видов насчитывает 58% от всех чужеродных растений, а случайных видов было зарегистрировано 42%. Наибольшее обилие адвентивных видов найдено в семействах Brassicaceae, Asterasea и Poaceae (14, 13 и 9% от общего количества соответственно). Среди чужеродных видов 28 определены как инвазионные. Отмечена тенденция к усилению инвазионности некоторых видов в последние годы.
Ключевые слова: адвентивные виды, археофиты, неофиты, случайные виды, натурализованные виды, инвазионность

Citation:
Baranovski, B., Khromykh, N., Karmyzova, L., Ivanko, I., Lykholat, Y. (2016). Analysis of the alien flora of Dnipropetrovsk Province. *Biological Bulletin of Bogdan Chmelnitskiy Melitopol State Pedagogical University,* 6 (3), 419–429.
Поступило в редакцию / Submitted: 25.11.2016
Принято к публикации / Accepted: 22.12.2016
crossref http://dx.doi.org/10.15421/2016113

INTRODUCTION

Biological invasions were defined as a fundamental driver of ecosystem degradation (Pyšek & Richardson, 2010; Schindler et al., 2016). Therefore, it is not unusual that spread of alien plants in different regions became the important

research topic in recent years (Richardson et al., 2000; Pyšek et al., 2012). Describing the negative effects of plant invasion, Blackburn et al. (2014) emphasize such danger for the native flora as decrease in species extinction probabilities, richness and abundance; significant changes in genetic composition of native populations, phylogenetic and taxonomic diversity, ecosystem productivity, and more. Analysis of alien flora composition and dynamics is an essential element for assessing infestation degree of different taxa (Pyšek, 2003). Blackburn et al. (2011) mentioned the need of integrated model, which could clarify the history and the pattern of invasions, and predict the time and ways to stop them.

In Ukraine, alien species propagation process manifested itself very clearly in areas having a long history of anthropogenic transformation. In Dnipropetrovsk province, located within the geographic area of Northern Steppe Dnieper, the extended anthropogenic impact resulted in overgrazing, quarrying, and pollutants action (Brygadyrenko & Reshetniak, 2014; Tsvetkova et al., 2016). In such circumstances, autochthonous flora undergoes profound destruction, rapid degradation, and loss of typical components replaced on synanthropic species, including aliens (Protopopova, 1991, 1999). Unfortunately, for various reasons, the process of alien species intrusion into the regional flora has not been received adequate attention of researchers (Holoborodko et al., 2016). At present, there are no reported complete lists of alien species confined to the Dnipropetrovsk province. At the same time, alien species discovering in regional flora was not a rare event 35 years ago (Tarasov, 1981), as well as during next years (Tarasov, 2012; Baranowski et al., 2012). European researchers (Pyšek et al., 2012) emphasize the research importance of the regional alien flora for better understanding the invasion process. In this paper, we provided the first checklist of alien species founded in the regional flora and assessed the current state of the alien species invasion process.

MATERIALS AND METHODS

The territory of Dnipropetrovsk province covering 31.974 km² is a plowed steppe (over 80% of territory) with minor forest areas on the river banks (Pakhomov & Brygadyrenko, 2005). Continental climate characterized by the sharp temperature fluctuations, unstable moisture, and seasonal drought periods. Annual evaporation exceeds precipitation by 2–3 times; an average rainfall is 472 mm, while it could fall to 250 mm in the dry years (Furdychko et al., 2006). Regional population density is 103 people per km²; the densities of railways and highways are 49.5 km and 283 km per 1,000 km² respectively. Ecological situation is exacerbated by emissions of 587 industrial enterprises, including 57 mining and metallurgical, and 17 chemical plants. In addition, two international airports and two river ports contribute to process of alien species penetration and propagation within the territory of the Dnipropetrovsk province.

The basis for checklist preparation were the numerous literary sources, own results and the herbarium collections of Oles Honchar Dnipropetrovsk National University. The earliest documentary evidences on floristic studies in the Northern Steppe Dnieper belong to the 18th century (Pallas, 1796). Grossgeim (1913) was one of the first researchers, who reported on plants previously unknown in flora of the region. Belgard (1950) has paid much attention to study of Steppe Dnieper woody vegetation. In different years, regional flora was presented in such fundamental catalogs as "Flora of the USSR" (1935–1965) and "Flora of the European part of the USSR" (1974–1989). During last period, a great contribution to regional alien flora exploration have made by Tarasov (1981, 1991, 2012), and Baranowski (1998, 2000).

Taxa names were given in accordance with Flora Europaea (Moore, 1982) and the modern species nomenclature adopted in Ukraine (Mosyakin & Fedoronchuk, 1999). Alien species have been identified in accordance with generally accepted approach (Pyšek, 1998; Blackburn et al., 2014) as a species appeared due to human activity in regions where previously it does not naturally occur. Definition of invasive status of alien species was made on the basis of the Richardson et al. (2000) criterion, which involves the species classification according to its stage along the introduction-naturalization-invasion continuum (INIC). In line with the approach used by Pyšek et al. (2012) alien plants were classified as naturalized species if they form self-sustaining populations for several life cycles without direct people intervention, or despite it; and plants were named as casual species if they do not form self-sustaining populations in the invaded region.

Following the concept used traditionally in plant invasions studies (Protopopova, 1991, 1999; Pyšek, 1998, 2004), we distinguished archaeophytes (for taxa introduced before 1500 AD) and neophytes (for taxa introduced after that date). Life histories of the species had been classified according to conventional approach (Pergl et al., 2016), namely: annual, over wintering herbaceous plants (biennial or perennial), shrub, and tree. As for the origin areas of the alien species, we stuck to the traditional approach (Pyšek et al., 2012) and identified the following geographical regions as Europe together with the separate Mediterranean region, Asia, Northern and South Americas.

RESULTS AND DISCUSSION

The checklist of regional alien flora consisted of 286 species, which belong to 61 different families and 210 genera. Considering the total number of regional flora includes 1,714 species (Tarasov, 2012), the current proportion of the alien species exceeds 16.7%. Taking into account the Dnipropetrovsk province area, it can be assumed there are 9 alien species per km². This index is much higher than the data shown by Pyšek (2003) for the Czech Republic alien flora (about 4 alien species per square kilometer). High aliens' abundance can be attributed by combination of such regional factors as a complex geomorphologic structure and suitable climatic conditions, as well as an active anthropogenic

transformation and transport communications plexus. Results obtained are in accordance with Fuentes et al. (2015) data, that economic activities and climate are substantial factors in alien plants establishment and invasion.

Most of the alien species were presented by herbaceous plants (252 species or 88% of total) with domination of annual species (Table 1).

Table 1. Distribution of the alien species according to their life history

	Annual	Biennial	Perennial	Shrub	Tree
Number of the species	144	52	56	21	13
% of total	50,3	18,2	19,6	7,3	4,6

In our study, the distribution of alien species between different families wasn't uniform, and there were only 7 families with large (10 species or more) presence of the aliens (Figure 1).

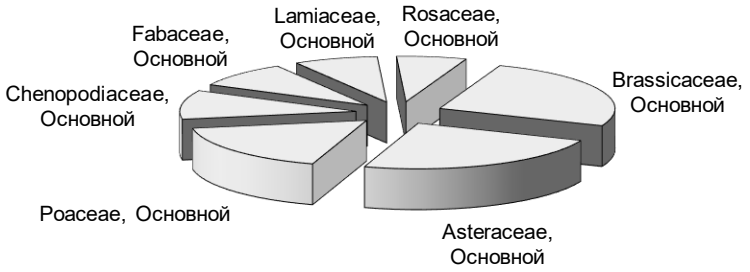

Fig. 1. Families with the highest abundance of alien species. Species number is given after the family title

The number of families with the highest diversity of alien species accounted for only 12% of the total number, however it consisted of 156 alien species covering 55% of the total number. Within this group, three families (Brassicaceae, Asteraceae, and Poaceae) were clearly dominant, embracing together more than 36% of total alien species number.

Substantial part of the families (30 or 49% of total) were represented by a smaller number of alien species (2–9 species), and 24 families (39% of total) contained only one alien species (Table 2).

Table 2. Families with the middle and lower abundance of alien species

Families containing 2–9 alien species		Families containing only 1 alien species	
Aceraceae	*Onagraceae*	*Araceae*	*Peganaceae*
Amaranthaceae	*Orobanchaceae*	*Cyperaceae*	*Portulacaceae*
Apiaceae	*Oxalidaceae*	*Liliaceae*	*Rubiaceae*
Boraginaceae	*Papaveraceae*	*Anacardiaceae*	*Rutaceae*
Caprifoliaceae	*Polygonaceae*	*Apocynaceae*	*Simarubaceae*
Caryophyllaceae	*Primulaceae*	*Asclepiadaceae*	*Thymelaeaceae*
Cucurbitaceae	*Ranunculaceae*	*Balsaminaceae*	*Urticaceae*
Cuscutaceae	*Resedaceae*	*Caesalpiniaceae*	*Valerianaceae*
Euphorbiaceae	*Salicaceae*	*Cannabaceae*	*Verbenaceae*
Fumariaceae	*Scrophulariaceae*	*Convolvulaceae*	
Geraniaceae	*Solanaceae*	*Elaeagnaceae*	
Hydrocharitaceae	*Ulmaceae*	*Grossulariaceae*	
Juglandaceae	*Violaceae*	*Hydrangeaceae*	
Malvaceae	*Vitaceae*	*Moraceae*	
Oleaceae	*Zygophyllaceae*	*Nyctaginaceae*	

Studies allowed establishing the percentage of archaeophytes and neophytes in the total number of alien plants. It was found that archaeophytes make up 40% of the total alien species abundance, while neophytes had 60% of alien plants (Fig. 2).

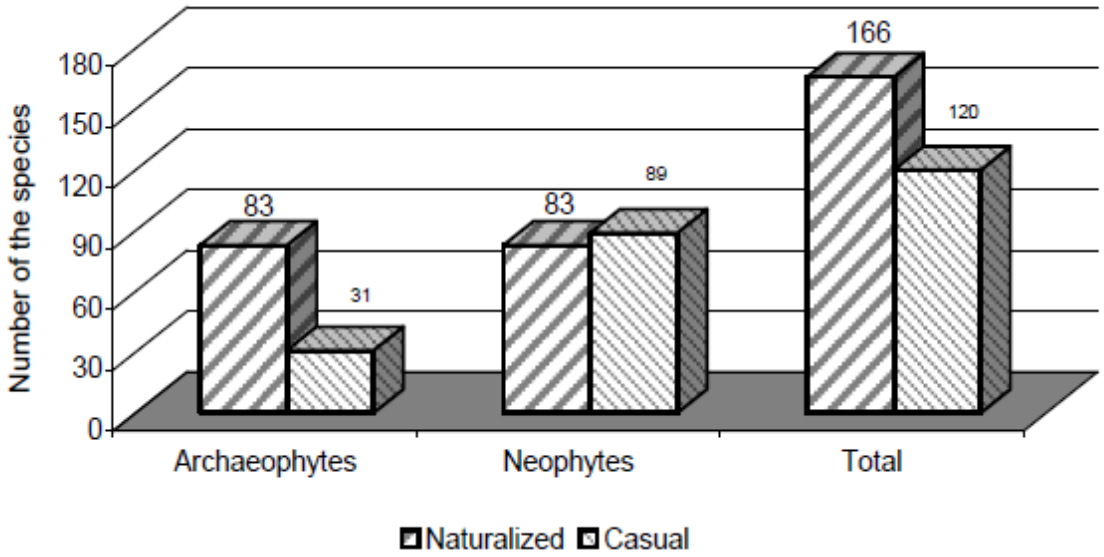

Fig. 2. Distribution of alien species according to invasion status (casual or naturalized) among archaeophytes, neophytes, and all aliens.

It is obvious that such a ratio indicates an active invasion of alien plants into the flora of Dnipropetrovsk province. Confirming this, Tarasov (1981) has found 51 new alien species in the regional flora in the 70s of the last century; whereas he has reported already about 75 new alien species two decades later (Tarasov, 2005). Overall, over the last 40 years, Tarasov (2012) has discovered and identified a large number of alien species in the regional flora, such as *Impatiens parviflora, Artemisia annua, Petrorhagia saxifrage, Hibiscus trionum, Malva mauritiana, Echinocystis lobata, Althaea armeniaca, Solidago serotinoides, Galinsoga parviflora, Galinsoga ciliata, Nicandra physaloides, Bidens frondosa, Solanum cornutum, Zygophyllum fabago, Artemisia tournefortiana*, *Ambrosia trifida*.

In our study, percentage of naturalized species reached 58% of total alien species number. However, index increased to 73% among the archaeophytes, while it reached only 48% among neophytes. Part of the casual species in regional alien flora (42% of total aliens' number) diminished to 27% among the archaeophytes, and covered 52% of the neophyte's number. The results obtained are much higher than data presented by Pyšek (2003), which showed a lower percentage (41% only) of the naturalized alien species in the flora of Czech Republic.

It was established that alien species penetrated into the territory of Dnipropetrovs'k province from the five main areas (Fig. 3). Among them, the greatest contribution to the regional alien flora was made by species originating from the Mediterranean region. At the same time, the definition of the origin areas had not been possible for some alien species; so they were combined into a single group. Using the approach described by Walter et al. (2009), we have identified this species as a cryptogenic (i.e, species of unknown origin).

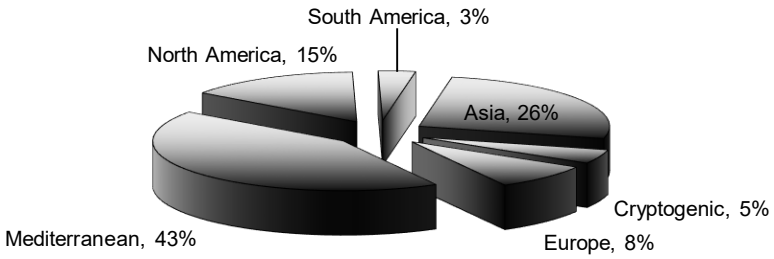

Fig. 3. Distribution of alien species according to the origin areas. Proportion of the alien species is given after the origin area title.

In our study, various propagation paths of alien species have been identified (Table 3). In particular, Baranovski (1998, 2000) had shown that alien trees and shrubs distribution was associated with introduction and subsequent naturalization in such habitats as coastal areas, ravines, and natural and planted forests. Currently, the most widespread aliens in arboreal regional flora are *Acer negundo, Robinia pseudacacia, Ulmus pumila, Ailanthus altissima, Amorpha fruticosa,* and *Partenocissus quinquefolia*. It was established, that alien species *Cenchrus pauciflorus*, *Zizania latifolia*, and *Juncellus serotinus* (Baranovski, 2000) were first discovered in the Dnieper River surrounding, indicating the waterway penetration. It was shown, that *Viola hissarica* (Tarasov, 2005) and *Thladiantha dubia* (Mytsyk & Baranovski, 2006) spread over the region, going beyond the territory of the Dnipropetrovs'k University Botanical Garden.

Table 3. Checklist of the alien species in Dnipropetrovsk province

No	Family	Species	Life history	Origin area	Naturalized		Casual	
					arche-ophyt	neo-phyt	arche-ophyt	neo-phyt
1	2	3	4	5	6	7	8	9
	Liliopsida Araceae	*Acorus calamus* L.	Per	As	+			
	Cyperaceae	*Juncellus serotinus* (Rottb.) Clarke	Per	As		+		
	Hydrocharitaceae	*Elodea canadensis* Michx.	Per	NA		+		
		Vallisneria spiralis L.	Per	As		+		
	Liliaceae	*Gagea villosa* (M.Bieb.) Duby	Per	M	+			
	Poaceae	*Anisantha sterilis* (L.) Nevski	Ann	M	+			
		Anisantha tectorum (L.) Nevsli (*Bromus* L.)	Ann	M	+			
		Apera spica-venti (L.) Beauv.	Ann	Crypt.	+			
		Avena fatua L.	Ann	As	+			
		Avena persica Steud.	Ann	M		+		
		Bromus arvensis L.	Ann	M	+			
		Bromus commutatus Schrad	Ann	E		+		
		Bromus squarrosus L.	Bien	M		+		
		Cenchrus longispinus (Hack.) Fernald	Ann	NA		+		
		Cynodon dactylon (L.) Pers.	Per	As		+		
		Digitaria aegyptica (Retz.) Willd.	Ann	As		+		
		Digitaria ischaemum (Schreb.) Muehl.	Ann	E	+			
		Digitaria sanguinalis (L.) Scop.	Ann	As	+			
		Echinochloa crusgalli (L.) Beauv.	Ann	As	+			
		Eragrostis minor Host	Ann	E		+		
		Eragrostis pilosa (L.) Beauv.	Ann	M		+		
		Hordeum jubatum L.	Ann	NA		+		
		Hordeum leporinum Link.	Ann	M		+		
		Hordeum murinum L.	Ann	M	+			
		Lolium temulentum L.	Ann	M	+			
		Panicum capillare L.	Ann	NA		+		
		Sclerochloa dura (L.) Beauv.	Ann	M	+			
		Setaria glauca (L.) Beauv.	Ann	As	+			
		Setaria verticillata (L.) H. B.	Ann	As	+			
		Setaria viridis (L.) Beauv.	Ann	M	+			
		Tragus racemosus (L.) All. (*Cenchrus*)	Ann	M		+		
		Zizania latifolia Stapf.	Per	As		+		
	Magnoliopsida Aceraceae	*Acer negundo* L.	Arb	NA		+		
		Acer pseudoplatanus L.	Arb	NA				+
	Amaranthaceae	*Amaranthus albus* L.	Ann	NA		+		
		Amaranthus blitoides S. Wats. (*A. blitus* L.)	Ann	NA		+		
		Amaranthus blitum (*A. lividum* L.)	Ann	E		+		
		Amaranthus caudatus L.	Ann	SA		+		
		Amaranthus cruentus L. (*paniculatus*)	Ann	SA		+		
		Amaranthus retroflexus L.	Ann	NA		+		
	Anacardiaceae	*Cotinus coggygria* Scop.	Fr	M		+		
	Apiaceae	*Aethusa cynapium* L.	Bien	E				+
		Bupleurum rotundifolium L.	Ann	M			+	
		Caucalis platycarpos L.	Ann	M			+	
		Conium maculatum L.	Bien	M	+			

	Levisticum officinale W.D.J. Koch	Per	As					+
	Turgenia latifolia (L.) Hoffm.	Ann	M					+
Apocynaceae	*Vinca minor* L.	Per	M		+			
Asclepiadaceae	*Asclepias syriaca* L.	Per	NA		+			
Asteraceae	*Ambrosia artemisifolia* L.	Ann	NA		+			
	Ambrosia trifida L.	Ann	NA					+
	Anthemis cotula L.	Ann	M	+				
	Artemisia absinthium L.	Per	As	+				
	Artemisia annua L.	Ann	As				+	
	Artemisia dracunculus L.	Per	As					+
	Artemisia tournefortiana Rchnb.	Ann	As		+			
	Bidens frondosa L.	Ann	NA		+			
	Carduus acanthoides L.	Bien	M	+				
	Carduus nutans L.	Bien	M	+				
	Centaurea cyanus L.	Bien	M	+				
	Centaurea diffusa Lam.	Bien	M		+			
	Cichorium inthybus L.	Per	M	+				
	Coniza canadensis (L.) Cronq.	Bien	NA		+			
	Galinsoga urticulata (Kunth) Benth (*G. ciliata* (Raf.) S.F.Blake)	Ann	SA					+
	Galinsoga parviflora Cav.	Ann	SA					+
	Grindelia squarrosa (Pursh) Dunal.	Per	NA					+
	Helianthus tuberosus L.	Per	NA					+
	Cyclachaena xanthiifolia (Nutt.) Fresen.	Ann	NA					+
	Lactuca serriola Torner	Bien	M	+				
	Lepidotheca suaveolens (Pursh) Nutt.	Ann	NA		+			
	Matricaria recutita L.	Ann	E	+				
	Onopordum acanthium L.	Bien	M	+				
	Petasites spurius (Retz.) Rchb.	Per	E					+
	Phalacroloma annuum (L.) Dumort.	Bien	NA		+			
	Senecio vulgaris L.	Ann	As	+				
	Solidago canadensis L.	Per	NA		+			
	Sonchus arvensis L.	Per	M	+				
	Sonchus asper (L.) Hill	Bien	M	+				
	Sonchus oleraceus L.	Ann	M	+				
	Tripleurospermum inodorum (L.) Sch.	Bien	As	+				
	Xantium albinum (Widd.) H. Scholtz	Ann	E		+			
	Xantium brasilicum Vellozo	Ann	M		+			
	Xantium californicum Greene	Ann	NA		+			
	Xantium spinosum L.	Ann	SA		+			
	Xantium strumarium L.	Ann	As	+				
	Verbesina encelioides (Cav.) Benth. & Hook. f. ex A. Gray	Ann	NA					+
Balsaminaceae	*Impatiens parviflora* DC.	Ann	As		+			
Boraginaceae	*Anchusa officinalis* L	Bien	M	+				
	Buglossoides arvensis (L.) I.M. Johnst.	Ann	M	+				
	Cynoglossum officinale L.	Ann	M	+				
	Lappula patula (Lehm.) Menyharth	Bien	As		+			
	Lappula squarrosa (Retz.) Dumort.	Bien	M	+				
	Myosotis arvensis (L.) Hill	Ann	M	+				
	Nonea pallens Petrovic	Ann	M					+
	Symphytum caucasicum M. Bieb.	Per	M					+
Brassicaceae	*Arabidopsis thaliana* (L.) Heynh.	Bien	M		+			
	Brassica campestris L.	Ann	As	+				
	Brassica juncea (L.) Czern.	Ann	As		+			
	Brassica nigra (L.) W.J. Koch	Ann	M		+			
	Bunias arvensis Jordan	Ann	M					+
	Bunias orientalis L.	Bien	M		+			
	Camelina microcarpa Andrcz.	Ann	M	+				
	Camelina rumelica Velen.	Ann	M		+			
	Camelina sativa (L.) Crantz.	Ann	Crypt.	+				
	Camelina sylvestris Wallr.	Bien	Crypt.					+
	Capsella bursa-pastoris (L.) Medik.	Ann	Crypt.	+				
	Cardaria draba (L.) Desv.	Per	E		+			

	Chorispora tenella (Pall.) DC.	Ann	As		+			
	Conringia orientalis (L.) Dumort.	Ann	M			+		
	Descurainia sophia (L.) Webb et Plantl	Ann	As	+				
	Diplotaxis muralis (L.) DC.	Bien	E		+			
	Diplotaxis tenuifolia (L.) DC.	Per	M		+			
	Erysimum cheiranthoides L.	Bien	Crypt.	+				
	Erysimum repandum L.	Bien	As			+		
	Euclidium syriacum (L.) R.Br.	Per	As					+
	Isatis tinctoria L.	Bien	As		+			
	Lepidium campestre (L.) R. Borbas	Bien	M	+				
	Lepidium densiflorum Schrad.	Bien	NA					+
	Lepidium perfoliatum L.	Bien	M		+			
	Lepidium ruderale L.	Bien	As	+				
	Lepidium sativum L.	Ann	As					+
	Microthlaspi perfoliata (L.) F. K. Meyer	Ann	As		+			
	Neslia paniculata (L.) Desv.	Ann	Crypt.		+			
	Raphanus raphanistrum L.	Ann	M	+				
	Rapistrum perenne (L.) All	Per	M					+
	Sinapis alba L.	Ann	M	+				
	Sinapis arvensis L.	Ann	E	+				
	Sinapis dissecta Lag.	Ann	M		+			
	Sisymbrium altissimum L.	Bien	E		+			
	Sisymbrium loeselii L.	Bien	M		+			
	Sisymbrium officinale (L.) Scop.	Bien	M	+				
	Sisymbrium orientale L.	Bien	M		+			
	Sisymbrium polymorphum (Murray) Roth (*S. junceum* M. B.)	Bien	As		+			
	Sisymbrium volgense M. Bieb. ex Fourn.	Per	M		+			
	Thlaspi arvense L.	Ann	As	+				
Caesalpiniaceae	*Gleditschia triacanthos* L.	Arb	NA		+			
Cannabaceae	*Cannabis ruderalis* Janisch.	Ann	As		+			
Caprifoliaceae	*Lonicera tatarica* L.	Fr	As					+
	Sambucus racemosa L.	Fr	E		+			
Caryophyllaceae	*Agrostemma githago* L.	Ann	Crypt.	+				
	Gypsophila acutifolia Fish. ex Spreng.	Per	M					+
	Gypsophila paulii Klokov	Per	E					+
	Lychnis chalcedonica L.	Per	As					+
	Petrorhagia saxifrage (L.) Link	Per	M					+
	Saponaria officinalis L.	Per	M					+
	Scleranthus annuus L.	Ann	M			+		
	Spergula arvensis L.	Ann	M	+				
	Vaccaria hispanica (Mill.) Rauschert	Ann	As			+		
Chenopodiaceae	*Atriplex aucheri* Moq.	Ann	As					+
	Atriplex micrantha C.A.Mey.	Ann	As					+
	Atriplex prostrata Boucher	Ann	M	+				
	Atriplex sagittata Borkh	Ann	As	+				
	Atriplex tatarica L.	Ann	M		+			
	Chenopodium botrys L.	Ann	M					+
	Chenopodium hybridum L.	Ann	M			+		
	Chenopodium opulifolium Schrad.	Ann	M			+		
	Chenopodium polyspermum L.	Ann	Crypt.			+		
	Chenopodium rubrum L.	Ann	As					+
	Chenopodium suecicum J. Murr	Ann	As					+
	Chenopodium vulvaria L.	Ann	M			+		
	Corispermum hyssopifolium L.	Ann	M					+
	Kochia laniflora (S. G. Gmel.) Borb.	Ann	M		+			
	Kochia scoparia (L.) Schrad.	Ann	As		+			
	Polycnemum arvense L.	Ann	M					+
Convolvulaceae	*Ipomaea purpurea* (L.) Roth	Ann	SA					+
Cucurbitaceae	*Bryonia alba* L.	Per	M					+
	Echinocystis lobata (Michx.) Torr. et Gray	Ann	NA		+			
Cuscutaceae	*Cuscuta campestris* Yunck.	Ann	NA					+
	Cuscuta cesatiana Bertol.	Ann	As					+
Elaeagnaceae	*Elaeagnus angustifolia* L.	Arb	M		+			

Euphorbiaceae	*Euphorbia falcata* L.	Ann	M				+	
	Euphorbia helioscopia L.	Ann	M				+	
	Euphorbia humifusa Willd. ex Schlecht.	Ann	M					+
	Euphorbia peplus L.	Ann	M				+	
	Euphorbia salicifolia Host	Per	E					+
Fabaceae	*Amorpha fruticosa* L.	Fr	NA			+		
	Caragana arborescens Lam	Fr	As			+		
	Lathyrus tuberosus L.	Per	As		+			
	Medicago sativa L.	Per	As					+
	Ornithopus perpusillus L.	Ann	M					+
	Robinia pseudacacia L.	Arb	NA			+		
	Tetragonolobus purpureus Moench	Ann	M					+
	Trifolium hybridum L.	Bien	M					+
	Trigonella caerulea (L.) Ser.	Ann	M					+
	Vicia angustifolia Reichard	Ann	M					+
	Vicia hirsuta (L.) S. F. Grag	Ann	M		+			
	Vicia pannonica Crantz	Ann	M				+	
	Vicia tetrasperma (L.) Schreb.	Ann	M		+			
	Vicia villosa Roth	Bien	M		+			
Fumariaceae	*Fumaria officinalis* L.	Ann	M				+	
	Fumaria parviflora Lam.	Ann	M					+
	Fumaria schleicheri Soy.-Willem.	Ann	As		+			
	Fumaria vailantii Loisel.	Ann	M				+	
Geraniaceae	*Geranium molle* L.	Ann	M					+
	Geranium pusillum L.	Ann	As		+			
Grossulariaceae	*Ribes aureum* Pursh	Fr	NA					+
Hydrangeaceae	*Philadelphus coronarius* L.	Fr	E					+
Juglandaceae	*Juglans mandshurica* Maxim.	Arb	As					+
	Juglans regia L.	Arb	As			+		
Lamiaceae	*Ballota nigra* L.	Per	M		+			
	Dracocephalum thymiflorum L.*	Bien	Crypt.					+
	Elsholtzia ciliata (Thunb.) Hyl.	Ann	As					+
	Lamium album L.	Per	As				+	
	Lamium amplexicaule L.	Bien	M		+			
	Lamium purpureum L.	Bien	M		+			
	Leonurus cardiaca L.	Per	M		+			
	Marrubium vulgare L.	Per	M				+	
	Mentha piperita L.	Per	E					+
	Nepeta cataria L.	Per	M		+			
	Salvia reflexa Hormem.	Ann	NA					+
	Stachys annua (L.) L.	Bien	M		+			
Malvaceae	*Abutilon theophrastii* Medik.	Ann	As					+
	Althaea officinalis L.	Per	As		+			
	Hibiscus trionum L.	Ann	M				+	
	Malva mauritiana L.	Bien	M					+
	Malva neglecta Wallr.	Per	As		+			
	Malva pusilla Smith	Ann	Crypt.		+			
	Malva sylvestris L.	Bien	M				+	
Moraceae	*Morus alba* L.	Arb	As		+			
Nyctaginaceae	*Oxybaphus nictagineus* (Michx.) Sweet	Per	NA			+		
Oleaceae	*Fraxinus lanceolata* Borkh.	Arb	NA			+		
	Fraxinus pennsylvanica Marschall	Arb	NA					+
	Syringa vulgaris L.	Fr	E					+
Onagraceae	*Oenothera biennis* L.	Bien	NA					+
	Oenothera renneri H. Scholz.	Bien	E					+
Orobanchaceae	*Orobanche cumana* Wallr.	Bien	As					+
	Pheliplanche ramosa (L.) Pomel.	Ann	As					+
Oxalidaceae	*Xanthoxalis corniculata* (L.) Small	Bien	SA					+
	Xanthoxalis dillenii (Jacq.) Holub	Per	NA					+
	Xanthoxalis stricta L. (L.) Small	Bien	As			+		
Papaveraceae	*Papaver dubium* L.	Ann	M				+	
	Papaver rhoeas L.	Ann	M				+	
Peganaceae	*Peganum harmala* L.	Per	M					+
Polygonaceae	*Fallopia convolvulus* (L.) A. Love	Ann	As		+			

	Reynoutria sachalinensis (F. Schmidt ex Maxim.) Nakai	Per	As				+
	Rumex longifolius DC.	Per	Crypt.				+
	Rumex patientia L.	Per	M				+
Portulacaceae	*Portulaca oleracea* L.	Ann	As	+			
Primulaceae	*Anagallis arvensis* L.	Ann	M			+	
	Anagallis foemina Mill.	Per	M			+	
Ranunculaceae	*Clematis vitalba* L.	Fr	M				+
	Consolida regalis S.F.Gray	Ann	M	+			
	Nigella arvensis L.	Ann	E	+			
Resedaceae	*Reseda lutea* L.	Ann	M		+		
	Reseda inodora Rchb.	Bien	M			+	
Rosaceae	*Cerasus tomentosa* (Tumb.) Wall.	Fr	As				+
	Malus domestica Borkh.	Per	As			+	
	Potentilla orientalis Juz.	Per	As				+
	Prunus armeniaca L.	Arb	As				+
	Prunus cerasus L.	Arb	E				+
	Prunus divaricata Ledeb.	Arb	E				+
	Prunus domestica L.	Arb	As				+
	Prunus mahaleb L.	Arb	E				+
	Prunus serotina Ehrh.	Per	NA		+		
	Prunus virginiana L.	Per	NA		+		
Rubiaceae	*Galium spurium* L.	Ann	Crypt.	+			
Rutaceae	*Ptelea trifoliata* L.	Fr	NA				+
Salicaceae	*Populus deltoides* Marsh.	Arb	NA				+
	Populus x *canadensis* Moench	Arb	NA				+
	Salix fragilis L.	Arb	As	+			
Scrophulariaceae	*Lindernia procumbens* (Krock.) Borb.	Ann	M				+
	Veronica arvensis L.	Bien	M	+			
	Veronica opaca Fr.	Ann	Crypt.	+			
	Veronica persica Poir.	Ann	As		+		
	Veronica polita Fries	Bien	M	+			
	Veronica triphyllos L.	Bien	As			+	
Simarubaceae	*Ailanthus altissima* (Mill.) Swingle	Arb	As		+		
Solanaceae	*Datura stramonium* L.	Ann	As		+		
	Hyoscyamus niger L.	Bien	M				+
	Lycium barbatum L.	Fr	As	+			
	Lycopersicon esculenthum Mill.	Ann	SA				+
	Nicandra physaloides (L.) P. Gaern.	Ann	SA				+
	Solanum cornutum Lam.	Ann	NA				+
	Solanum nigrum L.	Ann	E	+			
Thymelaeaceae	*Thymelea passerine* (L.) Coss. et Germ.	Ann	M			+	
Ulmaceae	*Celtis occidentalis* L.	Arb	NA				+
	Ulmus pumila L.	Arb	As		+		
Urticaceae	*Urtica urens* L.	Ann	M	+			
Valerianaceae	*Valerianella locusta* (L.) Laterr.	Bien	M			+	
Verbenaceae	*Verbena officinalis* L.	Per	M			+	
Violaceae	*Viola arvensis* Murray	Per	M	+			
	Viola hissrica Juz.	Per	As		+		
Vitaceae	*Partenocissus quinquefolia* (L.) Planch.	Fr	NA		+		
	Vitis vinifera L.	Fr	M				+
Zygophyllaceae	*Tribulus terrestris* L.	Ann	M		+		
	Zygophyllum fabago L.	Per	M				+

In accordance with approach of Pyšek et al. (2012), we investigated the naturalized species ability to spread over long distances from parent habitats in order to identify a subset of aliens with the obvious trend to invasiveness. Naturalized alien plants demonstrating the potential to spread over long distances were defined as invasive species in Dnipropetrovs'k province. The results obtained allowed to allocate group of invasive alien plants, which consisted of 28 species from 15 different families: *Cenchrus longispinus* (Hack.) Fernald, *Echinochloa crusgalli* (L.) Beauv., *Hordeum murinum* L., *Setaria viridis* (L.) Beauv. – Poaceae; *A. negundo* L. – Aceraceae; *Asclepias syriaca* L. – Asclepiadaceae; *Ambrosia artemisifolia* L., *Artemisia absinthium* L., *Carduus acanthoides* L., *Centaurea diffusa* Lam., *Conizа canadensis* (L.) Cronq., *Lactuca serriola* Torner, *Onopordum acanthium* L. – Asteraceae; *Capsella bursa-pastoris* (L.) Medik., *Descurainia sophia* (L.) Webb et Plantl, *Sisymbrium*

loeselii L. – Brassicaceae; *Sambucus racemosa* L. – Caprifoliaceae; *Echinocystis lobata* (Michx.) Torr. et Gray – Cucurbitaceae; *A. fruticosa* L., *R. pseudacacia* L. – Fabaceae; *Ballota nigra* L. – Lamiaceae; *Prunus serotina* Ehrh. – Rosaceae; *Salix fragilis* L. – Salicaceae; *A. altissima* (Mill.) Swingle – Simarubaceae; *Celtis occidentalis* L., *U. pumila* L. – Ulmaceae; *P. quinquefolia* (L.) Planch. – Vitaceae; *Tribulus terrestris* L. – Zygophyllacea.

The majority of invasive aliens was typical for such families: Acteraceae (7 alien species), Poaceae (4 species), and Brassicaceae (3 species) with high domination of the annual and biennial herbaceous plants. The woody invasive plants were presented by *R. pseudacacia* (Khromykh et al., 2015; Holoborodko et al., 2016), and *A. negundo* (Lykholat et al., 2016b).

Our study revealed the positive invasion trend during recent years. According to Baranovski (1998), *A. fruticosa* has acquired the invasive status over last 30 years; at present invasion of this species resulted in a significant distortion of natural structure of lowland habitat vegetation. Besides, the young growths of *P. serotina* and *C. occidentalis* have been found in the old-year urban plant communities as well as in the natural forests; *A. syriaca* could spread not only in the ruderal habitats, but also penetrate into the crops of wheat and other cultures. This invasion trend can be caused by the climatic changes typical for last years (Lykholat et al., 2016a; Walter et al., 2009).

CONCLUSION

Nowadays, the alien species occupy almost 17% in the flora of Dnipropetrovsk province, due to a combination of environmental and anthropogenic factors. The uneven alien species distribution between the families together with prevalence of *Brassicaceae*, *Asterasea*, and *Poaceae* was established. Results of our study allowed revealing various patterns and mechanisms of alien species intrusion into the regional flora (purposeful introduction, unintentional entering, and escape from a culture). Number of the neophytes was much higher than the archaeophytes, indicating constant invasion of alien species into the local flora and threats to natural floristic diversity of Dnipropetrovsk province. Invasion positive trend some alien species can be explained by the impact of climatic changes during last years.

REFERENCES

Baranovski, B.A. (1998). Pasprostranenie amorfy kystarnikovoy v dneprovskoy poyme v usloviyah kaskada. *Voprosy stepnogo lesovedeniya i rekultivatsiy zemel,* 147–151. (In Russian).

Baranovski, B.A. (2000). Rasitelnost ruslovogo ravninnogo vadohranilischa. *Dnepropetrovsk: Izd-vo DNU*, 172 pp. (In Russian).

Baranovski, B.O., Tarasov, V.V., Ivanko, I.A., Karmyzova, L.O. (2012). Adventyvna flora m. Dnipropetrovsk. *Mat. II Vseukr. Nauk. Konf. „Synantropizatsiya Roslynnogo Pokryvu Ukrainy,* 15–18 (In Ukrainian).

Belgard, A.L., 1950. Lesnaja rastitel'nost' jugo-vostoka USSR [Forest vegetation of south-eastern part of Ukraine]. KGU im. Shevchenko Press, Kyiv 227 pp. (in Russian).

Blackburn, T.M., Pyšek, P., Bacher, S., Carlton, J.T., Duncan, R.P., Jarosik, V., Wilson, J.R.U., Richardson, D.M. (2011). A proposed unified framework for biological invasion. *Trends in Ecology & Evolution,* 26(7), 333–339.

Blackburn, T.M., Essi, F., Evans, T., Hulme, P.I., Jeschke, J.M. (2014). A Unified Classification of Alien Species Based on the Magnitude of their Environmental Impacts. *PRO S Biol.,* 12(5). Doi 10.1371.

Brygadyrenko, V.V., Reshetniak, D.Y. (2014). Morphological variability among populations of *Harpalus rufipes* (Coleoptera, Carabidae): What is more important – the mean values or statistical peculiarities of distribution in the population? Folia Oecologica, 41(2), 109–133.

Fuentes, N., Saldaña, A., Kühn, I., Klotz, S. (2015). Climatic and socio-economic factors determine the level of invasion by alien plants in Chile. *Plant Ecology & Diversity.* 8(3), 371–377.

Furdychko, O.I., Gladun, G.B., Lavrov, V.V. (2006). Lis u stepu: osnoby stalogo rozvytku (Monografiya). *Kyiv: Osnova,* 496 pp. (in Ukrainian).

Grossgeim, A.A. (1913). Zametki o bolee redkih i novyh dlya flory okrestnostey g. Ekaterinoslava vidah. *Protokoly v „Trudah obsch. isp. pr.*“, 46(2), 11–18. (In Russian).

Holoborodko, K.K., Marenkov, O.M., Gorban, V.A., Voronkova, Y.S. (2016). The problem of assessing the viability of invasive species in the conditions of the steppe zone of Ukraine. Visnyk of Dnipropetrovsk University Biology, Ecology, 24(2), 466–472. doi:10.15421/011663

Khromykh, N.O., Ivanko, I.A., Kovalenko, I.M., Lykholat, Y.V., Alekseeva, A.A. (2015). Vplyv asotsiovanyh z altitudoyu shylu umov mikroklimatu ta osvitlenosti na fiziologo-biohimichni protsesy v lysti derev pribereznogo lisu. Visnyk of Dnipropetrovsk University Biology, Ecology, 23(2), 177–182. (In Ukrainian). doi:10.15421/011525

Lykholat, Y.V., Khromykh N., Ivanko I., Kovalenko, I., Shupranova, L., Kharytonov, M. (2016a). Metabolic responses of steppe fores rees to altitude-associated local environmental shanges. *Agriculture & Forestry,* 62(2), 163–171.

Lykholat, Y., Alekseeva, A., Khromykh N., Ivanko I., Kharytonov, M., Kovalenko, I. (2016b). Assessment and prediction of viability and metabolic activity of *Tilia platyphyllos* in arid steppe climate of Ukraine. *Agriculture & Forestry*, 62(3), 57–64.

Moore, D. M. (1982). Flora Europaea, checklist and chromosome index. *Cambridge University Press, London, New York, New Rochelle, Melbourne, Sydney,* 423 pp.

Mosyakin, S.L., Fedoronchuk, M.M. (1999). Vascular plants of Ukraine (Nomenclatural checklist). *Kyiv, Naukova Dumka*, 346 pp.

Mytsyk, L.P, Lykholat, Y.V., Tarasov, V.V. Adventives Herbaceous Plants of Technological Areas of Steppe Dnieper. (2000). *Ukrainian Botanical Journal,* 57(3), 289–293.

Mytsyk, L. & Baranovski, B. (2006). Nahodka *Thladiantha dubia Bunge* (Cucubritaceae) na Dnepropetrovschine. *Tezy dop. mizhnar. konf. "Problemy lisovoy rekultyvatsiy porushenyh zemel Ukrainy",* 64–65 (In Russian).

Pakhomov, O.Y., Brygadyrenko, V.V. (2005). Koncepcija systemy zahodiv z ohorony navkolyshn'ogo pryrodnogo seredovyshha Dnipropetrovs'koi' oblasti na 2005–2015 roky [Concept of system for actions on environment protection in Dnipropetrovsk re-gion for 2005–2015]. Visnyk of Dnipropetrovsk University Biology, Ecology, 13(1), 213–225. doi:10.15421/010538

Pallas, P. S. (1796). Verzeichniss der in Taurien wildwacksenden Pflancengattungen. Neue Nordisch. *Beitrage, St.-Petersb.*, 7, 426–438. (In German).

Pergl, J., Sadlo, J., Petřik, P., Danihelka, J., Chrtek, J., Hejda, M., Moravcova, L., Perglova, I., Štajerova, K. & Pyšek, P. (2016). Dark side of the fence: ornamental plants as a source of wild-growing flora in the Czech Republic. *Preslia,* 88: 163–184.

Protopopova, V. (1991). Synantropnaja flora Ukrainy i puti ee pazvitija. *Kiev: Naukova dumka*, 200 pp. (In Russian).

Protopopova, V. (1999). Some aspects of the expansions invasive plants in Ukraine. *Proceedings of XVI International Botanical Congress*, 1540.

Pyšek, P. (1998). Alien and native species in Central European urban floras: a quantative comparison. *Journal of Biogeography,* 25, 155–163.

Pyšek, P. (2003). How reliable are data on alien species in Flora Europea? *Flora*, 198, 499–507.

Pyšek, P., Richardson, D.M., Redjmanek, M., Webster, G., Williamson, M., Kirschner, J. (2004). Alien plants in checlist and floras: toward better communication between taxonomists and ecologists. *Taxonomy,* 53, 131–143.

Pyšek, P., Richardson, D.M. (2010). Invasive Species, Environmental Change and Management, and Health. *Annu. Rev. Environ. Resour.*, 35, 25–55.

Pyšek, P., Danihelka, J., Sadlo, J., Chrtek, J.J., Chytry, M., Jarosik, V., Kaplan, Z., Krahulec, F., Moravkova, L., Pergl, J., Stajerova, K., Tichy, L. (2012). Catalogue of alien plants of the Czech Republic (2nd edition): checklist update, taxonomac diversity and invasion patterns. *Preslia,* 84, 155–255.

Richardson, D.M., Pyšek, P., Redjmanek, M., Barbour, N.G., Panetta, F.D., West, S.J. (2000). Naturalization and invasion of alien plants: concepts and definitions. *Diversity & Distributions,* 6, 93–107.

Schindler, S., O'Neill, F.H., Biró, V., Damm, C., Gasso, V., Kanka, R., Sluis, T., Krug, A., Lauwaars, S.G., Sebesvari, Z., Pusch, M., Baranovski, B., Ehlert, T., Neukirchen, B., Martin, J.R., Euller, K., Mauerhofer, V., Wrbka, T. (2016). Multifunctional floodplain management and biodiversity effects: a knowledge synthesis for six European countries. *Biodiversity and Conservation*, 25, 1349–1382.

Tarasov, V.V. (1981). K voprosu o bio-ekologicheskoy pasportizatsiy sornyh rasteniy lesnyh kultur Dnepropetrovskoy oblasty. *Voprosy stepnogo lesovedeniya i rekultivatsiy zemel,* 122–139. (In Russian).

Tarasov, V.V. (1991). Dopolnenye k adventivnoy flore Dnepropetrovskoy oblasty. In: Kadastrovye issledjvaniya stepnyh biogeotsenozov Prysamarya Dneprovskogo, ih antropogennaya dinamika i ohrana. *Dnepropetrovsk: Izd-vo DGU*, 216 pp. (In Russian).

Tarasov, V.V. (2005). Flora Dnipropetrovskoy ta Zaporizkoy oblastey. Sudynni roslyny. Biologo-ekolkgichna harakterystyka vydiv (Monografiya). *Dnipropetrovsk: Vyd-vo DNU*, 276 pp. (In Ukrainian).

Tarasov, V.V. (2012). Flora Dnipropetrovskoy ta Zaporizkoy oblastey. *Dnipropetrovsk: Vyd-vo DNU ta Lira*, 296 pp. (In Ukrainian).

Tsvetkova, N.M., Pakhomov, O.Y., Serdyuk, S.M., Yakyba, M.S. (2016). Biologichne riznomanittja Ukrajiny. Dnipropetrovs'ka oblast'. Grunty. Metaly u gruntah [Biological diversity of Ukraine. The Dnipropetrovsk region. Soils. Metalls in the soils]. Lira, Dnipropetrovsk (in Ukrainian).

Walther, G.-R., Roques, A., Hulme, P. E., Sykes, M. T., Pyšˇek, P., Kuhn, I., Zobel, M. (2009). Alien species in a warmer world: risks and opportunities. *Trends in Ecology & Evolution.* 24(12): 686–693.