The features of urban habitats under conditions of the steppe zone of Ukraine and Russia

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Abstract. The paper is devoted to the research of urban flora formation under conditions of the steppe zone on the example of Ukrainian and Russian cities. A detailed description is given of the structure of flora of urban habitats of the Donetsk-Makiyivka Industrial Agglomeration. We have determined four groups and eight types of habitats under conditions of the Agglomeration. Cultivated green areas, seminatural steppe and residential areas are reported as having the greatest number of species. This fact may be accounted for by a great number of cultivated plants, escaping into the wild and ruderal species.

Key words: flora structure, urban flora, urban habitat

Introduction

One of the contemporary problems of botany is investigation of phytodiversity in urbanized territories because of the increasing urbanization rates and the fact that more than half of the world's population lives in cities (Pickett & Cadenasso 2008). Urban land cover is predicted to increase by 1.2 million km² globally by 2030 (Seto & al. 2012). In urban areas the impact by humans is more pronounced than in less densely populated areas. Human activities like building, industry, organization of the road transport system, gardening and landscaping, as well as recreational activities make urban areas subject to frequent disturbance (Rebele 1994).

However, there is still a glimmer of hope for preserving urban biodiversity because of the growing awareness that the health of the planet's biological diversity is essential for determination of human destiny (Uslu & Shakouri 2013).

Studies of the flora of urban habitats have a theoretical and applied character. First, they allow us to determine the main ways and sources of vegetation cover formation in urban territories, to reveal features of this process under the conditions of high anthropogenic pressure, and to predict and model a future composition of the transformed flora. This is particularly important since modern society is concerned with the problems of world biodiversity conservation. Second, the results of these studies form the basis for development of scientifically grounded recommendations for phyto-optimization of urban ecosystems.

Formation of urban flora in the steppe zone has its zonal features. Urban territory becomes increasingly xerophytic and the number of drought-resistant alien species increases. Along with this, some rare steppe species form refugia within cities, which serve as sources for natural phytodiversity preservation. In this respect, this investigation aims at determining the features of urban habitats under conditions of the steppe zone by a case study of the industrial Donetsk-Makiyivka Agglomeration.

Material and methods

In this paper, we have compared the quantitative characteristics of taxonomic structure of the flora and the origin of species in such steppe-zone cities as Mykolayiv (Melnik 2001), Kirovograd (Arkushina 2007), Kherson (Moysiyenko 1999) (Ukraine), Belgorod (Agafonova 2010), Saratov (Dimitriev & Maslennikov 2013), and Barnaul (Revyakyna & Kozyreva 2008) (the Russian Federation). We have considered in detail the floristic features of the Donetsk-Makiyivka Industrial Agglomeration (Ukraine), which reflects with particular clarity the characteristic features of the steppe urban flora and whose territory is most affected by the anthropogenic impact of all above-mentioned cities.

The Agglomeration of Donetsk-Makiyivka is a centre of the most economically developed region of the Ukraine. It is situated in the southeastern part of the country (Fig. 1), in the central part of the Donetsk Coal Basin. Its territory is a hilly plain in the southwestern part of the Donetsk Ridge. In the past, there were found petrophytic variants of herb-fescue-feather grass steppe; forest vegetation was represented mostly by ravine forests.

By urban flora we mean a complex of populations of all plant species, which have spontaneously settled within the Agglomeration perimeter (Burda 1991).

The study of urban flora of the Donetsk-Makiyivka Agglomeration was carried out within its perimeter during 2008-2014 time period, by standard methods of flora observation. In the course of our study, we have taken into account materials from the Herbaria of the M. G. Kholodny Institute of Botany of the NAS of the Ukraine (KW), of the Donetsk Botanic Garden of the NAS of the Ukraine (DNZ), and of the Department of Ecology (Donetsk National University).

Fig. 1. A map of location of the Donetsk-Makiyivka Agglomeration within the area of the Ukraine and Donetsk region.

We have analyzed the distribution of the Agglomeration flora species by ecological groups on the basis of ecomorph classification by O.L. Bel'gard (1980).

In this work, following some earlier publications (Clements & Shelford 1939; Udvardy 1959; El-Ghani & al. 2011; Stešević & al. 2014 etc.), we use the term "habitat". A classification of urban habitats of the Donetsk–Makiyivka Industrial Agglomeration was made according to Schulte & al. (1993); Cvejić & al. (2007) and Stešević & al. (2014), with modifications corresponding to the conditions of our study.

A comparison of the floristic composition of Agglomeration habitats was made using the Stugren-Radulescu Coefficient of Floristic Discrimination (Shmidt 1984).

Results and discussion

The flora of urban territories is distinguished by higher species diversity because, apart from the native species, it includes also some alien ones. However, intensification of the anthropogenic influence and formation of technogenic ecotopes has led to a sharp decrease in the number of native species (Table 1).

The area of the Donetsk-Makiyivka Industrial Agglomeration is much larger, as compared to the areas of other cities of the steppe zone, however, its flora is much poorer in terms of species numbers. This can be explained by the fact that the Agglomeration comprises about 125 spoil heaps, 17 coal mines, 196 large working enterprises, and 200 to 300 illegal dumps. The territories of mine sites and heaps are very specific habitats and few species can adapt to life under such extreme conditions.

We used the species-number-to-area ratio of logarithmic values to illustrate the above-stated facts. Figure 2 shows that this ratio is the lowest for the Donetsk-Makiyivka Industrial Agglomeration.

The flora of compared areas is quite similar by the ranges of leading families (the first ten families according to the number of species). First places are held by families *Asteraceae* and *Poaceae* (Fig. 3).

The forward position of the *Brassicaceae* family in within the ranges and the presence of the *Chenopodiaceae* family both point out to a significant anthropogenic transformation of the urban flora (in com-

Table 1. Quantitative characteristics of systematic structure and origin of the species of urban flora of the steppe zone.

City	City area, sq.km	The number in flora, pc			Origin of species, % of the total number of species	
		families	genera	species	native species	alien species
Mykolayiv	253	100	441	909	74.1	25.9
Kirovograd	105	98	450	951	79.7	20.3
Kherson	97.5	105	442	964	71.6	28.4
Donetsk-Makiyivka	996.7	101	442	897	71.8	28.2
Belgorod	153.1	90	364	681	72.1	27.9
Saratov	394	108	488	1020	75.6	24.4
Barnaul	322	110	431	992	–	–

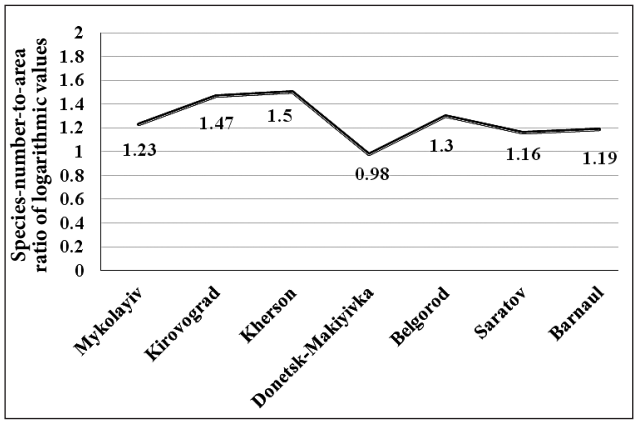

Fig. 2. Species-number-to-area ratio of logarithmic values for cities of the steppe zone.

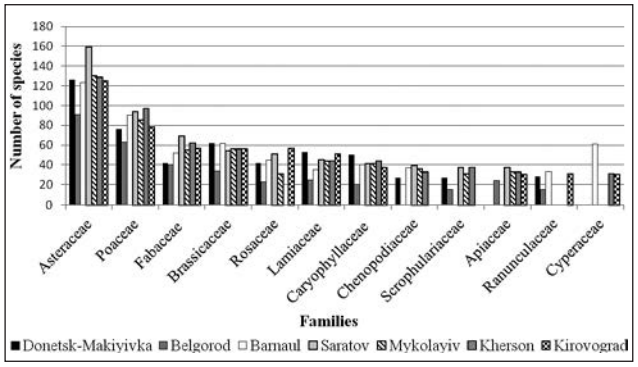

Fig. 3. Comparison of urban flora of the steppe zone cities by leading families ranges.

parison to regional flora), and to a process of gradual xerophytization. This agrees with the pattern of development of the European urban flora, where the role of such families as *Cyperaceae* and *Scrophulariaceae* is decreasing as compared to regional flora, and the part of *Chenopodiaceae* and *Fabaceae* families is increasing (Berezutsky & Panin 2007).

An important part of the urban flora study is definition of the types of city habitats. In this study, we describe the urban habitats of the steppe zone on the example of the Donetsk-Makiyivka Agglomeration. According to our research, they can be divided into four main groups, the first and the fourth group being further subdivided into types:

Main group of habitats I: urbanized area
Type of habitat 1. Residential zone
Type of habitat 2. Transportation network
Type of habitat 3. Cultivated green areas

Main group of habitats II: agricultural lands surface

Main group of habitats III: technogenic area

Main group of habitats IV: area of seminatural habitats
Type of habitat 1. Steppe
Type of habitat 2. Meadows
Type of habitat 3. Forests
Type of habitat 4. Waterside
Type of habitat 5. Water surface

Figure 4 shows the quantitative characteristics of a systematic structure of urban flora habitats of the Donetsk-Makiyivka Agglomeration. According to the number of species, dominants are: the flora of green areas of the urbanized territory (405), seminatural steppe zones (36) and residential zones (347). This can be explained by the presence of a significant number of introduced species that have escaped into the wild (for green area) and ruderal species (for residential zone), as well as by the remains of a rich regional steppe flora.

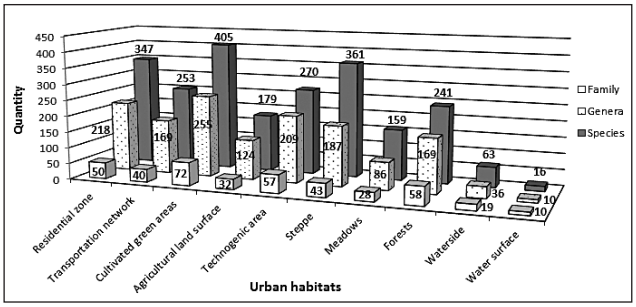

Fig. 4. Quantitative features of urban flora habitats of the Donetsk-Makiyivka agglomeration.

Below, we present a short description of the flora of habitats in the Donetsk-Makiyivka Agglomeration by the ranges of leading families, life forms, ecomorphs, and species origin.

Urbanized area

Residential zone

It is represented by 347 species (38.7 % of the total number of species of the urban flora under study). The overall majority of species from this zone are typically ruderal. Species, confined to other communities (e.g. *Alyssum alyssoides* (L.) L., *Inula salicina* L., *Leucanthemum vulgare* Lam., *Ranunculus ficaria* L., *Thalictrum minus* L., etc.) are either remnants of past natural phytocenoses, or cultivated as ornamentals by the local population. In the brackets after the number of species is given the percentage of the total number of species of a given type or group of habitats. The range of leading families is as follows: *Asteraceae* (65 species; 18.7 %), *Brassicaceae* (42; 12.1 %), *Poaceae* (34; 9.8 %), *Lamiaceae* (18; 5.2 %), *Fabaceae* (17, 4.9 %), *Rosaceae* (15; 4.3 %), *Boraginaceae*, *Chenopodiaceae* and *Caryophyllaceae* (13; 3.8 % each), and also *Apiaceae* (11; 3.2 %). Annuals (158; 45.5 %) and herbaceous perennials (126; 36.3 %) are dominating among the life forms. Mesotrophs with 237 species (68.3 %) dominate among the trophomorphs. Within the range of hygromorphs, dominating species are mesoxerophytes and xeromesophytes (112; 32.3 % and 110; 31.7 % respectively). The number of species of waterlogged habitats is small: hygromesophytes 14 (4.0 %) and hygrophytes 2 (0.6 %). In the latter group are *Rorippa amphibia* (L.) Besser and *Acorus calamus* L. Within the range of heliomorphs, the absolute majority of species is represented by heliophilous species (heliophytes 202; 58.2 % and scioheliophytes 133; 38.3 %). There are 190 (54.8 %) native species and 157 (45.2 %) adventive species.

Transportation network

Transportation network on the Agglomeration territory is represented by highways and railways, which play an important role in the formation of any urban flora, because they are the means by which a significant number of new adventive species is brought into the area. The flora of this territory comprises 253 species (28.2 % of the total number of species of the investigated urban flora). Most roadside species are ruderal. The range of leading families comprises: *Asteraceae* (47; 18.6 %), *Poaceae* (28; 11.1 %), *Brassicaceae* (25; 9.9 %), *Fabaceae* (17; 6.7 %), *Chenopodiaceae* (16; 6.3 %), *Rosaceae* (15; 5.9 %), *Boraginaceae* (13; 5.1 %), *Lamiaceae* (14; 5.5 %), and *Amaranthaceae* (7; 2.8 %). Within the range of life forms, the annuals hold the lead (121; 47.8 %). Perennials are also represented significantly (92; 36.4 %). Among trophomorphs, mesotrophs are the dominating species: 182 (71.9 %). Among gygromorphs, mesoxerophytes and xeromesophytes are the dominating species (101; 39.9 % and 71; 28.1 % respectively). Within the range of heliomorphs, heliophytes are most numerous: 149 species (58.9 %). The groups of species of the transport ecophyton by origin are represented almost equally: 134 natural (53.0 %) and 119 adventive (47.0 %) species.

Cultivated green areas

This type of habitat is the largest, according to the number of species in the urbanized area (405 species; 45.2 % of the total number of species of the investigated urban flora); it comprises almost half of all species of the urban flora of the Agglomeration. Such a big share of species is due to the fact that a significant number of all forests are located in places where remains of the natural coenoses with notable species diversity are saved. Furthermore, the species composition of this ecophyton is getting enriched on the account of cultural species escaping into the wild. Formation of a grass stand in parks and public gardens is provided by environing flora, mostly represented by ruderal and steppe species. The grass stand's character depends on the type and age of tree culture. Annual or biennial species and vegetative-versatile weeds with some steppe and meadow species, such as *Achillea pannonica* Scheele, *Bidens tripartita* L., *Elymus hispidus* (Opiz) Melderis, *Melilotus alb*a Medikus, *M. officinalis* L., *Picris hieracioides* L., *Salvia verticillata* L., *Trifolium pratense* L., *T. repens* L., etc., develop mostly in young tree stands without crown closure. As soon as the crown closure begins, mesophytization starts followed by sylvatization of the grass cover. The range of the leading families comprises: *Asteraceae* (65 species; 16.1 %), *Brassicaceae* (45; 11.1 %), *Poaceae* (39; 9.6 %), *Lamiaceae* (20; 4.9 %), *Fabaceae* (18; 4.4 %), *Boraginaceae* (16; 4.0 %), *Rosaceae* (15; 3.7 %), *Caryophyllaceae* (14; 3.5 %), *Chenopodiceae* (14; 3.5 %), and *Apiaceae* (10; 2.5 %). Among the life forms domi-

nante the herbaceous perennial species (170; 42.0 %). There are 23 (5.8 %) tree species and 17 (4.2 %) shrub and small shrub species. The range of trophomorphs comprises a significant number of species belonging to the group of mesotrophs: 267 (65.9 %). Leading hygromorphs are represented by xeromesophytes (124; 30.6 %) and mesoxerophytes (118; 29.1 %). There is also a significant number of mesophytes: 96 (23.7 %). Among heliomorphs, the absolute majority of species are heliophilous (heliophytes 200; 49.4 % and scioheliophytes 176; 43.4 %). The group of heliosciophytes is represented by 29 species (7.2 %). The greatest share in the composition of the green area flora is claimed by the native species (251; 62.0 %).

Agricultural lands surface

This group of habitats comprises the smallest number of species (179 species; 20.0 % of the total number of species of the investigated urban flora), which is due to the small areas of a cultivated land within the Agglomeration. Leading families in the systematic structure are: *Asteraceae* (39 species; 21.8 %), *Poaceae* (19; 10.6 %), *Brassicaceae* (16; 8.9 %), *Fabaceae* (15; 8.4 %), *Boraginaceae* (12; 6.7 %), *Lamiaceae* (9; 5.0 %), Apiaceae (8; 4.5 %), *Chenopodiaceae* (6; 3.4 %), *Polygonaceae* (6; 3.4 %), and *Caryophillaceae* (6; 3.4 %). In the segetal ecophyton, all species are represented by herbaceous life forms. Among trophomorphs, dominanting species are mesotrophs 123 species (68.7 %) and megatrophs 29 species (16.2 %). Within the range of hygromorphs, xeromesophytes and mesoxerophytes (62; 34.6 % and 58; 32.4 % respectively) hold the leading places. Among heliomorphs, heliophytes are the dominanting species: 111 species (62.0 %). The group of naturals comprises 95 species (53.1 %), the group of adventives 84 species (46.9 %), and 15 cultural adventive species have become wild.

Technogenic area

Specific ecological conditions are typical for the technogenic areas. These conditions have no natural analogues, and often they are not just unfavorable, but extreme for plant growing. Thus, in the heavily industrialized territories the substrata are represented mostly by fill-up soil and debris, and the air is full of phytotoxic pollutants. Steppe, petrophytic and meadow species are found in the natural vegetative cover of technogenic ecotopes in Southeast Ukraine. However, occasionally the natural vegetative cover in that territory can be totally destroyed, so that it does not cause transformation, but formation of new specific flora. Such conditions are most favorable for spreading and naturalization of the adventive species with wide ecological amplitude, because competition from native species is significantly reduced. In technogenic ecotopes of the Donetsk-Makiyivka Agglomeration, we have recorded 270 plant species (30.1 % of the total number of species of the investigated urban flora). The range of the leading families is as follows: *Asteraceae* (40; 14.8 %), *Brassicaceae* (32; 11.9 %), *Poaceae* (22; 8.2 %), *Fabaceae* (17; 6.3 %), *Chenopodiaceae* (15; 5.6 %), *Boraginaceae* (14; 5.2 %), *Caryophyllaceae* (13; 4.8 %), *Lamiaceae* (13; 4.8 %), *Polygonaceae* (10; 3.7 %), and *Ro*saceae (10; 3.7 %). Among life forms, a significant number of species belongs to the herbaceous perennials (115; 42.6 %). Within the range of trophomorhs the leading part is played by mesotrophs (181; 67.0 %). Among hygromorphs, mesoxerophytes (84; 31.1 %) and xeromesophytes (79; 29.2 %) are the dominanting species. The leading place among heliomorphs belongs to heliophytes (168; 62.2 %). In technogenic habitats, there is an increasing number of adventive species: 115 (42.6 %). Mention deserves the fact that some rare plant species can be also encountered in the technogenic ecotopes of the Agglomeration. These species find there conditions that meet their demands. Among them are *Crambeta tatarica* Sebeok and *Muscari neglectum* Guss. ex Ten.

Area of semi-natural habitats

Steppe

Ukrainian steppe ecosystems are considered among the high-priority environmentally protected sites as most vulnerable, because of their rapid decline under the impact of anthropogenic processes and slow recovery from different types of damage. A few fragments of seminatural steppe communities distinguished by a significant species diversity have remained on the Agglomeration territory. Furthermore, the Agglomeration perimeter contains the local Larinsky and Zoryansky Step Reserves created to preserve the standard zones of petrophytic steppe of the

Donetsk Ridge. The steppe flora of the studied area is represented by 361 plant species (40.2 % of the total number of species of the investigated urban flora). The range of leading families comprises: *Asteraceae* (53; 14.7 %), *Caryophyllaceae* (32; 8.9 %), *Rosaceae* (28; 7.8 %), *Lamiaceae* (26; 7.2 %), *Poaceae* (24; 6.7 %), *Brassicaceae* (24; 6.7 %), *Fabaceae* (22; 6.1 %), *Boraginaceae* (14; 3.9 %), *Ranunculaceae* (13; 3.6 %), and *Apiaceae* (9; 2.5 %). Among life forms, dominating species are the herbaceous perennials (229; 63.4 %). Within the range of trophomorphs the leading place is occupied by mesotrophs: 196 species (54.3 %). In terms of humidity, the majority of species belong to the group of mesoxerophytes (132; 36.6 %) and xerophytes (110; 30.5 %), which is typical of the steppe ecotopes. Within the range of heliomorphs, most species belong to the group of heliophytes: 235 (65.1 %). The absolute majority of steppe species are native. Adventive species are 28 in number (7.8 %).

The steppe ecotopes of the Agglomeration comprise 20 rare species included in the *Red Book of Ukraine*.

Forests

A special feature of forests of the green area in Southeast Ukraine is that they get into residential zones. Thus, more than 80 % of forests of the Donetsk green area are located within the city perimeter. This leads to disturbance of the balance of forest coenoses. On the Agglomeration territory, they number 241 plant species (26.9 % of the total number of species of the investigated urban flora). The range of leading families is as follows: *Asteraceae* (29; 12.0 %), *Poaceae* (24; 10.0 %), *Brassicaceae* (20; 8.3 %), *Lamiaceae* (15; 6.2 %), *Fabaceae* (13; 5.4 %), *Ranunculaceae* (11; 4.6 %), *Rosaceae* (9; 3.7 %), *Caryophyllaceae* (8; 3.3 %), and *Apiaceae* (8; 3.3 %).

Herbaceous perennials dominate within the range of life forms: 138 species (57.3 %). Trees number 19 species (7.9 %). By the amount of nutrients, most species are mesotrophs: 158 (65.6 %). According to the ecological conditions of forests, most species tend to moderate humidity: xeromesophytes and mesophytes: 75 species each (31.1 %). Within the range of heliomorphs, the leading place belongs to scioheliophytes: 139 species (57.7 %). This type of habitats consists of 192 native and 49 other species. Among the forest species there are five rare, protected at the state legislative level.

Meadows

Meadow flora of the studied area includes 159 species (17.7 % of the total number of the urban flora species). Within the range of leading families, the rating is as follows: *Asteraceae* and *Fabaceae* (20; 12.6 % each). Next come *Poaceae* (17; 10.7 %), *Lamiaceae* (10; 6.3 %), *Boraginaceae*, *Polygonaceae* and *Cyperaceae* (8 species each; 5.0 %), *Rosaceae* (5; 3.1 %).

Life forms of the pratophyton are represented solely by herbaceous plants. Within the range of trophomorphs, mesotrophs (88; 55.3 %) are the dominanting species. Among hygromorphs, most species are mesophytes: 51 (32.1 %). In relation to lighting, the dominating group is of heliophytes – 90 species (56.6 %), there are no sciophytes. The absolute majority of meadow species are native (147; 92.5 %). Adventive species are 12 (7.5 %) in number.

Waterside

The flora of this type of habitats is represented by 63 species (7.0 % of the total number of the urban agglomeration flora). Such relatively insignificant number of species is explained by excessive humidity. The range of leading families differs strongly from those of the other habitats, because of its habitat specifics. The first place within the range is occupied by the family *Cyperaceae* (12; 19.1 %). It is followed by *Poaceae* (10; 15.9 %), *Lamiaceae* (8; 12.7 %), *Juncaceae* (4; 6.3 %), *Polygonaceae*, *Apiaceae*, *Lythraceae*, *Onagraceae,* and *Typhaceae* (3 species each; 4.8 %). Life forms of the hygrophyton are represented exclusively by herbaceous perennials (55; 87.3 %) and annuals (8; 12.7 %).

Among trophomorphs, most species belong to the group of mesophytes (32; 50.8 %). Within the range of hygromorphs, mesohygrophytes (24 species; 38.1 %) are the dominating species. In relation to lighting conditions, heliophytes (37; 58.7 %) hold the leading position. All species of the hygrophyton, with the exception of *Acorus calamus* L., are native.

Water surface

This type of habitats has the smallest number of species within the studied urban flora. It comprises 16 species (1.8 % of the total number of species of the studied urban flora). The largest genus in the hydrophyton is *Potamogeton* L. consisting of five species. Life forms are represented solely by herbaceous perennials. Among trophomorphs, there are 14 (87.5 %) mesotrophs and two (12.5 %) alcomegatrophs. In

terms of humidity, 15 species are aquaphytes and one is a hygrophyte. Among heliomorphs, the majority of species are scioheliophytes (9; 56.2 %). All species of the hygrophyton, with the exception of *Elodea canadensis* Michx., are native.

An important feature of the urban flora is the degree of similarity and difference of flora in the particular habitats. The degree of similarity of the floristic spectra of urban flora habitats in the Donetsk-Makiyivka Agglomeration has been determined by using the Stugren-Radulescu Coefficient of Floristic Discrimination. Their matrix is given in Table 2.

Table 2. Matrix of Stugren-Radulescu coefficients of the floristic spectra of urban flora in the Donetsk-Makiyivka agglomeration.

Groups and types of habitats		ALS	UA			TA	ASH				
			Rz	Tn	Cga		St	Md	Fr	Wt	Ws
ALS		–	0.15	0.25	0.31	0.31	0.79	0.74	0.60	1	1
UA	Rz	0.15	–	0.19	-0.25	0.20	0.72	0.73	0.46	0.99	1
	Tn	0.25	0.19	–	0.30	0.21	0.70	0.76	0.61	0.98	1
	Cga	0.31	-0.25	0.30	–	0.22	0.71	0.71	0.29	0.95	1
TA		0.31	0.20	0.21	0.22	–	0.73	0.75	0.54	0.91	0.96
ASH	St	0.79	0.72	0.70	0.71	0.73	–	0.86	0.75	1	1
	Md	0.74	0.73	0.76	0.71	0.75	0.86	–	0.70	0.69	1
	Fr	0.60	0.46	0.61	0.29	0.54	0.75	0.70	–	1	1
	Wt	1	0.99	0.98	0.95	0.91	1	0.69	1	–	0.89
	Ws	1	1	1	1	0.96	1	1	1	0.89	–

Note: **ALS** – agricultural land surface, **UA** – urbanized area, **TA** – technogenic area, **ASH** – area of the seminatural habitats, **Rz** – residential zone, **Tn** – transportation network, **Cga** – cultivated green areas, **St** – steppe, **Md** – meadows, **Fr** – forests, **Wt** – waterside, **Ws** – water surface.

On the basis of this matrix, we have constructed a dendrogram illustrating that habitats of the investigated urban flora are similar in species composition (Fig. 5).

The closest relation (with Coefficient of Discrimination 0.25) has been observed between the flora of the residential zone and the green area, which is due to the numerous common adventive and ruderal species. The steppe flora differs significantly from other habitats by its species composition: the smallest value of the Coefficient of Discrimination (0.70) is recorded for these types of habitats and the transportation network area. The forest flora is most similar by composition to the city's green area. This can be explained by a large number of common tree and shrub, as well as ruderal species. Meadows are connected with forest and waterside areas by nearly the same values of the Coefficient (0.70 and 0.68 respectively). The water surface flora is slightly similar only to the waterside and technogenic area flora. Waterside flora is connected to the latter by such species as *Lemna minor* L., *Myriophillum verticillatum* L., *Potamogeton pectinatus* L., and *Zannichellia palustris* L.

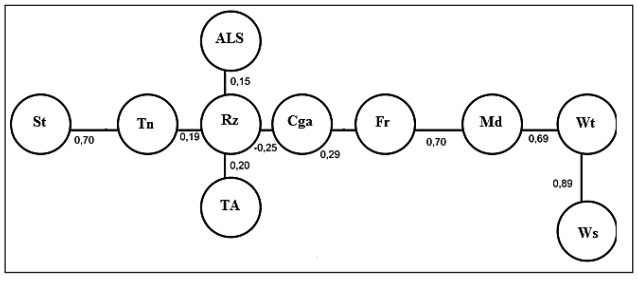

Fig. 5. Dendrogram of the similarity of floristic spectra of urban flora habitats of the Donetsk-Makiyivka agglomeration. Note: the legend is as in table 2.

Conclusions

Thus, urban floras in the steppe zone under strong human pressure have reduced species numbers unrelated to area. This fact is evident from the case study of urban flora of the Donetsk-Makiyivka Industrial Agglomeration, which has the greatest area and the strongest anthropogenic transformation as compared to other cities of the steppe zone, while its species diversity is the lowest.

Selection and analysis of the different types of flora and groups of habitats within the perimeter of the Donetsk-Makiyivka Agglomeration have shown a difference between them by the ranges of leading families, dominating life forms and ecomorphs, and have revealed major changes in the urban territory flora, as compared to the seminatural areas of steppe, forest and meadow vegetation within the Agglomeration perimeter. By the number of species, the leading types of flora are the green area (405; 45.2 %), steppe (362; 40.2 %) and residential zone (347; 38.7 %). Domination of the first group of habitats is explained by the combination of the remains of natural forest vegetation with a significant number of cultural species that have become wild and ruderal species. Domination of the steppe species is explained by the remains of seminatural steppe communities within the studied territory. Although their areas are relatively small, they are distinguished by a significant species phytodiversity. A great number of species in the residential area is associated with the presence of alien species. Areas of forest and meadow remains on the Agglomeration territory are small (241;

26.9 % and 159; 17.7 % respectively) due to its zonal features. Furthermore, they suffer from permanent excessive recreational pressure and gathering of plants by the local population as ornamental and medicinal. Waterside and water surface habitats have the smallest number of species (63; 7.0 % and 16; 1.8 % respectively). This is caused, first, by the specific ecological conditions and, second, by xerophytization of the flora under conditions of the urbanized habitat.

Thus, the species and ecological diversity of urban flora of the steppe zone depends on the degree of impact of anthropogenic factors. Under excessive pressure it gradually transforms and decreases.

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