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Alien fraction of Chernihiv urban flora: analysis and checklist

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Abstract: The results of complex analysis of alien species of the urban flora of Chernihiv (Forest zone of Ukraine) are presented. The total nonnative flora of Chernihiv includes 263 species. It comprises 25% of the total number of the urban flora species. Following groups prevail in ecological, geographical, life forms and coenotic spectra of the alien fraction of the urban flora: submesophytes, those of Mediterranean origin, annual, ruderal plants. After its taxonomic structure the studied urban flora is similar to the zonal flora of Polissya, but has closer relations to the flora of the ancient Mediterranean area due to its synanthropization.

Key words: urban flora, alien species, archaeophytes, kenophytes, Chernihiv, Ukraine

1. Introduction

Recently on the territory of Ukraine the floristic studies have been conducted in many cities of various geographical zones (Burda 1997; Moysiyenko 1999; Mosyakin & Yavorska 2003; Kagalo *et al*. 2004; Gubar 2006; Arkushyna 2007; Iepikhin 2008; Khlystun 2006). However, urban floras have not been studied in the north of the country. Therefore the study of the Chernihiv urban flora, and its alien fraction in particular, is timely and of current interest.

Chernihiv is situated in the Forest zone of Ukraine on the right bank of the Desna River (Fig. 1). It's geographical position is N 48°37' E 22°18'. The area of the city occupies 78 square km, the population is 299.0 thousand inhabitants. It is an administrative, transport, social and economic center of the Chernihiv region. Chernihiv is one of the oldest cities in Ukraine. It was founded in the VII-VIII century A.D.

At the Kiev Rus time (historical period from IX to the first half of XIII century A.D.) it was the second significant city after Kiev. Complicated history of the Chernihiv city influenced the development of the urban flora. Chernihiv traded with Caucasus, Byzantium, Mediterranean countries, which contributed to deliberate or unintentional introduction of different plant species which enriched the urban flora. In different historical periods the city was under authority of different countries (Poland, Lithuania, Russia, Germany), which influenced negatively on its development (frequent wars cased nearly total destruction of the city). In fact, the natural forest phragments had not preserved on the territory of the city, this is to say that almost all forest phragments are plantations of forest parks or parks. It is notable that most of these plantations were the species of the native flora but with different nonnative species which were naturalized later. As a result of the special study of the Chernihiv urban flora 1050 plant species which occur spontaneously within the administrative borders of the city have been found. Almost a fourth of the total species number is comprised by the species of alien fraction. A brief analysis of this plant group and the checklist of the non-indigenous plants of the Chernihiv urban flora in this report are provided.

2. Material and methods

The research of the alien plants species of the city of Chernihiv was carried out in 2001-2007. Researches were executed by the field survey method and comparative taxonomical, geographical (origin of alien species) method of study. Other used sources of data were: literature and herbarium collections (KW, Chernihiv Pedagogical University). While carrying out the immigration

Fig. 1. Location of Chernihiv on the territory of Ukraine

analyses of the alien fraction of the urban flora of Chernihiv, the classification of alien plants (Kornaś 1968) modified by Protopopova (1991) are used. The following degrees of naturalization: ephemerophytes (non-naturalized, occasional immigrants, casuals, or waifs), colonophytes (epoecophyte occurring in the area in one to several stable colonies but showing little or no trend toward further expansion), epoecophytes (naturalized in human-made and disturbed habitats), agriophytes (naturalized in natural and seminatural habitats) are used. Taxonomic structure of nonnative species have been analyzed (Tolmachev 1974). For each weed species included in the study, the following information was assembled: biological type (Raunkiaer 1934), type of root system and underground shoots, life form (Serebriakov 1962), origin (Protopopova 1991), confinedness to the city zones and frequency of occurring. For ecological analysis the species were divided into the ecological groups according to requirement of insolation and in relation to humidity (Didukh 2000a, 2000b). The species names are given according to "Vascular plants of Ukraine. A nomenclatural checklist" (Mosyakin & Fedoronchuk 1999).

3. Results

The alien component of the Chernihiv urban flora includes 263 species which constitutes 25% of the total number of vascular plant species of the studied flora and 31.7% of the total number of nonnative component of the flora of Ukraine (Protopopova *et al*. 2006). The alien component of the flora of Ukraine constitutes 13.8% (less as 1.8 times), which confirms a considerable role of cities in spread of alien species, as well as the high level of anthropogenic transformation of the urban floras due to urbanization (comp. Appendix 1).

According to the time of immigration the nonnative flora of the Chernihiv city is divided into archaeophytes (91 species of plants) and kenophytes (172 plant species). Nonnative species belong to 174 genera (45 – only archaeophytes, 107 – only kenophytes, 22 – archaeophytes and kenophytes) and 57 families.

An important characteristic of an alien species within flora is the degree of its naturalization. Among the nonnative plants of the Chernihiv urban flora epoecophytes (166 species) prevail, other groups are smaller: agriophytes (18), colonophytes (43), and ephemerophytes (36). Thus the stable component (i.e species with high degrees of naturalization, agriophytes and epoecophytes) of the nonnative fraction of the Chernihiv urban flora comprises 70% (184 species).

Taxonomic spectrum of 10 leading places from the alien fraction includes 13 families, they are arranged after the number of species in decreasing order: Asteraceae (27 genera; 46 species); Brassicaceae (18; 28); Poaceae (15; 26); Chenopodiaceae (6; 15); Fabaceae (9; 14);

Solanaceae (8; 10), Rosaceae (8; 10); Lamiaceae (7; 9); Boraginaceae (7; 7); Apiaceae (6; 6); Caryophyllaceae (5; 5), Polygonaceae (3; 5), Scrophulariaceae (1; 5). Three leading families comprise 60 genera (34.5%) and 100 species (38%). Thirteen leading families aggregate 120 genera (69%) and 186 species (71%). The number of families with one or two species amounts 34 (59.6%), which totals 43 plant species (16%). This allocation with leading families enclosing almost two thirds of the species number is typical for alien and synanthropic floras of Ukraine (Protopopova 1991; Mosyakin & Yavorska 2003; Gubar 2006).

According to the results of investigation, only eleven leading genera after the species number are selected, but they occupy first three places in the spectrum of genera, since the allocation of genera after the species number is as follows: the biggest after the species number is the genus *Chenopodium* (6), genera *Veronica* and *Vicia* have 5 species each; *Amaranthus*, *Atriplex*, *Brassica*, *Bromus*, *Papaver*, *Setaria*, *Sisymbrium*, *Xanthium* have 4 species each. 11 genera have 3 species, 23 genera – 2, the rest 129 genera are monotypic, which is typical for alien fraction of urban floras (Ilminskikh & Shmidt 1986; Protopopova 1991; Moysiyenko 1999; Panasenko 2002).

For the analysis of the biomorphological structure in the alien fraction of the urban flora biotypes have been considered (Raunkiaer 1934), as well as root system or underground shoots type, and life forms of the studied species (Serebriakov 1962). Generally the analysis of biological types and life forms of the species on the example of the studied alien flora of Chernihiv allowed noting same its features which are typical for alien flora of Ukraine (Protopopova 1991). In particular, most of the nonnative plants in the urban flora of Chernihiv are herbaceous (233; 88.6%), more than half are annuals (150; 57%), the rest are perennials (113; 43%). Among the perennials there are: herbaceous polycarps (53), biennial monocarps (28), shrubs (12), trees (18) woody vines (2).

In the alien fraction of the Chernihiv the following biotypes of plants occur: therophytes (157), hemicryptophytes (67), phanerophytes (30), geophytes (5), helophytes (1), chamaephytes (2) and hydrophytes (1). Among the types of root system and underground shoots the taproot type prevails (209 species), the rest have fibrous roots (41), rhizome (12). Hence the confinedness of the nonnative fraction of the Chernihiv urban flora to human-made habitats conditions on the small diversity of life forms of the species in this group.

The alien fraction of the Chernihiv urban flora varies in origin. The basis for this group of plants is comprised by the species of Mediterranean origin (54 plant species), North American (54), and Asian origin (40 plant species, including species which originated from East (10), Central (5), South (2), South-Eastern (4), South-Western (2) and Minor Asia (1)). According to the results of investigation, the most of the plant species with Mediterranean origin are archaeophytes. The most species among the group of plants originating from North America are kenophytes, which enriched the urban flora of Chernihiv during the 20th century. Twenty nine species have Mediterraneo-Irano-Turanian origin, 17 originated from Central and Southern Europe, 16 have Irano-Turanian origin, 9 from Central and South America, for 7 species the origin is unknown, 3 are the species of anthropogenic origin. Besides there are 1-2 species of Indo-Malayan, Euro-Siberian, Mediterraneo-Turanian, Iranian and Mediterraneo-Athlantic-European, Caucasus and other origins. This allocation of alien species after their origin enables tracing of floristic relations of the studied flora with the floras of adjacent territories and other continents. Taking into account the degree of naturalization of the species it gives an idea on the period of dispersal to the city's territory.

An important role in the process of naturalization of alien plants in the "foreign" for them territories belongs to the conditions of the environment (Burda 1991). The specifity of conditions in urban environments lies first of all in its aridization (Ilminskikh 1989). That is in the conditions of a city plants have more heat and less moisture, which promotes successful naturalization of the species which inhabit open plots and are able to survive long term droughty conditions. Taking this into account in the research, the attention is paid to humidity and insolation as growth conditions for alien plants in Chernihiv. It is established that among the nonnative plants of the studied territory the group of submesophytes prevail (154 species). The second place is occupied by mesophytes (75 species), which can be explained by two rivers floating thru the city as well as many natural and artificial water reservoirs with ditch water. Subxerophytes (29), xerophytes (2), hygrophytes (1) and hydrophytes (2) also occur there. The alien species have following allocation in ecological groups after requirements of insolation: heliophytes (186), scioheliophytes (65), heliosciophytes (7), sciophytes (5). Thus the species growing in open areas with moderate soil humidity prevail in the alien fraction of the Chernihiv urban flora.

Diversity of plant communities in which alien species occur is important for evaluation of success of naturalization of the species. On the territory of Chernihiv 11 ecological-coenotic groups with nonnative plant species in their composition are noted. The species are distributed among the groups as following: aquatic (1), littoral (4), meadow-bog (1), wet meadow (1), meadow (16), meadow-steppe (9), forest (39), forest margins (11), segetal (56), ruderal (234), psammophytic (4). Thus, the majority of species occurs in antropically

changed habitats within the composition of ruderal and segetal communities; few species occur in seminatural and natural ecotopes in meadow, meadow-steppe, forest, forest margins communities.

The species composition of the Chernihiv urban flora is established, in particular its alien fraction, 50 representatives of the latter has enriched the city flora during last 10-20 years (*Ambrosia artemisifolia*, *Phytolacca americana*, *Hemerocallis lilioasphodelus*, *Grindelia squarrosa*, *Heracleum mantegazzianum*, *Bidens frondosa*, *Rudbeckia laciniata*, *Oenothera depressa* and others). In conclusion it is worth to mention that non-indigenous flora is a dynamic component of urban flora; processes and mechanisms of alien species naturalization and their interactions with natural flora require further fundamental study in order to prevent plant invasion which is a threat to biodiversity in any natural zone (Protopopova *et al*. 2002).

4. Conclusions

According to the taxonomic structure the studied urban flora is similar to the zonal flora of Polissya, but has closer relations to the flora of the ancient Mediterranean due to its synanthropization. It is established that the result of urbanization of the studied flora is the higher position of the families Brassicaceae, Chenopodiaceae and Fabaceae in the spectrum of leading families in its alien fraction. This is typical for arid territories. The results of biomorphological analysis point to prevalence of annuals over perennials, terophytes over hemicryptophytes, and tap rooted plants according to the type of root system. Alien fraction amounts 25% of the total urban flora, which points to the considerable anthropogenic transformation of the latter. According to the results of the ecological analysis 87% of the alien fraction comprises submesophytes and mesophytes, 71% – heliophytes; species of the ruderal group amount 89% according to the ecological-coenotic confinedness. Kenophytes prevail according to the time of immigration; Mediterranean and North American plant species – after the origin, epoecophytes – after the degree of naturalization.

Thus, according to the obtained results, the studied flora is under considerable anthropogenic pressure, which is reflected in the significant role of its alien component in the vegetative cover of urbanized landscapes of the town of Chernihiv.

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Appendix 1. Checklist of the alien fraction of Chernihiv urban flora

Families and species	1	2	3	4	5	6	7
Araceae							
Acorus calamus L.	Ar	As	Agr	Ms	Lit	Surb	R
Hemerocallidaceae							
Hemerocallis lilioasphodelus L.	Kn	EAs	Col	Ms	Rud, Seg, M	Urb&Surb	S
Hydrocharitaceae							
Elodea canadensis Michx.	Kn	NAm	Agr	Hd	Aq	Urb&Surb	C
Iridaceae							
Sisyrinchium septentrionale Bicknell	Kn	NAm	Agr	Ms	M	Surb	R
Juncaceae							
Juncus tenuis Willd.	Kn	NAm	Agr	Ms	M, wM	Surb	C
Liliaceae							
Gagea pratensis (Pers.) Dumort.	Ar	Med	Epo	Ms	M	Urb	S
Poaceae							
Anisantha sterilis (L.) Nevski	Ar	MedIT	Epo	SubMs	Rud	Urb&Surb	C
Anisantha tectorum (L.) Nevski	Ar	MedET	Epo	SubMs	Rud	Urb&Surb	C
Apera spica-venti (L.) P. Beav.	Ar	un	Epo	SubMs	M, Rud	Urb&Surb	S
Avena sativa L.	Kn	SEur	Epo	SubMs	Rud	Urb&Surb	S
Bromus arvensis L.	Ar	Med	Epo	SubMs	Rud	Urb&Surb	S
Bromus commutatus Schrad.	Kn	CEur	Epo	SubMs	Rud	Urb&Surb	C
Bromus secalinus L.	Ar	EMed	Epo	Ms	Rud	Urb&Surb	S
Bromus squarrosus L.	Kn	MedIT	Epo	SubMs	Rud, M-S	Urb&Surb	C
Ceratochloa carinata (Hook. & Arn.) Tutin	Kn	NAm	Eph	SubXr	Rud	Urb	R
Digitaria aegyptiaca (Retz.) Willd.	Kn	As	Epo	SubMs	Rud	Urb	R
Digitaria ischaemum (Schreb.) Muehl.	Ar	CEur	Epo	SubMs	Rud	Urb&Surb	R
Digitaria sanguinalis (L.) Scop.	Ar	S-EAs	Epo	SubXr	Rud	Urb&Surb	C
Echinochloa crussgalli (L.) P. Beauv.	Ar	As	Epo	Ms	Seg, Rud	Urb&Surb	C
Eragrostis minor Host	Kn	SEur	Epo	SubMs	Rud	Urb&Surb	S
Eragrostis pectinacea (Michx.) Nees	Kn	NAm	Eph	SubMs	Rud	Urb	R
Eragrostis pilosa (L.) P. Beauv.	Kn	Med	Col	Ms	Rud	Urb	R
Hordeum murinum L.	Ar	MedIT	Col	SubXr	Rud	Urb	C
Leymus sabulosus (M. Bieb.) Tzvelev	Kn	PontCa	Eph	SubXr	Psam	Surb	R
Lolium remotum Schrenk	Ar	a	Epo	Ms	Rud	Urb	S
Panicum capillare L.	Kn	NAm	Eph	SubXr	Rud	Urb	S
Setaria glauca (L.) P. Beauv.	Ar	IMal	Epo	Ms	Rud	Urb&Surb	C
Setaria italica (L.) P. Beauv.	Kn	As	Eph	SubMs	Rud	Urb	O
Setaria verticillata (L.) P. Beauv	Ar	IMal&Sud	Epo	SubMs	Rud	Urb	S
Setaria viridis (L.) P. Beauv.	Ar	MedIT	Epo	SubMs	Rud	Urb&Surb	C
Sorghum halepense (L.) Pers.	Kn	Med	Col	SubMs	Rud	Urb	R
Zea mays L.	Kn	C&SAm	Eph	SubMs	Rud, Seg	Urb&Surb	R
Typhaceae							
Typha laxmannii Lepech.	Kn	MedCAs	Col	Hg	Rud, B	Surb	S
Aceraceae							
Acer negundo L.	Kn	NAm	Agr	Ms	Rud, F	Urb&Surb	C
Acer pseudoplatanus L.	Kn	NAm	Agr	Ms	Rud, F	Urb&Surb	C
Acer saccharinum L.	Kn	NAm	Epo	Ms	Rud, F	Urb	S
Amaranthaceae							
Amaranthus albus L.	Kn	NAm	Epo	SubMs	Rud	Urb&Surb	C
Amaranthus blitoides S.Watson	Kn	NAm	Epo	SubXr	Rud	Urb&Surb	C
Amaranthus blitum L.	Kn	SEur	Epo	SubXr	Rud	Urb&Surb	S
Amaranthus retroflexus L.	Kn	NAm	Epo	SubMs	Rud	Urb&Surb	C
Apiaceae							
Aethusa cynapium L.	Ar	CEur	Epo	SubXr	Rud, F	Urb&Surb	S
Anetum graveolens L.	Kn	MedIT	Eph	Ms	Rud, Seg	Urb&Surb	C
Conium maculatum L.	Ar	MedIT	Epo	SubMs	Rud	Urb&Surb	C
Coriandrum sativum L.	Kn	Med	Eph	SubMs	Rud, Seg	Urb&Surb	R
Heracleum mantegazzianum Sommier & Levier	Kn	Ca	Col	Ms	Rud	Surb	R
Levisticum officinale W. D. J. Koch	Kn	I	Col	Ms	Seg, Rud	Urb&Surb	R
Apocinaceae							
Vinca minor L.	Kn	Med	Agr	Ms	F	Surb	S
Asclepiadaceae							
Asclepias syriaca L.	Kn	NAm	Epo	SubMs	Rud	Surb	R
Asteraceae							
Ambrosia artemisifolia L.	Kn	NAm	Epo	SubMs	Rud	Urb&Surb	S
Anthemis cotula L.	Ar	Med	Epo	SubMs	Seg, Rud	Urb&Surb	C
Artemisia absynthium L.	Ar	IT	Epo	Ms	Rud	Urb&Surb	C
Artemisia annua L.	Kn	SAs	Epo	SubMs	Rud	Urb&Surb	S
Artemisia dracunculus L.	Kn	As	Col	Ms	Rud	Urb&Surb	S

Aster nova-angliae L.	Kn	NAm	Col	Ms	Rud	Urb&Surb	R
Aster novi-belgii L.	Kn	NAm	Col	Ms	Rud	Urb&Surb	R
Bidens frondosa L.	Kn	NAm	Agr	Ms	M-B, Rud	Urb&Surb	C
Calendula arvensis L.	Kn	Med	Epo	SubMs	Rud	Urb&Surb	S
Calendula officinalis L.	Kn	Med	Epo	Ms	Rud	Urb&Surb	R
Carduus acantoides L.	Ar	Med	Epo	SubMs	Rud	Urb&Surb	S
Carduus cinereus M. Bieb.	Kn	IT	Epo	SubMs	Rud	Urb&Surb	S
Carduus nutans L.	Ar	Med	Epo	SubXr	Rud	Urb&Surb	C
Centaurea cyanus L.	Ar	Med&SEur	Epo	SubMs	Seg, Rud	Urb&Surb	S
Centaurea diffusa Lam.	Kn	MedIT	Epo	Xr	Rud	Urb&Surb	S
Cichorium intybus L.	Ar	MedIT	Epo	SubMs	Rud	Urb&Surb	C
Conyza canadensis (L.) Cronq.	Kn	NAm	Agr	Ms	Rud, M, M-S	Urb&Surb	C
Cosmos bipinnatus Cav.	Kn	CAm	Col	SubMs	Rud	Urb&Surb	S
Galinsoga parviflora Cav.	Kn	SAm	Epo	Ms	Seg, Rud	Urb&Surb	C
Galinsoga urticifolia (Kunth) Benth.	Kn	CAm or SAm	Col	Ms	Seg, Rud	Surb	R
Grindelia squarrosa (Pursh) Dunal	Kn	NAm	Epo	SubMs	Rud	Urb	S
Helianthus annuus L.	Kn	NAm	Col	SubMs	Rud	Urb&Surb	S
Helianthus subcanescens (A. Gray)	Kn	NAm	Epo	Ms	Rud	Urb&Surb	S
Helianthus tuberosus L.	Kn	NAm	Epo	Ms	Rud	Urb&Surb	C
Heliopsis scabra Dunal	Kn	NAm	Epo	SubMs	Rud, Fm	Surb	S
Iva xanthiifolia Nutt.	Kn	NAm	Epo	SubMs	Rud	Urb&Surb	C
Lactuca serriola L.	Ar	MedIT	Epo	SubMs	Rud	Urb&Surb	C
Lepidotheca suveolens (Pursh) Nutt.	Kn	NAm	Epo	Ms	Rud	Urb&Surb	C
Onopordum acanthium L.	Ar	Med	Epo	SubXr	Rud	Urb&Surb	S
Petasites spurius (Retz.) Rchb.	Kn	EurSib	Epo	Ms	Lit	Surb	S
Phalacroloma anuum (L.) Dumort.	Kn	NAm	Agr	Ms	Rud, M-S, M, F	Urb&Surb	C
Phalacroloma septentrionale (Fernald & Wiegand) Tzvelev	Kn	NAm	Epo	Ms	Rud, M, F	Urb&Surb	S
Phalacroloma strigosum (Muehl. ex Willd.) Tzvelev	Kn	NAm	Eph	Ms	Rud	Urb	R
Rudbeckia hirta L.	Kn	NAm	Epo	SubMs	Rud, Seg	Urb&Surb	S
Rudbeckia laciniata L.	Kn	NAm	Epo	SubMs	Rud, Seg	Urb&Surb	S
Senecio viscosus L.	Kn	CEur	Epo	SubMs	Rud	Urb&Surb	C
Senecio vulgaris L.	Ar	As	Epo	SubMs	Rud	Urb&Surb	C
Solidago canadensis L.	Kn	NAm	Epo	Ms	Rud, M	Urb&Surb	S
Solidago serotinoides A. Löve & D. Löve	Kn	NAm	Col	Ms	Rud, M, Fm	Urb&Surb	S
Sonchus arvensis L.	Ar	Med	Epo	Ms	Rud, Seg	Urb&Surb	C
Sonchus oleraceus L.	Ar	Med	Epo	Ms	Rud, Seg	Urb&Surb	C
Tripleurospermum inodorum (L.) Sch. Bip.	Ar	As	Epo	Ms	Rud	Urb&Surb	C
Xanthium albinum (Widder) H. Scholz	Kn	CEur	Epo	SubMs	Rud, M	Urb&Surb	S
Xanthium ripicola Holub	Kn	CEur	Epo	SubMs	Rud, Lit	Urb&Surb	S
Xanthium spinosum L.	Kn	SAm	Epo	SubMs	Rud	Urb&Surb	S
Xanthium strumarium L.	Ar	IT	Epo	SubMs	Rud	Urb&Surb	S
Balsaminaceae							
Impatiens glandulifera Royle.	Kn	S-EAs	Epo	Hg	Rud, Lit	Urb&Surb	S
Impatiens parviflora DC.	Kn	CAs	Agr	Ms	Rud, F, Fm	Urb&Surb	C
Boraginaceae							
Anchusa officinalis L.	Ar	Med	Epo	SubXr	Rud	Urb&Surb	C
Borago officinalis L.	Kn	Med	Epo	SubMs	Seg	Surb	R
Buglossoides arvensis (L.) I. M. Johnst.	Ar	MedIT	Epo	SubMs	Rud	Urb&Surb	C
Cynoglossum officinale L.	Ar	Med	Epo	SubMs	Rud	Urb&Surb	C
Lappula squarrosa (Retz.) Dumort.	Ar	MedIT	Epo	SubMs	Rud	Urb&Surb	C
Lycopsis arvensis L.	Ar	Med	Epo	SubMs	Rud	Urb&Surb	C
Myosotis arvensis (L.) Hill	Ar	MedIT	Epo	Ms	Rud, Fm, M-S	Urb&Surb	C
Brassicaceae							
Arabidopsis thaliana (L.) Heynh.	Kn	MedIT	Epo	SubMs	Rud	Urb	S
Armoracia rusticana P. Gaertn., B. Mey. & Scherb.	Kn	IT	Col	Ms	Rud, Seg	Urb&Surb	S
Brassica campestris L.	Ar	CAs	Epo	SubXr	Rud, Seg	Urb&Surb	S
Brassica juncea (L.) Czern.	Kn	S-EAs	Col	SubMs	Rud, Seg	Urb	S
Brassica napus L.	Kn	SEur	Eph	SubMs	Rud, Seg	Surb	S
Brassica nigra (L.) W.D.J. Koch	Kn	Med	Eph	Ms	Rud, Seg	Surb	S
Bunias orientalis L.	Kn	EMed	Epo	SubMs	Rud	Urb&Surb	S
Camelina microcarpa Andrz.	Ar	MedET	Epo	SubMs	Rud, Seg	Urb&Surb	S
Capsella bursa-pastoris (L.) Medik.	Ar	un	Epo	SubMs	Rud, M-S	Urb&Surb	C
Cardaria draba (L.) Desv.	Kn	SEur & As	Epo	SubMs	Rud	Urb&Surb	S
Diplotaxis tenuifolia (L.) DC.	Kn	Med	Epo	SubXr	Rud	Urb	S
Descurania sophia (L.) Webb ex Prantl	Ar	IT	Epo	SubMs	Rud	Urb&Surb	S
Erysimum cheiranthoides L.	Ar	un	Epo	SubMs	Rud, Fm	Urb&Surb	C
Hesperis sibirica L.	Kn	S-WAs	Eph	Ms	Rud	Urb&Surb	R
Lepidium densiflorum Schrad.	Kn	NAm	Eph	SubMs	Rud	Urb&Surb	S
Lepidium ruderale L.	Ar	IT	Epo	SubMs	Rud	Urb&Surb	S
Lepidium sativum L.	Kn	As	Eph	SubMs	Rud, Seg	Surb	S

Lunaria annua L.	Kn	SEur	Eph	Ms	Fm	Surb	O
Neslia paniculata (L.) Desv.	Ar	a	Epo	SubMs	Rud	Urb	S
Raphanus raphanistrum L.	Ar	Med	Epo	SubMs	Rud, Seg	Urb&Surb	S
Raphanus sativus L.	Kn	Med	Col	SubMs	Rud, Seg	Surb	S
Sinapis alba L.	Ar	MedIT	Epo	Ms	Seg, Rud	Surb	R
Sinapis arvensis L.	Ar	MedAtlEur	Epo	SubMs	Seg, Rud	Surb	S
Sisymbrium altissimum L.	Kn	SEur & As	Epo	Ms	Rud	Urb&Surb	C
Sisymbrium loeselii L.	Kn	Med & As	Epo	SubXr	Rud	Urb&Surb	S
Sisymbrium officinale (L.) Scop.	Ar	Med	Epo	SubMs	Rud	Urb&Surb	C
Sisymbrium polymorphum (Murray) Roth	Kn	IT	Eph	SubXr	Rud	Urb	R
Thlaspi arvense L.	Ar	IT	Epo	Ms	Rud	Urb&Surb	S
Caesalpiniaceae							
Gleditsia triacanthos L.	Kn	NAm	Col	SubMs	F	Urb&Surb	R
Cannabaceae							
Cannabis ruderalis Janisch.	Kn	Med	Epo	SubMs	Rud	Urb&Surb	S
Cannabis sativa L.	Kn	SAs	Epo	SubMs	Rud, Fm	Urb&Surb	C
Caprifoliaceae							
Lonicera caprifolium L.	Kn	Med	Eph	SubXr	F	Urb&Surb	S
Lonicera tatarica L.	Kn	Sib	Eph	SubXr	F	Surb	R
Caryophyllaceae							
Agrostemma githago L.	Ar	a	Epo	SubMs	Seg	Surb	R
Dianthus barbatus L.	Kn	CEur	Eph	Ms	Rud	Surb	R
Saponaria officinalis L.	Kn	Med	Epo	Ms	Rud	Urb&Surb	S
Scleranthus annuus L.	Ar	Med	Epo	SubMs	Rud	Urb&Surb	S
Spergula arvensis (L.) Clairv.	Ar	Med	Epo	SubMs	Rud	Urb&Surb	S
Chenopodiaceae							
Atriplex hortensis L.	Kn	As	Epo	Ms	Rud	Urb&Surb	S
Atriplex prostrata Boucher ex DC	Ar	MedIT	Epo	Ms	Rud	Urb&Surb	S
Atriplex sagitatta Borkh.	Ar	IT	Epo	SubXr	Rud	Urb&Surb	S
Atriplex tatarica L.	Kn	MedIT	Epo	SubMs	Rud	Urb&Surb	S
Chenopodium botrys L.	Kn	MedT	Epo	Ms	Rud	Urb	S
Chenopodium hybridum L.	Ar	Med	Epo	SubMs	Rud	Urb&Surb	C
Chenopodium murale L.	Ar	MedET	Epo	SubMs	Rud	Urb&Surb	S
Chenopodium polyspermum L.	Ar	un	Epo	SubMs	Rud	Urb&Surb	S
Chenopodium rubrum L.	Kn	CEur	Epo	Ms	Rud	Urb&Surb	S
Chenopodium strictum Roth	Kn	Med	Col	SubXr	Rud	Urb&Surb	S
Corispermum hyssopifolium L.	Kn	Med	Col	SubXr	Rud	Urb&Surb	S
Kochia laniflora (S. G. Gmel.) Borbas	Kn	MedT	Epo	SubXr	Rud, Psam	Urb&Surb	S
Kochia scoparia (L.) Schrad.	Kn	IT	Epo	SubXr	Rud, Psam	Urb&Surb	S
Polycnemum arvense L.	Kn	MedIT	Epo	Xr	Rud	Urb&Surb	S
Spinacea oleracea L.	Kn	As	Eph	Ms	Seg	Surb	R
Crassulaceae							
Aizopsis aizoon (L.) Grulich	Kn	EAs	Eph	SubMs	F, Rud	Surb	O
Cucurbitaceae							
Brionia alba L.	Kn	MedIT	Agr	SubMs	F, Rud	Surb	S
Echinocystis lobata (Michx.) Torr. & A.	Kn	NAm	Agr	Ms	Rud, Fm	Urb&Surb	S
Thladiantha dubia Bunge	Kn	NAm	Agr	Ms	Rud, Fm	Urb&Surb	S
Elaeagnaceae							
Elaeagnus angustifolia L.	Kn	Med	Epo	SubXr	F	Surb	S
Hippophaë rhamnoides L.	Kn	un	Epo	SubMs	Psam	Urb/R, Surb/S	
Euphorbiaceae							
Euphorbia helioscopia L.	Ar	Med	Col	SubMs	Rud	Urb	S
Euphorbia peplus L.	Ar	Med	Epo	Ms	Rud, Seg	Surb	S
Fabaceae							
Amorpha fruticosa L.	Kn	NAm	Epo	Ms	Rud, F, Fm	Urb&Surb	S
Caragana arborescens Lam.	Kn	un	Epo	SubXr	Rud, F, Fm	Urb&Surb	S
Lens culinaris Medik.	Kn	Med	Eph	SubMs	Seg	Surb	O
Lupinus luteus L.	Kn	Med	Eph	SubMs	Rud	Surb	O
Lupinus polyphyllus Lindl.	Kn	NAm	Col	SubMs	Rud, F, Fm	Surb	S
Medicago sativa L.	Kn	As	Epo	SubMs	Rud, Seg	Urb&Surb	S
Onobrychis vicifolia Scop.	Kn	SEur	Eph	SubMs	Rud	Urb&Surb	R
Robinia pseudoacacia L.	Kn	NAm	Epo	SubMs	F, Fm	Urb&Surb	S
Trifolium hybridum L.	Kn	Med	Epo	Ms	M	Urb&Surb	S
Vicia angustifolia Reichard	Kn	MedIT	Agr	SubMs	Rud, F	Urb&Surb	S
Vicia hirsuta (L.) S. F. Grey	Ar	WMed	Epo	SubMs	Rud, Seg, M-S	Urb&Surb	C
Vicia sativa L.	Kn	MCAs	Col	SubMs	Rud, Seg	Urb&Surb	S
Vicia tetrasperma (L.) Schreb.	Ar	Med	Epo	SubMs	Rud, Seg, M	Urb&Surb	C
Vicia villosa Roth	Ar	Med	Epo	SubMs	Rud, Seg, M, Fm	Urb&Surb	C
Fagaceae							
Quercus rubra L.	Kn	NAm	Col	SubMs	F	Urb&Surb	S

Fumariaceae							
Fumaria officinalis L.	Ar	Med	Epo	SubMs	Rud	Urb&Surb	S
Fumaria schleicheri Soy.-Willem.	Ar	IT	Epo	SubMs	Rud, M-S	Surb	S
Fumaria vaillantii Loisel.	Ar	MedIT	Eph	SubXr	Rud	Urb	R
Geraniaceae							
Geranium molle L.	Kn	Med	Epo	SubMs	Rud, F	Urb&Surb	S
Geranium pusillum L.	Ar	IT	Epo	SubMs	Rud	Urb&Surb	S
Geranium sibiricum L.	Kn	As	Epo	SubMs	Rud, F	Urb&Surb	S
Hippocastanaceae							
Aesculus hippocastanum L.	Kn	SEur	Col	SubMs	Rud, F	Urb&Surb	R
Hydrangeaceae							
Philadelphus coronarius L.	Kn	Sib-Ca & AsMin	Col	SubMs	Rud, F	Urb&Surb	R
Hydrophyllaceae							
Phacelia tanacetifolia Benth.	Kn	NAm	Col	SubMs	Rud, Seg	Surb	S
Juglandaceae							
Juglans cinerea L.	Kn	NAm	Col	SubMs	Rud	Urb&Surb	R
Juglans regia L.	Kn	As	Col	SubMs	Rud	Urb&Surb	R
Lamiaceae							
Ballota nigra L.	Ar	MedIT	Epo	SubMs	Rud	Urb&Surb	C
Elsholtzia ciliata (Thunb.) Hyl.	Kn	As	Epo	SubMs	Rud	Urb&Surb	C
Galeopsis ladanum L.	Ar	Med	Epo	Ms	Rud, Fm	Surb	S
Lamium album L.	Ar	IT	Epo	Ms	Rud	Urb&Surb	S
Lamium amplexicaule L.	Ar	MedIT	Epo	SubMs	Seg, Rud	Surb	S
Lamium purpureum L.	Ar	Med	Epo	SubMs	Rud	Urb&Surb	C
Leonurus cardiaca L.	Ar	MedIT	Epo	SubMs	Rud	Urb&Surb	S
Nepeta cataria L.	Ar	EMed	Epo	SubMs	Rud, Fm	Urb&Surb	C
Salvia verticillata L.	Kn	Eur & AsMin	Epo	SubMs	Rud	Surb	R
Linaceae							
Linum usitatissimum L.	Kn	Atl & CEur	Eph	SubMs	Rud	Urb	O
Malvaceae							
Althaea officinalis L.	Ar	IT	Epo	Ms,Hms	Rud	Surb	S
Malva mauritiana L.	Kn	Med	Epo	SubMs	Rud	Surb	R
Malva neglecta Wallr.	Ar	IT	Epo	SubMs	Rud, Fm	Urb&Surb	C
Malva pusilla Smith	Ar	Resistant Arch	Epo	SubMs	Rud, M	Urb&Surb	S
Moraceae							
Morus alba L.	Kn	EAs	Col	Ms	Rud, Seg	Urb&Surb	S
Oleaceae							
Fraxinus pennsylvanica Marshall	Kn	NAm	Col	SubMs	Rud, F	Urb	R
Ligustrum vulgare L.	Kn	un	Col	SubMs	Rud, F	Surb	R
Syringa vulgaris L.	Kn	EMed	Epo	SubXr	Rud, F, Fm	Urb&Surb	S
Onagraceae							
Epilobium adenocaulon Hausskn.	Kn	NAm	Epo	Ms	Rud	Urb&Surb	R
Oenothera biennis L.	Kn	NAm	Agr	SubMs	Rud, M, M-S	Urb&Surb	C
Oenothera depressa E. Greenó	Kn	NAm	Epo	SubMs	Rud	Urb&Surb	S
Oenothera rubricaulis Klebahn	Kn	NAm	Agr	SubMs	Rud, M-S	Urb&Surb	C
Orobanchaceae							
Phelipanche ramosa (L.) Pomel	Kn	MCAs	Eph	SubMs	Rud, Seg	Surb	R
Oxalidaceae							
Xanthoxalis stricta (L.) Small	Kn	NAm	Epo	Ms	Rud, Seg	Urb&Surb	S
Papaveraceae							
Papaver argemone L.	Ar	MedIT	Epo	SubXr	Rud	Urb	R
Papaver dubium L.	Ar	MedIT	Epo	SubMs	Rud	Urb	R
Papaver rhoeas L.	Ar	MedIT	Epo	SubMs	Rud, Seg	Urb&Surb	C
Papaver somniferum L.	Kn	Med	Col	SubMs	Rud	Urb&Surb	R
Phytolaccaceae							
Phytolacca americana L.	Kn	NAm	Eph	SubMs	Rud	Urb	R
Polemoniaceae							
Phlox paniculata L.	Kn	NAm	Col	SubMs	Rud	Urb	R
Polygonaceae							
Fagopyrum esculentum Moench	Kn	CAs	Eph	SubMs	Rud, Seg	Surb	R
Fagopyrum tataricum (L.) Gaertn.	Kn	CAs	Epo	SubMs	Rud, Seg	Surb	R
Fallopia convolvulus (L.) A. Löve	Ar	As	Epo	SubMs	Rud, Seg	Urb&Surb	C
Reynoutria japonica Houtt.	Kn	EAs	Epo	Ms	Rud	Urb&Surb	S
Reynoutria sachalinensis (F. Schmidt ex Maxim.) Nakai	Kn	EAs	Eph	Ms	Rud	Urb	O
Portulacaceae							
Portulaca oleracea L.	Ar	IT	Epo	SubMs	Rud	Urb&Surb	S
Primulaceae							
Anagallis arvensis L.	Ar	MedIT	Epo	SubMs	Rud, Seg	Surb	R
Ranunculaceae							
Aquilegia vulgaris L.	Kn	Eur	Agr	Ms	F	Urb&Surb	S

Consolida ajacis (L.) Schur	Kn	Med	Epo	SubMs	Rud, Seg	Surb	R
Consolida regalis S. F.Gray	Ar	MedIT	Epo	SubXr	Rud, Seg	Urb&Surb	S
Rosaceae							
Armeniaca vulgaris Lam.	Kn	CAs	Epo	SubMs	Rud, Seg	Surb	S
Cerasus avium (L.) Moench	Kn	EurMedI	Col	SubMs	Seg	Surb	R
Crataegus sanguinea Pall.	Kn	Eur-Sib	Epo	SubMs	F	Urb&Surb	S
Padus serotina (Ehrh.) Ag.	Kn	NAm	Epo	SubMs	F	Urb&Surb	S
Padus virginiana (L.) Roem.	Kn	NAm	Col	SubMs	F	Surb	R
Physocarpus opulifolius (L.) Maxim.	Kn	NAm	Col	SubXr	Rud, F	Urb&Surb	R
Prunus domestica L.	Kn	I & AsMin	Epo	SubMs	Rud, Seg	Urb&Surb	S
Rosa rugosa Thunb.	Kn	EAs	Col	SubMs	Rud, F	Urb&Surb	R
Spiraea media F. Schmidt	Kn	CAs & SAs	Col	Ms	F	Surb	R
Spiraea salicifolia L.	Kn	Sib	Col	Ms	F	Surb	R
Salicaceae							
Populus deltoides Marshall	Kn	MCAs	Epo	SubMs	Rud, F	Urb&Surb	S
Salix fragilis L.	Ar	AsMin	Agr	Ms	Rud, F	Urb&Surb	C
Scrophulariaceae							
Veronica agrestis L.	Ar	Med	Epo	SubMs	Rud, F	Surb	S
Veronica arvensis L.	Ar	MedIT	Epo	SubMs	Rud, M	Urb&Surb	C
Veronica persica Poir.	Kn	S-WAs	Epo	SubMs	Rud, F	Urb&Surb	S
Veronica polita Fries	Ar	MedIT	Epo	SubMs	Rud, M	Surb	S
Veronica triphyllos L.	Ar	As	Epo	SubMs	Rud	Urb&Surb	S
Solanaceae							
Datura stramonium L.	Kn	S-EAs	Epo	SubMs	Rud	Urb&Surb	S
Hyoscyamus niger L.	Kn	Med IT	Epo	SubMs	Rud	Urb&Surb	S
Lycium barbatum L.	Ar	EAs	Epo	SubMs	Rud, F	Urb&Surb	S
Lycopersicon esculentum Mill.	Kn	SAm	Eph	SubMs	Rud, Seg	Urb&Surb	R
Nycandra physaloides (L.) P.Gaertn.	Kn	SAm	Eph	SubMs	Rud, Seg	Urb&Surb	R
Nycotiana rustica L.	Kn	SAm	Eph	Ms	Rud, Seg	Urb&Surb	R
Physalis ixocarpa Brot. ex Hornem.	Kn	CAm	Eph	Ms	Rud, Seg	Urb&Surb	R
Physalis pubescens L.	Kn	SAm	Eph	Ms	Rud, Seg	Urb&Surb	R
Solanum nigrum L.	Ar	SEur	Epo	Ms	Rud	Urb&Surb	S
Solanum tuberosum L.	Kn	SAm	Eph	SubMs	Rud, Seg	Urb&Surb	R
Ulmaceae							
Ulmus pumila L.	Kn	EAs	Epo	SubMs	Rud, F	Urb&Surb	S
Urticaceae							
Urtica cannabina L.	Kn	EAs	Col	SubMs	Rud	Urb&Surb	R
Urtica urens L.	Ar	Med	Epo	SubMs	Rud	Urb&Surb	S
Violaceae							
Viola arvensis Murray	Ar	Med	Epo	Ms	Rud, M, F	Urb&Surb	C
Vitaceae							
Parthenocissus quinquefolia (L.) Planch.	Kn	NAm	Epo	SubMs	Rud, Fm	Urb&Surb	C
Vitis amurensis Rupr.	Kn	EAs	Col	SubMs	Rud	Urb&Surb	R

Explanations: 1 – Time of immigration, Ar – archaeophytes, Kn – kenophytes; 2 – Geographical origin, a – anthropogenic, As – Asian, AsMin – Asia Minor, AtCEur – Atlantic and Central European, Ca – Caucasian, CAm – Central American, CAs – Central Asian, CEur – Central European, CSAm – Central and South American, EAs – Eastern Asian, EM – Eastern Mediterranean, EurSib – Europeo-Siberian, I – Iranian, IMal – Indo-Malayan, IMal&Sud – Indo-Malayan and Sudanian, IT – Irano-Turanian, M – Mediterranean, MAtEur – Mediterraneo-Atlantic-European, MCAs – Mediterraneo-Central-Asian, MedIT – Mediterraneo-Irano-Turanian, MET – Mediterranean Eastern Turanian, MT – Mediterraneo-Turanian, NAm – North American, SAm – South American, SAs – South Asian, S-EAs – South-East Asian, SEur – South European, Sib – Siberian, Sib-Ca – Siberian-Caucasian, un – unknown, SWAs – South-West Asian, WM – Western Mediterranean; 3 – Degree of naturalization, Agr – agriophytes, Col – colonophytes, Eph – ephemerophytes, Epo – epoecophytes; 4 – Ecological groups in relation to water requirements, Hd – hydrophytes, Hg – hygrophytes, Ms – mesophytes, SubMs – submesophytes, SubXr – subxerophytes, Xr – xerophytes; 5 – Ecological-coenotic groups, Aq – aquatic, F – forest, Fm – forest margins, Lit – littoral, M – meadow, M-B – meadow-bog, M-S – meadow-steppe, Psam – psammophytic, Rud – ruderal, Seg – segetal, wM – wet meadow; 6 – Confinedness to the city zones, Surb – suburban zone, Urb – urban zone; 7 – Frequency of occurrence, C – common, O – occasional, R – rare, S – sporadic