Masaryk University
Faculty of Science
Department of Botany and Zoology

DIVERSITY OF PERENNIAL RUDERAL AND TRAMPLED VEGETATION OF THE CZECH REPUBLIC

Summary of Ph.D. Thesis

Author: Deana Láníková

Supervisor: doc. RNDr. Milan Chytrý, Ph.D.

Brno 2009

CONTENTS

1. INTRODUCTION

1.1. Brief history of research on ruderal flora and vegetation

Ruderal vegetation is usually defined as vegetation colonising man-made habitats or habitats influenced by human activities to various degrees. Unlike weed vegetation, these habitats are not regularly managed and are left to grow at their own pace (Pyšek P. 1996, Lososová et al. 2006). Usually, these are habitats in settlements and their surroundings, but to man-made habitats also belong for example, forest roads, walls of castle ruins, regulated riverbanks, etc. Ruderal vegetation is mostly characterised by high demands on nutrients, mainly nitrogen and phosphorus. Particular ruderal vegetation types are adapted to different disturbance regimes; in strongly disturbed habitats vegetation dominated by annual species prevails and often represents the early stages of secondary succession. On the other hand, in less disturbed habitats vegetation with high representation of perennial ruderal species develops. These stands might continue in annual ruderal vegetation types in succession. Transitional stands between annual and perennial ruderal vegetation types are very common.

In Europe, study of ruderal vegetation has a relatively short history. Most botanists have concentrated mainly on natural and semi-natural flora and vegetation. At the beginning of the twentieth century, the first studies dealing with ruderal flora (mainly introduced alien species) appeared. This branch is known as ‘adventitious floristics’(Pyšek P. 1996, Wittig 2002).

The first studies dealing with ruderal vegetation appeared after World War II. Ruderal vegetation was studied on bombed areas in some cities, for example, in Germany (e.g. Engel 1949, Kreh 1955) and England (e.g. Salisbury 1943, Lousley 1944, Kent 1951), where vegetation succession was mostly studied and right up until the 1960s more detailed studies were published elaborating the ruderal flora and vegetation of certain large European cities (for detailed survey of papers see Pyšek P. 1993 or Wittig 2002), surveys of ruderal communities of particular smaller regions (e.g. Gutte 1969, Hilbig 1972, Hilbig et al. 1972, Hadač 1978) or even whole states (e.g. Oberdorfer 1957, Medwecka-Kornaś et al. 1959, Westhoff & den Held 1969) or geographic areas (Tüxen 1950).

The beginning of more detailed studies of ruderal vegetation in the Czech Republic can be dated to the 1970s. The main proponents were Karel Kopecký (e.g. Kopecký 1969, 1974a,b,c, 1980, 1981a,b, 1982a,b, 1983, 1984a,b, 1985, 1986a,b, 1988, 1989, 1990a,b, Kopecký & Hejný 1971, 1973) and Antonín Pyšek (e.g. Pyšek A. 1972, 1973, 1974a,b, 1975, 1976, 1977, 1978, 1981, 1992, Pyšek A. & Šandová 1979, Pyšek A. & Pyšek P. 1983, Pyšek A. & Lorber 1992, Pyšek A. et al. 1993), who studied ruderal flora and vegetation in various parts of Bohemia. In Moravia, František Grüll dealt with ruderal flora and

vegetation mainly in Brno and its surroundings (e.g. Grüll 1973, 1974, 1978, 1979, 1980, 1981, 1982, 1983, 1984, 1990, 1997).

Owing to intensive urbanisation in the last decades, there is an obvious trend of increasing representation of ruderal flora and vegetation in the landscape (Sukopp & Werner 1983, Sukopp 2002, Wittig 2002), which has led to considerable changes of biodiversity in the Central European landscape (Gilbert 1989, Pickett et al. 2001). For these reasons the investigation of ruderal flora and vegetation in urbanised areas is of considerable importance today. In the eighties, ruderal flora and vegetation of villages and rural landscapes were chiefly studied, and until approximately the nineties the main research interest was in ruderal flora and vegetation of big cities (e.g. Višňák 1986, Tlusták 1990, Celesti-Grapow & Blasi 1998, Pyšek P. 1998, Wittig 2002, Chocholoušková & Pyšek P. 2003, Pyšek P. et al. 2004, Celesti-Grapow et al. 2006). Compared with the surrounding landscape, big cities are characterised by high heterogeneity of habitats in a relatively small area and high diaspore pressure of alien plants, which enrich the diversity of flora (Pyšek P. 1998, Kühn et al. 2004, Wania et al. 2006). They are often invasive species, which might further spread into the landscape. Today, study of plant invasions and invasibility of habitats is very topical.

Vegetation colonising man-made habitats usually has a high proportion of alien species, both archaeophytes and neophytes. The highest representation of aliens was recorded in annual weed vegetation on arable land, annual ruderal vegetation, anthropogenous tall-forb stands and vegetation of trampled habitats (Kowarik 1995, Pyšek P. et al. 2002, Chytrý et al. 2005, 2008, Vilà et al. 2007). It is generally recognised that the representation of aliens differs among different types of man-made habitats (Hill et al. 2002, Pyšek P. et al. 2004, Celesti-Grapow et al. 2006, Lososová et al. 2006, Wania et al. 2006). Nevertheless, little is known about which factors influence the representation of aliens in different vegetation types, i.e. the role of local habitat conditions, availability of diaspores from the surroundings or climate.

One of the man-made habitats are walls. They are usually located in settlements, where they are exposed to high diaspore pressure of alien species. Although several studies on flora and vegetation of walls were published in the Czech Republic (Klimeš 1986, Kolbek et al. 2001, Duchoslav 2002, Chludová 2003, Procházková & Duchoslav 2004, Simonová 2008), little is known about the representation of alien flora in this type of ruderal vegetation and its importance in invasive ecology.

1.2. History of classification of Czech vegetation

In the second half of the twentieth century, with the increasing knowledge of ruderal vegetation there was a need for classification of this vegetation type.

Classification of ruderal vegetation is quite difficult: it is mostly composed of species with wide ecological amplitudes and particular vegetation types do not have their own diagnostic species and many stands are transitional between two or more vegetation units. Ruderal vegetation is also typical of various transitional growth stages. Owing to often highly unstable environments (with different frequency and effect of disturbances), which ruderal vegetation colonises, and diaspore supply from the surroundings, dominant species often alternate during short temporal periods (Hejný et al. 1979).

In the seventies, the deductive method of syntaxonomical classification was created for typisation of ruderal communities (Kopecký & Hejný 1971, 1973, 1978, 1980, 1990). This method was used for complex surveys of ruderal vegetation of the Czech Republic by Kopecký & Hejný (1992). Using the deductive method, authors are also able to classify communities which are composed of species with poor diagnostic value and are characteristic rather of higher syntaxonomical units. This classification resulted in a high number of distinguished vegetation units and unnoticed classification system.

A survey of units of ruderal vegetation elaborated by traditional methods of phytosociological classification was published by Hejný and colleagues (1979). Later, Moravec and colleagues (1983, 1995) published a handbook, *Plant communities of the Czech Republic and their endangerment*, which includes a survey of associations. Unfortunately, delimitation of associations is not very clear and they are without detailed description. Some of the vegetation units overlap with their content or have only poor floristic delimitation or there are no phytosociologically documented examples from the country. Moreover, regarding syntaxonomical nomenclature, invalid syntaxa names are often used.

Most Czech and foreign authors have used traditional methods of phytosociological classification until today. Delimitation of units of ruderal vegetation differs, however, in various countries, according to the various conceptions of authors, who use different criteria for classification. Delimitation is often inconsistent, based only on an expert opinion and mostly without any data analysis. Exceptions are some modern European vegetation surveys, for example, in Great Britain (Rodwell 2000), Netherlands (Schaminée et al. 1998), Germany (Berg et al. 2004) and Slovakia (Jarolímek et al. 1997), which are based on analyses of large datasets, and include revised nomenclature of vegetation units and synoptic tables. In any case, a disadvantage of these phytosociological classifications is that they are closed and have not defined criteria for assignment of new relevés to already defined units (Chytrý 2000).

In the last few years many studies have been published on formalised phytosociological classification of vegetation using the Cocktail method (Bruelheide 1995, 2000). With the help of this classification method we can define explicit criteria for assignment of phytosociological relevés to defined

associations and enable assignment of newly-obtained relevés to vegetation units independently in the whole dataset. Various vegetation types were classified through this approach in the Czech Republic (Kočí et al. 2003, Lososová 2004, Havlová 2006, Boublík et al. 2007, Roleček 2007, Douda 2008), and also, for example, in Slovakia (Dítě et al. 2007, Janišová 2007) or Slovenia (Šilc & Čarni 2007).

The formalised classification approach was also used in this Ph.D. thesis for elaboration of selected types of perennial ruderal and trampled vegetation. Final classification will form part of the second volume of the monograph *Vegetation of the Czech Republic* and will follow on from the previous volume dealing with grassland and heathland vegetation (Chytrý 2007).

2. MAIN AIMS

1) Revise the syntaxonomical conception of recent phytosociological classification of particular types of perennial ruderal and trampled vegetation of the Czech Republic (i.e. alliances *Onopordion acanthii, Dauco-Melilotion, Convolvulo-Agropyrion, Arction lappae, Galio-Alliarion, Aegopodion podagrariae, Polygonion avicularis* and *Centrantho-Parietarion*, according to Moravec and colleagues (1995)) and with regard to the main gradients in the species composition of studied vegetation and the representation of sociological groups of species to create formalized phytosociological classification of plant communities for the monograph *Vegetation of the Czech Republic.*

2) Reveal the level of invasion of particular types of studied ruderal vegetation and analyse environmental factors, which might influence the representation of alien plant species (i.e. archaeophytes and neophytes).

3. MATERIAL AND METHODS

3.1. Datasets and their general characteristics

Basic datasets used for particular topics included in the thesis were compiled from data from the Czech National Phytosociological Database (Chytrý & Rafajová 2003). The database includes phytosociological relevés of various

vegetation types provided by various authors from the Czech Republic. Relevés are stored in the database program TURBOVEG (Hennekens & Schaminée 2001).

Phytosociological relevés were completed by environmental data (mean annual temperature and precipitation, elevation, etc.). These data were obtained by means of the ArcGIS 8.3 geographic information system in laboratory BioGIS at the Department of Botany and Zoology at Faculty of Science MU in Brno (O. Hájek).

Species traits necessary for analysis were obtained from available electronic databases. Classification of alien species and their characteristics were added with the help of the *Catalogue of alien plants of the Czech Republic* (Pyšek P. et al. 2002). Biological species traits (e.g. life forms, life strategies, etc.) were obtained by means of the database Biolflor (Frank & Klotz 1990, Klotz et al. 2002) and for the characterisation of ecological demands of species Ellenberg indicator values were used (Ellenberg et al. 1992). These data were elaborated in the program JUICE 6.5 (Tichý 2002).

Indirect gradient analysis (DCA) in the program CANOCO 4.5 (ter Braak & Šmilauer 2002) was applied to reveal the variability of vegetation independent of environmental factors. The regression tree model method in program STATISTICA 7.1 (www.statsoft.com) was also used. A detailed description of individual methods is included in particular papers. Nomenclature of names of vascular plant taxa is in accordance with Kubát and colleagues (2002) and nomenclature of bryophyte names is in accordance with Kučera & Váňa (2004).

3.2. Preparation and analysis of data for the monograph *Vegetation of the Czech Republic*

Relevés of perennial ruderal and trampled vegetation ranked in the classes *Artemisietea vulgaris, Agropyretea repentis, Galio-Urticetea, Plantaginetea majoris* and *Parietarietea* (Moravec et al. 1995) were extracted from the Czech National Phytosociological Database. This dataset was completed with unpublished relevés of these vegetation types and relevés obtained in own field research. The final dataset included approximately 8800 relevés. They were added to the overall data et composed of relevés of different vegetation types stored in the central database.

In view of the fact that some areas of the Czech Republic are oversampled, the dataset was geographically stratified. Stratification was performed in a geographical grid with cells sized 1.25 minutes of longitude × 0.75 minutes of latitude, i.e. approximately 1.5 × 1.4 km. If two or more relevés assigned by their authors to the same association fell in the same grid cell, only one of them was selected. The final stratified dataset included 43499 relevés and it was used

for primary analyses (e.g. cluster analysis) and for creation of sociological species groups and testing of formal definitions.

Formalised phytosociological classification

The Cocktail method (Bruelheide 1995, 2000) was used for the formalised phytosociological classification. First, sociological species groups were created with the stratified dataset. These are groups of species which have a statistical tendency to occur together in relevés (cf. Lososová 2004, Havlová 2006, Chytrý 2007, Roleček 2007). The degree of species co-occurrence is calculated by means of the Phi coefficient of association (Sokal & Rohlf 1995, Chytrý et al. 2002). Subsequently, the formal definitions of particular associations were created by use of the logical operators AND, OR and NOT (Bruelheide 1997). They were defined mainly by the dominance of some species and also by combinations with species groups. The formal definitions of associations were elaborated in such a way that the groups of relevés specified by them matched as much as possible the traditionally distinguished associations (Moravec et al. 1995). All the procedures mentioned above were performed in the JUICE 6.5 program (Tichý 2002).

Description of vegetation units

Vegetation units are described in four hiearchical ranks – class, alliance, association and variant. Each association is characterised by specific species combination (diagnostic, constant and dominant species), formal definition, and detailed description including results of analyses of biological species traits, ecological demands of species and the representation of alien species in a particular community. Internal variability of given association is described by two to four variants, which were defined by means of the cluster analysis in the PC-ORD 4 program (McCune & Mefford 1999, with the chord distance as a measure of dissimilarity and the beta-flexible linkage method with the coefficient $\beta = -0.25$) or the method Twinspan in the JUICE 6.5 program (Tichý 2002). Variants were performed separately for each group of relevés assigned to the individual associations.

Nomenclature of syntaxa was revised according to the *International Code of Phytosociological Nomenclature* (Weber et al. 2000, 2002). For details, see Chytrý (2007).

Synoptic tables of plant communities were created from the dataset of stratified relevés (43499 relevés) of all vegetation types of the Czech Republic. Species were ranked according to decreasing fidelity. Diagnostic species were characterised as those with Phi coefficient higher than 0.25 (for detailed information, see Chytrý 2007). In each table the percentage frequency of the occurrence of species in relevés assigned to individual associations was illustrated. Species with low frequency were excluded from the table.

Approximately 62500 unstratified relevés of non-forest vegetation types of the Czech Republic were used to document the distribution of individual associations of studied vegetation in the country. Relevés from this dataset were compared with the formal definitions of associations formed by the Cocktail method. Maps were created in the program DMAP (Morton 2001).

4. STRUCTURE OF PH.D. THESIS

The main part of the thesis comprises four manuscripts of the chapters for the second volume of the monograph *Vegetation of the Czech Republic*. For coherence and simplicity with regard to the survey of vegetation units, texts of phytosociological associations and alliances written by other authors were included, too (approx. 20% of the whole text). The thesis also includes three published papers, which are closely related to the texts prepared for the monograph.

Manuscripts of chapters for the monograph *Vegetation of the Czech Republic*

1. **Láníková D.**, Chytrý M. & Lososová Z. (2009): Suchomilná ruderální vegetace s dvouletými a vytrvalými druhy (Artemisietea vulgaris) [Xerophilous ruderal vegetation with biennial and perennial species]. In: Chytrý M. (ed.), *Vegetace České republiky 2. Plevelová, ruderální, skalní a suťová vegetace*. [Vegetation of the Czech Republic 2. Weed, ruderal, rock and scree vegetation]. Academia, Praha (submitted).

2. **Láníková D.**, Kočí M., Sádlo J., Šumberová K., Hájková P, Hájek M. & Petřík P. (2009): Nitrofilní vytrvalá vegetace vlhkých a mezických stanovišť (Galio-Urticetea). [Nitrophilous perennial vegetation of wet to mesic habitats]. In: Chytrý M. (ed.), *Vegetace České republiky 2. Plevelová, ruderální, skalní a suťová vegetace*. [Vegetation of the Czech Republic 2. Weed, ruderal, rock and scree vegetation]. Academia, Praha (submitted).

3. **Láníková D.** & Lososová Z. (2009): Vegetace sešlapávaných míst (Polygono arenastri-Poëtea annuae). [Vegetation of trampled habitats]. In: Chytrý M. (ed.), *Vegetace České republiky 2. Plevelová, ruderální, skalní a suťová vegetace.* [Vegetation of the Czech Republic 2. Weed, ruderal, rock and scree vegetation]. Academia, Praha (submitted).

4. Láníková D. & Sádlo J. (2009): Nitrofilní vegetace zdí (Cymbalario muralis-Parietarietea diffusae). [Nitrophilous vegetation on walls]. In: Chytrý M. (ed.), *Vegetace České republiky 2. Plevelová, ruderální, skalní a suťová vegetace*. [Vegetation of the Czech Republic 2. Weed, ruderal, rock and scree vegetation]. Academia, Praha (submitted).

Published papers

1. Simonová D. (2008): Vegetation of trampled habitats in the Czech Republic: a formalized phytosociological classification. *Phytocoenologia* 38: 177–191.

2. Simonová D. & Lososová Z. (2008): Which factors determine plant invasions in man-made habitats in the Czech Republic? *Perspectives in Plant Ecology, Evolution and Systematics* 10: 89–100.

3. Simonová D. (2008): Alien flora on walls in southern and western Moravia (Czech Republic). In: Tokarska-Guzik B., Brock J.H., Brundu G., Child L., Daehler, C.C. & Pyšek P. (eds), *Plant Invasions: Human perception, ecological impacts and management*, pp. 317–332. Backhuys Publishers, Leiden, The Netherlands.

5. CO-AUTHOR PARTICIPATION

Michal Hájek – co-author of the manuscript no. 2, class *Galio-Urticetea* (co-author of the text of the association *Carici pendulae-Eupatorietum cannabini*)

Petra Hájková – co-author of the manuscript no. 2, class *Galio-Urticetea* (main author of the text of the association *Carici pendulae-Eupatorietum cannabini*)

Milan Chytrý – co-author of the manuscript no. 1, class *Artemisietea vulgaris* (author of the text of the alliance *Artemisio-Kochion* and its association)

Martin Kočí – co-author of the manuscript no. 2, class *Galio-Urticetea* (author of the text of the alliances *Petasition hybridi* and *Rumicion alpini* and their associations)

Zdeňka Lososová – co-author of the manuscript no. 1, class *Artemisietea vulgaris* (co-author of the text of the association *Cardarietum drabae*), the manuscript no. 3, class *Polygono arenastri-Poëtea annuae* (co-author of the text of the association *Eragrostio-Polygonetum*), and the published paper no. 2

Petr Petřík – co-author of the manuscript no. 2, class *Galio-Urticetea* (co-author of the text of the association *Arunco-Lunarietum*)

Jiří Sádlo – co-author of the manuscript no. 2, class *Galio-Urticetea* (co-author of the text of the class *Galio-Urticetea*, author of the text of the alliance *Impatienti-Stachyion* and the main author of its associations), co-author of the manuscript no. 4, class *Cymbalario-Parietarietea* (author of the text of the class and the main author of the text of the alliance *Cymbalario-Asplenion*)

Kateřina Šumberová – co-author of the manuscript no. 2, class *Galio-Urticetea* (the main author of the text of the alliance *Senecionion fluviatilis* and most of its associations, co-author of the text of the association *Chaerophylletum bulbosi*)

6. RESULTS

(1) By means of the Cocktail method, formal definitions of associations of the alliances *Onopordion acanthii, Dauco-Melilotion, Convolvulo-Elytrigion, Arction lappae, Geo-Alliarion, Aegopodion podagrariae, Coronopodo-Polygonion, Saginion procumbentis* and *Cymbalario-Asplenion* were created. Owing to the character of ruderal vegetation, which is composed mainly of species with wide ecological amplitude, the use of sociological species groups could only be narrow. Therefore, most definitions of ruderal plant communities are based on the dominance of particular species (Kočí et al. 2003). Formal definitions are part of an expert system within the JUICE program (http://www.sci.muni.cz/botany/vegsci/expertni_system.php?lang=cz).

(2) Some associations distinguished by Moravec and colleagues (1995) had only poor floristic delimitation or had only local distribution. These associations were not defined in the new formalised survey. Some of the traditionally distinguished associations coincided with each other; wider conception was mostly prefered and their inner variability was described by use of variants. On the other hand, some associations were newly delimited compared with the survey by Moravec and colleagues (1995):

these were *Salvio nemorosae-Marrubietum peregrini*, *Artemisio vulgaris-Echinopsietum sphaerocephali*, *Convolvulo arvensis-Brometum inermis*, *Rumici acetosellae-Spergularietum rubrae*, and *Lolio perennis-Matricarietum suaveolentis*. They are documented by phytosociological relevés from the country and have adequately favourable floristic delimitation. For the sake of lucidity and completeness of the new classification system, growths dominated by commonly-distributed invasive neophytes were described on the association level, too. Overall, the number of units of perennial ruderal and trampled vegetation was reduced in comparison with the previous phytosociological survey of Czech vegetation (Moravec et al. 1995, Table 1). This has led to better clarity of the new classification system of ruderal vegetation, which generally has a tendency to inflate vegetation units (Pignatti 1968, Hejný et al. 1979). The new vegetation survey of the Czech Republic is based on comprehensive analyses of large relevé datasets from the country as a whole and it can be used for comparison with vegetation of other European countries.

Main syntaxonomical changes:

- In comparison with the vegetation survey of Moravec and colleagues (1995) the class *Agropyretea repentis* is not distinguished, because it has no self-diagnostic species (Chytrý & Tichý 2003). Its alliance *Convolvulo arvensis-Elytrigion repentis* is ranked in the class *Artemisietea vulgaris*.

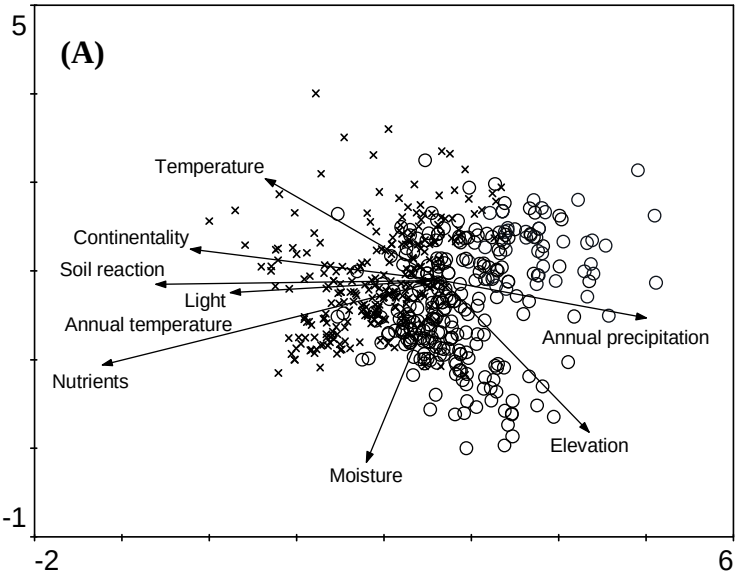
- In the class *Artemisietea vulgaris* we also rank the alliance *Arction lappae*, which has a transitional position between vegetation of the classes *Artemisietea vulgaris* and *Galio-Urticetea*, and which was traditionally ranked in the class *Galio-Urticetea* (Hejný in Moravec et al. 1995: 144–151). Owing to the similarity of its floristic composition to other alliances of the class *Artemisietea vulgaris*, we classify *Arction lappae* in this class similarly to most authors from surrounding European countries (Mucina in Mucina et al. 1993: 169–202, Müller in Oberdorfer 1993: 135–277, Pott 1995, Jarolímek et al. 1997, Klotz in Schubert et al. 2001: 387–403, Borhidi 2003, Matuszkiewicz 2007).

- The conception of the class *Polygono-Poëtea annuae* was accepted for vegetation of trampled habitats in the Czech Republic. In comparison with the previous conception of the class *Plantaginetea majoris* (Hejný et al. in Moravec et al. 1995: 152–157) this class includes vegetation types dominated by annual species. In the survey

Vegetation of the Czech Republic, perennial types of trampled vegetation are ranked in the grassland vegetation of the classes *Molinio-Arrhenatheretea* and *Festuco-Puccinellietea* (Chytrý 2007). The main gradients of the species composition of the vegetation of *Polygono-Poëtea* class are shown in Figure 1 (more details in **Paper 1**).

Table 1. Comparison of number of associations of studied vegetation in the last phytosociological survey of the Czech Republic (Moravec et al. 1995) and in the new Czech vegetation survey using the Cocktail classification method.

Alliances	**Moravec et al. (1995)**	**Formalized classification**
Artemisietea vulgaris	**25**	**22**
Onopordion acanthii	5	3
Dauco-Melilotion	6	11
Convolvulo-Agropyrion	7	4
Arction lappae	7	4
Galio-Urticetea	**14**	**13**
Geo-Alliarion	5	3
Aegopodion podagrariae	9	10
Polygono-Poëtea	**13**	**9**
Coronopodo-Polygonion	13	4+5
Saginion procumbentis (orig. *Polygonion avicularis*)		
Cymbalario-Parietarietea	**2**	**2**
Cymbalario-Asplenion (orig. *Centrantho-Parietarion*)	2	2
Total number of associations	**54**	**46**


(A)
5
-1
-2
6
Temperature
Continentality
Soil reaction
Light
Annual temperature
Nutrients
Annual precipitation
Elevation
Moisture

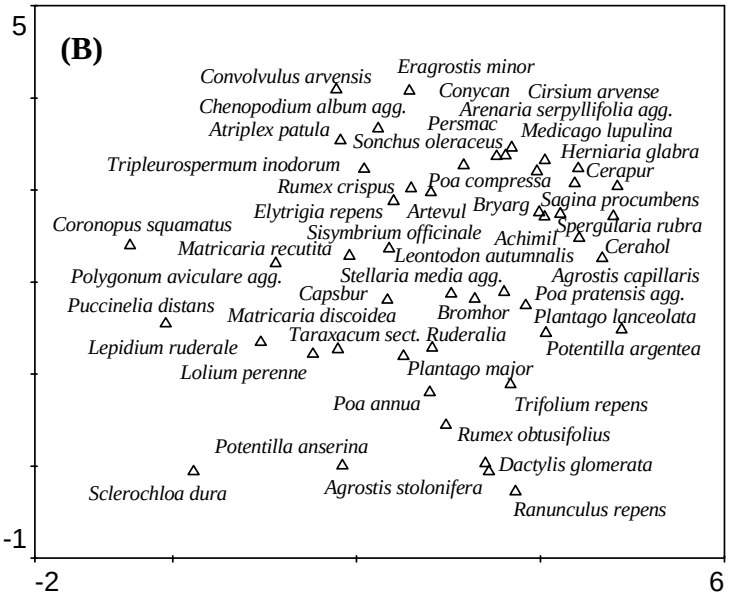

(B)
5
-1
-2
6
Convolvulus arvensis
Eragrostis minor
Conycan
Cirsium arvense
Chenopodium album agg.
Arenaria serpyllifolia agg.
Atriplex patula
Persmac
Medicago lupulina
Sonchus oleraceus
Herniaria glabra
Tripleurospermum inodorum
Cerapur
Rumex crispus
Poa compressa
Sagina procumbens
Elytrigia repens
Artevul
Bryarg
Coronopus squamatus
Spergularia rubra
Sisymbrium officinale
Achimil
Matricaria recutita
Cerahol
Leontodon autumnalis
Polygonum aviculare agg.
Stellaria media agg.
Agrostis capillaris
Capsbur
Poa pratensis agg.
Puccinelia distans
Matricaria discoidea
Bromhor
Plantago lanceolata
Taraxacum sect. Ruderalia
Lepidium ruderale
Potentilla argentea
Lolium perenne
Plantago major
Poa annua
Trifolium repens
Rumex obtusifolius
Potentilla anserina
Dactylis glomerata
Agrostis stolonifera
Sclerochloa dura
Ranunculus repens

Fig. 1. **(A)** DCA ordination diagram with Ellenberg indicator values (averages for relevés), elevation, mean annual temperature and mean annual precipitation projected as supplementary variables. Two groups of relevés belonging to different alliances of the class *Polygono-Poëtea* are distinguished by crosses (*Coronopodo-Polygonion*) and open circles (*Saginion procumbentis*). Eigenvalues: axis 1 – 0.464, axis 2 – 0.355. **(B)** DCA ordination diagram of species. Only species with the highest weight are shown.

- Nitrophilous vegetation of walls is ranked in the alliance *Cymbalario muralis-Asplenion* in the class *Cymbalario muralis-Parietarietea diffusae*, although this alliance is mostly classified within the class *Asplenietea trichomanis* (e.g. Mucina in Grabherr & Mucina 1993: 241–275, Valachovič in Valachovič et al. 1995: 15–41, Meertens et al. in Schaminée et al. 1998: 13–38, Berg & Wollert in Berg et al. 2004: 286–289, in the Czech Republic, Kolbek 1997). Nevertheless, *Cymbalario muralis-Asplenion* differs from the class *Asplenietea trichomanis* in the presence of nitrophilous ruderal species with high demands on nutrients, scarce occurrence of species of oligotrophic habitats and the high proportion of therophytes. Alliance *Centrantho-Parietarion* presented in the vegetation survey by Moravec and colleagues (1995) was rejected for the national classification, because it includes different wall vegetation with Mediterranean distribution.

(3) Nomenclatoric revision of names of all syntaxa was done. Each vegetation unit described in the survey *Vegetation of the Czech Republic* includes original diagnosis of a valid name and its author. Synonyms often used in modern European vegetation surveys are also presented.

(4) Distribution maps of associations of studied vegetation were created. Unfortunately, these maps do not adequately represent the real distribution of particular associations in the Czech Republic, because often concentration of phytosociological relevés of ruderal vegetation is mainly in big cities, e.g. Plzeň (Bartošová 1983), Praha (e.g. Kopecký 1980, 1982a,b, 1984b, 1986b, 1990b), Liberec (Višňák 1992), Olomouc (Tlusták 1990) or Brno (e.g. Grüll 1979, 1981), or in some smaller regions (e.g. Kopecký & Hejný 1971, Kopecký 1974a, Zlámalík 1978, Jehlík 1986, Chlapek 1998, Cigánek 1998, Kolbek et al. 2001, Douda 2003). Most ruderal communities are more often in the country than maps indicate.

(5) The highest representation of alien species among particular types of ruderal vegetation was recorded in annual ruderal vegetation (class *Stellarietea mediae* = *Chenopodietea*, Table 2, more details in **Paper 2**).

On the other hand, perennial ruderal vegetation of the class *Galio-Urticetea* (alliances *Aegopodion podagrariae* and *Geo-Alliarion*) was invaded the least. The representation of alien species is significantly influenced by ecological and local abiotic conditions,and less influenced by climate and diaspore pressure from the surroundings. Both archaeophytes and neophytes mostly occur in heavily disturbed sites with high nutrient content in warm lowland regions. Analysis of factors determining the representation of archaeophytes in vegetation showed that their occurrence is influenced more by local abiotic conditions compared with neophytes. Archaeophytes colonise sunnier, dryer habitats with higher soil reaction. It seems that some neophytes have not so far adapted to ecological conditions in a secondary distribution range and do not colonise all favourable habitats. Their occurrence is limited mainly to strongly urbanised areas in lowlands.

Table 2. The overview of anthropogenic vegetation types (Moravec et al. 1995) included in the analysis and percentages of archaeophytes and neophytes (mean ± SD, percentage values are rounded).

No.	Phytosociological unit	No. of relevés	Arch (%)	Neo (%)
	Chenopodietea			
1	*Malvion neglectae*	54	54±15	10±8
2	*Bromo-Hordeion murini*	81	53±15	8±6
3	*Sisymbrion officinalis*	514	50±14	11±9
4	*Eragrostion minoris*	29	48±12	17±8
5	*Salsolion ruthenicae*	22	42±7	22±8
	Artemisietea vulgaris			
6	*Onopordion acanthii*	42	46±17	6±6
7	*Dauco-Melilotion*	374	33±16	7±6
	Galio-Urticetea			
8	*Galio-Alliarion*	187	18±12	5±6
9	*Arction lappae*	514	37±15	6±7
10	*Aegopodion podagrariae*	450	13±11	3±5
	Agropyretea repentis			
11	*Convolvulo-Agropyrion*	252	32±16	6±6
	Plantaginetea majoris			
12	*Polygonion avicularis*	901	26±18	8±7

(6) Wall habitats are characterised by high representation of alien species (Figure 2, more details in **Paper 3**) and are important for colonisation and further spread of archaeophytes and neophytes (22.7% and 16.5% respectively, counted from the total flora of walls of southern and western Moravia). Invasive species are a significant part of wall flora (23%). In comparison with the species composition of wall vegetation in the other parts of the Czech Republic, the high representation of aliens is probably largely influenced by the localisation of studied walls in big cities in warm regions.

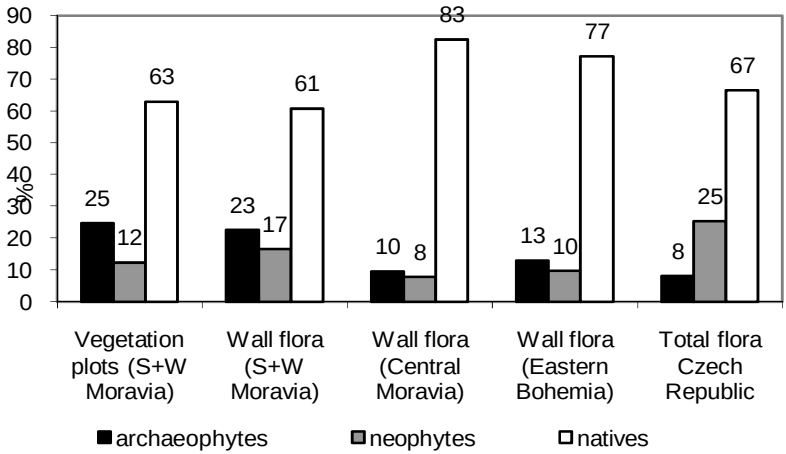


Fig. 2. Representation of alien and native species in vegetation plots and flora on walls in various regions of the Czech Republic and in the total flora of the country: southern and western Moravia (S+W Moravia), central Moravia (Chludová 2003), eastern Bohemia (Duchoslav 2002) and in the total flora of the Czech Republic (Pyšek et al. 2002). The percentage values are rounded.

7. LITERATURE

Bartošová L. (1983): *Srovnání vegetace dvou typů městské zástavby v Plzni*. Ms., dipl. pr., PřF UK, Praha.

Berg C., Dengler J., Abdank A. & Isermann M. (eds.) (2004): *Die Pflanzengesellschaften Mecklenburg-Vorpommerns und ihre Gefährdung – Textband*. Weissdorn-Verlag, Jena.

Borhidi A. (2003): *Magyarország növénytársulásai*. Akadémiai Kiadó, Budapest.

Boublík K., Petřík P., Sádlo J., Hédl R., Willner W., Černý T. & Kolbek J. (2007): Calcicolous beech forests and related vegetation in the Czech Republic: a comparison of formalized classifications. *Preslia* 79: 141–161.

Bruelheide H. (1995): Die Grünlandgesellschaften des Harzes und ihre Standortsbedingungen. Mit einem Beitrag zum Gliederungsprinzip auf der Basis von statistisch ermittelten Artengruppen. *Diss. Bot.* 244: 1–338.

Bruelheide H. (1997): Using formal logic to classify vegetation. *Folia Geobot. Phytotax.* 32: 41–46.

Bruelheide H. (2000): A new measure of fidelity and its aplication to defining species groups. *J. Veg. Sci.* 11: 167–178.

Celesti-Grapow L. & Blasi C. (1998): A comparison of the urban flora of different phytoclimatic regions in Italy. *Global Ecol. Biogeogr. Lett.* 7: 367–378.

Celesti-Grapow L., Pyšek P., Jarošík V. & Blasi C. (2006): Determinants of native and alien species richness in the urban flora of Rome. *Diversity Distrib.* 12: 490–501.

Cigánek D. (1998): *Synantropní vegetace Národního parku Podyjí*. Ms., dipl. pr., PřF MU, Brno.

Dítě D., Hájek M. & Hájková P. (2007): Formal definitions of Slovakian mire plant associations and their application in regional research. *Biologia* 62: 400–408.

Douda J. (2003): *Flóra a vegetace přírodovědně významných lokalit okolí Bechyně.* Ms., dipl. pr., FLE ČZU, Praha.

Douda J. (2008): Formalized classification of the vegetation of alder carr and floodplain forests in the Czech Republic. *Preslia* 80: 199–224.

Duchoslav M. (2002): Flora and vegetation of stony walls in east Bohemia (Czech Republic). *Preslia* 74: 1–25.

Ellenberg H., Weber H. E., Düll R., Wirth W., Werner W. & Paulißen D. (1992): Zeigerwerte von Pflanzen in Mitteleuropa. Ed. 2. *Scr. Geobot.* 18: 1–258.

Engel H. (1949): Trümmerpflanzen von Monster. *Natur und Heimat* 9: 1–12.

Frank D. & Klotz S. (1990): Biologisch-ökologische Daten zur Flora der DDR. *Wiss. Beitr. Martin-Luther-Univ. Halle-Wittenberg* 41: 1–167.

Gilbert O. L. (1989): *Ecology of Urban Habitats*. Chapman and Hall, London.

Grüll F. (1973): *Chenopodietum glauco-rubri* Lohm. 1950 ap. Oberd. 1957 a *Lamio-Conietum* Oberd. 1957, ze skládek města Brna. *Zprávy Československ. Bot. Společn.* 8: 191–193.

Grüll F. (1974): *Chaerophylletum aromatici* (Tüxen 1967) Neuh. Z., Neuh. R. et Hejný 1969 im Moravský kras (Mährischer Karst). *Preslia* 46: 350–358.

Grüll F. (1978): Die Vegetation der Eisenbahnstrecken und ihre Pflanzengesellschaften im Areal der Stadt Brno. *Acta Bot. Acad. Sci. Slov., Ser A*, 3: 245–251.

Grüll F. (1979): Rostlinná společenstva železničních tratí a nádražních objektů v širším areálu města Brna. *Preslia* 51: 129-140.

Grüll F. (1980): Výskyt a charakteristika méně známých ruderálních společenstev svazů *Sisymbrion officinalis* a *Arction* v širším areálu města Brna. *Preslia* 52: 269–278.

Grüll F. (1981): Fytocenologická charakteristika ruderálních společenstev na území města Brna. *Studie ČSAV* 10: 1–127, Academia, Praha.

Grüll F. (1982): Málo známá pionýrská společenstva rostlin na obnažených půdách stavenišť města Brna. *Preslia* 54: 149–166.

Grüll F. (1983): Výskyt a charakteristika rostlinného společenstva s *Iva xanthifolia* v Brně. *Zprávy Československ. Bot. Společn.* 18: 141–144.

Grüll F. (1984): Ruderalvegetation in Neusiedlungen von Brno. *Acta Bot. Slov., Ser. A, Suppl.* 1: 27–36.
Grüll F. (1990): Rostlinná společenstva železničního uzlu Brno v oblasti seřaďovacího nádraží v letech 1970–1986. *Preslia* 62: 73–90.
Grüll F. (1997): Výskyt rostlinného společenstva s *Panicum capillare* podél železniční tratě mezi Brnem hl. n. a zastávkou Horní Heršpice. *Zprávy České Bot. Společn.* 32: 97–99.
Gutte P. (1969): *Die Ruderalpflanzengesselschaften West- und Mittelsachsens und ihre Bedeutung für die Pflanzengeographische Gliederung des gebietes*. Diss. Univ. Leipzig.
Hadač E. (1978): Ruderal vegetation of the Broumov basin, NE. Bohemia. *Folia Geobot. Phytotax.* 13: 129–163.
Havlová M. (2006): Syntaxonomical revision of the Molinion meadows in the Czech Republic. *Preslia* 78: 87–101.
Hejný S., Kopecký J., Jehlík V. & Krippelová T. (1979): Přehled ruderálních rostlinných společenstev Československa. *Rozpr. Čs. Akad. Věd, Ser. Math.-Natur.*, 89/2: 1–100.
Hennekens S. M. & Schaminée J. H. J. (2001): TURBOVEG, a comprehensive data base management systém for vegetation data. *J. Veg. Sci.* 12: 589–591.
Hilbig W. (1972): Beitrag zur Kenntnis einiger wenig beachteter Pflanzengesselschaften Mitteldeutschlands. *Wiss. Z. Univ. Halle* 21: 83–98.
Hilbig W., Heinrich W. et Niemann E. (1972): Übersicht über die Pflanzengesellschften des südlichen Teiles der DDR. IV. Die nitrophilen Staudenfluren. *Hercynia N.F.* 9: 229–270.
Hill M.O., Roy D.B. & Thompson K. (2002): Hemeroby, urbanity and ruderality: bioindicators of disturbance and human impact. *J. Appl. Ecol.* 39: 708–720.
Chlapek J. (1998): *Ruderální vegetace centrální části Moravskoslezských Beskyd*. Ms., dipl. pr., PřF MU, Brno.
Chludová K. (2003): *Flóra a vegetace zdí na střední Moravě*. Ms., dipl. pr., PřF UP, Olomouc.
Chocholoušková Z. & Pyšek P. (2003): Changes in composition and structure of urban flora over 120 years: a case study of the city Plzeň. *Flora* 198: 366–376.
Chytrý M. & Rafajová M. (2003): Czech National Phytosociological Database: basic statistics of the available vegetation-plot data. *Preslia* 75: 1–15.
Chytrý M. & Tichý L. (2003): Diagnostic, constant and dominant species of vegetation classes and alliances of the Czech Republic: a statistical revision. *Folia Fac. Sci. Nat. Univ. Masaryk. Brun.*, Masaryk University, Brno.
Chytrý M. (2000): Formalizované přístupy k fytocenologické klasifikaci vegetace. *Preslia* 72: 1–29.
Chytrý M., Maskell L.C., Pino J., Pyšek P., Vilà M., Font X. & Smart S.M. (2008): Habitat invasions by alien plants: a quantitative comparison among Mediterranean, subcontinental and oceanic regions of Europe. *J. Applied Ecol.* 45: 448–458.
Chytrý M., Pyšek P., Tichý L., Knollová I. & Danihelka J. (2005): Invasions by alien plants in the Czech Republic: a quantitative assessment across habitats. *Preslia* 77: 339–354.
Chytrý M., Tichý L., Holt J. & Botta-Dukát Z. (2002): Determination of diagnostic species with statistical fidelity measures. *J. Veg. Sci.* 13: 79–90.

Chytrý, M. (ed.) (2007): *Vegetace České republiky, 1. Travinná a keříčková vegetace*. Academia, Praha.

Janišová (2007): *Travinnobylinná vegetácia Slovenska – elektronický expertný systém na identifikáciu syntaxonov*. Botanický ústav SAV, Bratislava.

Jarolímek I., Zaliberová M., Mucina L. & Mochnacký S. (1997): *Rastlinné spoločenstvá Slovenska. 2. Synantropná vegetácia*. Veda, Bratislava.

Jehlík V. (1986): *The vegetation of railways in Northern Bohemia (eastern part)*. Academia, Praha.

Kent D. H. (1951): The flora of bombed sites in Canterbury. *Watsonia* 2: 12–17.

Klimeš L. (1986): *Sedo acri-Poetum compressae* – rostlinné společenstvo korun zdí na Hané (ČSR). *Preslia* 58: 29–42.

Klotz S., Kühn I. & Durka W. (2002): Biolflor – eine Datenbank mit biologisch-ökologischen Merkmalen zur Flora von Deutschland. *Schriftenr. Vegetationsk.* 38: 1–334.

Kočí M., Chytrý M. & Tichý L. (2003): Formalized reproduction of an expert-based phytosociological classification: A case study of subalpine tall-forb vegetation. *J. Veg. Sci.* 14: 601–610.

Kolbek J. (1997): Plant communities on walls in the Czech Republic – preliminary notes. *Zprávy České Bot. Společn.*, 32, Mater. 15: 61–67.

Kolbek J., Neuhäuslová Z., Sádlo J., Dostálek J., Havlíček P., Husáková J., Kučera T., Kropáč Z. & Lecjaksová S. (2001): *Vegetace Chráněné krajinné oblasti a Biosférické rezervace Křivoklátsko 2. Společenstva skal, strání, sutí, primitivních půd, vřesovišť, termofilních lemů a synantropní vegetace.* Academia, Praha.

Kopecký K. & Hejný S. (1971): Nitrofilní lemová společenstva víceletých rostlin severovýchodních a středních Čech. *Rozpr. Československ. Akad. Věd, Tř. Mat. Přír.*, 81/9: 1–126.

Kopecký K. & Hejný S. (1973): Neue syntaxonomische Auffassung der Gesellschaften ein- bis zweijähriger Pflanzen der *Galio-Urticetea* in Böhmen. *Folia Geobot. Phytotax.* 8: 49–66.

Kopecký K. & Hejný S. (1978): Die Anwendung einer „deduktiven Methode syntaxonomischer Klassifikation" bei der Bearbeitung der strassebegleitenden Pflanzengesellschaften Nordostböhmens. *Vegetatio* 36: 43–51.

Kopecký K. & Hejný S. (1980): Deduktivní způsob syntaxonomické klasifikace rostlinných společenstev. *Zprávy Československ. Bot. Společn.* 15, Mater. 1: 51–58.

Kopecký K. & Hejný S. (1990): Die stauden- und grasreichen Ruderalgesellschaften Böhmens unter Anwendung der deduktiven Methode der syntaxonomischen Klassifizierung. *Folia Geobot. Phytotax.* 25: 357–380.

Kopecký K. & Hejný S. (1992): Ruderální společenstva bylin České republiky. *Stud. ČSAV*, Academia, Praha, 1992/1: 1–128.

Kopecký K. (1969): Zur Syntaxonomie der natürlichen nitrophilen Saumgesellschaften in der Tschechoslowakei und zur Gliederung der Klasse *Galio-Urticetea*. *Folia Geobot. Phytotax*. 4: 235–259.

Kopecký K. (1974a): Die anthropogene nitrophile Saumvegetation des Gebirges Orlické hory (Adlergebirge) und seines Vorlandes. *Rozpr. Československ. Akad. Věd, Tř. Mat. Přír.* 84/1: 1–173.

Kopecký K. (1974b): K fytocenologickému hodnocení a rozšíření antropogenních porostů s *Anthriscus nitida* (Wahlb.) Hazslinzky v Orlických horách. *Preslia* 46: 57–63.
Kopecký K. (1974c): Kritische Bemerkungen zur Syntaxonomie einiger nitrophilen Apophyten-Gesellschaften. *Folia Geobot. Phytotax*. 9: 329–340.
Kopecký K. (1980): Die Ruderalpflanzengesellschaften im südwestlichen Teil von Praha (1). *Preslia* 52: 241–267.
Kopecký K. (1981a): Die Ruderalpflanzengesellschaften im südwestlichen Teil von Praha (2). *Preslia* 53: 121–146.
Kopecký K. (1981b): Syntaxonomická klasifikace nitrofilních lemových společenstev v Československu. *Zprávy Československ. Bot. Společn.*, 16, Mater. 2 (Klasifikace vegetace II): 111–114.
Kopecký K. (1982a): Die Ruderalpflanzengesellschaften im südwestlichen Teil von Praha (3). *Preslia* 54: 67–89.
Kopecký K. (1982b): Die Ruderalpflanzengesellschaften im südwestlichen Teil von Praha (4). *Preslia* 54: 123–139.
Kopecký K. (1983): Die Ruderalpflanzengesellschaften im Südwestlichen Teil von Praha 5. *Preslia* 55: 289-298.
Kopecký K. (1984a): Der Apophytisierungsprozess und die Apophytengesellschaften der *Galio-Urticetea* mit eineigen Beispielen aus der südwestlichen Umgebung von Praha. *Folia Geobot. Phytotax*. 19: 113–138.
Kopecký K. (1984b): Die Ruderalpflanzengesellschaften im südwestlichen Teil von Praha (6). *Preslia* 56: 55–72.
Kopecký K. (1985): K syndynamice a rozšíření *Alliario-Chaerophylletum temuli* Lohm. 1949 a odvozených společenstev s Impatiens parviflora v jihozápadní části Prahy. *Zprávy Československ. Bot. Společn*. 20: 133–144.
Kopecký K. (1986a): Ústup společenstva *Malvetum neglectae* a sukcese na jeho stanovištích. Preslia, 58: 63-74.
Kopecký K. (1986b): Versuch einer Klassifizierung der ruderalen *Agropyron repens*- und *Calamagrostis epigejos*-Gesellschaften unter Anwendung der deduktiven Methode. *Folia Geobot. Phytotax.* 21: 225–242.
Kopecký K. (1988): Einfluss der Strassen auf die Synanthropisierung der Flora und Vegetation nach Beobachtungen in der Tschechoslowakei. *Folia Geobot. Phytotax*. 23: 145–171.
Kopecký K. (1989): Rozbor tzv. procesu apofytizace druhu *Chaerophyllum bulbosum* s použitím deduktivní metody syntaxonomické klasifikace. *Zprávy Československ. Bot. Společn*. 24: 105–113.
Kopecký K. (1990a): Ustupující a mizející společenstva svazu *Polygonion avicularis* na bývalé periferii jihozápadní části Prahy. *Preslia* 62: 221–239.
Kopecký K. (1990b): Změny ruderální vegetace na bývalé periferii jihozápadní části Prahy během posledních třiceti let. *Zprávy Československ. Bot. Společn*. 25: 51–71.
Kowarik I. (1995): On the role of alien species in urban flora and vegetation. In: Pyšek P., Prach K., Rejmánek M. & M. Wade (eds.), *Plant Invasions: General Aspects and Special Problems*, pp. 85–103. SPB Academic Publishing, Amsterdam, The Netherlands.
Kreh W. (1955): Das Ergebnis der Vegetationsentwicklung auf dem Stuttgarter Trümmerschutt. *Mitt. Flor.-soz. Arb. gem.* 5: 69–75.

Kubát K., Hrouda L., Chrtek J. jun., Kaplan Z., Kirschner J. & Štěpánek J. (eds.) (2002): *Klíč ke květeně České republiky*. Academia, Praha.

Kučera J. & Váňa J. (2003): Check- and Red List of bryophytes of the Czech Republic (2003). *Preslia* 75: 193–222.

Kühn I., Brandl R., May R. & Klotz S. (2004): The flora of German cities is naturally species rich. *Evolutionary Ecology Research* 6: 749–764.

Lososová Z. (2004): Weed vegetation in southern Moravia (Czech Republic): a formalized phytosociological classification. *Preslia* 76: 65–85.

Lososová Z., Chytrý M., Kühn I., Hájek O., Horáková V., Pyšek P. & Tichý L. (2006): Plant trait patterns in annual vegetation of Central European human-made habitats. *Perspect. Plant Ecol. Evol. Syst.* 8: 69–81.

Lousley J.E. (1944): *The pioneer flora of bombed sites in central London*. Report of the Botanical Society and Exchange Club of the British Isles 1941/42, 528–531.

Matuszkiewicz W. (2007): *Przewodnik do oznaczania zbiorovisk roślinnych Polski*. Wydawnictwo Naukowe PWN, Warszawa.

McCune B. & Mefford M. J. (1999): *PC-ORD. Multivariate analysis of ecological data. Version 4.* MjM Software Design, Gleneden Beach.

Medwecka-Kornaś A., Kornaś J. et Pawłowski B. (1959): *Przeglad ważniejszych zespolów roślinnych Polski.* In: Szafer W. (red.): Szata roślinna Polski, p. 274–484, Warszawa.

Moravec J. Balátová-Tuláčková E., Blažková D., Hadač E., Hejný S., Husák Š., Jeník J., Kolbek J., Krahulec F., Kropáč Z., Neuhäusl R., Rybníček K., Řehořek V. & Vicherek J. (1995): Rostlinná společenstva České republiky a jejich ohrožení. Ed. 2. *Severočes. Přír., Litoměřice, suppl.* 1995/1: 1–206.

Moravec J. Balátová-Tuláčková E., Hadač E., Hejný S., Jeník J., Kolbek J., Kopecký K., Krahulec F., Kropáč Z., Neuhäusl R., Rybníček K. & Vicherek J. (1983): Rostlinná společenstva České socialistické republiky a jejich ohrožení. *Severočeskou Přír., Příl.* 1983/1: 1–110.

Morton A. (2001): DMAP. Distribution mapping software. URL: http://www.dmap.co.uk.

Mucina L., Grabherr G. & Ellmauer T. (eds.) (1993): *Die Pflanzengesellschaften Österreichs. Teil I. Anthropogene Vegetation*. Gustav Fischer Verlag, Jena/Stuttgart/New York.

Oberdorfer E. (1957): Süddeutsche Pflanzengesellschaften. *Pflanzensoziologie* 10: 1–564.

Oberdorfer E. (ed.) (1993): *Süddeutsche Pflanzengesellschaften. Teil III. Wirtschaftswiesen und Unkrautgesellschaften. Ed. 3*. Gustav Fischer Verlag, Jena/Stuttgart/New York.

Pickett, S.T.A., Cadenasso, M.L., Grove, J.M., Nilon, C.H., Pouyat, R.V., Zipperer, W.C. & Costanza, R. (2001): Urban ecological systems: linking terrestrial ecological, physical, and socioeconomic components of metropolitan areas. *Ann. Rev. Ecol. Syst.* 32: 127–157.

Pignatti S. (1968): *Die Inflation der höheren pflanzensoziologischen Einheiten*. In: Tüxen R. (ed.), Pflanzensoziologische Systematik, W. Junk, Den Haag, pp. 71–77.

Pott R. (1995): *Die Pflanzengesellschaften Deutschlands. Ed. 2*. Eugen Ulmer, Stuttgart.

Procházková K. & Duchoslav M. (2004): Vegetace kamenných zdí na střední Moravě. *Biosozologia* 2: 34–48.

Pyšek A. & Lorber J. (1992): *Sclerochloo-Polygonetum avicularis* Soó ex Korneck 1969 v Krásném Dvoře na Lounsku a v některých sídlištích Chomutovska. *Severočes. Přír.* 26: 1–4.
Pyšek A. & Pyšek P. (1983): *Sambucetum ebuli* Felföldy 1942 v okrese Plzeň-jih. *Zprav. Západočes. Poboč. ČSBS* 1983/3: 7–8.
Pyšek A. & Šandová M. (1979): Die Vegetation der Abraumhalden von Ejpovice. *Folia Mus. Rer. Natur. Bohemia Occid., Bot.* 12: 3–45.
Pyšek A. (1972): Ein Beitrag zur Kenntnis der Ruderalvegetation der Stadt Sušice (Westböhmen). *Folia Mus. Rer. Natur. Bohem. Occid., Bot.* 2: 1–33.
Pyšek A. (1973): Přehled ruderálních společenstev obce Vroutku v okrese Louny. *Severočes. Přír.* 4: 1–35.
Pyšek A. (1974a): Kurzgefasste Übersicht der Ruderalvegetation von Plzeň und seiner nahen Umgebung. *Folia Mus. Rer. Natur. Bohemiae Occid., Bot*. 4: 1–41.
Pyšek A. (1974b): Společenstva třídy *Galio-Urticetea* Pass. 1967 em. Kopecký 1969 v rekreační oblasti přehrady na Hracholuskách. *Zprávy Muz. Západočesk. Kraje, Přír.*, 16: 27–36.
Pyšek A. (1975): Základní charakteristika ruderální vegetace Chomutova. *Severočes. Přír.* 6: 1–69.
Pyšek A. (1976): Vegetation auf dem Gelände des VEB Chemische Betriebe Sokolov (Westböhmen). *Folia Mus. Rer. Nat. Bohemiae Occid., Bot*. 8: 1–19.
Pyšek A. (1977): Sukzession der Ruderalpflanzengesellschaften von Gross-Plzeň. *Preslia* 49: 161–179.
Pyšek A. (1978): Grundlegende Charakteristik der westböhmischen Siedlungsvegetation. *Acta Bot. Slov. Acad. Sci. Slovacae, Ser. A*, 3: 339–352.
Pyšek A. (1981): Übersicht über die westböhmische Ruderalvegetation. *Folia Mus. Rer. Natur. Bohemiae Occid., Bot.* 15: 1–23.
Pyšek A. (1992): *Chenopodietum vulvariae* (Gutte 1969) Gutte et Pyšek 1976 roste v západních Čechách dodnes. *Zprav. Západočes. Poboč. ČSBS* 30/2: 7–8.
Pyšek A., Ondráček Č. & Lorber J. (1993): *Coronopodo-Polygonetum avicularis* Oberd. 1971 na Kadaňsku a v přilehlém území. *Severočes. Přír.* 27: 1–18.
Pyšek P. (1993): Factors effecting uhe diversity of flora and vegetation in central European settlements. *Vegetatio* 106: 89–100.
Pyšek P. (1996): *Synantropní vegetace*. Bot. ústav AV ČR, Průhonice.
Pyšek P. (1998): Alien and native species in Central European urban floras: a quantitative comparison. *J. Biogr.* 25: 155–163.
Pyšek P., Chocholoušková Z., Pyšek A., Jarošík V., Chytrý M. & Tichý L. (2004): Trends in species diversity and composition of urban vegetation over three decades. *J. Veg. Sci.* 15: 781–788.
Pyšek P., Sádlo J. & Mandák B. (2002): Catalogue of alien plants of the Czech Republic. *Preslia* 74: 97–186.
Rodwell J. S. (ed.) (2000): *British plant communities. Vol. 5. Maritime communities and vegetation of open habitats.* Cambridge Univ. Press, Cambridge.
Roleček J. (2007): Formalized classification of thermphilous oak forests in the Czech Republic: what brings the Cocktail method? *Preslia* 79: 1–21.
Salisbury E. (1943): The flora of bombed areas. *Nature* 151: 462–466.

Schaminée J. H. J., Weeda E. J. & Westhoff V. (eds) (1998): *De Vegetatie van Nederland. Deel 4. Plantengemeenschappen van de kust en van binnenlandse pioniermilieus*. Opulus Press, Uppsala/Leiden.

Schubert R., Hilbig W. & Klotz S. (2001): *Bestimmungsbuch der Pflanzengesellschaften Deutschlands*. Spektrum Akademischer Verlag, Heidelberg.

Simonová D. (2008): Rostlinná společenstva zdí na jižní a západní Moravě. *Příroda*. (v tisku)

Sokal R. R. & Rohlf F. J. (1995): *Biometry. Ed. 3.* W. H. Freeman and Company, New York.

Sukopp H. & Werner P. (1983): *Urban environments and vegetation*. In: Holzner, W., Werger, M.J.A., Ikusima, I. (Eds.), Man's Impact on Vegetation. Junk Publishers, The Hague. pp. 247–260.

Sukopp H. (2002): On the early history of urban ecology in Europe. *Preslia* 4: 373–393.

Šilc U. & Čarni A. (2007): Formalized classification of the weed vegetation of arable land in Slovenia. *Preslia* 79: 283–302.

ter Braak C.J.F. & Šmilauer P. (2002): *CANOCO reference manual and CanoDraw for Windows user's guide. Software for Canonical Community Ordination (version 4.5).* Biometris, Wageningen/České Budějovice.

Tichý L. (2002): JUICE, software for vegetation classification. *J. Veg. Sci.* 13: 451–453.

Tlusták V. (1990): *Ruderální společenstva Olomouce*. Ms., kand. dis. pr., Botanický ústav AV ČR, Průhonice.

Tüxen R. (1950): Grundriss einer Systematik der nitrophilen Unkrautgesellschaften in der Eurosibirischen Region Europas. *Mitt. Florist.-Soziol. Arbeitsgem*. 2: 94–175.

Valachovič M., Oťahelová H., Stanová V. & Maglocký Š. (1995): *Rastlinné spoločenstvá Slovenska 1. Pionierska vegetácia.* Veda, Bratislava.

Vilà M., Pino J. & Font X. (2007): Regional assesment of plant invasions across different habitat types. *J. Veg. Sci.* 18: 35–42.

Višňák R. (1986): Příspěvek k poznání antropogenní vegetace v severních Čechách, zvláště v městě Liberci. *Preslia* 58: 353–368.

Višňák R. (1992): *Vegetace a flóra města Liberec I–III*. Ms., dipl.pr., PřF UK, Praha.

Wania A., Kühn I. & Klotz S. (2006): Plant richness patterns in agricultural and urban landscapes in Central Germany – spatial gradients of species richness. *Landscape Urban Plann*. 75: 97–110.

Weber H. E., Moravec J. & Theurillat J.-P. (2000): International Code of Phytosociological Nomenclature. 3rd edition. *J. Veg. Sci.* 11: 739–768.

Weber H. E., Moravec J. & Theurillat J.-P. (2002): Mezinárodní kód fytocenologické nomenklatury. 3. vydání. *Zprávy České Bot. Společn.*, Příl. 2002/1: 1–80.

Westhoff V. & den Held A. J. (1969): *Plantengemeenschappen in Nederland*. Zutphen, Cloth.

Wittig R. (2002): *Siedlungsvegetation.* Ulmer, Stuttgart.

Zlámalík J. (1978): *Studie o antropogenních společenstvech jihovýchodní části Českomoravské vrchoviny*. Ms., disert. pr., PřF MU, Brno.

8. CURRICULUM VITAE

Deana Láníková (born Simonová), Mgr.

Born 1981 in Brno, Czech Republic

Education:

Mgr. (1999–2004): Masaryk University, Faculty of Science, Department of Botany. Master's thesis: Flora and vegetation of walls in southern and western Moravia (supervisor doc. RNDr. Milan Chytrý, Ph.D.)

Ph.D. (since 2004): Masaryk University, Faculty of Science, Department of Botany and Zoology. Ph.D. thesis: Diversity of perennial ruderal and trampled vegetation of the Czech Republic (supervisor doc. RNDr. Milan Chytrý, Ph.D.)

Employment history:

since 2005: researcher in Vegetation Science Group at Department of Botany and Zoology, Faculty of Science, Masaryk University, Brno

since 2009: researcher at Department of Ecology, Institute of Botany, Academy of Sciences of the Czech Republic, Brno

Evaluation:

2008: Dean's Award of Faculty of Science MU in Brno

Research interests:

Vegetation classification, diversity and ecology of plant communities, data analysis of large vegetation data bases, invasibility of anthropogenic habitats by alien plants

Project cooperation:

2005–2007: Vegetation of the Czech Republic: formalised classification, monograph and expert system (grant GA ČR 206/05/0020, applicant M. Chytrý)

2005–2008: Evolutionary ecological analysis of biological systems: research centrum for PhD studies (grant GA ČR 524/05/H536, applicant M. Chytrý)

2005–2011: Diversity of biotic communities and populations: causal analysis of variation in space and time (institutional long-term research plan MSM 0021622416, applicant M. Chytrý)

2008–2010: Macroecological patterns of urban biodiversity: species richness, invasions and biotic homogenization in two taxonomic groups (grant GA AV ČR IAA601630803, applicant Z. Lososová)

9. LIST OF PUBLICATIONS

Publications in SCI papers

Simonová D. (2008): Vegetation of trampled habitats in the Czech Republic: a formalized phytosociological classification. *Phytocoenologia* 38: 177–191.

Simonová D. & Lososová Z. (2008): Which factors determine plant invasions in man-made habitats in the Czech Republic? *Perspectives in Plant Ecology, Evolution and Systematics* 10: 89-100.

Lososová Z. & **Simonová D.** (2008): Changes in species composition of synanthropic vegetation in Moravia during the last century. *Preslia* 80: 291–305.

Other publications

Simonová D. (2007): Alien flora on walls in southern and western Moravia (Czech Republic). In: Tokarska-Guzik B., Brock J.H., Brundu G., Child L., Daehler C.C. & Pyšek P. (eds), *Plant Invasions: Human perception, ecological impacts and management*, pp. 317–332. Backhuys Publishers, Leiden, The Netherlands.

Hájková P., Hájek M., Blažková D., Kučera T., Chytrý M., Havlová M., Šumberová K., Černý T., Novák J. & **Simonová D.** (2007): Louky a mezofilní pastviny (Molinio-Arrhenatheretea). [Meadows and mesic pastures]. In: Chytrý M. (ed.), *Vegetace České republiky 1. Travinná a keříčková vegetace*. [Vegetation of the Czech Republic 1. Grassland and heathland vegetation]. Academia, Praha.

Simonová D. (2008): Rostlinná společenstva zdí na jižní a západní Moravě. [Plant communities of walls in southern and western Moravia]. Příroda. (in press)

Láníková D., Chytrý M. & Lososová Z. (2009): Suchomilná ruderální vegetace s dvouletými a vytrvalými druhy (Artemisietea vulgaris) [Xerophilous ruderal vegetation with biennial and perennial species]. In: Chytrý M. (ed.), *Vegetace České republiky 2. Plevelová, ruderální, skalní a suťová vegetace*. [Vegetation of the Czech Republic 2. Weed, ruderal, rock and scree vegetation]. Academia, Praha (submitted).

Láníková D., Kočí M., Sádlo J., Šumberová K., Hájková P, Hájek M. & Petřík P. (2009): Nitrofilní vytrvalá vegetace vlhkých a mezických stanovišť (Galio-Urticetea). [Nitrophilous perennial vegetation of wet to mesic habitats]. In: Chytrý M. (ed.), *Vegetace České republiky 2. Plevelová, ruderální, skalní a suťová vegetace*. [Vegetation of the Czech Republic 2. Weed, ruderal, rock and scree vegetation]. Academia, Praha (submitted).

Láníková D. & Lososová Z. (2009): Vegetace sešlapávaných míst (Polygono arenastri-Poëtea annuae). [Vegetation of trampled habitats]. In: Chytrý M. (ed.), *Vegetace České republiky 2. Plevelová, ruderální, skalní a suťová vegetace*. [Vegetation of the Czech Republic 2. Weed, ruderal, rock and scree vegetation]. Academia, Praha (submitted).

Láníková D. & Sádlo J. (2009): Nitrofilní vegetace zdí (Cymbalario muralis-Parietarietea diffusae). [Nitrophilous vegetation on walls]. In: Chytrý M. (ed.), *Vegetace České republiky 2. Plevelová, ruderální, skalní a suťová vegetace*. [Vegetation of the Czech Republic 2. Weed, ruderal, rock and scree vegetation]. Academia, Praha (submitted).

Lososová Z., Otýpková Z., Sádlo J. & **Láníková D.** (2009): Jednoletá vegetace polních plevelů a ruderálních stanovišť (Stellarietea mediae). [Annual vegetation of arable weeds and ruderal habitats]. In: Chytrý M. (ed.), *Vegetace České republiky 2. Plevelová, ruderální, skalní a suťová vegetace*. [Vegetation of the Czech Republic 2. Weed, ruderal, rock and scree vegetation]. Academia, Praha (submitted).

Popularizations

Simonová D. (2007): Zdi – sekundární stanoviště pro růst rostlin. [Walls – secondary habitats for plants]. *Živa* 2: 62–64.

Simonová D. (2008): Flóra a vegetace sešlapávaných míst. [Flora and vegetation of trampled habitats]. *Živa* 4: 161–163.

Fajmon K. & **Simonová D.** (2008): Merlíky, opomíjení průvodci našich cest. [Species of *Chenopodium* genus, common ruderal plants around us]. *Živa* 5: 205–207.

10. CONFERENCES

Simonová D. (2004): Flora and vegetation of walls in southern and western Moravia. – First Meeting of Czech and Hungarian Ph.D. Students in Plant Ecology and Botany, Vácrátót, Hungary, 7.–10.9.2004. (lecture)

Simonová D. (2004): Flóra a vegetace zdí na jižní a západní Moravě. [Flora and vegetation of walls in southern and western Moravia]. – Konference České botanické společnosti, Doktorandské inspirace v botanice, Prague, 20.–21.11.2004. (poster)

Simonová D. (2005): Alien species on walls in southern and western Moravia. – 8th International Conference on the Ecology and Management of Alien Plant Invasions (EMAPI), Katowice, Poland, 5.–12.9.2005. (poster)

Simonová D. (2006): Vegetation of trampled habitats in the Czech Republic: a formalized phytosociological classification. – European Vegetation Survey, 15th Workshop, „Vegetation in agricultural landscapes“ and „Natura 2000“, Catania, Italy, 24.–27.3.2006. (poster)

Simonová D. (2006): Alien plants in different types of ruderal vegetation. – NEOBIOTA, From Ecology to Conservation, 4th European Conference on Biological Invasions, Vienna, Austria, 27–29.9.2006. (poster)

Simonová D. (2007): Walls vs. rocks – secondary and natural habitats. – European Vegetation Survey, 16th Workshop, „Change in Vegetation“, Roma, Italy, 22–26.3.2007. (poster)

Simonová D. (2007): Perennial ruderal vegetation of the Czech Republic: a formalized phytosociological classification. – Third Meeting of Czech and Hungarian Ph.D. Students in Vegetation Science, Botany and Plant Ecology, Senetea, Romania, 10.–13.9.2007. (lecture)

Simonová D. & Lososová Z. (2007): Jaké faktory podmiňují rostlinné invaze na antropogenních stanovištích v České republice? [Which factors determine plant invasions in vegetation of anthropogenous habitats in the Czech Republic?]. – Konference České botanické společnosti, Rostlinné invaze v České republice: situace, výzkum a management, Prague, 30.11.–1.12.2007. (poster)

Simonová D. (2008): Perennial ruderal vegetation of the Czech Republic: a new vegetation survey. – 17th International Workshop "European Vegetation Survey", Using phytosociological data to adress ecological questions, Brno, 1.–4.5.2008. (poster)

Simonová D. & Lososová Z. (2008): Which factors determine plant invasions in vegetation of man-made habitats in the Czech Republic? – Urban Biodiversity & Design, Implementing the Convention on Biological Diversity in towns and cities, Third conference of the competence network urban ecology, Erfurt, Germany, 21.–24.5.2008. (poster)