

The urban anthropogenic flora of Budapest (Hungary)

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Abstract

The research of urban anthropogenic habitats has recently gained big emphasis. We started the systematic mapping of the urban flora and habitats of Budapest, Hungary in 2018. Our main goal was to create a comparable study on the anthropogenic urban habitats of the inhabited areas. The territorial units were street sections, where we recorded the presence of vascular plants separately in each ecologically different habitat. Based on the experience gathered during the field survey, we distinguished 18 ecologically different anthropogenic urban habitats. We recorded 647 spontaneously growing plant species in more than 27,000 survey units. Our survey evinced the spontaneous occurrence of 193 alien plant species in Budapest. Our knowledge about the distribution of 81 of them is insufficient, while 10 are new introductions in Hungary. 53.9% of the aliens are cultivated frequently in Hungary. Our research suggests that there is a need for systematic mapping of urban habitats because these areas are centres of introduction and spreading of aliens, while may serve as refuges for native species at the same time. The most species-rich habitats are attached to roads, they bear the most adventive species as well. The corridor role of roads is also supported by our research.

Aim

- 1) the large-scale, detailed data collection on the urban flora of Budapest;
- 2) determining, describing and mapping the anthropogenic urban habitats of Budapest;
- 3) to determine the distribution of adventive (possibly invasive) species and to collect information on their spread.

Material and methods

- Data collection: Budapest (Hungary), 2018 September to November
- In the course of the research, we surveyed the smallest possible, clearly identifiable units (territorial units). In the territorial units, the species were registered separately for each habitat (survey plots). The territorial units were street sections, public places (e.g. squares, parks) and domestic spaces. A street section is a 50–150 m long section located between two delimiting units (e.g. cross streets, squares) (Fig. 1). Open public places (e.g. squares) are delimited by surrounding streets and blocks, while closed domestic areas (e.g. yards) are delimited by fences or walls (Fig. 1) and both cover an area of 100–1000 m².
 - In the research data sheet, the following data were recorded per survey plot: the complete list of spontaneously occurring species, spontaneous occurrences of cultivated species and distances from the presumed planted mother plant.
 - And the following data was recorded per territorial units: date, name of administrative unit, GPS coordinates, occurring habitats. The occurrences of rare, protected or newly introduced species were also recorded with GPS devices.

Table 1. Distinguished habitats with descriptions, grouped in habitat groups.

Habitat group	Subcategories (Abbreviation)	Description
Road attached areas	Road verges (Rv)	Lawns directly adjacent to the driveway (between driveway and pavement)
	Railways (Ra)	Areas along railway tracks, tram rails, usually filled with stone rubble
	Roadslopes (Rs)	Mostly dry, grassy slopes on banks, ditches and railway embankments
	Safety islands (Si)	Paved islands in the middle of roads
	Planting pits (Pp)	Pits for planted trees, often fenced off, covered with grid or plastic. These are located in roadside lawns or in any paved urban areas.
Public areas	Island beds (Ib)	Maintained, usually fenced off and / or elevated beds located on the street
	Shrubby roadsides, alleys (Sh)	Stands of spontaneously growing shrubs and trees along roads and in urban green areas
	Front gardens (Fg)	Council owned public areas in front of private houses, mostly maintained by the residents.
	Amenity grasslands (Ag)	Lawns that are not in the immediate vicinity of roads, mostly between the pavement and residential buildings. Maintained and cultivated, public, green areas with mowed lawns and ornamental plantings
Domestic areas	Parks (Pa)	Areas continuously exposed to disturbance, paved with gravel or any other material, mostly in enclosed areas
	Ruderals (Ru)	Private, fenced off, cultivated areas
Overlapping subcategories	Ground-plots (Pl)	Abandoned vacant plots and construction sites
	Courtyards (Co)	Private, uncultivated, mostly paved areas
	Walls (Wa)	Vertical surfaces of built walls (plants growing at the base of the walls belong to the 'cracks' (Cr))
	Urban hedges (Uh)	Shrubs planted in rows to enclose areas or for ornamental purposes.
	Cracks (Cr)	Any pavement cracks on roads, paths, sidewalks etc., and at the base of walls, fences, etc.
	Flower-boxes (Fb)	Flower boxes, pots and jars filled with soil, compost or planting mixes



Fig. 1. Territorial units of the research: street sections (red), a square (yellow) and a closed yard (blue). Made by using Google Earth.

Results

- Based on our experience gained during the research, we distinguished 18 habitats that are ecologically different. The 18 habitat categories were divided into 3 groups for manageability (Table 1). The division was based on the degree of availability and disturbance. Thus, the division is as follows: 1) road attached areas; 2) public areas and 3) domestic areas. For habitats that cannot be associated with any of the main categories, we have created a fourth, mixed category.
- In the course of the research we examined a total of 2241 survey plots, among which the domestic areas (due to limited accessibility) are underrepresented (Table 2). We detected 647 species in the flora of Budapest, collecting a total of more than 27,000 records (Table 2).
- Among the 20 most common species registered in the research, weed species predominate (Table 3). Of the 10 most common species, 4 are non-native to Hungary.
- We found 117 species exclusively in road attached habitats, all of them with a single or few known localities there (e.g. *Astragalus glycyphyllos*, *Peucedanum alsaticum*). A significant part of the most common species found in Budapest is strongly associated with road attached habitats and cracks, e.g. 82.9% of the records of *Eleusine indica* and 81.9% of the records of *Eragrostis minor* were registered in these habitats. In contrast, most of the species that are rarer in an urban environment (e.g. *Ranunculus repens*, *Asplenium ruta-muraria*) completely avoid the former habitats. It should also be mentioned that 117 species were found only in road attached habitats, all of which have very few records, such species are for example *Astragalus glycyphyllos* and *Peucedanum alsaticum*.
- In the case of open public areas, the presence of many species is contingent, many of which have only 1-2 occurrence records (e.g. *Leontodon autumnalis*, *Mentha longifolia*). However, usually the most common species in public areas do not have more than 20 records (e.g. *Hieracium pilosella*, *Thrinicia nudicaulis*). Some species associated with natural habitats were found only once in total (e.g. *Asparagus officinalis*, *Campanula persicifolia*, *Carpinus betulus*, *Hieracium sabaudanum*, *Fraxinea vesca*, *Vicia sepium*, *Astragalus onobrychis*). All such species were found in or around domestic areas. Here it should be mentioned again that domestic areas are underrepresented in research. It is also typical in the domestic areas and their surroundings that some cultivated plants occur only spontaneously here. (e.g. *Taxus baccata*, *Vinca major*, *Melissa officinalis*). It should also be emphasized that the walls (especially those made of bricks) are home to a significant number of ferns, *Thelypteris palustris*, a fern protected in Hungary were found on 11 different brick walls in Budapest.
- 70.2% of the found taxa are native and 29.8% (193 species) are non-native, from these 61.3% are casuals, 11.1% are naturalised, 21.6% are considered invasive in the natural and semi-natural habitats of Hungary and 6% of them are new introductions in Hungary. The 10 new introductions are the following: *Artemisia verlotiorum*. Lamotte, *Begonia cf. cucullata* Willd., *Celosia argentea* L., *Eragrostis virescens* J. Presl, *Euonymus japonicus* Thunb., *Gazania rigens* (L.) Gaertn., *Nepeta × fassenii* Bergmans ex Stearn, *Saccharum ravennae* (L.) L., *Salix babylonica* L. and *Vitex agnus-castus* L. 53.9% of non-native species are cultivated or consumed plants in Budapest.

Results

Table 2. Descriptive data of the surveyed plots

	Total	Habitats (Abbreviations)																	
		Rv	Rs	Ra	Si	Pp	Ib	Sh	Fg	Ag	Pa	Ru	Ga	Pl	Co	Wa	Uh	Cr	Fb
Nr. of species	647	363	172	147	45	132	37	40	209	309	157	165	201	136	230	146	114	362	186
Nr. of records	27105	5065	482	435	69	890	57	67	1253	4098	608	401	950	422	1275	435	498	9305	804
Studied survey plots	2241	265	16	18	4	157	6	7	104	188	37	16	90	24	113	73	135	969	119

Table 3. The rank of the 20 most frequent species in studied habitats (the numbers in the 'Rank' columns indicate that if the plants are sorted by frequency, what would be the given plant in the row; '-' means that the plant is missing from the given habitat).

Taxon name	Total rank	Rank in habitat																	
		Rv	Rs	Ra	Si	Pp	Ib	Sh	Fg	Ag	Pa	Ru	Ga	Pl	Co	Wa	Uh	Cr	Fb
<i>Polygonum aviculare</i> agg.	1	1	27	30	1	2	-	9	1	2	31	41	15	58	9	60	1	18	
<i>Taraxacum officinale</i> agg.	2	2	4	30	6	2	2	8	1	2	1	16	2	6	5	9	60	2	2
<i>Setaria viridis</i>	3	3	6	2	1	5	14	-	11	6	24	2	3	3	6	3	42	6	5
<i>Conyza canadensis</i>	4	6	11	1	1	10	1	-	6	8	3	5	3	2	9	1	16	5	12
<i>Stellaria media</i>	5	10	37	47	-	3	7	3	2	19	3	55	8	19	10	9	42	8	1
<i>Eleusine indica</i>	6	9	63	91	-	8	-	-	15	17	24	31	112	43	84	43	60	3	43
<i>Sonchus oleraceus</i>	7	16	11	7	-	7	14	-	4	23	18	20	16	6	13	4	16	7	4
<i>Chenopodium album</i> agg.	8	4	16	10	20	5	2	-	3	9	10	1	11	3	18	17	30	12	7
<i>Eragrostis minor</i>	9	34	63	21	6	23	14	-	34	28	88	20	82	84	72	28	22	4	10
<i>Allanthus altissima</i>	10	21	11	3	20	11	14	3	18	20	34	2	7	1	8	6	2	10	13
<i>Hypochaeris radicata</i>	11	11	37	47	6	17	-	-	16	4	5	85	22	62	4	43	22	16	33
<i>Portulaca oleracea</i> agg.	12	25	16	10	6	14	7	-	34	13	40	9	53	43	72	22	60	9	10
<i>Plantago lanceolata</i>	13	7	11	3	1	36	-	-	48	3	24	85	33	19	26	17	-	17	95
<i>Erigeron annuus</i>	14	17	4	30	6	28	-	-	6	17	10	20	6	6	10	43	30	22	23
<i>Ballota nigra</i>	15	15	16	47	-	29	14	8	10	27	15	6	11	15	1	12	30	31	15
<i>Celis occidentalis</i>	16	47	63	3	-	23	14	-	16	32	31	2	1	19	6	33	1	29	15
<i>Poa annua</i>	17	44	-	-	-	4	14	-	29	60	40	-	41	43	-	43	42	11	5
<i>Digitaria sanguinalis</i>	18	26	63	6	6	26	2	-	24	38	51	31	44	28	109	22	60	13	23
<i>Oxalis corniculata</i>	19	62	-	-	-	17	-	-	5	47	18	55	11	84	26	28	42	15	3
<i>Plantago major</i>	20	22	-	-	-	12	-	-	29	25	40	85	53	43	72	74	-	14	33

Conclusion

We consider it important to carry out systematic, high-resolution, repetitive research on secondary habitats and urban ecosystems. Detailed habitat-based mapping allows a huge amount of data to be collected in a short period of time, and the data collected in this way serves as information on both species (and their preferences) and habitats. In the future, this will make it possible to track the spread of non-native and native species in cities with the help of reliable datasets. Our goal in the future is to supplement our research by recording the phenophases of plants, so we can obtain information not only about the presence of species, but also about the development of individuals in the urban environment.