Alien plants in different types of ruderal vegetation

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Aliens in human settlements

Human settlements harbour many alien species, which occur in various anthropogenic habitats. Generally, man-made habitats situated in towns and villages and their surroundings are exposed to a strong propagule pressure of aliens, various irregular disturbances of different intensity and have diverse ecological conditions. The ratio of archaeophytes, neophytes and natives in vegetation varies depending on these factors.

Material

The data set was extracted from the Czech National Phytosociological Database (Chytrý & Rafajová 2003) and included relevés of annual and perennial ruderal vegetation from anthropogenic habitats in the Czech Republic (Table 1). Only relevés from plots with size of 4–25 m^2 were used. The data set contained 3538 relevés with 917 species.

Table 1. The overview of the studied vegetation divided into 13 vegetation types (phytosociological alliances). Mean number of species in relevés and plot size for particular alliances are shown (mean ± SD). Nomenclature of syntaxa follows Moravec et al. (1995).

Nr.	Vegetation type		No. of relevés	Mean no. of species	Relevé area
	Chenopodietea	annual nitrophilous vegetation on disturbed soils			
1	*Chenopodion glauci*	nitrophilous vegetation around dung depositions	118	10±4	10±6
2	*Malvion neglectae*	nitrophilous vegetation of low-grown herbs	54	14±5	11±5
3	*Bromo-Hordeion murini*	thermophilous vegetation of low-grown winter annual grasses	81	17±7	13±6
4	*Sisymbrion officinalis*	tall-herb vegetation of spring annuals on sandy skeletal soils	514	16±8	13±6
5	*Eragrostion minoris*	xerophilous vegetation of sandy soils	29	14±4	9±5
6	*Salsolion ruthenicae*	vegetation of heavily disturbed anthropogenic substrates	22	14±4	8±4
	Artemisietea vulgaris	perennial and thistle-rich (sub)xerophilous vegetation			
7	*Onopordion acanthii*	vegetation of tall thorny biennials on nutrient-rich soils	42	21±8	15±7
8	*Dauco-Melilotion*	xero-mesophilous vegetation on nutrient-rich skeletal soils	374	20±10	14±6
	Galio-Urticetea	tall-herb mesophilous anthrop. fringe vegetation of woodlands and scrub			
9	*Galio-Alliarion*	semi-natural nitrophilous vegetation of biennials in moist fringe habitats	187	17±5	13±6
10	*Arction lappae*	vegetation of anthropogenic substrates of rubbles and dumps	514	18±8	16±6
11	*Aegopodion podagrariae*	vegetation of nitrophilous perennials in moist anthropogenic habitats	450	17±7	12±6
	Agropyretea repentis	tall-herb grass-dominated vegetation on dry loamy and base-rich soils			
12	*Convolvulo-Agropyrion*		252	17±9	13±7
	Plantaginetea majoris	therophyte-rich vegetation of trampled habitats			
13	*Polygonion avicularis*		901	12±6	9±5

Alien species in different ruderal vegetation types (Fig. 1)

The highest representation of alien species was recorded in annual ruderal vegetation belonging to alliances 5 – *Eragrostion* (65%), 2 – *Malvion*, 6 – *Salsolion* (both 64%), 3 – *Bromo-Hordeion* (62%) and 4 – *Sisymbrion* (61%). **Archaeophytes** are well-represented mainly in 2 – *Malvion* (54%), 3 – *Bromo-Hordeion* (53%), 4 – *Sisymbrion* (50%), 5 – *Eragrostion* (48%) and 7 – *Onopordion* (46%), whereas **neophytes** are most abundant in vegetation types 6 – *Salsolion* (22%), 5 – *Eragrostion* (17%), 4 – *Sisymbrion* (11%) and *Malvion* (10%). In contrast, **native species** prevail mostly in perennial ruderal vegetation of the alliances 11 – *Aegopodion*, 9 – *Galio-Alliarion*, 12 – *Convolvulo-Agropyrion*, 8 – *Dauco-Melilotion*, 10 – *Arction* and trampled vegetation of 13 – *Polygonion*.

Invasive species (Fig. 2)

The highest proportion of invasive species were found in annual ruderal vegetation of alliances 4 – *Sisymbrion* and 6 – *Salsolion*, both of which included on the average 23% of invasive taxa with the most frequent species being *Triplerospermum inodorum* and *Conyza canadensis*. Invasive species were considerably represented also in 5 – *Eragrostion* alliance and in perennial ruderal vegetation of alliances 8 - *Dauco-Melilotion*, 10 – *Arction* and 7 – *Onopordion*.

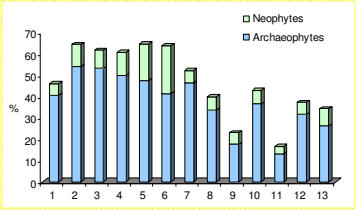


Fig. 1. Percentage ratio of the number of archaeophytes and neophytes in relevés of particular alliances (1–13, for definition see Table 1). Mean percentage values counted from the total number of species.

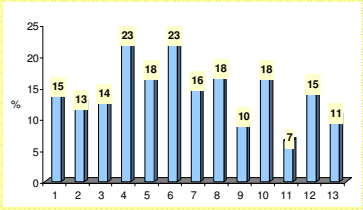
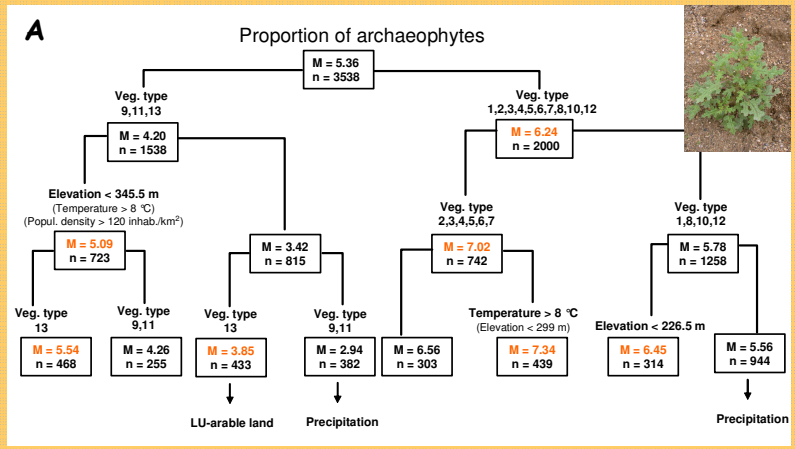


Fig. 2. The percentage representation of invasive species in particular alliances (1–13, for definition see Table 1). Mean percentage values were calculated from the total number of species.



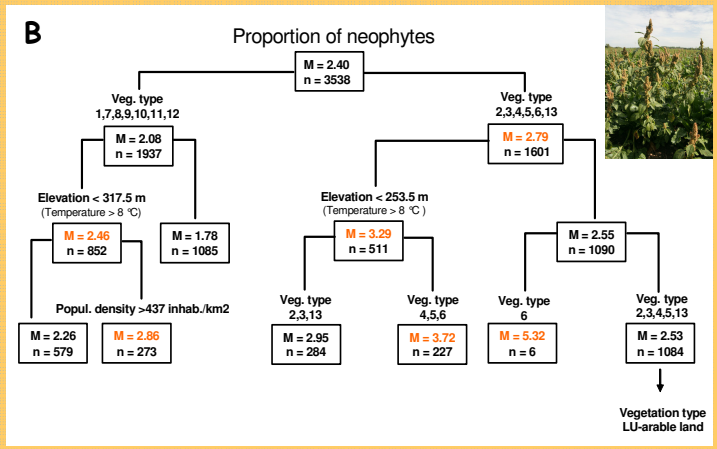


Fig. 3. Regression tree models explaining the proportion of archaeophytes (A) and neophytes (B). Each node is characterized by the primary split variable and its split value, mean of percentage of archaeophytes (neophytes) and number of vegetation plots assigned to that node. Surrogates (variables assigning at least 40% of the cases to the same group as the primary split variable) are in parentheses. The tree A explained 54% of variation in proportion of archaeophytes and the tree B 84% of variation in proportion of neophytes.

Regression tree models

To determine the relationship between the ratio of aliens in different ruderal vegetation types and environmental factors the data set was subjected to regression tree analyses (using 10-fold cross-validation method with Standard Error Rule = 0). The **response variables** were the proportional numbers of archaeophytes and neophytes in relevés. The percentage proportions were square-root transformed after adding 0.5 to each value. The following **predictor variables** were used: 1. Elevation, 2. Mean annual temperature, 3. Mean annual precipitation, 5. Land use (percentage cover of land use categories in a circle of 0.5 km: (a) arable land, (b) urbanized areas, (c) grasslands and (d) forests, 6. Population density (number of inhabitants per km^2 in a region). The most important predictor variables for the particular regression trees (Fig. 3A & 3B) were vegetation types classification and elevation (Table 2).

Table 2. Relative importance values of predictor variables in regression trees. Variables are ranked by decreasing value of the explained variation in percentage proportion of archaeophytes and neophytes (values for two separate regression trees).

Variable	**Archaeophytes**	Variable	**Neophytes**
Vegetation type	100	Elevation	100
Elevation	78	Vegetation type	91
Temperature	66	Population density	62
Precipitation	51	Temperature	58
Population density	40	LU-urbanized areas	56
LU-urbanized areas	36	LU-grassland	22
LU-grassland	20	LU-arable land	19
LU-forest	19	Precipitation	18
LU-arable land	9	LU-forest	15

♥ The optimal tree explaining the **proportion of archaeophytes** in vegetation plots is shown in Fig. 3A. In the first node three vegetation types with the lowest proportion of archaeophytes are separated. In this vegetation archaeophytes are more frequently represented in regions with elevations below 345 m and with higher population density. In the second main group the relevés were divided according to different vegetation types, with higher proportion of archaeophytes in annual ruderal vegetation and *Onopordion* alliance. The highest proportion of archaeophytes was found in this vegetation in areas with elevation under 299 m and mean annual temperatures above 8 °C.

♥ The main branch in the regression tree explaining the **proportion of neophytes** (Fig. 3B) divided annual and perennial vegetation types. Neophytes were presented mainly in annual vegetation of *Sisymbrion, Eragrostion* and *Salsolion* alliance in warm areas with elevation below 253 m. In the second main group that included perennial vegetation types the highest proportion of neophytes was related to densely populated warmer areas at elevations below 317 m.

References

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