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Original article

The dynamics of the taxonomic composition of the alien fraction of the urban flora in the Kyiv urban area, Ukraine

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ABSTRACT

This article presents the results of an investigation into the recent taxonomic composition of the alien fraction of the urban flora in the Kyiv urban area (KUA). Its main dynamic tendencies over the last 20 years have been highlighted, along with the most probable phytoinvasive threats. The obtained linear regression equation allowed forecasting for the growth in the abundance of alien plant species against the background of the enlargement of the Kyiv urban area (r=0.53) and its human population numbers (r=0.87). The alien fraction of the urban flora of the KUA contains 717 taxa of vascular plants (668 species, 41 subspecies, 6 varieties, 1 form and 1 nothoform). In the past 20 years, the number of species of the urban flora of the KUA has increased by at least 166 alien taxa, some of which are representatives of new genera, families, and orders for our flora. This enrichment of the taxonomic structure of the alien fraction in the urban flora of the KUA has caused changes in the ratio of life forms, ecotypes, invasiveness of species, and other features. We specified probable invasive threats, conditioned by the formation of the group of new woody species, hydrophytes capable of rapidly accumulating their phytomass, some genera complexes involving alien and local species, which are inclined to hybridization.

KEY WORDS: alien invasive plants, spreading invasive species, stable and unstable plant taxonomic components

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1. Introduction

The inventory of biological diversity is one of the conditions for its preservation. A relevant task of modern invasive biology is to detect and accurately determine the taxonomic and invasive status of an alien species. Correct and timely determination of the mentioned parameters (taxonomic and invasive status) prevents the spreading of an anthropophyte up to the complete elimination of its invasion. The EU Directive on assessing the risk, related to invasive alien species, sets the taxonomic identification of the species as the first priority (EUROPEAN PARLIAMENT, 2018). In recent decades, scientific interest in urbo-floristic studies has increased (GAERTNER ET AL., 2017), as agglomerations contribute to the spread of alien species and these are interesting from the point of view of taxonomic diversity. All over the world there are many examples of studies of the urban flora of megacities: for example, Warsaw (SUDNIK-WÓJCIKOWSKA, 1988), Berlin (MAURER ET AL., 2000), New York (CLEMANTS & MOORE, 2005), Budapest (RIGÓ ET AL., 2023).

The scientific study of the alien fraction of the flora in Ukraine began a long time ago. The first known floristic publications belong to leading scientists

(Besser, 1822; Rogovych, 1869; Montrezor, 1886–1890; Shmalhauzen, 1895; 1897). These mentioned wild cultivated plants and obligate weeds, including alien species. Some authors continued the study of the flora of the Kyiv urban area, and others joined later (Kotov, 1921, 1979; Malyushytska, 1949; Protopopova, 1974; Mosyakin, 1988, 1996; Chopyk et al., 1998; Burda, 2007, 2011, 2012a, 2012b, 2014; Bagatska, 2007; Mosyakin & Yavorska, 2012; Protopopova et. al, 2014; Burda et al., 2015; Prokopuk, 2016, 2017; Mosyakin & Mándak, 2020; Mosyakin & Mosyakin, 2021; Burda & Koniakin, 2018; 2019; Shynder, 2018; Pryadko et al., 2019; Zub & Prokopuk, 2018, 2020; Koniakin & Gubar, 2022; Prokopuk & Zub, 2022; Shynder et. al., 2022; Koniakin et al., 2022, 2023).

Although the alien species of the Kyiv urban flora have been studied for a long time, there is an urgent need to update the data, to expand the knowledge about alien invasive plants within the KUA, and to deepen the comprehensive analysis of the combined flora. Therefore, we continued the preliminary studies of the taxonomic composition of the alien fraction of the urban flora of the KUA in order to analyze its dynamics at the current stage.

2. Materials and methods

The Kyiv city agglomeration is a settlement and man-made complex with an area of 13,534 km^2 (Agglomerations..., 2017), which was formed in the central part of the East European plain on the border of Polissia in the zone of mixed forests and forest-steppe and partly in the zone of European broad-leaved forests, and crossed by the River Dnipro (Fig. 1).

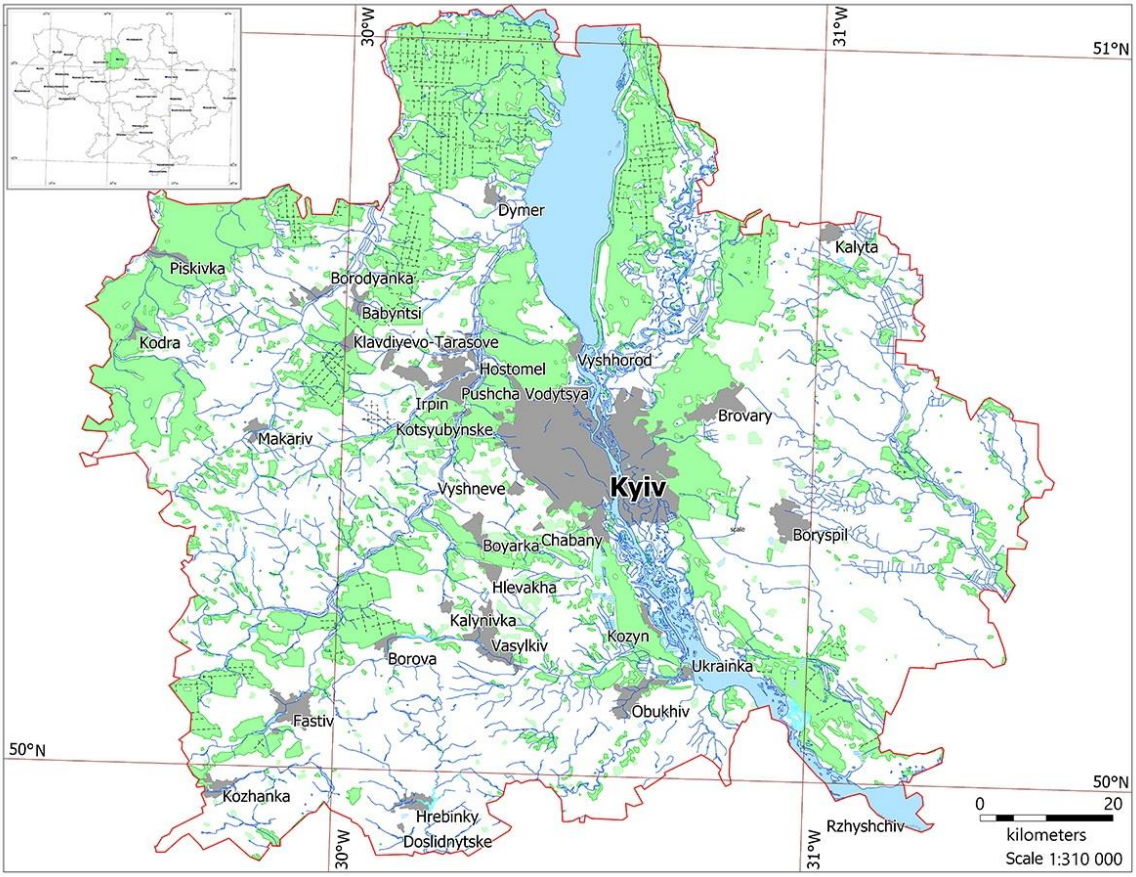

Fig. 1. Map of the location of the Kyiv urban area

The northern part of Kyiv is located in the Poliska lowland, the area of the South-Western right-bank is in the Dnipro upland, and the South-Eastern left bank is in the Dnipro lowland. In addition to the city of Kyiv, the KUA includes 11 cities (Boryspil, Boyarka, Brovary, Bucha, Vasylkiv, Vyshhorod, Vyshneve, Irpin (including the urban village of Vorzel), Gostomel, Kotsyubynske, Obukhiv (including the urban village of Kozyn), 8 urban villages (Glevakha, Gostomel, Kalynivka (Brovarsky district), Kalynivka (Vasylkivsky district), Kotsyubynske, Chabany) and 51 rural territorial communities in the territory of 6 districts

adjacent to Kyiv – this is a total of 70 communities altogether. A single modern urban flora of the KUA is being collated within the specified limits.

The digital data obtained were processed by generally accepted methods of statistical research (ŁOMNICKI, 2011; BUDZHAK, 2013). The work involved general field inspections of the area, detailed route examinations, and processing in laboratory conditions of the flora in the period from 2007–2023. When compiling the list of alien species of the urban flora of the KUA, the authors analyzed all available sources and iNaturalist the online resource of citizen science (https://www.inaturalist.org). The published species list of MOSYAKIN & YAVORSKA (2002) served as the basis for creating an updated checklist of the alien species of the KUA flora.

Verification of the taxonomic composition of the urban flora of the KUA involved the use of general floristic data about Ukraine's flora (FLORA OF THE USSR, 1936–1965; FLORA OF THE EUROPEAN PART OF THE USSR, 1974–1987; FLORA OF THE EUROPEAN PART OF THE USSR, 1989–1996; FLORA OF THE EASTERN EUROPE, 1996–2004; MOSYAKIN & FEDORONCHUK, 1999). After analysis of the previous list of KUA species, some taxa that could have been omitted are left in the list, because the authors did not exclude the possibility of their new findings within the KUA. Some species that have not yet created their local geographic populations and are represented by single individuals or vegetative clones have also been added to the list of alien species of the KUA of urban flora. The scientific names of taxa are presented according to the Plants of the World Online (POWO) (https://powo.science.kew.org/). The scope of genera, families, orders, classes, and divisions is accepted according to the pragmatic classification of Pteridophyta – (MOSYAKIN & TYSHCHENKO, 2010), Pinophyta – Magnoliophyta – according to the classification, adapted to the flora of Ukraine (MOSYAKIN, 2013).

3. Results

The urban flora of Kyiv has been formed for centuries against a background of change both in the city configuration and area and in the growth of its population. Revealing the chronological dynamics of the urban flora of the KUA makes it possible to find out the relationship between the frequency of the appearance of alien species with the growth of the urban area and the population density of the city and its suburbs. A sharp increase in the number of alien plant species was observed between 1979 and 2002 (of about 16 species annually), and since 2003, there was a tendency towards a decrease this number (about 9 species in a year) has been noted. (Fig. 2, Table 1). The authors relate this critical trait of the urban flora of the KUA to the situation when the settlement zone of the city proper was insignificantly enlarged, and the city agglomeration was not yet formed. During the reconstruction of Kyiv after the Second World War, green areas were created, and urban ornamental horticulture developed. When plantations reach the generative age, some tree species become naturalized within their generic complexes, such as the genus *Juglans* (BURDA & KONIAKIN, 2018). The number of new immigrants continues to grow against this background. Although at the beginning of the 21st century, the rise in the volume of the alien fraction of the urban flora slowed down somewhat, the number of new alien species increased due to the rapid enlargement of the area within the KUA. A similar situation with an increase in the alien fraction was described for the urban flora of Kharkiv in the 20th and early 21st centuries (ZVYAGINTSEVA, 2015).

Table 1. The dynamics of detecting the alien species of the urban flora of the KUA against the background of the enlargement of the area and an increase in the population (*Sources. **Smoliy, 2007; ***Kudrytskyi, 1985; ****Ecological Passport, 2022; ***** Agglomerations: international experience, trends, conclusions for Ukraine: analytical note, 2017)

Year	Number of alien species; & source	Area of Kyiv, sq.km.	Number of residents, thousand
1915	111; Vasiliev-Yakovlev, 1915	1911: 123.4**	1913: 627**
1945	143; Kotov, 1979	680***	470***
1949	88; Malyushytska, 1949	680***	180***
1979	173; Kotov, 1979	1980: 788***	2137***
2002	536; Mosyakin & Yavorska, 2002	824****	2616****
2023	717; present study	Kyiv, 836**** KUA, 13534*****	2957.241**** 4280.00****

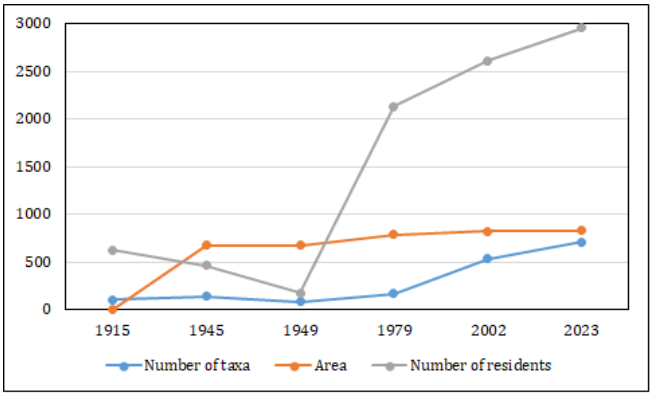

Fig. 2. The dynamics of the number of alien species in the urban flora of the KUA against the background of the enlargement of the area and an increase in the population

According to our study, the alien fraction of the urban flora of the KUA currently includes 717 taxa (Table 1), 357 genera, which belong to 97 families, 44 orders, 6 classes, and three divisions (Pteridophyta, Pinophyta, Magnoliophyta). The checklist of alien species of the urban flora of the Kyiv urban area is listed in Appendix 1 (for the whole research period 1915–2023).

The authors added 166 taxa to the taxonomic composition of the non-native fraction of the urban flora of the KUA (Mosyakin & Yavorska, 2002) (Appendix 2). The sources for expanding the edition of "The cumulative list of alien species in the urban flora of the KUA" after 2002 are as follows: taxa personally found in nature by the authors – 27, established according to scientific publications – 47, those found on the iNaturalist platform – 12, and 80 alien species of the urban flora of the KUA, previously additionally published by the authors (Koniakin et al., 2023).

The reliable ($p<0.05$) correlation dependencies between the abundance of alien plant species and the area of the investigated territory area ($r=0.53$) were determined along with the close correlation ($r=0.87$) between the number of alien plant species and the population sizein the investigated territory (Fig. 3).

The availability of such close correlation dependencies became the basis for the linear regression equation, which allows for forecasting the rise in the abundance of alien plant species under the impact of the enlargement of the urban area and the number of its residents (Fig. 4).

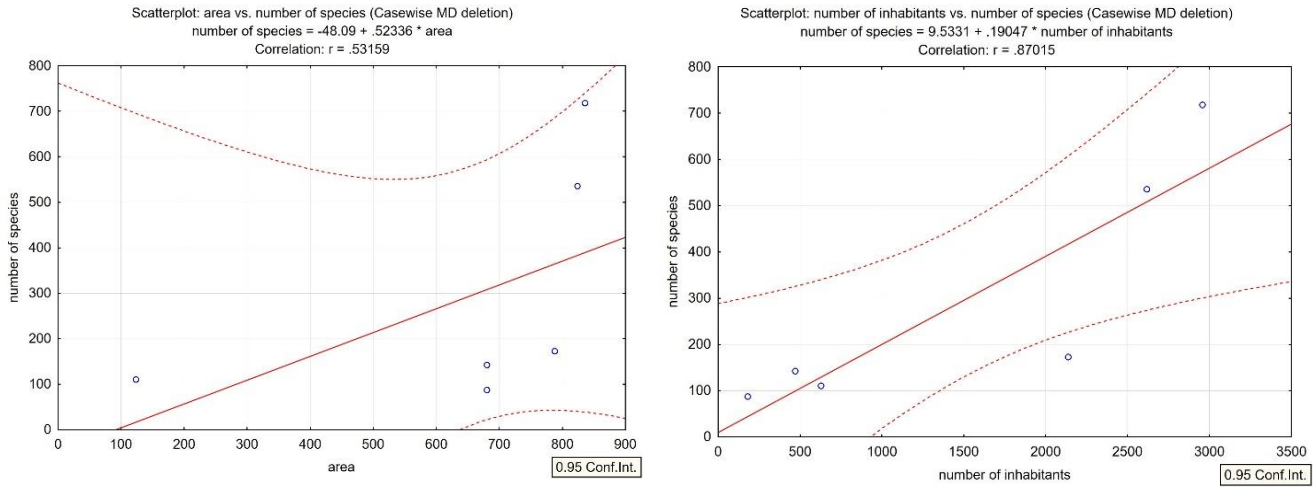

Fig. 3. The correlation dependencies between the abundance of alien plant species, the area of the investigated territory, and the population size in the investigated territory

Due to the nomenclatural adjustments, declared by the Plants of the World Online web site (POWO, 2023), 50 taxa were subject to changes in the rank of pecies. Among these, 32 were reduced to the rank of intraspecific: 26 subspecies, 5 varieties and 1 nothoform, and 18 taxa were reduced to 28 synonyms (Appendix 3).

Below is the general analysis of the cumulative list, composed by the authors, which contains 717 specific taxa. Three out of 97 families are considered to be the main ones: *Asteraceae* – 87 species, *Poaceae* – 79 species and *Brassicaceae* – 59 species. Next follows: *Chenopodiaceae* – 40 species, *Rosaceae* – 33 species, *Fabaceae* – 31, *Lamiaceae* – 28, *Caryophyllaceae* – 20, *Solanaceae* and *Apiaceae* – 19 species, *Polygonaceae* and *Ranunculaceae* – 16 species each, *Boraginaceae, Papaveraceae* – 15 species, *Amaranthaceae* and *Malvaceae* – 14 species, *Onagraceae* – 12 species, *Salicaceae* – 10 species, *Plantaginaceae* – 9 species, *Cucurbitaceae* and *Euphorbiaceae* – 8 species each,

Geraniaceae and *Vitaceae* – 7 species each, *Juglandaceae* – 6 species, *Caprifoliaceae* and *Convolvulacaeae* – 5 species each, *Anacardiaceae, Araceae, Bignoniaceae*, *Crassulaceae, Oleaceae, Primulariaceae* and *Urticaceae* – 4 species each. Thirteen families contain 3 species each, 21 families – 2 species each, and 32 families – 1 species each. For comparison, in the alien fraction of the Czech flora, the largest families in the spectrum coincide with ours: *Asteraceae* – 207, *Poaceae* – 168, *Brassicaceae* – 103, Rosaceae – 98, *Fabaceae* – 95 species (PYŠEK ET AL., 2022). Below is the taxonomic composition and the spectrum of families and genera of the alien floras, (KUA; Czech Republic; Ukraine in general) (Table 2, 3).

The spectrum of genera consists of about two dozen main taxa (Table 3): *Amaranthus* – 14, *Bromus* and *Chenopodium* 12, *Artemisia* – 11, *Oenothera* – 9, *Atriplex*, *Prunus*, *Solanum* and *Veronica* – 8, *Euphorbia*, *Helianthus* and *Lepidium* – 7, *Populus, Echinochloa*, *Geranium*, *Hordeum*, *Malva*, *Juglans*, *Papaver*, *Salvia, Setaria*, *Silene*, *Sisymbrium*, *Spiraea* and *Vicia* – 6 species, *Coryspermum*, *Eragrostis*, *Rumex*, *Symphiotricum* and *Vitis* – 5, 12 genera have 4 species each, 31 – 3, 74 – 2 each, and 213 genera – one species. A number of dominating genera of the KUA flora coincide with the most representative genera of the alien fraction of the Czech flora: *Amaranthus* – 26, *Oenothera* – 23, *Chenopodium* – 18, *Bromus* – 17, *Solanum* – 16 species (PYŠEK ET AL., 2022). The generic spectrum of the alien fraction of the KUA flora is left-side – the genera, containing from 1 to 3 species, make up over one-fourth of the specific taxa of the urban flora. Only one-seventh of the are in five leading genera. This structure of the spectra of families and genera is not typical for the natural flora of Ukraine (ZAVERUHA, 1985), but it almost coincides with the spectra of the corresponding taxa of its alien fraction (PROTOPOPOVA, 1991).

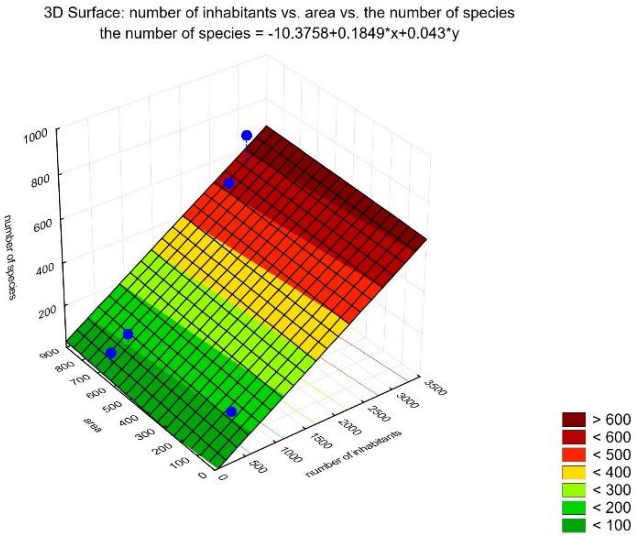

Fig. 4. A linear regressive dependence of the abundance of alien species in the KUA on the urban area and the population size

Table 2. Taxonomic composition and the spectrum of families of the alien floras

Taxon	The alien flora, species			Adventive flora of Ukraine: Protopopova, 1991	Natural flora of Ukraine: Zaveruha, 1985
	KUA, 2023	KUA: Mosyakin & Yavorska, 2002	Czech Republic: Pyšek et al., 2022		
Numbers of species	717	536	1576	1125	4429
Numbers of genera	357	297	630	450	1015
Numbers of families	97	71	122	84	132
Rank of leading families / number of species					
Asteraceae	I/87	II/74	I/207	I/96	I/664
Poaceae	II/79	I/78	II/168	III/65	II/357
Brassicaceae	III/59	III/55	III/ 103	II/75	V/232
Chenopodiaceae	IV/40	IV/33	-	V/29	XIV/88
Rosaceae	V/33	VI/21	IV/ 98	-	IV/237
Fabaceae	VI/31	V/27	V/95	IV/30	III/286
Lamiaceae	VII/28	VII/16	VII/65	VII/22	VII/213
Caryophyllaceae	VIII/20	VI/17	X/37	X/20	VI/222
Apiaceae	IX/19	VII/16	VIII/46	VI/25	IX/148
Solanaceae	IX/19	IX/13	XII/36	-	-
Polygonaceae	X/16	X/11	XIV/29	-	XVII/57
Ranunculaceae	X/16	VIII/15	XV/26	-	XI/137
Boraginaceae	XI/15	XII/10	XIII/31	VIII/21	XIII/101
Papaveraceae	XI/15	XII/5	XVI/25	-/11	-
Amaranthaceae	XII/14	IX/13	VI/81	-/10	-

Malvaceae	XII/14	X/11	XV/26	-	-
Onagraceae	XIII/12	XI/6	IX/40	-	-
Salicaceae	XIV/10	XIII/4	-	-	-
Euphorbiaceae	XV/9	XI/6	-	-	XVIII/54
Plantaginaceae	XV/9	-	XI/37	-	-
Cucurbitaceae	XVI/8	XI/6	-	-/9	-
Geraniaceae	XVII/7	XI/6	-	-	-
Vitaceae	XVII/7	XIII/4	-	-	-
Juglandaceae	XVIII/6	XV /2	-	-	-
Caprifoliaceae	XIX/5	XIII//4	-	-	-
Anacardiaceae,	XX/4	XV/2	-	-	-
Araceae	XX/4	XVI/1	-	-	-
Bignoniaceae	XX/4	-	-	-	-
Crassulaceae	XX/4	XV/2	-	-	-
Oleaceae	XX/4	XIII//4	-	-	-
Primulariaceae	XX/4	-	-	-	-
Urticaceae	XX/4	XV/2	-	-	-
13 families	3 each	-	-	-	-
21 families	2 each	-	-	-	-
32 families	1 each	-	-	-	-

Table 3. The spectrum of genera in the alien floras

Genus	The alien species fraction			Adventive flora of Ukraine: Protopopova, 1991	Natural flora of Ukraine: Zaveruha, 1985
	KUA, 2023	KUA: Mosyakin & Yavorska, 2002	Czech Republic: Pyšek et al., 2022		
Amaranthus	I/14	II/13	I/26	II/10	-
Bromus	II/12	VI/6	V/17	-	-
Chenopodium	II/12	I/19	IV/18	I/17	XXI/30
Artemisia	III/11	III/10	IX/13	-	-
Oenothera	IV/9	VII/5	II/23	III/8	-
Atriplex	V/8	VII/5	XII/10	-	-
Euphorbia	V/8	VII/5	VI/16	-	VI/50
Prunus	V/8	-	X/12	-	-
Solanum	V/8	VIII/4	VI/16	-	-
Veronica	V/8	VII/5	IX/13	-	VII/48
Helianthus	VI/7	VI/6	-	V/5	-
Lepidium	VI/7	VII/5	X/12	-	-
Echinochloa	VII/6	IV/8	-	-	-
Geranium	VII/6	VII/5	IX/13	-	-
Hordeum	VII/6	VIII/4	-	IV/6	-
Juglans	VII/6	X/2	-	-	-
Malva	VII/6	VI/6	-	-	-
Papaver	VII/6	VIII/4	-	-	-
Populus	VII/6	IX/3	-	-	-
Salvia	VIII/6	-	-	-	-
Setaria	VII/6	V/7	-	IV/6	-
Silene	VII/6	VIII/4	IX/11	-	-
Sisymbrium	VII/6	VII/5	-	-	-
Spiraea	VII/6	IX/3	-	-	-
Vicia	VII/6	VI/6	VII/15	-	XIX/33
Corispermum	VIII/5	IX/3	-	-	-
Eragrostis	VIII/5	VII/5	-	-	-
Rumex	VIII/5	VIII/4	-	-	-
Symphyotrichum	VIII/5	-	-	-	-
Vitis	VIII/5	X/2	-	-	-
12 genera	4 each	-	-	-	-
31 genera	3 each	-	-	-	-
74 genera	2 each	-	-	-	-
213 genera	1 each	-	-	-	-

4. Discussion

In the recent two or three decades, increase in the alien fraction has achieved new levels both in the number of taxa, which spontaneously enter the KUA, and in the volume of structural changes, including the temporal dynamics of the taxonomic composition. In the two recent decades, the urban flora of the KUA has been enriched at all the taxonomic levels. This phenomenon has been caused by the impact of time and the expansion of the territory of the flora under investigation. The number of families which were not in the previous list increased by 19 (MOSYAKIN & YAVORSKA, 2002). These new families were as follows: *Agavaceae*, *Araliaceae*, *Azollaceae*, *Bignoniaceae*, *Cactaceae, Celastraceae*, *Colchicaceae*, *Cupressaceae*, *Fagaceae*, *Ginkgoaceae*, *Grossulariaceae*, *Hydrangeaceae*, *Magnoliaceae*, *Menispermaceae*, *Paulowniaceae*, *Phyllanthaceae*, *Platanaceae*, *Pontederiaceae* and *Taxaceae.* Twelve of these families are new to the spontaneous flora of Ukraine: *Agavaceae*, *Araliaceae*, *Bignoniaceae*, *Cactaceae, Celastraceae*, *Ginkgoaceae*, *Magnoliaceae, Menispermaceae*, *Paulowniaceae*, *Phyllanthaceae*, *Platanaceae* and *Pontederiaceae.* Four of these are new to the flora of Ukraine: *Agavaceae*, *Cactaceae, Magnoliaceae* and *Menispermaceae*, according to the checklist for Ukraine's flora (MOSYAKIN & FEDORONCHUK, 1999).

The generic spectrum of the urban flora of the KUA was enriched with 60 genera: *Abies*, *Acalypha*, *Aesculus*, *Aristolochia*, *Brunnera*, *Buddleja*, *Callistephus*, *Campsis*, *Catalpa*, *Celastrus*, *Coleus*, *Deutzia*, *Eichhornia*, *Egeria*, *Elaeagnus*, *Erechtites*, *Eschscholzia*, *Ficus*, *Gaillardia*, *Ginkgo*, *Groenlandia*, *Grossularia*, *Gymnocladus*, *Hedera, Hippophae*, *Hosta*, *Kitaibelia*, *Liriodendron*, *Macleaya*, *Menispermum, Muscari*, *Opuntia, Ornithogalum*, *Paeonia*, *Paulownia*, *Perilla, Phellodendron*, *Philadelphus*, *Phytolacca, Picea*, *Pistia*, *Platanus*, *Primula*, *Prunus*, *Psephellus*, *Rheum*, *Rhus*, *Ribes*, *Riparіosida*, *Roemeria*, *Rubus*, *Taxus*, *Telekia*, *Thuja*, *Torilis*, *Tragus*, *Tricyrtis*, *Verbesina*, *Weigela* and *Zizania.* As a result, the generic spectrum of the spontaneous flora of Ukraine was enriched with 36 genera. 9 genera from this list contain cultivated and naturalized species (MOSYAKIN & FEDORONCHUK, 1999).

Some structural changes of the urban flora appeared, directly related to the degree of potential invasive threat of new species. Among 166 new species, there are over 70 woody plants (trees – about 40, 8 of them are gymnosperms, shrubs – 20, lianas – 10). They are either at the stage of forming local populations or, having formed these, are starting to claim their territory. For instance, *Amelanchier ovalis* has become a common species of suburban forests (CHOPYK ET AL., 1998). Some of them have been pronounced edificators or center of consortiums, thus posing a probable threat as potential invasive species. The results of the studies by European scientists show that alien species of trees are actively expanding their habitat in Europe against the background of climate change (PUCHAŁKA ET AL., 2023).

Most of them are far from new to the flora of Central Europe, where at the end of the last century they were evaluated as agriophytes and epoecophytes (LOHMEYER & SUKOPP, 1992). The exceptions are found in *Catalpa bignonioides*, *C.×erubescens* Carrière, *C. speciosa*, *Ginkgo biloba*, and hybrid forms of *Paulownia tomentosa* (Fig. 5-a). The latter species spreads more actively not from decorative city plantings but from places of cultivation for phytomass purposes. Noteworthy is also *Parietaria judaica*, recognized in Central Europe as an archaeophyte, agriophyte, and epoecophyte (LOHMEYER & SUKOPP, 1992). In Ukraine, this alien species is common on the Crimean Peninsula. The first finding of *Parietaria judaica* for KUA was recorded (SHYNDER ET AL., 2018). *P. judaica* may have penetrated the Syrets arboretum of the KUA along with the planting material in the last decade. This species is actively spreading near greenhouses.

The species, which belong to a life form, not common for our latitudes, – woody lianas – require careful control even now, during a period of initial introduction. The econiche, taken by them in local ecosystems, is empty, and the advantages in the competition are not on the side of the aboriginal species. These lianas are clingy, woody plants that acquire the status of "transformer species" and are able to rapidly transform the structure of local forests. They cling to trees, use them for support, compete for light and other resources, and in the end, local species of trees declined. For instance, these are woody lianas that became naturalized within the KUA in recent years: *Aristolochia macrophylla* (BURDA, 2014), *Campsis radicans* (Fig. 5.-b) *Celastrus flagellaris* (PRYADKO ET AL., 2019), *C. orbiculatus* (MOSYAKIN & MOSYAKIN, 2021), *Menispermum dauricum* (https://www.inaturalist.org/observations/116968142; 10 findings), *Vitis amurensis*, *V. riparia* (SHYNDER, 2019a), *V. vulpina* (SHYNDER ET AL., 2018). Five species of the genus *Vitis* are present in the current urban flora of the KUA. Two more species should be added to the three specified: *V. labrusca*, *V. vinifera*. According to our observations, they were almost inconspicuous in forests, mostly limited to disposal

sites and fences near buildings. After the penetration of expansive species of the *Vitis* genus into the KUA forest ecosystems in the most recent decade, the negative impact of these woody lianas on aboriginal ecosystems is obvious.

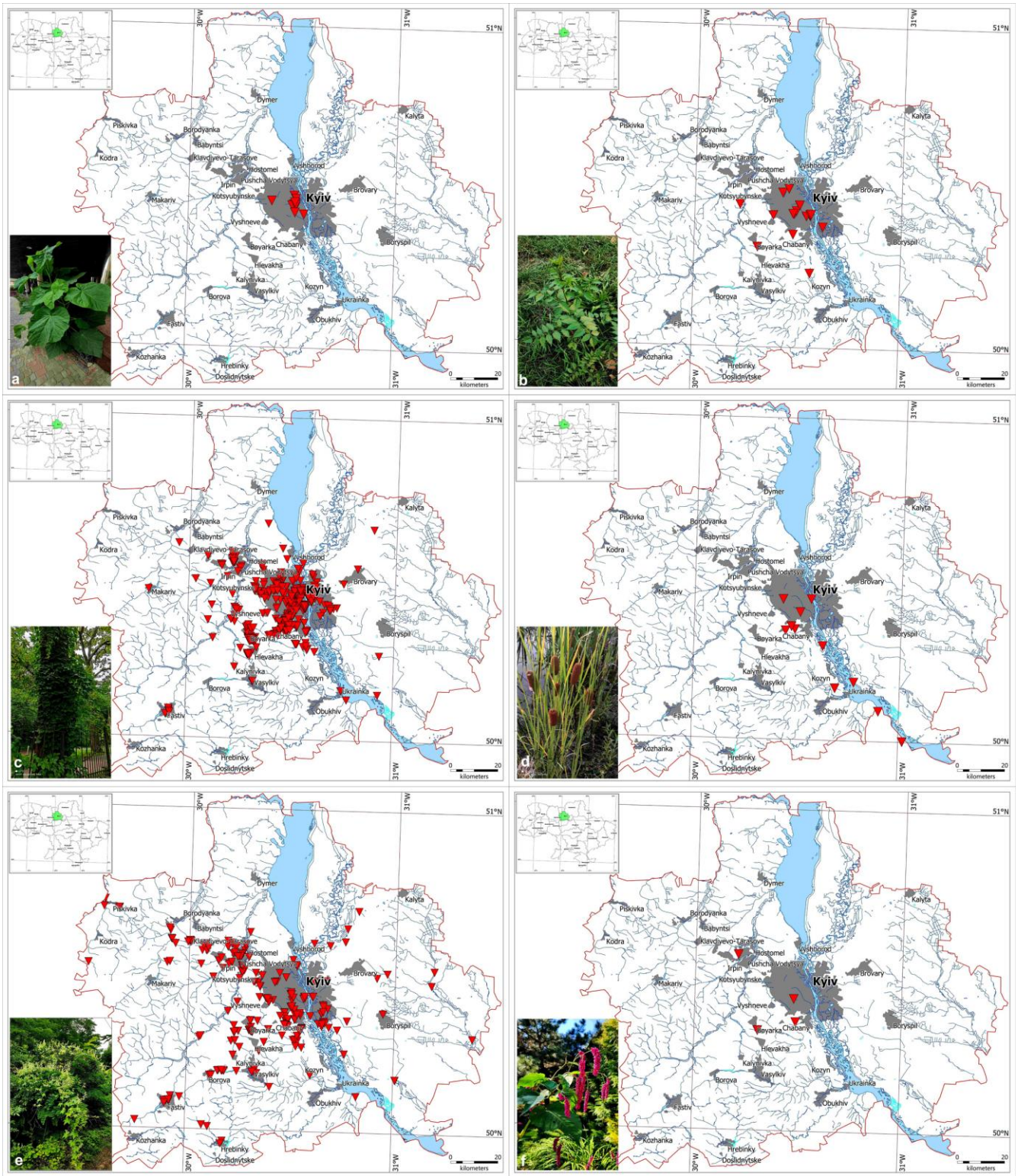

Fig. 5. Distribution of some alien species in the Kyiv Urban Area: a – *Paulownia tomentosa*, b – *Campsis radicans,* c – *Parthenocissus inserta*, d– *Typha laxmannii,* e –*Echinocystis lobata*, f – *Persicaria orientalis*

It should be recognized that the first woody liana in the Kyiv forest ecosystems was the North American *Parthenocissus inserta*. This species was brought to the KUA in the 19th century, almost at the same time as it was introduced to Central Europe (1884), and became naturalized in the most recent 50 years, so now it is an agriophyte, and an epoecophyte (Fig. 5-c). This species is common in hornbeam-oak forests (*Carpinetalia betuli*), including in the territories of the nature reserve fund (BURDA, 2011; 2012b; BURDA ET AL., 2015). In addition to its vertical clingy form, this liana has a terrestrial, slender form, which significantly affects the seasonal synusium of spring ephemeroids of hornbeam-oak forests of the KUA (BURDA, 2012b). By rapidly expanding its vegetative mass, *P. inserta* closes off access to light, and exhausts water and mineral resources required for herbage. This species has already formed consortium with the aboriginal representatives of the biota. It was found that *P. inserta* became the con-centre of the consortia with 17 species of birds, built on trophic and topotype relations – some birds consume the very fruit of the anthropophyte, and the rest eat invertebrates, which settle on the vine, flowers, and fruit of the naturalized plant (SHUPOVA, 2022).

There has been a noteworthy increase in alien hydrophytes in recent years. The list, (MOSYAKIN & YAVORSKA, 2002), contains 4 hydrophytes, whereas our list has 14 of them (about 2%). The hydrophilic flora of the terrestrial globe comprises only 1% of the specific composition of tracheophytes, and in Northern Eurasia – up to 2% (KUSMICHOV & KRASNOVA, 2001). Some species of hydrophytes have periodically occurred in the waters of Kyiv at the end of the 20-th century, but they were not mentioned in the previous list of the urban flora of the KUA. For instance, the occurrence of *Pistia stratiotes* was reported in one of the ponds of Holosiivsky Park in the central part of the city (KOTELEVETS ET AL., 1983). MOSYAKIN (1991b) reported the cultivation of *P. stratiotes* in Kyiv in aquaria, referring to the publication mentioned by us KOTELEVETS ET AL. (1983) about the naturalization of the species, which was not a certain fact. It may be the reason why this species was not mentioned in the final publication (MOSYAKIN & YAVORSKA, 2002). The presence of the species in the Holosiivskyi Pond was confirmed (BURDA, 2007; LUSHPA, 2009). Later, there were some findings of *P. stratiotes* in other districts of Kyiv, but the populations were not stable and often declined after winter. In recent years, the Holosiiv population has recovered, however, it is inferior in number to *P. stratiotes*, which naturalized in the waters of the Dnipro (PROKOPUK, 2017; ZUB & PROKOPUK, 2018; PROKOPUK & ZUB, 2023) and is notable for the "explosive" character of its distribution.

There were reports about *Azolla caroliniana* (PROKOPUK, 2016), *A. filiculoides* (ZUB & PROKOPUK, 2018), *Egeria densa* (BAGATSKA, 2007), *Elodea nuttallii* (CHORNA ET AL., 2006), and *Groenlandia densa* (ZUB & PROKOPUK, 2018) in the Dnipro and its inlets. In addition, there were reports about *Phragmites australis* subsp. *isiacus* (ZUB ET AL., 2022) in the Dnipro within the KUA. According to the information on the iNaturalist platform, *Zizania latifolia* was registered in 9 locations within the KUA, which has already become an agriophyte in the estuaries of large rivers in the South of Ukraine (PROTOPOPOVA, 1991). The rate of alien species settling in Ukrainian hydrohabitats is rather high. Ten years ago, the North American hydrophyte *Lemna turionifera* was first found in Ukraine – in two hydrohabitats on small rivers in the Zhytomyr region and one – in the Chernihiv region (ORLOV & YAKUSHENKO, 2013). The authors predicted a rapid emergence of the species in the waters of the Dnipro. At present, five hydrohabitats with *L. turionifera* have been registered in the Dnipro within the KUA. In the opinion of Ukrainian botanists (DUBYNA ET AL., 2017), at the current stage *Pistia stratiotes* and *Egeria densa* are most dangerous for hydrotopes. They have a broad ecological amplitude and high invasive potential, and climate change promotes their expansion in the water bodies of Ukraine. A longer but unceasing path of penetration and further expansion is demonstrated by *Typha laxmannii*, which has a long history of spreading in Ukraine. In the Manual of Higher Plants of Ukraine VOLODCHENKO (1965) mentioned *T. laxmannii* in water meadows, along ravines, near spring wells only in the South of the Steppe zone, seldom, in the Crimea – only near Sudak. KRASNOVA (1987) in the Manual of Higher Plants of Ukraine indicated the species was found on the banks of rivers, lakes, bays: seldom – in the Forest-Steppe, usually – in the Steppe and in the Crimea. The increase in the amount of *T. laxmannii* directly in Kyiv was first reported by BORTNYAK (1976). This plant was found near the District Road to the South of the National Complex Expocenter of Ukraine (VDNG), in the ditch, on August 07, 1971. The author of this finding noted that later, this species was not present there due to the draining of the area. At present, there are several known locations of *T. laxmannii* in the KUA (Fig. 5-d). For instance, we saw this species in Kyiv, not far from the location, indicated by Bortnyak, between the residential district of Teremky and the Big Belt

Road, near Odeska Square. In a permanent puddle near one of the drain-age man-holes on the lawn, there formed an "island" complex of hydrophilic species (*Iris pseudacorus*, *Phragmites australis*, *Sparganium polyedrum*, a species of *Juncus*, etc.). A small plant of *T. laxmannii* grew and blossomed in the center of this island. As of the end of the last century, only several hydrophytes were noted among the alien species in Central Europe: *Acorus calamus*, *Azolla filiculoides*, *Elodea canadensis* and *E. nuttallii* (LOHMEYER & SUKOPP, 1992).

Among new immigrants are annual herbs and grasses, known for the short duration of their vegetative period, rich seed production, and different morphological and phenological forms of seeds, capable of germinating for several years. For instance, the variety *Bassia scoparia* var. *trichophylla* (*Kochia scoparia* f. *trichophylla*), found by us, is often viewed as a garden form – *K. s.* f. *trichophylla* hort., which has been known for a long time in Ukraine. The area of the Kyiv population of up to 100 sq. m., located in the suburbs of Kyiv, was close to a newly built house on a desolate plot. An immigrant plant attracted our attention because, in spring, it had a rich germination and was inconspicuous. In August-September, it had abundant overgrowth and rich blossom. For instance, it was mentioned by SHMALHAUSEN (1897). ILYIN (1952) indicated that in Ukraine *B. s.* var. *trichophylla* was widely cultivated to produce brooms. In recent years, this plant has become popular in private urban and dacha floricultures. No cases of its use have been noted in the floriculture of Kyiv. According to the reports of our colleagues (MAYOROV ET AL., 2012) *B. s.* var. *trichophylla* was introduced into the plantings in Moscow. The plants, observed by us, do not have column-shaped, or obovate habitus; they stand out among *B. scoparia* due to their pubescent upper part of the shoots and narrow, almost thread-like pubescent leaves. However, it was noted that the character of branching is more important for the differentiation of this variety: basitonic branching is observed among adventive plants, at least large ones, and mesotonic branching is observed in the plants in the culture. According to the observations of Bochkin (MAYOROV ET AL., 2012), self-sown seeds of the adventive variety *B. s.* var. *trichophylla* do not preserve the species characteristics of parental plants and they split.

In the most recent decade, a similar strategy of spreading has been demonstrated in the forests of Kyiv by the Central Asian monocarp *Impatiens parviflora*. In the park, the monument of landscape architecture, Feofania, in the oak-hornbeam forest, the number of plants was 29 per one sq. m., while typical forest species amounted to 3 plants per one sq. m. (BURDA, 2012a). Similar expansion is shown by a herbaceous liana *Echinocystis lobata* (Fig. 5-e). The finding of *Persicaria orientalis* in the KUA was first reported by MOSYAKIN (1988a), and that this decorative plant, became naturalized, and occured seldom in ruderal places, but in 1985–1986 it was found in the fields of spring crops (town of Hrebinky, Bila Tserkva district). PROTOPOPOVA (1991) characterized its status in the flora of Ukraine as a South Asian kenophyte, ergasiophyte, and cosmopolite. In the urban flora of the KUA, *P. orientalis* looks like an ergasiophygophyte with diffuse character of spreading; according to the information of the current means of information registration (https://www.inaturalist.org/observations/183328242) as of September 25, 2023, it had five known locations, including the preserved park Feofania. In 2023, the plant became self-sown here; it had not been cultivated there before, and after its discovery, it has been carefully looked after (Fig. 5-f). Noteworthy is a group of anthropophytes – anecophytes, the distribution of which was limited exclusively to cultivated or highly disturbed soils. These are segetal and ruderal weeds, whose primary origin is unknown. SUKOPP (1998) called them "homeless plants".

A number of alien species, indicated for the urban flora of the KUA, have probably vanished; they are either not present or unnoticed in the territory under investigation due to their low prevalence. For instance, these are species, detected in recent decades, but not found in their first place of discovery, or any other place ever since: *Ficus carica* (BURDA & KONIAKIN, 2019) and *Lagenaria siceraria* (MOSYAKIN, 1992). A completely different group consists of the species that have not been detected within the KUA in the recent 30-40 years: *Adonis aestivalis*, *A. annua*, *A. flammea* (MOSYAKIN & YAVORSKA, 2002); *Aegilops cylindrica*, *Agropyron cristatum*, *Brassica elongata* subsp. *integrifolia* (VASILIEV-YAKOVLEV, 1915); *Capsella rubella* (KOTOV, 1979); *Caucalis platycarpos* (*C. lappula*, *C. daucoides*); *Helianthus petiolaris* (KOTOV, 1979); *Humulus scandens* (ANDRIK ET AL., 2010); *Papaver pavoninum* (*P. ocellatum*), *Roemeria refracta* (DAVYDOV, 2019); *Silene crispata* (BORTNYAK, 1962); *Veronica agrestis* (ROGOVICH, 1869).

The same situation was true for the species, specified below, but according to the confirmed observations of the online resource iNaturalist, they are still present in the urban flora of the KUA. For instance, *Bupleurum rotundifolium* (SHMALHAUSEN, 1895;

https://www.inaturalist.org/observations/170989470). There are eight other species: *Agrostemma githago*, *Colchicum autumnale*, *Corispermum pallasii*, *Gypsophila perfoliata*, *G. vaccaria*, *Lepidium perfoliatum*, *Pilosella bauhini*, *Thymelaea passerina*. Among these, *Agrostemma githago* is a common weed, well-known in Ukraine for a long time. In the 1950s, the leading Ukrainian specialists in agrotechnology of agricultural crops, including such weed researchers as Professor D.K. Larionov and his colleague, I.A. Makodzeba (LARIONOV & MAKODZEBA, 1957), assessed *A. githago* as a malicious segetal weed. This species litters winter and spring grain crops, and grows on uncultivated land. With the change of agricultural technology, *A. githago* is almost not found in the fields. Almost all known locations of this species have vanished. In Kyiv, it can be seen only either in the botanical garden or in private floriculture. At the same time, there is a report about the naturalization of *A. githago* at the beginning of this century in the O.V. Fomin Botanical Garden in Kyiv (BERESKINA ET AL., 2007). Obviously, under these conditions, the species became naturalized due to a completely different strategy of immigration and coexistence with humans. *A. githago* is registered in Kyiv (https://www.inaturalist.org/observations/124016085).

A similar transformation in the survival strategy under urban flora conditions is demonstrated by a number of late segetal weeds with decorative properties. They may have vanished or at least occur seldom and are inconspicuous. We have referred them to the group of "probably vanished species": *Adonis aestivalis*, *A. annua*, *A. flammea* and *Gypsophila vaccaria.* For instance, during the times of devastation in Kyiv after World War II MALUSCHYTSKA (1949) collected *Nigella arvensis* "in the ruins of a house in Khreshchatyk near the Krytyi rynok; *Delphinium consolida* – on the slopes under St. Andrew's Church; *Lepidium perfoliatum* – in Lukianivka, near the cemetery", etc. A group of cultivated forage leguminous species was mentioned as naturalized ones; they were seen along roads, and fields: *Lupinus luteus* and *Trifolium incarnatum* (CHOPYK ET AL., 1998).

Some alien species of flora are adapted to survive in urban conditions thanks to their own reserves of life and environmental conditions. For example, it is unwise to talk about any decorative or practical value to humans of the following two species, but they remain inconspicuous and survive for decades and sometimes hundreds of years.

Thymelaea passerina is well-known in Kyiv as an annual plant, which is a weed. This species was mentioned by ROGOVICH (1869) for the current KUA: Boryspil, Brovary; in Kytayiv, it was seen by SHMALHAUSEN (1897). Last century, BORTNYAK (1962) found *Th. passerina* in dry pastures near the village of Shybene, in Borodianka District. KOTOV (1979) saw this species on the outcrops of clay, chalk, or limestone in Ukraine, it was rarely a weed. PROTOPOPOVA (1991) characterizes this species as an archaeophyte of Mediterranean-Iranian-Turanian origin, an epoecophyte. *Th. passerina* was mentioned in Kyiv and its suburbs (MOSYAKIN & YAVORSKA, 2002). We have not found any later mentions of it in the urban flora of Kyiv in the domestic literature. To the South of KUA, close to the town of Rzhyshchiv, *Th. passerina* grew on the fallow fields (https://www.inaturalist.org/observations/98911326, O.I. Shynder, 05.09.2021).

Tribulus terrestris is common on the coastal sands of the Azov and Black Seas. In Kyiv, the species was brought here and has been known since the end of the 19th century (SHMALHAUSEN, 1895), and some time later, it was reported for Mykilska Sloboda, near roads, as a weed (VASILIEV-YAKOVLEV, 1915). DOBROCHAEVA (1955) characterized *T. terrestris* as a weed on sands, watermelon plantations, kitchen gardens, etc., and, referring to Klokov, she noted: "It grows near Darnytsia." Some authors observed this species in different places of the KUA: BORTNYAK (1976) in Bortnychi; MOSYAKIN (1991a): Kyiv-Pasazhyrskyi, Kyiv-Tovarnyi, Darnytsia railway stations, meat-processing factory, etc. Currently it spreads spontaneously. On 15.09.2023, the iNaturalist platform for the KUA urban flora had 41 reports of findings of *T. terrestris.*

The taxonomic composition of the urban flora of the KUA contains 24 alien hybrid taxa, which belong to 20 genera and 16 families:

Amaranthus×budensis, Bidens×garumnae, *Catalpa×erubescens, Clematis×jackmanii,* *Fragaria×ananassa*, *Helianthus×laetiflorus,* *Iris×germanica*, *Medicago×varia*, *Mentha×piperita,* *Mesembryanthemum×vascosilvae,* *Oenothera×drawertii*, *Oe.×polgari*, *Paeonia×suffruticosa*, *Petunia×atkinsiana*, *Platanus×hispanica*, *Populus×canadensis*, *Reynoutria×bohemica, Salix×fragilis* L., *S.×pendulina* nothof. *pendulina*, *Spiraea×billiardii*, *S.×vanhouttei*, *Symphyotrichum×salignum*, *S.×versicolor*, *Tradescantia×andersoniana*.

This spectrum of hybrid forms in the urban flora is direct confirmation of the role of evolutionary phenomena, including hybridization, in the immigration course of

phytoinvasions, highlighted by modern authors (RICHARDSON ET AL., 2000; BLACKBURN ET AL., 2011; 2014; ZENNI ET AL., 2017). There are known cases of the hybridization of alien species among themselves within the genera of *Juglans* in Kyiv (BURDA, 2019; KONIAKIN & BURDA, 2019) and *Platanus* in Kyiv (GORDIENKO, 1974). According to the observations of Kyiv scientists (DUBYNA ET AL., 2017), the previously mentioned *Phragmites australis* subsp. *isiacus* is inclined to hybridize with the local *P. australis.*

Summing up, we would like to note the role of woody plants, especially lianas, monocarps, and hydrophytes, in the expansion of alien species into the urban flora of the KUA. Noteworthy is the occurrence of hybridization phenomena during phytoinvasions, which leads to contamination of the local phytogenetic gene pool. The high assessment of the negative impact on local ecosystems in the Czech Republic of a number of species attracts attention. These species also make up the newest element of the alien fraction of the urban flora of the KUA. Two out of 40 of the assessed species in the Czech flora – *Populus×canadensis*, *Robinia pseudoacacia,* which are long present in the culture and became naturalized in the KUA, have received the highest impact categories – "massive impact". The impact categories of "major impact" was given to 24 species, including *Ailanthus altissima*, *Arrhenatherum elatius*, *Asclepias syriaca*, *Fraxinus pennsylvanica*, *Lycium barbarum*, *Prunus serotina*, *Reynoutria×bohemica*, *Rudbeckia laciniata*, etc. (PYŠEK ET AL., 2022).

5. Conclusions

In the modern urban flora of the KUA, there is a notable increase in numbers at all taxonomic levels, conditioned territory expansion, increase in human numbers, successful formation of consortive relations between anthropophytes and local biota species, and some changes in the human population.

The dynamics and constancy of the taxonomic composition of the urban flora of the KMA are closely related. In the first place, this dynamic is conditioned by the detection of the novel flora element, which appeared either spontaneously or via naturalization of decorative species, and with the change in the status of the alien species towards invasive aggression or weakening. It is very rare for alien species to remain in a stable state, especially those that have not yet become invasive. The opposite behavior of an alien species – the stability of being in the composition of the urban flora of the KUA, is based on the extreme ability of the alien species to adapt to the change in environmental conditions caused either by natural factors or human activity.

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Appendix 1. Checklist of the alien species of the urban flora of the Kyiv urban area (KUA) (For The Whole Research Period 1915-2023)

PTERIDOPHYTA
AZOLLACEAE: 1. *Azolla caroliniana* Willd.; 2. *Azolla filiculoides* Lam.
PINOPHYTA
TAXACEAE: 3. *Taxus baccata* L.; 4. *Taxus cuspidata* Siebold & Zucc.
PINACEAE: 5. *Abies alba* Mill.; 6. *Abies nordmanniana* (Steven) Spach; 7. *Picea abies* (L.) H.Karst.
CUPRESSACEAE: 8. *Thuja occidentalis* L.; 9. *Thuja plicata* Donn ex D.Don.
GINKGOACEAE: 10. *Ginkgo biloba* L.
MAGNOLIOPHYTA
ARISTOLOCHIACEAE: 11. *Aristolochia macrophylla* Lam.
MAGNOLIACEAE: 12. *Liriodendron tulipifera* L.
ARACEAE: 13. *Acorus calamus* L.; 14. *Lemna turionifera* Landolt; 15. *Pistia stratiotes* L.; 16. *Egeria densa* (Planch.) Casp.
HYDROCHARITACEAE: 17. *Elodea canadensis* Michx.; 18. *Elodea nuttallii* (Planch.) H.St.John
POTAMOGETONACEAE: 19. *Groenlandia densa* (L.) Fourr.
COLCHICACEAE: 20. *Colchicum autumnale* L.
LILIACEAE: 21. *Tricyrtis hirta* (Thunb.) Hook.
IRIDACEAE: 22. *Iris×germanica* L.; 23. *Sisyrinchium septentrionale* E.P.Bicknell
HEMEROCALLIDACEAE: 24. *Hemerocallis fulva* (L.) L.; 25. *Hemerocallis lilioasphodelus* L.
ASPHODELIACEAE: 26. *Anthericum liliago* L.
HYACANTHACEAE: 27. *Muscari botryoides* (L.) Mill.; 28. *Ornithogalum umbellatum* L.
AGAVACEAE: 29. *Hosta plantaginea* (Lam.) Asch.
COMMELINACEAE: 30. *Commelina communis* L.; 31. *Tradescantia×andersoniana* W.Ludw. & Rohweder; 32. *Tradescantia virginiana* L.
PONTEDERIACEAE: 33. *Pontederia crassipes* Mart.
TYPHACEAE: 34. *Typha laxmannii* Lepech.
JUNCACEAE: 35. *Juncus tenuis* Willd.
POACEAE: 36. *Aegilops cylindrica* Host; 37. *Agropyron cristatum* (L.) Gaertn.; 38. *Alopecurus myosuroides* Huds.; 39. *Apera spica-venti* (L.) P.Beauv.; 40. *Arrhenatherum elatius* (L.) P.Beauv. ex J.Presl & C.Presl; 41. *Avena fatua* L.; 42. *Avena nuda* L.; 43. *Avena sativa* L.; 44. *Avena strigosa* Schreb.; 45. *Beckmannia syzigachne* (Steud.) Fernald; 46. *Bothriochloa ischaemum* (L.) Keng; 47. *Bromus arvensis* L.; 48. *Bromus carinatus* Hook. & Arn.; 49. *Bromus catharticus* Vahl; 50. *Bromus commutatus* Schrad.; 51. *Bromus diandrus* Roth; 52. *Bromus hordeaceus* L.; 53. *Bromus japonicus* subsp. *japonicus*; 54. *Bromus scoparius* L.; 55. *Bromus secalinus* L.; 56. *Bromus squarrosus* L.; 57. *Bromus sterilis* L.; 58. *Bromus tectorum* L.; 59. *Cenchrus longispinus* (Hack.) Fernald; 60. *Cynodon dactylon* (L.) Pers.; 61. *Digitaria ischaemum* (Schreb.) Muhl.; 62. *Digitaria sanguinalis* (L.) Scop.; 63. *Echinochloa colonum* (L.) Link; 64. *Echinochloa colonum* subsp. *edulis* (Honda) Banfi & Galasso; 65. *Echinochloa crus-galli* (L.) P.Beauv.; 66. *Echinochloa crus-galli* subsp. *utilis* (Ohwi & Yabuno) T.Koyama; 67. *Echinochloa muricata* (P.Beauv.) Fernald; 68. *Echinochloa oryzoides* (Ard.) Fritsch; 69. *Eleusine indica* (L.) Gaertn.; 70. *Elymus sibiricus* L.; 71. *Elymus violaceus* (Hornem.) J.Feilberg; 72. *Eragrostis cilianensis* (All.) Vignolo ex Janch.; 73. *Eragrostis minor* Host; 74. *Eragrostis multicaulis* Steud.; 75. *Eragrostis pectinacea* (Michx.) Nees; 76. *Eragrostis pilosa* (L.) P.Beauv.; 77. *Eremopyrum orientale* (L.) Jaub. & Spach; 78. *Hordeum bulbosum* L.; 79. *Hordeum jubatum* L.; 80. *Hordeum murinum* L.; 81. *Hordeum murinum* subsp. *leporinum* (Link) Arcang.; 82. *Hordeum vulgare* L.; 83. *Hordeum vulgare* subsp. *distichon* (L.) Körn.; 84. *Leymus racemosus* (Lam.) Tzvelev; 85. *Lolium multiflorum* Lam.; 86. *Lolium persicum* Boiss. & Hohen.; 87. *Lolium remotum* Schrank; 88. *Lolium temulentum* L.; 89. *Panicum capillare* L.; 90. *Panicum miliaceum* L.; 91. *Phalaris canariensis* L.; 92. *Phragmites australis* subsp. *isiacus* (Arcang.) ined.; 93. *Puccinellia hauptiana* (V.I.Krecz.) Kitag.; 94. *Puccinellia nuttalliana* (Schult.) Hitchc.; 95. *Puccinellia poecilantha* (K. Koch) Grossh.; 96. *Puccinellia tenuissima* (Litv. ex V.I.Krecz.) Pavlov; 97. *Sclerochloa dura* (L.) P.Beauv.; 98. *Secale cereale* L.; 99. *Secale sylvestre* Host; 100. *Setaria adhaerens* (Forssk.) Chiov.; 101. *Setaria faberi* R.A.W.Herrm.; 102. *Setaria pumila* (Poir.) Roem. & Schult.; 103. *Setaria italica* (L.) P.Beauv.; 104. *Setaria verticillata* (L.) P. Beauv.; 105. *Setaria viridis* (L.) P.Beauv.; 106. *Sibirotrisetum sibiricum* (Rupr.) Barberá; 107. *Sorghum bicolor* (L.) Moench; 108. *Sorghum bicolor* nothosubsp. *drummondii* (Nees ex Steud.) de Wet ex Davidse; 109. *Sorghum halepense* (L.) Pers.; 110. *Tragus racemosus* (L.) All.; 111. *Triticum aestivum* L.; 112. *Triticum turgidum* subsp. *durum* (Desf.) Husn.; 113. *Zea mays* L.; 114. *Zizania latifolia* (Griseb.) Hance ex F.Muell.
MENISPERMACEAE: 115. *Menispermum dahuricum* DC.
BERBERIDACEAE: 116. *Berberis aquifolium* Pursh; 117. *Berberis thunbergii* DC.; 118. *Berberis vulgaris* L.
RANUNCULACEAE: 119. *Adonis aestivalis* L.; 120. *Adonis annua* L.; 121. *Adonis flammea* Jacq.; 122. *Aquilegia vulgaris* L.; 123. *Clematis×jackmanii* T.Moore; 124. *Clematis vitalba* L.; 125. *Clematis viticella* L.; 126. *Delphinium ajacis* L.; 127. *Delphinium consolida* L.; 128. *Delphinium consolida* subsp. *divaricatum* (Ledeb.) A.Nyar.; 129. *Delphinium consolida* subsp. *paniculatum* (Host) N.Busch; 130. *Nigella arvensis* L.; 131. *Nigella damascena* L.;132. *Nigella sativa* L.; 133. *Nigella segetalis* M.Bieb.;134. *Ranunculus arvensis* L.
PAPAVERACEAE: 135. *Corydalis caucasica* DC.; 136. *Fumaria officinalis* L.; 137. *Fumaria schleicheri* Soy.-Will.; 138. *Fumaria vaillantii* Loisel.; 139. *Eschscholzia californica* Cham.; 140. *Glaucium corniculatum* (L.) Rudolph; 141. *Macleaya cordata* (Willd.) R.Br.; 142. *Papaver albiflorum* (Elkan) Pacz.; 143. *Papaver dubium* L.; 144. *Papaver dubium* subsp. *stevenianum* (Mikheev) Kubát & Šípošová; 145. *Papaver rhoeas* L.; 146. *Papaver setiferum* Goldblatt; 147. *Papaver somniferum* L.; 148. *Roemeria ocellata* (Woronow) Banfi, Bartolucci, J.-M.Tison & Galasso; 149. *Roemeria refracta* DC.
PLATANACEAE: 150. *Platanus×hispanica* Mill. ex Münchh.
PAEONIACEAE: 151. *Paeonia officinalis* L.; 152. *Paeonia×suffruticosa* Andrews
GROSSULARIACEAE: 153. *Ribes aureum* Pursh; 154. *Ribes uva-crispa* L.

CRASSULACEAE: 155. *Petrosedum orientale* ('t Hart) Grulich; 156. *Petrosedum rupestre* (L.) P.V.Heath; 157. *Phedimus spurius* (M.Bieb.) 't Hart.; 158. *Sedum hispanicum* L.
VITACEAE: 159. *Parthenocissus inserta* (A.Kern.) Fritsch; 160. *Parthenocissus quinquefolia* (L.) Plach.; 161. *Vitis amurensis* Rupr.; 162. *Vitis labrusca* L.; 163. *Vitis riparia* Michx.; 164. *Vitis vinifera* L.; 165. *Vitis vulpina* L.
ZYGOPHYLLACEAE: 166. *Tribulus terrestris* L.
FABACEAE: 167. *Amorpha fruticosa* L.; 168. *Astragalus onobrychis* L.; 169. *Caragana arborescens* Lam.; 170. *Caragana frutex* (L.) K.Koch; 171. *Gleditsia triacanthos* L.; 172. *Gymnocladus dioica* Lam.; 173. *Lathyrus odoratus* L.; 174. *Lathyrus sativus* L.; 175. *Lathyrus tuberosus* L.; 176. *Lupinus angustifolius* L.; 177. *Lupinus polyphyllus* Lindl.; 178. *Medicago minima* (L.) Bartal.; 179. *Medicago sativa* L.; 180. *Medicago×varia* Martyn; 181. *Onobrychis viciifolia* Scop.; 182. *Ornithopus sativus* Brot.; 183. *Robinia hispida* L.; 184. *Robinia neomexicana* A.Gray; 185. *Robinia pseudoacacia* L.; 186. *Robinia viscosa* Michx. ex Vent.; 187. *Trifolium hybridum* L.; 188. *Trifolium incarnatum* L.; 189. *Trifolium resupinatum* L.; 190. *Trifolium pratense* subsp. *pratense*; 191. *Trigonella caerulea* (L.) Ser.; 192. *Vicia faba* L.; 193. *Vicia hirsuta* (L.) Gray; 194. *Vicia sativa* subsp. *sativa*; 195. *Vicia sativa* subsp. *nigra* Ehrh.; 196. *Vicia tetrasperma* (L.) Schreb.; 197. *Vicia villosa* subsp. *villosa*
ROSACEAE: 198. *Amelanchier canadensis* (L.) Medik.; 199. *Amelanchier ovalis* Medik.; 200. *Aronia melanocarpa* (Michx.) Elliot; 201. *Chaenomeles japonica* (Thunb.) Lindl. ex Spach; 202. *Cotoneaster laxiflorus* J.Jacq. ex Lindl.; 203. *Cotoneaster melanocarpus* Fischer ex Blytt; 204. *Fragaria×ananassa* (Duchesne ex Weston) Duchesne ex Rozier; 205. *Malus baccata* (L.) Borkh.; 206. *Malus domestica* (Suckow) Borkh.; 207. *Physocarpus opulifolius* (L.) Maxim.; 208. *Potentilla indica* (Andr.) Th.Wolf; 209. *Potentilla longifolia* Willd. ex D.F.K.Schltdl.; 210. *Potentilla supina* subsp. *paradoxa* (Nutt.) Soják; 211. *Potentilla tergemina* Soják; 212. *Prunus armeniaca* L.; 213. *Prunus cerasifera* Ehrh.; 214. *Prunus cerasus* L.; 215. *Prunus domestica* L.; 216. *Prunus mahaleb* L.; 217. *Prunus serotina* Ehrh.; 218. *Prunus tomentos* Thunb.; 219. *Prunus virginiana* L.; 220. *Rosa rugosa* Thunb.; 221. *Rubus occidentalis* L.; 222. *Sanguisorba minor* subsp. *balearica* (Bourg. ex Nyman) Muñoz Garm. & C.Navarro; 223. *Sanguisorba minor* subsp. *minor*; 224. *Sorbaria sorbifolia* (L.) A.Braun; 225. *Spiraea×billardii* Hérincq; 226. *Spiraea chamaedryfolia* L.; 227. *Spiraea douglasii* Hook.; 228. *Spiraea japonica* L.f.; 229. *Spiraea salicifolia* L.; 230. *Spiraea×vanhouttei* (Briot) Carrière
ELAEAGNACEAE: 231. *Elaeagnus angustifolia* L.; 232. *Hippophaë rhamnoides* L.
ULMACEAE: 233. *Celtis occidentalis* L.; 234. *Ulmus pumila* L.
CANNABACEAE: 235. *Cannabis sativa* L.; 236. *Humulus scandens* (Lour.) Merr.
MORACEAE: 237. *Ficus carica* L.; 238. *Morus alba* L.; 239. *Morus rubra* L.
URTICACEAE: 240. *Parietaria judaica* L.; 241. *Parietaria officinalis* L.; 242. *Urtica cannabina* L.; 243. *Urtica urens* L.
FAGACEAE: 244. *Fagus sylvatica* L.; 245. *Quercus palustris* Münchh.; 246. *Quercus rubra* L.
JUGLANDACEAE: 247. *Juglans cinerea* L.; 248. *Juglans mandshurica* Maxim.; 249. *Juglans mandshurica* var. *cordiformis* (Makino) Kitam.; 250. *Juglans mandshurica* var. *sachalinensis* (Komatsu) Kitam.; 251. *Juglans nigra* L.; 252. *Juglans regia* L.
BETULACEAE: 253. *Corylus colurna* L.
CUCURBITACEAE: 254. *Bryonia alba* L.; 255. *Citrullus lanatus* (Thunb.) Matsum. & Nakai; 256. *Cucurbita pepo* L.; 257. *Ecballium elaterium* (L.) A.Rich.; 258. *Echinocystis lobata* (Michx.) Torr. & A.Gray; 259. *Lagenaria siceraria* (Molina) Standl; 260. *Sicyos angulatus* L.; 261. *Thladiantha dubia* Bunge
CELASTRACEAE: 262. *Celastrus orbiculatus* Thunb.; 263. *Celastrus flagellaris* Rupr.
OXALIDACEAE: 264. *Oxalis corniculata* L.; 265. *Oxalis dillenii* Jacq.; 266. *Oxalis stricta* L.
SALICACEAE: 267. *Populus balsamifera* L.; 268. *Populus×canadensis* Moench; 269. *Populus deltoides* W.Bartram ex Marshall; 270. *Populus nigra* f. *italica* (Münchh.) A.Andersen; 271. *Populus suaveolens* Fisch. ex Poit. & A.Vilm.; 272. *Populus tristis* Fisch.; 273. *Salix babylonica* L.; 274. *Salix×fragilis* L.; 275. *Salix×pendulina* nothof. *pendulina*
VIOLACEAE: 276. *Viola sororia* Willd.
EUPHORBIACEAE: 277. *Acalypha australis* L.; 278. *Euphorbia davidii* Subils; 279. *Euphorbia dentata* Michx.; 280. *Euphorbia falcata* L.; 281. *Euphorbia helioscopia* L.; 282. *Euphorbia humifusa* Willd.; 283. *Euphorbia maculata* L.; 284. *Euphorbia marginata* Pursh; 285. *Euphorbia peplus* L.
PHYLLANTHACEAE: 286. *Flueggea suffruticosa* (Pall.) Baill.
LINACEAE: 287. *Linum usitatissimum* L.
GERANIACEAE: 288. *Erodium cicutarium* (L.) L'Hér.; 289. *Geranium dissectum* L.; 290. *Geranium molle* L.; 291. *Geranium nepalense* Sweet; 292. *Geranium pusillum* L.; 293. *Geranium pyrenaicum* Burm. f.; 294. *Geranium sibiricum* L.
ONAGRACEAE: 295. *Epilobium ciliatum* subsp. *ciliatum*; 296. *Epilobium pseudorubescens* A.K.Skvortsov; 297. *Epilobium saximontanum* Hausskn.; 298. *Oenothera biennis* L.; 299. *Oenothera×drawertii* Renner ex Rostański; 300. *Oenothera elata* subsp. *elata*; 301. *Oenothera glazioviana* Micheli; 302. *Oenothera laciniata* Hill; 303. *Oenothera oakesiana* (A.Gray) J.W.Robbins ex S.Watson; 304. *Oenothera×polgari* Rostański; 305. *Oenothera villosa* Thunb.; 306. *Oenothera villosa* subsp. *villosa*
ANACARDIACEAE: 307. *Cotinus coggygria* Scop.; 308. *Rhus glabra* L.; 309. *Rhus typhina* L.; 310. *Toxicodendron radicans* (L.) Kuntze
ACERACEAE: 311. *Acer negundo* L.; 312. *Acer pseudoplatanus* L.; 313. *Acer saccharinum* L.
HIPURICACEAE: 314. *Aesculus pavia* L.; 315. *Aesculus hippocastanum* L.
RUTACEAE: 316. *Phellodendron amurense* Rupr.; 317. *Ptelea trifoliata* L.
SIMAROUBACEAE: 318. *Ailanthus altissima* (Mill.) Swingle
MALVACEAE: 319. *Abutilon theophrasti* Medik.; 320. *Alcea rosea* L.; 321. *Althaea officinalis* L.; 322. *Hibiscus syriacus* L.; 323. *Hibiscus trionum* L.; 324. *Kitaibelia vitifolia* Willd.; 325. *Malva alcea* L.; 326. *Malva neglecta* Wallr.; 327. *Malva pusilla* Sm.; 328. *Malva sylvestris* L.; 329. *Malva trimestris* (L.) Salisb.; 330. *Malva verticillata* L.; 331. *Pariosida hermaphrodita* (L.) Weakley & D.B.Poind.; 332. *Sida rhombifolia* L.
TILIACEAE: 333. *Tilia americana* L.; 334. *Tilia dasystyla* subsp. *caucasica* (V.Engl.) Pigott
THYMELAEACEAE: 335. *Thymelaea passerina* (L.) Coss. & Germ.

RESEDACEAE: 336. *Reseda lutea* L.; 337. *Reseda luteola* L.
BRASSICACEAE: 338. *Arabidopsis thaliana* (L.) Heynh.; 339. *Armoracia rusticana* P.Gaertn., B.Mey. & Scherb.; 340. *Brassica elongata* subsp. *integrifolia* (Boiss.) Breistr.; 341. *Brassica juncea* (L.) Czern.; 342. *Brassica napus* L.; 343. *Brassica rapa* L.; 344. *Bunias erucago* L.; 345. *Bunias orientalis* L.; 346. *Camelina alyssum* (Mill.) Thell.; 347. *Camelina microcarpa* Andrz. ex DC.; 348. *Camelina sativa* (L.) Crantz; 349. *Capsella bursa-pastoris* (L.) Medik.; 350. *Capsella orientalis* Klokov; 351. *Capsella rubella* Reut.; 352. *Chorispora tenella* (Pall.) DC.; 353. *Descurainia sophia* (L.) Webb ex Prantl; 354. *Diplotaxis muralis* (L.) DC.; 355. *Diplotaxis tenuifolia* (L.) DC.; 356. *Eruca vesicaria* (L.) Cav.; 357. *Erysimum canum* (Piller & Mitterp.) Polatschek; 358. *Erysimum cheiranthoides* L.; 359. *Erysimum cuspidatum* (M.Bieb.) DC.; 360. *Erysimum repandum* L.; 361. *Euclidium syriacum* (L.) W.T.Aiton; 362. *Goldbachia laevigata* DC.; 363. *Hesperis matronalis* L.; 364. *Hirschfeldia incana* (L.) Lagr.-Foss.; 365. *Iberis amara* L.; 366. *Iberis umbellata* L.; 367. *Isatis tinctoria* L.; 368. *Lepidium appelianum* Al-Shehbaz; 369. *Lepidium densiflorum* Schrad.; 370. *Lepidium draba* L.; 371. *Lepidium latifolium* L.; 372. *Lepidium perfoliatum* L.; 373. *Lepidium ruderale* L. 374. *Lepidium sativum* L.; 375. *Lobularia maritima* (L.) Desv.; 376. *Lunaria annua* L.; 377. *Matthiola longipetala* (Vent.) DC.; 378. *Matthiola longipetala* subsp. *bicornis* (Sm.) P.W.Ball; 379. *Matthiola incana* (L.) W.T.Aiton; 380. *Mutarda nigra* (L.) Bernh; 381. *Myagrum perfoliatum* L.; 382. *Neslia paniculata* (L.) Desv.; 383. *Raphanus raphanistrum* subsp. *raphanistrum*; 384. *Raphanus raphanistrum* subsp. *sativus* (L.) Domin; 385. *Rapistrum perenne* (L.) All.; 386. *Rapistrum rugosum* (L.) All.; 387. *Rhamphospermum arvense* (L.) Besser; 388. *Sinapis alba* L.; 389. *Sinapis alba* subsp. *dissecta* (Lag.) Simonk.; 390. *Sisymbrium altissimum* L.; 391. *Sisymbrium loeselii* L.; 392. *Sisymbrium officinale* (L.) Scop.; 393. *Sisymbrium orientale* L.; 394. *Sisymbrium polymorphum* (Murray) Roth; 395. *Sisymbrium volgense* M.Bieb. ex E.Fourn.; 396. *Thlaspi arvense* L.
PLUMBAGINACEAE: 397. *Limonium scoparium* (Pall. ex Willd.) Stankov
POLYGONACEAE: 398. *Fagopyrum esculentum* Moench; 399. *Fagopyrum tataricum* (L.) Gaertn.; 400. *Fallopia baldschuanica* (Regel) Holub; 401. *Fallopia convolvulus* (L.) Á.Löve; 402. *Persicaria orientalis* (L.) Spach; 403. *Polygonum ramosissimum* Michx.; 404. *Reynoutria×bohemica* Chrtek & Chrtková; 405. *Reynoutria japonica* Houtt.; 406. *Reynoutria sachalinensis* (F.Schmidt) Nakai; 407. *Rheum rhabarbarum* L.; 408. *Rheum rhaponticum* L.; 409. *Rumex longifolius* DC.; 410. *Rumex patientia* L.; 411. *Rumex pulcher* L.; 412. *Rumex stenophyllus* Ledeb.; 413. *Rumex triangulivalvis* (Danser) Rech.f.
CARYOPHYLLACEAE: 414. *Agrostemma githago* L.; 415. *Atocion armeria* (L.) Raf.; 416. *Dianthus barbatus* L.; 417. *Dianthus trifasciculatus* subsp. *pseudobarbatus* (Schmalh.) Jalas; 418. *Eremogone saxatilis* (L.) Ikonn.; 419. *Gypsophila perfoliata* L.; 420. *Gypsophila vaccaria* (L.) Sm.; 421. *Petrorhagia saxifraga* (L.) Link; 422. *Saponaria officinalis* L.; 423. *Scleranthus annuus* L.; 424. *Silene crispata* Steven; 425. *Silene csereii* Baumg.; 426. *Silene chalcedonica* (L.) E.H.L.Krause; 427. *Silene dichotoma* Ehrh.; 428. *Silene gallica* L.; 429. *Silene pendula* L.; 430. *Spergula arvensis* L.; 431. *Spergula arvensis* subsp. *arvensis*; 432. *Spergula morisonii* Boreau.
AMARANTHACEAE: 433. *Amaranthus albus* L.; 434. *Amaranthus blitoides* S. Watson; 435. *Amaranthus blitum* L.; 436. *Amaranthus×budensis* Priszter; 437. *Amaranthus caudatus* L.; 438. *Amaranthus cruentus* L.; 439. *Amaranthus graecizans* subsp. *silvestris* (Vill.) Brenan; 440. *Amaranthus hybridus* L.; 441. *Amaranthus hypochondriacus* L.; 442. *Amaranthus palmeri* S.Watson; 443. *Amaranthus powellii* S.Watson; 444. *Amaranthus retroflexus* L.; 445. *Amaranthus spinosus* L.; 446. *Amaranthus tuberculatus* (Moq.) J.D.Sauer.
CHENOPODIACEAE: 447. *Atriplex hortensis* L.; 448. *Atriplex littoralis* L.; 449. *Atriplex micrantha* Ledeb.; 450. *Atriplex prostrata* Boucher ex DC.; 451. *Atriplex prostrata* subsp. *calotheca* (Rafn) M.A.Gust.; 452. *Atriplex rosea* L.; 453. *Atriplex sagittata* Borkh.; 454. *Atriplex tatarica* L.; 455. *Ceratocarpus arenarius* L.; 456. *Bassia scoparia* (L.) A.J. Scott; 457. *Blitum virgatum* L.; 458. *Chenopodiastrum hybridum* (L.) S.Fuentes, Uotila & Borsch; 459. *Chenopodiastrum murale* (L.) S.Fuentes, Uotila & Borsch; 460. *Chenopodium album* L.; 461. *Chenopodium album* var. *album*; 462. *Chenopodium album* var. *reticulatum* (Aellen) Uotila; 463. *Chenopodium album* var. *missouriense* (Aellen) Bassett & Crompton; 464. *Chenopodium betaceum* Andrz.; 465. *Chenopodium berlandieri* Moq.; 466. *Chenopodium ficifolium* Sm.; 467. *Chenopodium opulifolium* Schrad. ex W.D.J.Koch & Ziz; 468. *Chenopodium pratericola* Rydb.; 469. *Chenopodium striatiforme* Murr; 470. *Chenopodium ucrainicum* Mosyakin & Mandàk; 471. *Chenopodium vulvaria* L.; 472. *Corispermum declinatum* Stephan ex Iljin; 473. *Corispermum elongatum* Bunge ex Maxim.; 474. *Corispermum pallasii* Steven; 475. *Corispermum pallasii* subsp. *membranaceum* (Bisch. ex Shnittspalm) Tzvelev; 476. *Corispermum redowskii* Roem. & Schult.; 477. *Dysphania ambrosioides* (L.) Mosyakin & Clemants; 478. *Dysphania botrys* (L.) Mosyakin & Clemants; 479. *Dysphania schraderiana* (Schult.) Mosyakin & Clemants; 480. *Lipandra polysperma* (L.) S.Fuentes, Uotila & Borsch; 481. *Oxybasis rubra* (L.) S.Fuentes, Uotila & Borsch; 482. *Oxybasis urbica* (L.) S.Fuentes, Uotila & Borsch; 483. *Polycnemum arvense* L.; 484. *Salsola collina* Pall.; 485. *Salsola tragus* L.; 486. *Spinacia oleracea* L.
MESEMBRYANTHEMACEAE: 487. Mesembryanthemum ×vascosilvae (Gideon F.Sm., E.Laguna, F.Verloove & P.P.Ferrer) Sáez & Aymerich
PHYTOLACCACEAE: 488. *Phytolacca acinosa* Roxb.; 489. *Phytolacca americana* L.
NYCTAGINACEAE: 490. *Mirabilis nyctaginea* (Michx.) MacMill.
PORTULACACEAE: 491. *Portulaca grandiflora* Hook.; 492. *Portulaca oleracea* L.
CACTACEAE: 493. *Opuntia humifusa* (Raf.) Raf.
CORNACEAE: 494. *Cornus alba* L.; 495. *Cornus sanguinea* subsp. *australis* (C.A.Mey.) Jáv.; 496. *Cornus sericea* L.
HYDRANGEACEAE: 497. *Deutzia scabra* Thunb.; 498. *Philadelphus coronarius* L.; 499. *Philadelphus microphyllus* A.Gray
BALSAMINACEAE: 500. *Impatiens balsamina* L.; 501. *Impatiens glandulifera* Royle; 502. *Impatiens parviflora* DC.
POLEMELIACEAE: 503. *Phlox paniculata* L.; 504. *Phlox subulata* L.
PRIMULARIACEAE: 505. *Lysimachia arvensis* (L.) U.Manns & Anderb.; 506. *Lysimachia punctata* L. 507. *Primula veris* L.; 508. *Primula veris* subsp. *macrocalyx* (Bunge) Lüdi
RUBIACEAE: 509. *Galium rubioides* L.; 510. *Galium spurium* L.; 511. *Sherardia arvensis* L.
APOCYNACEAE: 512. *Apocynum cannabinum* L.; 513. *Asclepias syriaca* L.; 514. *Vinca minor* L.
BORAGINACEAE: 515. *Anchusa officinalis* L.; 516. *Borago officinalis* L.; 517. *Brunnera macrophylla* (Adams) I.M.Johnst.; 518. *Brunnera sibirica* Steven; 519. *Buglossoides arvensis* (L.) I.M.Johnst.; 520. *Cynoglossum officinale* L.; 521. *Echium plantagineum* L.;

522. *Heliotropium sibiricum* (L.) J.I.M.Melo; 523. *Lappula marginata* (M.Bieb.) Gürke; 524. *Lappula squarrosa* (Retz.) Dumort.; 525. *Myosotis arvensis* (L.) Hill; 526. *Phacelia tanacetifolia* Benth.; 527. *Symphytum asperum* Lepech.; 528. *Symphytum caucasicum* M.Bieb.; 529. *Symphytum officinale* subsp. *officinale*

CONVOLVULACEAE: 530. *Calystegia sepium* subsp. *spectabilis* Brummitt; 531. *Ipomoea hederacea* Jacq.; 532. *Ipomoea purpurea* (L.) Roth

CUSCUTACEAE: 533. *Cuscuta campestris* Yunck.; 534. *Cuscuta gronovii* Willd. ex Schult.

SOLANACEAE: 535. *Alkekengi officinarum* Moench; 536. *Datura innoxia* Mill.; 537. *Datura stramonium* L.; 538. *Datura wrightii* Regel; 539. *Hyoscyamus niger* L.; 540. *Lycium barbarum* L.; 541. *Lycium chinense* Mill.; 542. *Nicandra physalodes* (L.) Gaertn; 543. *Nicotiana alata* Link & Otto; 544. *Petunia×atkinsiana* (Sweet) D.Don & W.H.Baxter; 545. *Physalis ixocarpa* Brot. ex Hornem.; 546. *Solanum angustifolium* Mill.; 547. *Solanum carolinense* L.; 548. *Solanum heterodoxum* Dunal; 549. *Solanum hoehnei* C.V.Morton; 550. *Solanum lycopersicum* L.; 551. *Solanum nigrum* L.; 552. *Solanum rostratum* Dunal; 553. *Solanum tuberosum* L.

OLEACEAE: 554. *Fraxinus americana* L.; 555. *Fraxinus pennsylvanica* Marshall; 556. *Ligustrum vulgare* L.; 557. *Syringa vulgaris* L.

PLANTAGINACEAE: 558. *Antirrhinum majus* L.; 559. *Veronica agrestis* L.; 560. *Veronica arvensis* L.; 561. *Veronica cardiocarpa* (Kar. & Kir.) Walp.; 562. *Veronica filiformis* Sm.; 563. *Veronica hederifolia* L.; 564. *Veronica persica* Poir.; 565. *Veronica polita* Fr.; 566. *Veronica triphyllos* L.

SCROPHURIACEAE: 567. *Buddleja davidii* Franch.; 568. *Digitalis purpurea* L.

LAMIACEAE: 569. *Ballota nigra* L.; 570. *Dracocephalum thymiflorum* L.; 571. *Elsholtzia ciliata* (Thunb.) Hyl.; 572. *Galeopsis ladanum* L.; 573. *Hyssopus officinalis* L.; 574. *Lamium album* L.; 575. *Lamium amplexicaule* L.; 576. *Lamium purpureum* L.; 577. *Leonurus cardiaca* L.; 578. *Marrubium vulgare* L.; 579. *Melissa officinalis* L.; 580. *Mentha arvensis* L.; 581. *Mentha×piperita* L.; 582. *Mentha spicata* L.; 583. *Nepeta cataria* L.; 584. *Nepeta racemosa* Lam.; 585. *Coleus scutellarioides* (L.) Benth.; 586. *Perilla frutescens* (L.) Britton; 587. *Salvia hispanica* L.; 588. *Salvia nemorosa* subsp. *pseudosylvestris* (Stapf) Bornm.; 589. *Salvia reflexa* Hornem.; 590. *Salvia sclarea* L.; 591. *Salvia splendens* Sellow ex Nees; 592. *Salvia yangii* B.T. Drew; 593. *Sideritis montana* L.; 594. *Stachys annua* (L.) L.; 595. *Stachys byzantina* K.Koch; 596. *Stachys germanica* L.

PAULOWNIACEAE: 597. *Paulownia tomentosa* (Thunb.) Steud.

VERBENACEAE: 598. *Verbena officinalis* L.

BIGNONIACEAE: 599. *Campsis radicans* (L.) Bereau; 600. *Catalpa bignonioides* Walter; 601. *Catalpa×erubescens* Carrière; 602. *Catalpa speciosa* Teas

CAMPANULACEAE: 603. *Campanula medium* L.

ASTERACEAE: 604. *Achillea micrantha* Willd.; 605. *Ageratum houstonianum* Mill.; 606. *Ambrosia artemisiifolia* L.; 607. *Ambrosia trifida* L.; 608. *Anthemis arvensis* L.; 609. *Anthemis cotula* L.; 610. *Artemisia absinthium* L.; 611. *Artemisia annua* L.; 612. *Artemisia argyi* H.Lev. & Vaniot; 613. *Artemisia dracunculus* L.; 614. *Artemisia glauca* Pall. ex Willd.; 615. *Artemisia rubripes* Nakai; 616. *Artemisia selengensis* Turcz. ex Besser; 617. *Artemisia sieversiana* Ehrh. ex Willd.; 618. *Artemisia tournefortiana* Rchb.; 619. *Artemisia verlotiorum* Lamotte; 620. *Artemisia umbrosa* (Besser) Turcz. ex Verl.; 621. *Bellis perennis* L.; 622. *Bidens connata* Muchl. ex Willd.; 623. *Bidens×garumnae* Jeanj. & Debray; 624. *Bidens frondosa* L.; 625. *Calendula officinalis* L.; 626. *Callistephus chinensis* (L.) Nees; 627. *Carduus acanthoides* L.; 628. *Carduus nutans* L.; 629. *Centaurea cyanus* L.; 630. *Centaurea depressa* M.Bieb.; 631. *Centaurea diffusa* Lam.; 632. *Centaurea trichocephala* M.Bieb. ex Willd.; 633. *Cichorium endivia* L.; 634. *Cichorium intybus* L.; 635. *Coreopsis grandiflora* Hogg ex Sweet; 636. *Coreopsis lanceolata* L.; 637. *Cosmos bipinnatus* Cav.; 638. *Cyclachaena xanthiifolia* (Nutt.) Fresen.; 639. *Erechtites hieraciifolius* (L.) Raf. ex DC.; 640. *Erigeron annuus* (L.) Desf; 641. *Erigeron canadensis* L.; 642. *Erigeron strigosus* var. *septentrionalis* (Fernald & Wiegand) Fernald; 643. *Gaillardia pulchella* Foug.; 644. *Galinsoga quadriradiata* Ruiz & Pav.; 645. *Galinsoga parviflora* Cav.; 646. *Grindelia squarrosa* (Pursh) Dunal; 647. *Helianthus annuus* L.; 648. *Helianthus decapetalus* L.; 649. *Helianthus×laetiflorus* Pers.; 650. *Helianthus petiolaris* Nutt.; 651. *Helianthus pauciflorus* Nutt.; 652. *Helianthus salicifolius* A.Dietr.; 653. *Helianthus tuberosus* L.; 654. *Inula helenium* L.; 655. *Lactuca sativa* L.; 656. *Lactuca serriola* L.; 657. *Lactuca tatarica* (L.) C.A.Mey.; 658. *Lophiolepis ciliata* (Murray) Del Guacchio, Bureš, Iamonico & P.Caputo; 659. *Matricaria chamomilla* L.; 660. *Matricaria discoidea* DC.; 661. *Onopordum acanthium* L.; 662. *Pilosella bauhini* (Schult.) Arv.-Touv.; 663. *Psephellus dealbatus* (Willd.) K.Koch; 664. *Rhaponticum repens* (L.) Hidalgo; 665. *Rudbeckia hirta* L.; 666. *Rudbeckia laciniata* L.; 667. *Senecio viscosus* L.; 668. *Senecio vulgaris* L.; 669. *Silphium perfoliatum* L.; 670. *Solidago canadensis* L.; 671. *Solidago gigantea* Aiton; 672. *Sonchus arvensis* L.; 673. *Sonchus asper* (L.) Hill; 674. *Sonchus oleraceus* L.; 675. *Symphyotrichum lanceolatum* (Willd.) G.L.Nesom; 676. *Symphyotrichum novae-angliae* (L.) G.L.Nesom; 677. *Symphyotrichum novi-belgii* (L.) G.L.Nesom; 678. *Symphyotrichum×salignum* (Willd.) G.L.Nesom; 679. *Symphyotrichum×versicolor* (Willd.) G.L.Nesom; 680. *Tagetes erecta* L.; 681. *Tagetes tenuifolia* Cav.; 682. *Tanacetum bipinnatum* subsp. *bipinnatum*; 683. *Tanacetum partheniifolium* (Willd.) Sch.Bip.; 684. *Tanacetum parthenium* (L.) Sch.Bip.; 685. *Telekia speciosa* (Schreb.) Baumg.; 686. *Tripleurospermum inodorum* (L.) Sch.Bip.; 687. *Verbesina encelioides* (Cav.) Benth. & Hook.f. ex A.Gray; 688. *Xanthium orientale* L.; 689. *Xanthium spinosum* L.; 690. *Xanthium strumarium* L.

SAMBUCACEAE: 691. *Symphoricarpos albus* (L.) S.F.Blake

VIBURNACEAE: 692. *Viburnum lantana* L.

CAPRIFOLIACEAE: 693. *Lonicera fragrantissima* subsp. *fragrantissima*; 694. *Lonicera ruprechtiana* Regel; 695. *Lonicera tatarica* L.; 696. *Lonicera xylosteum* L.; 697. *Weigela florida* (Bunge) A.DC.

ARALIACEAE: 698. *Hedera helix* L.

APIACEAE: 699. *Aethusa cynapium* L.; 700. *Anethum graveolens* L.; 701. *Anthriscus caucalis* M.Bieb.; 702. *Anthriscus cerefolium* (L.) Hoffm.; 703. *Bifora radians* M.Bieb.; 704. *Bupleurum rotundifolium* L.; 705. *Carum carvi* L.; 706. *Caucalis platycarpos* L.; 707. *Conium maculatum* L.; 708. *Coriandrum sativum* L.; 709. *Foeniculum vulgare* Mill.; 710. *Heracleum mantegazzianum* Sommier & Levier; 711. *Heracleum sosnowskyi* Manden.; 712. *Levisticum officinale* W.D.J.Koch; 713. *Pastinaca sativa* L.; 714. *Pastinaca sativa* subsp. *urens* (Req. ex Godr.) Čelak.; 715. *Petroselinum crispum* subsp. *crispum*; 716. *Torilis arvensis* (Huds.) Link; 717. *Turgenia latifolia* (L.) Hoffm.

Appendix 2. Checklist of alien species of urban flora of the Kyiv urban area, discovered and published after 2002 (Note. The sign "!!" - finds of plants that have not been made public are marked)

PTERIDOPHYTA

1. *Azolla caroliniana* (Prokopuk, 2016; Zub & Prokopuk, 2018; Koniakin et al., 2023); 2. *Azolla filiculoides* (Zub & Prokopuk, 2018; Koniakin et al., 2023)

PINOPHYTA

3. *Abies alba* (Shynder et al., 2018); 4. *Abies nordmanniana* (Shynder et al., 2018); 5. *Ginkgo biloba* (Pryadko et al., 2019); 6. *Picea abies* (Shynder et al., 2018); 7. *Taxus baccata* (Shynder et al., 2018; Glukhova et al., 2020; Koniakin et al., 2023); 8. *Taxus cuspidata* (Shynder et al., 2018); 9. *Thuja occidentalis* (Shynder et al., 2018); 10. *Thuja plicata* (Shynder et al., 2018)

MAGNOLIOPHYTA

11. *Acalypha australis* (Shynder et al., 2019); 12. *Aesculus hippocastanum* (Burda, 2012; Burda & Koniakin, 2019; Koniakin & Gubar, 2022); 13. *Aesculus pavia* (Burda & Koniakin, 2019); 14. *Amelanchier canadensis* (Pryadko et al., 2019); 15. *Anthriscus caucalis* (Shynder, 2019b); 16. Aristolochia macrophylla (Burda, 2014); 17. *Arrhenatherum elatius* (Shabarova et al., 2006; Protopopova et al., 2014); 18. *Artemisia verlotiorum* (!!; https://www.inaturalist.org/observations/72473139); 19. *Bidens×garumnae* (Mosyakin, 1988b); 20. *Bothriochloa ischaemum* (Bortnyak, 1975; https://www.inaturalist.org/observations/153080165); 21. *Brunnera macrophylla* (!!); 22. *Brunnera sibirica* (!!); 23. *Buddleja davidii* (Burda & Koniakin, 2019); 24. *Callistephus chinensis* (!!); 25. *Campsis radicans* (!!); 26. *Catalpa×erubescens* (!!); 27. *Catalpa bignonioides* (Burda & Koniakin, 2019; Koniakin & Gubar, 2022); 28. *Catalpa speciosa* (!!); 29. *Celastrus flagellaris* (Pryadko et al., 2019); 30. *Celastrus orbiculatus* (Mosyakin & Mosyakin, 2021); 31. *Chaenomeles japonica* (!!); 32. *Chenopodium ucrainicum* (Mosyakin & Mandàk, 2020; Mosyakin & Mosyakin, 2021); 33. *Clematis vitalba* (Shynder et al., 2018; Shynder, 2019a; Koniakin & Gubar, 2022; Koniakin et al., 2023); 34. *Coleus scutellarioides* (Shynder et al., 2018); 35. *Coreopsis lanceolata*, (!!; https://www.inaturalist.org/observations/123375102 36); *Cornus alba* (Klymenko, 2018); 37. *Cornus sanguinea* subsp. *australis* (Klymenko, 2018); 38. *Cornus sericea* (Klymenko, 2018); 39. *Corydalis caucasica* (Shynder, 2019a; Shynder et al., 2022; Koniakin et al., 2023); 40. *Corylus colurna* (Shynder et al., 2018); 41. *Datura innoxia* (Mosyakin & Mosyakin, 2021); 42. *Datura wrightii* (!!; https://www.inaturalist.org/observations/174909554); 43. *Deutzia scabra* (Burda & Koniakin, 2019); 44. *Digitalis purpurea* (!!); 45. *Digitaria ischaemum* (Shynder et al., 2018; Pryadko et al., 2019; Koniakin & Gubar, 2022; Koniakin et al., 2023); 46. *Dysphania ambrosioides* (Shynder, 2021); 47. *Egeria densa* (*Bagatska,* 2007; Zub & Prokopuk, 2018; Zub et al., 2022; Prokopuk et al., 2023); 48. *Elaeagnus angustifolia* (Burda, & Koniakin, 2019; Koniakin & Gubar, 2022); 49. *Elodea nuttallii* (Chorna et al., 2006; Zub & Prokopuk, 2018; Zub et al., 2022); 50. *Epilobium pseudorubescens* (!!); 51. *Erechtites hieraciifolius* (Mosyakin & Mosyakin, 2021); 52. *Eremogone saxatilis* (Bortnyak, 1962); 53. *Erysimum cuspidatum* (Shynder, 2019b); 54. *Eschscholzia californica* (!!); 55. *Euphorbia humifusa* (Shynder et al., 2018); 56. *Euphorbia maculata* (Shynder, 2021); 57. *Fagus sylvatica* (Shynder et al., 2018; Shynder et al., 2022); 58. *Fallopia baldschuanica* (Koniakin & Gubar, 2022); 59. *Ficus carica* (Burda & Koniakin, 2019); 60. *Fraxinus americana* (Burda & Koniakin, 2019); 61. *Gaillardia pulchella* (!!; https://www.inaturalist.org/observations/174457434; 62. *Geranium nepalense* (Chopyk et al., 1998); 63. *Glaucium corniculatum* (Protopopova, 2003); 64. *Groenlandia densa* (Zub & Prokopuk, 2018); 65. *Gymnocladus dioicus* (Pryadko et al., 2019); 66. *Hedera helix* (Shynder, 2019a*);* 67. *Hippophae rhamnoides* (Burda & Koniakin, 2019); 68. *Hordeum bulbosum* (Shynder, 2021); 69. *Hosta plantaginea* (!!); 70. *Hyssopus officinalis* (Shynder et al., 2018); 71. *Juglans cinerea* (Burda Koniakin, 2018; 2019); 72. *Impatiens balsamina* (!!); 73. *Juglans cinerea* (Burda Koniakin, 2018; 2019); 74. *Juglans mandshurica* var. *cordiformis* (Burda & Koniakin, 2018; 2019); 75. *Juglans mandshurica* var. *sachalinensis* (Burda & Koniakin, 2018; 2019); 76. *Juglans nigra* (Burda & Koniakin, 2018; 2019); 77. *Kitaibela vitifolia* (!!); 78. *Lemna turionifera* (https://www.inaturalist.org/observations/180403131); 79. *Liriodendron tulipifera* (Burda & Koniakin, 2019; Koniakin et al., 2023); 80. *Lonicera ruprechtiana* (Shynder, 2019a); 81. *Lonicera xylosteum* (Shynder et al., 2022); 82. *Lunaria annua* (Koniakin et al., 2023); 83. *Lupinus luteus* (Chopyk et al., 1998); 84. *Lycium chinense* (Shynder et al., 2018); 85. *Lysimachia punctata* (Chopyk et al., 1998); 86. *Macleaya cordata* (Orlov *&* Gubar, 2009*;* !!); 87. *Malva trimestris* (!!); 88. *Menispermum dahuricum* (https://www.inaturalist.org/observations/116968142); 89. *Mesembryanthemum×vascosilvae* (Gideon F.Sm., E.Laguna, F.Verloove & P.P.Ferrer) Sáez & Aymerich (Mosyakin & Mosyakin, 2021); 90. *Morus rubra* (Burda & Koniakin, 2019); 91. *Muscari botryoides* (Shynder, 2019a); 92. *Nepeta racemosa* (!!); 93. *Oenothera×drawertii* (*Rostanski et al., 2010); 94. Oenothera glazioviana* (Skvortsov, 1996); *95. Oenothera×polgari* (*Rostanski et al., 2010); 96. Ornithogalum umbellatum* (Pryadko et al., 2019); 97. *Opuntia humifusa* (Raf.) Raf. (Didenko et al., 2021); 98. *Oxalis corniculata* (Protopopova, 1974); 99. *Oxalis stricta* (Vasiliev-Yakovlev, 1915; Kotov, 1921; Protopopova, 1974); 100. *Paeonia×suffruticosa* (!!); 101. *Paeonia officinalis* (!!)*; 102. Papaver albiflorum* (Davydov, 2019); 103. *Papaver dubium* subsp. *stevenianum* (Davydov, 2019); 104. *Parietaria judaica* (Shynder et al., 2018); 105. *Paulownia tomentosa* (!!); 106. *Perilla frutescens* (Koniakin et al., 2023); 107. *Petrosedum orientale* (https://www.inaturalist.org/observations/169763095); 108. *Phellodendron amurense* (Burda, 2012; Burda & Koniakin, 2019; Pryadko et al., 2019); 109. *Phragmites australis* subsp. *isiacus* (Zub et al., 2022; Koniakin et al., 2023); 110. *Phytolacca acinosa* (Shynder et al., 2022); 111. *Phytolacca americana* (Pryadko et al., 2019); 112. *Pilosella bauhini* (!!;https://www.inaturalist.org/observations/148287853); 113. *Pistia stratiotes* (Kotelevetz et al., 1983; Mosyakin, 1991; Krasnova, 2001; Lushpa, 2009; Prokopuk, 2017*;* Zub, Prokopuk, 2018; Prokopuk et al., 2019; Prokopuk & Zub, 2022; Prokopuk et al., 2023); 114. *Platanus×hispanica* (Burda & Koniakin, 2019); 115. *Pontederia crassipes* (Prokopuk et al., 2023); 116. *Populus nigra* f. *italica* (Burda & Koniakin, 2019; Koniakin, Gubar, 2022); 117. *Populus×canadensis* (Burda & Koniakin, 2019); 118. *Populus suaveolens* (Burda & Koniakin, 2019); 119. *Populus tristis* (Burda & Koniakin, 2019); 120. *Potentilla indica* (Viktorovskiy, 1929; !!); 121. *Primula veris* (Shynder et al., 2018); 122. *Primula veris* subsp. *macrocalyx* (Shynder et al., 2018); 123. *Psephellus dealbatus* (Koniakin & Gubar, 2022); 124. *Reynoutria×bohemica* (*Mosiakin,* 1992; Koniakin & Gubar, 2022; Koniakin et al., 2023); 125. *Rheum rhabarbarum* (!!); 126. *Rheum rhaponticum* (!!); 127. *Rhus glabra* (Burda & Koniakin, 2019; Koniakin & Gubar, 2022); 128. *Rhus typhina* (Chopyk et al.., 1998; Burda & Koniakin, 2019); 129. *Ribes aureum* (Burda & Koniakin, 2019; Koniakin & Gubar, 2022); 130. *Ribes uva-crispa* subsp. *uva-crispa* (Vasiliev-Yakovlev, 1915; Bortnyak, 1962; Burda & Koniakin, 2019); 131. *Riparіosida hermaphrodita* (Olyanizka & Tzvelev, 1996; !!); 132. *Robinia hispida* (Burda &

Koniakin, 2019); 133. *Robinia neomexicana* (Burda & Koniakin, 2019); 134. *Robinia viscosa* (Burda & Koniakin, 2019); 135. *Rubus occidentalis* (Shynder et al., 2022); 136. *Rumex pulcher* (Mosiakin, 1992); 137. *Salix×pendulina* nothof. *pendulina* (Burda & Koniakin, 2019); 138. *Salix babilonica* (Burda & Koniakin, 2019); 139. *Salvia hispanica* (!!); 140. *Salvia sclarea* (Koniakin & Gubar, 2022); 141. *Salvia splendens* (!!); 142. *Salvia yangii* B.T. Drew (!!); 143. *Sedum hispanicum* (Koniakin & Gubar, 2022); 144. *Sisymbrium polymorphum* (Bortniak, 1976); 145. *Solanum heterodoxum* (Shynder, 2021); 146. *Spiraea×vanhouttei* (Chopyk et al., 1998; Pryadko et al., 2019); 147. *Stachys byzantina* (!!); 148. *Stachys germanica* (!!); 149. *Symphytum caucasicum* (Shynder, 2021); 150. *Symphytum officinale* subsp. *officinale* (Shynder, 2021); 151. *Tagetes erecta* (Koniakin & Gubar, 2022); 152. *Telekia speciosa* (!!); 153. *Tilia americana* (Burda & Koniakin, 2019); 154. *Tilia dasystyla* subsp. *caucasica* (Burda & Koniakin, 2019); 155. *Torilis arvensis* (Koniakin et al., 2023); 156. *Tradescantia×andersoniana* (Shynder et al., 2018); 157. *Tragus racemosus* (!!; https://www.inaturalist.org/observations/129424462); 158. *Tricyrtis hirta* (Shynder et al., 2018); 159. *Urtica cannabina* (https://www.inaturalist.org/observations/72461845); 160. *Verbesina encelioides* (https://www.inaturalist.org/observations/179792181); 161. *Veronica agrestis* (Rogovich, 1869; Protopopova, 1991; Chopyk et al., 1998; Shynder et al., 2022); 162. *Viola sororia* (Shyder et al., 2018); 163. *Vitis amurensis* (Shyder et al., 2018); 164. *Vitis riparia* (Shynder et al., 2019a; Shynder et al., 2022); 165. *Vitis vulpina* (Shyder et al., 2018); 166. *Zizania latifolia* (https://www.inaturalist.org/observations/184011758).

Appendix 3. Additional checklist of taxa that have undergone changes in species rank.

32 are reduced to the rank of intraspecific: 26 subspecies, 5 varieties and 1 nothoform. *Atriplex prostrata* subsp. *calotheca* (*A. hastata*), *Brassica elongata* subsp. *integrifolia* (*Erucastrum armoracioides*), *Calystegia sepium* subsp. *spectabilis* (*C. spectabilis*), *Cornus sanguinea* subsp. *australis* (*C. australis*), *Delphinium consolida* subsp. *paniculatum* (*Consolida paniculata*), *Dianthus trifasciculatus* subsp. *pseudobarbatus* (*Dianthus euponticus*), *Echinochloa colonum* subsp. *edulis* (*E. frumentacea*), *Lonicera fragrantissima* subsp. *fragrantissima* (*L. caprifolium*), *Oenothera elata* subsp. *elata* (*Oe. salicifolia*), *Oe. villosa* subsp. *villosa* (*Oe. depressa*), *Papaver dubium* subsp. *stevenianum* (*P. stevenianum*), *Phragmites australis* subsp. *isiacus* (*Ph. altissimus*), *Potentilla supina* subsp. *paradoxa* (*P. paradoxa*), *Primula veris* subsp. *macrocalyx* (*P. macrocalyx*), *Raphanus raphanistrum* subsp. *raphanistrum* (*R. candidus*), *Raphanus raphanistrum* subsp. *sativus* (*R. sativus*), *Sanguisorba minor* subsp. *balearica* (*Poterium polygamum*), *Sanguisorba minor* subsp. *minor* (*P. sanguisorba*), *Sorghum bicolor* nothosubsp. *drummondii* (*S.×drummondii*), *Spergula arvensis* subsp. *arvensis* (*S. maxima*), *Symphytum officinale* subsp. *officinale* (*S. peregrinum*), *Tanacetum bipinnatum* subsp. *bipinnatum* (*Matricaria matricarioides*), *Trifolium pratense* subsp. *pratense* (*Trifolium sativum*), *Triticum turgidum* subsp. *durum* (*T. durum*), *Vicia sativa* subsp. *sativa, Vicia sativa* subsp. *nigra* (*V. angustifolia*), *Vicia villosa* subsp. *villosa.* Five varieties were distinguished: *Bassia scoparia* var. *trichophylla*, *Chenopodium album* var. *album* (*Ch. strictum*), *Juglans mandshurica* var. *cordiformis* (*J. subcordiformis* Dode), *J. mandshurica* var. *sachalinensis* (*J. ailanthifolia*), *Populus nigra* f. *italica* (*P. pyramidalis*) and a nothoform *Salix×pendulina* nothof. *pendulina* (*S.×blanda*).

17 taxa replaced 28 names reduced to synonyms:
Agropyron cristatum (*A. pectinatum*; *A. cristatum* var. *glabrispiculatum*); *Chenopodium album* var. *album* (*Chenopodium probstii*); *Chenopodium album* var. *missouriense* (*Chenopodium missouriense*); *Echinochloa muricata* (*E. microstachya*; *E. wiegandii*); *Echinochloa oryzoides* (*E. oryzicola*); *Helianthus tuberosus* (*H. subcanescens*; *H. tomentosus*); *Oxalis corniculata* (*Xanthoxalis corniculata*; *X. corniculata* subsp. *repens*); *Oxalis stricta* (*Xanthoxalis stricta*; *X. stricta* subsp. v*illicaulis*); *Prunus cerasifera* (*P. divaricata*); *Rhus typhina* (*Rh. typhina* f. *laciniata*); *Solanum angustifolium* (*S. cornutum*; *S. rostratum*); *Solanum nigrum* (*S. decipiens*; *S. schultesii*); *Solidago gigantea* (*S. serotina*; *S. serotinoides*); *Sorghum bicolor* (*S. cernuum*; *S. saccharatum*); *Sorghum bicolor* nothosubsp. *drummondii* (*S.×drummondii*); *S.×sudanense*; *Tagetes erecta* (*T. patula*) and *Xanthium orientale* (*X. albinum*; *X. rupicola*).