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Anthropogenic transformation of the flora of urbanoecosystems of the Northern Pryazov territories

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The paper provides a thorough analysis of the current situation about biodiversity of model city in the Northern Pryazov territories – Henichesk (Kherson region). The urban flora species composition of this city is represented at first time. There are 507 species, which belongs to two divisions, 61 families and 233 genera. Urban flora was analyzed in systematical, biomorphological and environmental aspects. The species richness of families of the studied urban flora is characterized by a predominance of families which include 1–2 species. The most part of urban flora species are herbaceous plants – 80.1% (406 species), including herbaceous monocarpics – 236 species and herbaceous polycarpics – 170. It was found that terophytes have prevalence – 36.1% by the types of biological species in the urban flora of Henichesk, the second place takes hemicryptophytes – 31.9%. Other biological types are represented in a small quantity – 32%. An important characteristic of flora is species distribution for the main types of vegetation (rythmologic groups). The dominated status in the researched urban flora set the summer green plants – 430 species (84.8%). Analyzing the position of the aerial shoot for the leaves position we have differed rosette, semirosette and rosetteless plants. Species with rosetteless shoot are dominating. Rhizomeless species in the flora of Henichesk are dominating (51.1%) and species with caudex (23.6%), indicating the dominance of xerophytic habitats and increased soil density in cities. The largest environmental group is a group of moderate moisture, which consists of 349 species (68.8% of the total species number). There is predominance of heliophilous and shade-tolerant species, and mezotrophs. Adventive component of Henichesk flora has 217 species (159 genera and 52 families). The most part among them kenophytes, xenophytes, epecophytes. It was found that Henichesk have specific urban flora that combines elements of natural flora and typical urban components.

Keywords: urban flora; Northern Pryazov territories; biodiversity; adventive fraction

Introduction

The researches of vascular plant flora of the Northern Pryazov territories received much attention by scientists and mainly concerns natural ecosystems (Dudina and Sheliag-Sosonko, 1995; Kolomyichuk, 2012). The consequence of increasing urbanization in modern world is in the field of knowledge of various sciences. The most important aspect of this problem is to monitor the biodiversity of urban areas as the main condition of sustainable development (Bezushko et al., 2009; Shekhovtseva and Mal'tseva, 2015).

There not so much researches about urban flora of the Northern Pryazov'ye. Urban flora of Henichesk (one of the Northern Pryazov'ye cities with an interesting history of economic development) has a particular interest. Modern flora of vascular and nonvascular plants in this region develops in the conditions of active commercial activity (Burda, 1997; Sudnik-Wójcikowska and Moysiyanenko, 2008, 2011; Scherbina et al., 2014; Derevyanska and Glukhov, 2016; Maltsev et al., 2017). Anthropogenic transformation leads to changes in vegetation, natural plant communities transform into floral synanthropic (Burda, 1991; Sal'nikov and Pilipenko, 2005; Kuhn and Klotz, 2006; Muratet et al., 2007; Knapp et al., 2010; Fagot et al., 2011; Williams et al., 2015). As a result, there are changes of qualitative and quantitative character in native and adventive fractions in flora. For example, the last one is enriched by the new naturalization of extraneous and some cultivated species (Sukopp, 2002; Celesti-Gradow et al., 2006; Protopopova et al., 2006; La Sorte et al., 2007; Loeb, 2012; Gunnarsson et al., 2017). In this regard, the importance of identifying the new adventive species and their further

monitoring in this area increases (Nazarov et al., 2001; Protopopova et al., 2006; Trentanovi et al., 2013; Protopopova and Shevera, 2014; Ćwikliński, 2017). Recently flora replenished by non-aboriginal plants through their conscious (cultivation) and spontaneous (with seeds of other plants, by vehicles, etc.) migration (Pyšek, 1993, 1998; Kowarik, 1994; Jenkins and Parker, 2000; Ricotta et al., 2009; Lososova et al., 2011; 2012).

Materials and methods

Material for this study was collected in the original fieldwork and represented in herbarium during the spring and autumn period in 2013–2015. In addition, the available fragmentary literature data are included (Dudina and Sheliag-Sosonko, 1995; Burda, 1997; Kolomyichuk, 2012; Shumilova and Fedoronchuk, 2013; Protopopova and Shevera, 2014; Maltseva and Solonenko, 2015; Maltseva, 2015, 2016; Derevyanska and Glukhov, 2016; Maltseva and Maltsev, 2017) and herbarium data obtained from Bogdan Khmelnytskyi Melitopol State Pedagogical University (MELIT). The names of species are represented by “Vascular plants of Ukraine. A nomenclatural checklist” (Mosyakin and Fedoronchuk, 1999). Analysis of species diversity of flora was made by the conventional morphological, ecological and geographic methods and with a method of comparative floristic. To analyze the biomorphological structure of urban flora of Henichesk we have chosen biomorphological features that are practically independent from the influence of environmental factors (Raunkiaer, 1936; Didukh, 2004; Ricotta et al., 2009). Analyzing the adventive fraction, the independent

attributes were used: the time and method of migration, the degree of naturalization (the level of adaptation to new geographical conditions) (Schroeder, 1969; Sudnik-Wójcikowska, 1988; Ricotta et al., 2010).

Results

Henichesk (46°10' N, 34°47' E) – is a central city of Henichesk district, Kherson region in the southern part of Ukraine. The first mention of Henichesk belongs to 1784, when a small settlement Ust-Azov appeared on the banks of the Azov Sea and Sivash (later – Henichesk) (Maltseva, 2015). The city area is 60 383 km², population – 21,633.

The species composition of urban flora of Henichesk includes 507 species of trees, shrubs and herbaceous plants that belong to 233 genera and 61 families (Table 1). Basis of flora consists of angiosperms – 98.4% of total species quantity. Class Liliopsida is represented by 12.4% of total families' quantity, 19.3% – genera and 13.6% – species, Magnoliopsida – 80.3%, 78.6%, and 84.8% respectively.

Table 1
Quantitative composition of flora by department and class

Phyla and classes	Quantity of species		Quantity of genera		Quantity of families	
	abs.	%	abs.	%	abs.	%
Pinophyta	8	1.6	5	2.1	2	3.3
Magnoliophyta	499	98.4	228	97.9	59	96.7
Magnoliopsida	430	84.8	183	78.6	49	80.3
Liliopsida	69	13.6	45	19.3	10	16.4
Total	507	100.0	233	100.0	61	100.0

The predominance of angiosperms in the flora, and among them the species of the dicotyledon class as a whole, is because they are more resistant to the stress factors that exist in the urban environment (Burda, 1991; Kuhn and Klotz, 2006; Knapp et al., 2010; Lososova et al., 2012; Dobbs et al., 2017).

The leading families in the studied urban flora are Asteraceae (66 species, 13%), Poaceae (50; 9.8%), Brassicaceae (44; 8.6%), Rosaceae (28; 5.5%), Fabaceae (25; 4.9%), Boraginaceae (22; 4.3%), Caryophyllaceae (22; 4.3%), Lamiaceae (13; 2.5%), Scrophulariaceae and Apiaceae (11 each of them; 2.1%) (Table 2). In the flora of Henichesk, two first places belong to the families Asteraceae, Poaceae, which is typical for holarctic floras in general and for many regions and cities (Malyshev, 1972; Pyšek, 1993; Luck and Smallbone, 2011; Maltseva and Solonenko, 2015). Ten leading families consist of 57.1% of specific and 56.0% of generic diversity of flora.

Table 2
Family spectrum of the flora of Henichesk

Family	Species quantity		Rank
	abs.	%	
Asteraceae	66	13.0	1
Poaceae	50	9.8	2
Brassicaceae	44	8.6	3
Rosaceae	28	5.5	4
Fabaceae	25	4.9	5
Boraginaceae	22	4.3	6–7
Caryophyllaceae	22	4.3	6–7
Lamiaceae	13	2.5	8
Scrophulariaceae	11	2.1	9–10
Salicaceae	11	2.1	9–10
Total	292	57.1	–

Quite high status has family Brassicaceae and it is typical for Mediterranean and Iranian-Turanian areas, and typical for the urban environment среды (Malyshev, 1972; Burda, 1991, 1997; Protopenova and Shevera, 2014; Maltseva and Solonenko, 2015). It is connected with the synanthropization of the flora, as well as with the biological characteristics of the species of this family (greater seed productivity). In the Mediterranean flora, this family takes from the 5th to 7th rank, and in Boreal from the 5th to 6th. In the natural

flora of Northern Pryazov'ye and in the coastal zone of the Azov Sea this family takes 8th and 4th ranks respectively in the spectrum of leading families. In a city where occurs xerophytization of growth conditions, the role of xerophytic families Rosaceae (4th rank) and Fabaceae (5th rank) increases, they easily find free ecological niches for themselves, competing with native species. The increase in the role of the Rosaceae family is also associated with the peculiarities of plant introduction in the city and its environs because the greatest number of introducents belongs to this family.

Ten leading families of local component flora of Henichesk comprise together 105 species (58.5% of the native species of urban flora). There are 85 genera concentrated in the top ten families (55.4% of all the native component families). Small number of species represents most of the native faction families in the urban flora: each of the nine families includes only two species (16.3% of the local component families in urban flora). Each of 22 families includes only one specie (40.2%), for example, Euphorbiaceae, Aceraceae, Paeoniaceae, Typhaceae.

The species richness of families of the studied urban flora is characterized by presence of large number of families, which include 1–2 species (amounting to 32 families or 52.4% of total urban flora families).

The most number of representatives was noticed for genera *Euphorbia* (eight species, 1.6% of the total number of species), *Chenopodium* (7 species; 1.3%), *Artemisia* (6 species, 1.1%), *Atriplex* (5 species, 1.0%). Twelve leading genera include 11.2% of total species number. The generic spectrum of the urban flora is closely resembles to the spectrum of the natural steppe flora of the Northern Azov Sea (Kolomiychuk, 2012).

The most part of urban flora species are herbaceous plants – 80.1% (406 species), including herbaceous monocarpics – 236 species and herbaceous polycarpics – 170 (Table 3). The percentage of trees and shrubs do not exceed 18.1% (92 species). The percentage of woody plants in total does not exceed 18.1% (92 species). It is worth noting that some species, under certain conditions, can change the life form (tree or shrub), for example, *Elaeagnus angustifolia* L., *E. argentea* Pursh, *Sorbus aucuparia* L., *Cerasus mahaleb* (L.) Mill. (Maltseva, 2016). The shrubs are used in city gardening as hedges, in the group plantings, as well as along roadways (Maltseva, 2016).

Table 3
Biomorphological spectrum of the Henichesk flora

Living form	Species quantity	
	abs.	%
Trees	44	8.7
Shrubs	33	6.5
Low shrub	3	0.6
Tree or shrub	10	1.9
Ligneous	2	0.4
Total	92	18.1
Semi-shrub	7	1.4
Low semi-shrub	2	0.4
Total	9	1.8
Herbal monocarpics	236	46.6
Herbal polycarpics	170	33.5
Total	406	80.1
Altogether	507	100.0

Participation of bushes and semi-bushes does not exceed 2%. It shows that studied flora have a plain landscape features. According to other researchers of urban flora (Sal'nikov and Pilipenko, 2005; Knapp et al., 2010; Rysiak and Czarnicka, 2017) bushes and semi-bushes are among the least stable groups against the effects of urbanization. Predominance of monocarpics is caused by the invasion of adventive plants – there are 179 species of adventive monocarpics (54.7% of the total) in the studied urban flora. There are 146 annual plant species (44.6%). Many annuals are cultivars – *Anethum graveolens* L., *Antirrhinum majus* L., *Calendula officinalis* L., *Cosmos bipinnatus* Cav., *Petunia atkinsiana* (Sweet) D. Don ex Loudon. Another part of annuals – ruderal species which have become a common plants and firmly hold its position in the ecotopes because of the high

seed productivity and prolonged area capturing (*Aegilops cylindrica* Host, *Ambrosia artemisiifolia* L., *Chenopodium polyspermum* L., *Setaria viridis* (L.) P. Beauv., *Urtica urens* L.).

As a result of analysis of biological species types of urbanoflora of Henichesk it was found that that almost the same number have terophytes 36.1% (183 species) and hemicryptophytes – 31.9% (162 species) (e. g., *Lactuca serriola* L., *Geum urbanum* L., *Carduus acanthoides* L., *Chelidonium majus* L., *Chondrilla latifolia* M. Bieb., *Senecio jacobaea* L., etc.) (Fig. 1). Significant part of terosphyt (*Aegilops cylindrica*, *Alyssum desertorum* (Stapf) Botsch., *Artemisia annua* L., *Cardamine parviflora* L., *Digitaria sanguinalis* (L.) Scop.) is a feature of xeric conditions of Ancient Mediterranean areas (Moysiyenko, 1999). Other biological types are represented in a small amount and their total percentage is 32%.

The next position is occupied by the phanerophytes – 82 species, 16.2%. There is a significant number of wildered introduct species among the woody plants (for example *Acer negundo* L., *Ailanthus altissima* (Mill.) Swingle, *Catalpa bignonioides* Walter, *Cerasus vulgaris* Mill., *Lonicera tatarica* L., *Prunus stepposa* Kotov, *Robinia viscosa* Vent.).

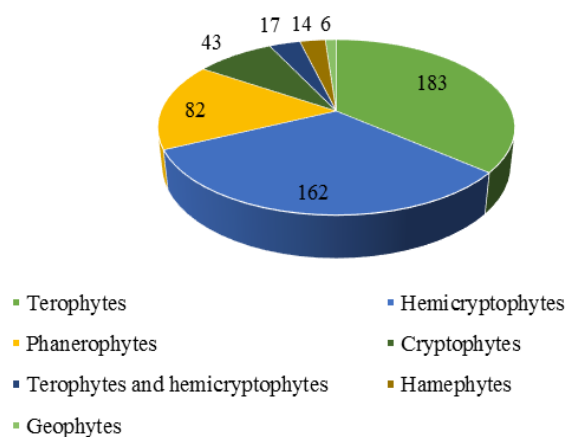


Fig. 1. Spectrum of biological types of plants of the Henichesk flora (by K. Raunkier)

High terophytes diversity and reducing the role of hamephytes and cryptophytes – is a characteristic feature of the whole urban flora (Burda, 1991; Lososova et al., 2011). Increasing the part of terophytes in flora of urban areas indicates a weak level of plant community's formation. It caused by their high naturalization ability (by the intensive seed reproduction, the presence of open disturbed habitats suitable for their growth, weakening competition from perennials).

An important characteristic of flora is species distribution for the main types of vegetation (rythmologic groups) (Table 4). The dominated status in the researched urban flora set the summer green plants – 430 species (84.8%). Analyzing the position of the aerial stems for the leaves position, we have differed rosette, semirosette and rosetteless plants (Table 4). Species with rosetteless shoot are dominating – 346 species (68.2%); the second place takes semirosette plants – 134 (26.4%) in urban flora of Henichesk. Species with rosette shoots were not much characteristic for the investigated urban flora (5.4% of total number of species). Rhizomeless species in the flora of Henichesk are dominating (51.1%) and species with caudex (23.6%), indicating the dominance of xerophytic habitats and increased soil density in cities. Such quite large percentage of rhizomeless type of structures is mainly represented mainly by annual herbaceous monocarpics. It can be explained by the complex edaphic nature of ecotope (high or low substrate density, chemical pollution and low soil aeration), formed in cities. Structure of underground shoots closely correlates with plant root types. Thus, there is a significant part of species with a taproot system – 349 (68.9%) in the surveyed urban flora. This type of root system in all urban flora fractions was investigated.

To understand the specific features of the influence of the urban environment on the flora, it is necessary to establish the ecological groups of plants it constitutes. We have conducted an ecological analysis of the

urbanoflora of the Northern Pryazov territories based on three environmental factors: humidity, lighting and soil fertility (Fig. 2, 3, 4).

Table 4

The main types of vegetation (rythmologic groups) of Henichesk urbanoflora

Living form	Species quantity	
	abs.	%
Main types of vegetation		
Evergreen plants	11	2.2
Winter green plants	16	3.1
Summer green plants	430	84.8
Summer-winter	20	3.9
Ephemeral plants	16	3.2
Ephemeroïds	14	2.8
Type of aerial stems		
Rosette	27	5.4
Semirosette	134	26.4
Resetteless	346	68.2
Type of underground stems		
Rhizomeless	259	51.1
Deep-rooting	45	8.9
Shallow-rooting	67	13.2
With caudex	120	23.6
Caudex-shallow-rooting	4	0.8
Alliaceous	8	1.6
Tuber	4	0.8
Root system type		
Taproot	349	68.9
Fibrous	118	23.2
Taproot-fibrous	39	7.7
Without roots or rhizomes	1	0.2
Total	507	100.0

The largest environmental group is a group of moderate moisture, which consists of 349 species (68.8% of the total species number). The group includes xeromezophytes (197 species, 38.5%) mezophytes (139; 27.4%) and hygromezophytes (13; 2.6%). Second place takes a group of drought-tolerant species, which includes xerophytes (67; 13.2%) and mezoxerophytes (77; 15.2%). There are 144 species (28.4%) in this group. Such high rates of xerophytes are caused by the influence of anthropogenic pressure and confinement of the studied area to the Steppe zone of Ukraine.

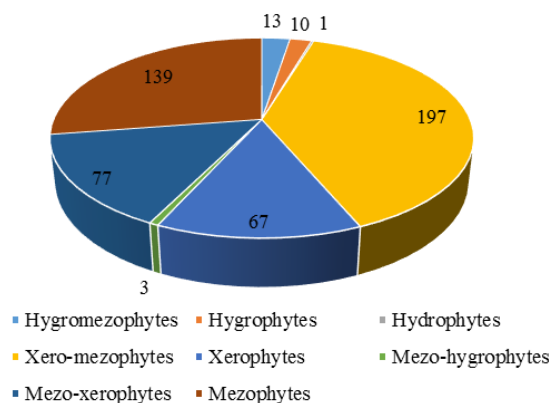


Fig. 2. Distribution of flora species of Henichesk in relation to humidity

One of the most important environmental factors in the plants' life is light. There is predominance of heliophilous and shade-tolerant species (73.0% of the urban flora species) that can be associated with the presence in a large number of well-lit areas. Shade-requiring and light-tolerant species mainly grow in less disturbed habitats (green areas, parks, gardens) – 27.0% of species.

Among the species of investigated urbanoflora, with respect to the fertility of the soil, prevail the plants that grow on soils with an average nutrient content-mezotrophs (41.2% or 209 species) (*Amaranthus retroflexus* L., *Narcissus poeticus* L., *Triticum aestivum* L., *Torilis arvensis* (Huds.) Link, etc.). The prevalence of mesotrophs in

the ecological spectrum is often noted by various authors in different regions of Ukraine, and in many fractions of the flora.

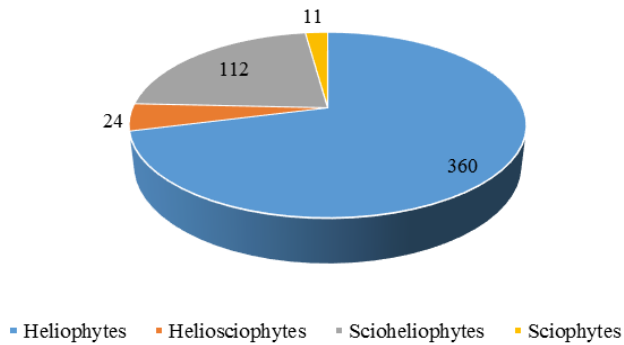


Fig. 3. Distribution of flora species of Henichesk in relation to lighting conditions

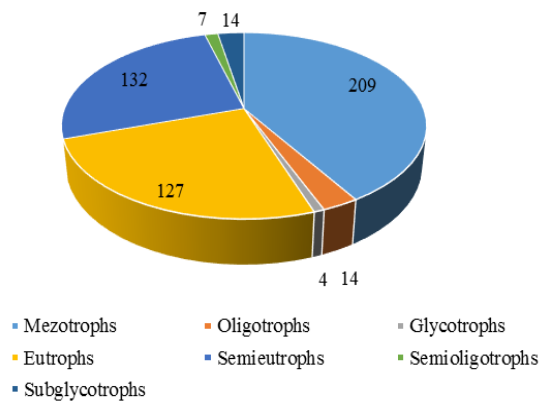


Fig. 4. Distribution of flora species of the Henichesk in relation to the soil fertility factor

We consider the synanthropization as an increase in the share of synanthropic species in flora participation. To synanthropic plants we attribute anthropophytes in the composition of which we distinguish the adventitive and aboriginal parts (Table 5).

Table 5
Composition of anthropophytic element of the Henichesk flora

Groups and subgroups	Species quantity	
	abs.	%
Anthropophytes	366	72.2
Apophytes	155	30.6
Advent	211	41.6
Including the time of migration		
Archaeophytes	80	15.8
Kenofits	131	25.8
Including the way of migration		
Xenophytes	96	18.9
Ergasiofity	87	17.2
Acolytophytes	28	5.5
Including the degree of naturalization		
Epecophytes	121	23.9
Agriophytes	23	4.5
Ergasiophytes	51	10.1
Ephemerophytes	16	3.1
Total:	211	41.6

Adventive component of Henichesk flora has 211 species (159 genera and 52 families). By the time of migration, kenophytes predominate – 131 species, which is typical for the flora of the Northern Azov Sea and the flora of Ukraine (Protopopova et al., 2006).

The most part among the adventitious species of the investigated urbanoflora are xenophytes (randomly introduced species that are spread because of anthropogenic transformation) 18.9%, or 96 species, such as *Anisantha tectorum* (L.) Nevski, *Cardaria draba* (L.) Desv., *Reseda lutea* L., etc. Plants that become wild near the places of

human cultivation – ergasiophytes – occupy the second place in the total number of species (87 species, or 17.2%). The most common among them are *Acer negundo*, *Amorpha fruticosa* L., *Calendula officinalis* etc. The advent element of Henichesk has 28 species of acolytophytes, or 5.5%, this group is most interesting for establishing specific ways of invasion of adventitious plants. After all, they are brought in not too long ago, they grow locally near the place of their migration, and therefore it is possible to accurately determine the centers of invasion of these species.

Analysis of adventive species of Henichesk shows that the main ways of migration is a transport network, urban planting of greenery, adjacent agricultural landscapes. The dominance of the ancient mediterranean origin (Mediterranean, Mediterranean-Iran-Turanian and Iranian-Turanian) is noticed, constituting 56.6% of the total number of adventive species in the studied flora.

Discussion

A sufficient number of studies have been devoted to the investigation of anthropogenic changes of the vegetation cover (Pyšek, 1998; Lososova et al., 2011). Also intensively studying the change of systematic diversity in urbanization (Sudnik-Wójcikowska, 1988; Burda, 1991). The urban environment is a new transformed natural environment, which is characterized by a number of characteristics that determine this habitat for plants (Dobbs et al., 2017; Gunnarsson et al., 2017). An adequate amount of work has been devoted to the anthropogenic changes in the vegetation cover (Pyšek, 1998; Lososova et al., 2011). Including intensively studying the change in systematic diversity in urbanization (Sudnik-Wójcikowska, 1988; Burda, 1991). The urban environment is a new transformed natural environment, which is characterized by a number of environmental characteristics that determine the habitat conditions for plants (Dobbs et al., 2017; Gunnarsson et al., 2017).

Analyzing the systematic structure of model city Henichesk (Northern Pryazov territories), it was noted that the basis of flora constitute Magnoliophyta, representatives of Magnoliopsida are dominating among them. A significant decrease of monocots is specific for urban floras (Sudnik-Wójcikowska, 1988; Burda, 1991; Celesti-Grapow et al., 2006; Knapp et al., 2010). Our results are consistent with the data (Luck and Smallbone, 2011; Trentanovi et al., 2013) that the higher spore-bearing plants do not tolerate even a slight degree of anthropogenic influence and the lack of these plant groups is specific for the studied urban flora. Range of leading families of Henichesk flora is consistent with the spectrum of the majority of European urban floras (Kowarik, 1994; Lososova et al., 2011; Knapp et al., 2017), but with a few permutations. Therefore, the leading position of Asteraceae and Poaceae is specific for the spectrum of Holarctic flora and regional natural flora (Malyshev, 1972; Kolomiychuk, 2012). Nevertheless, the increase in rank of synanthropic thermophilic families Brassicaceae, Rosaceae, Fabaceae, Boraginaceae reflects the extreme conditions of the urban environment. Thus, the flora of Henichesk as a model city of the Northern Pryazov territories, undergoing a significant transformation, retains its zonal features in a systematic structure. Urbanoflora become more appropriate to more southerly and developing flora of extreme conditions by the presence of adventive fraction. This fact is consistent with other studies (Jenkins and Parker, 2000; Bezushko et al., 2009; Lososova et al., 2012).

Our results differ from the studies of regional natural flora and in the urban floras of the temperate zone (Burda, 1991, 1997; Sudnik-Wójcikowska and Moysiyyenko, 2011; Kolomiychuk, 2012; Rysiak and Czarnicka, 2017). There is a prevalence of herbaceous monocarpic plants in Henichesk, whereas the prevalence of herbaceous polycarpic plants is specific for the above-mentioned flora. Increase of the herbaceous monocarpic proportion, especially annuals, in the flora of the studied city is due to the adventitious species and tells about the acquisition of specific features, because of anthropogenic transformation. Strengthening position of young herbaceous plants expresses instability and vulnerability of urban flora according to Burda (1991), which conducted the study of the southeast of Ukraine.

The flora of Henichesk recorded a prevailing of terophytes (Fig. 1). According to Knapp et al. (2010), they are more widely represented in highly urbanized floras. According to Sudnik-Wójcikowska (1988), in Central Europe a high percentage of terophytes indicates a high anthropogenic effect, which is quite high in Henichesk (a resort city that has a developed network of roads, railways and sea routes). A decrease in the contribution of cryptophytes along the gradient of recreational transformation was also established (Williams et al., 2005). However, it should also be noted the increase of the phanerophytes' role (trees and shrubs) in the flora of Henichesk, due to the wildness of the introducers (Muratet et al., 2007). The data obtained are consistent with the most part of the city flora researchers (Kowarik, 1994; Pyšek, 1998, Kuhn and Klotz, 2006, Aronson et al., 2007; Ricotta et al., 2010; Maltseva and Solonenko, 2015) and anthropogenically disturbed floras (Bezushko et al., 2009).

Wittig and Becker (2010) showed in their studies that cities represent a special habitat complex where prevailing only certain plant species. The main adaptations for living in the city conditions are: the high lighting level, specific temperature (higher than in the vicinity of city), absence of confinement to wet soils, indifference to the reaction of the soil (or preferring pH not less than 6, with some exceptions), adaptation to eutrophication. As for the plant species noted in Henichesk, all these statements are confirmed (Table 4, Fig. 2, 3, 4).

The main trends in the anthropogenic transformation of flora are the impoverishment of the local flora and the emergence of adventitious plant species, accidentally introduced because of human economic activity and because of the introduced species wildering (Schroeder, 1969; Burda, 1991; Ricotta et al., 2009). Species of native flora have a variety of ecological amplitude ranges, show different ability to adapt to urban conditions life and it reflects in their activity (Sudnik-Wójcikowska, 1988). Williams et al. (2010, 2015) suggests a focusing on measuring of the specific response of morphological and functional plant's features under the stress conditions that accompany urbanization. Data processing, analysis of these results will facilitate a meta-analysis and will allow the comparison of the generalized results. In this case, the study of simple data types in many cities (for example, lists of urban flora) will continue to be useful, but targeted studies and experimental measurement of the relevant features are necessary to confirm the cause-effect processes that structure urban floras. It is revealed that today low-active stenotope species associated with a narrow range of ecological conditions become more rare in the cities, as well as ordinary steppe, littoral species become rare too (Gungor et al., 2008). During our research of the urban flora of Henichesk, it was not possible to note the a lot of rare and protected species that were included to the Abstract of the Pryazov region flora (Kolomyichuk, 2012). Conversely, many steppe species are widely distributed. A group of local apophyte species, which migrate to the synanthropic sites has been identified. This group of plants makes up to 30.6% of the total number of species in urbanoflora of Henichesk and it brings the data closer to the results of other researchers (Kuhn and Klotz, 2006).

The other side of anthropogenic transformation is the emergence of adventive species. The increase of number and diversity of anthropogenic disturbed natural ecotopes and the emergence of new niches promotes the introduction of alien species into synanthropic and disturbed natural sites (Kowarik, 1994; Protopopova and Shevera, 2014). It was shown by studies that adventive plants quickly become dominant species that contribute not only the disturbance of the structure of vegetation cover but also to the biodiversity reduction in general (Schroeder, 1969, Pyšek, 1993; Kowarik, 2008; Grapow et al., 2006; Ricotta, 2010). Analysis of the adventive species of Henichesk showed that the main ways of their entry are the road transport network, urban landscaping, and adjoining agricultural landscapes. Transport and trade activities increase the possibility of new species immigration according to the researches (Fagot et al., 2011; Sukopp, 2002).

Accidentally introduced plants are prevailing by way of migration. This fact indicates the intensity of flora formation processes and their non-directional character. Similar processes are typical for other

cities (Celesti-Grapow et al., 2006; Ricotta et al., 2010; Lososova et al., 2011). Prevalence of the representatives with ancient Mediterranean origin among the adventive plant species confirms the influence of urbanization on the flora aridization process (Burda, 1991; Pyšek, 1998; Loeb, 2012). There is a prevalence of naturalized species (epicophytes) in the adventive component of the flora of Henichesk. These species are fixed in the flora and spreading over the disturbed habitats. Today in Ukraine, we can notice facilitation of naturalization for some ergasophyte species and the growth suppression of some local flora species. These processes are caused by climatic changes, amplification of the mesophytic conditions of ecotopes in the Steppe zone. (Protopopova and Shevera, 2014).

Conclusions

Systematic, ecological, biological structures of urban flora of Henichesk were analyzed. It was established that species composition of urban flora of this city consists of 507 species that belong to two divisions, 61 families and 233 genera. Zonal features of urban flora of Henichesk were found because of systematic structure studies. Such features are expressed in the composition range of leading families and genera, major proportions and ratios.

The analysis of species distribution in the groups of biomorphological spectrum showed that flora of the city should be assessed as "terophytic-hemicryptophytic". Leading position of terophytes is explained by the strong transformation of vegetation in urban area. Thus, the morphological characteristics of urban flora of Henichesk are specific because the plant species should adapt to the urban environment where the limiting factor is soil compaction, transport zones factors, entire buildings conditions. The environmental structure of flora reflects the species proportion in the groups to the influence of abiotic factors dependence. The main routes of adventive species migration are transport network, urban planting of greenery, adjacent agricultural landscapes.

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