

## Phytosociological study of arable weed communities in Slovakia

### Pflanzensoziologische Studien der Ackerunkraut-Gesellschaften in der Slowakei

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#### Abstract

A phytosociological survey of weed (segetal) vegetation in Slovakia was performed. A total of 508 relevés were sampled in 2002–2008. The aims of this study were to determine the actual distribution of the segetal communities, to analyze their floristic structure, and to evaluate their relationships to selected environmental factors.

Thirteen plant communities of the class *Stellarietea mediae* were distinguished by cluster analysis; 11 communities were included in the subclass *Violenea arvensis* (*Lathyro tuberosi-Adonidetum aestivalis*, *Consolido-Anthemidetum austriacae*, *Euphorbio exiguae-Melandrietum noctiflori*, *Veronicetum trilobae-triphyllidi*, *Lamio amplexicauli-Thlaspietum arvensis*, *Taraxacum* sect. *Ruderalia* community, *Spergulo arvensis-Scleranthetum annui*, *Myosotido-Sonchetum arvensis*, *Echinochloo-Setarietum pumilae*, *Galinsogo-Setarietum*, and *Stachyo annui-Setarietum pumilae*) and two in the subclass *Sisymbrienea* (*Portulacetum oleraceae* and *Setario viridis-Erigeronetum canadensis*). Communities were characterized by diagnostic, constant, and dominant species and their structure, ecology, and distribution were estimated. The species composition of these communities was documented in synoptic and association tables. DCA ordination and analysis of variance was used to determine the main environmental factors of floristic differentiation and to determine ecological and structural differences among the communities. The analyses showed that the most important factors affecting floristic composition and classification of the weed communities are their time of development (agroecophase), the type of crops and altitude.

**Keywords:** ordination, segetal communities, species composition, *Stellarietea mediae*, syntaxonomy, weed ecology

**Erweiterte deutsche Zusammenfassung am Ende des Manuskripts**

### 1. Introduction

The first interest in weed vegetation in Slovakia dates only from the period following World War II. The initial publication was a floristic study by FRANTOVA (1947), followed by ecological (OPLUŠTILOVÁ 1953) and phytosociological studies (ZAHRADNÍKOVÁ-ROŠETZKÁ 1955). More authors then became interested in segetal vegetation research (e.g. MOCHNACKÝ 1984b, PASSARGE & JURKO 1975, KROPÁČ & MOCHNACKÝ 2009, MÁJEKOVÁ et al. 2010);

some authors concentrated on the ecology and distribution of segetal species (e.g. KRIPPELOVÁ 1974, ELIÁŠ & BARANEC 2005) or on the decline and extinction of more specialized weed species and communities (SKALICKÝ 1981). Several communities were described for the first time from the Slovak Republic. A full list of references about the research of segetal flora and vegetation in Slovakia is provided in the electronical Appendix S1.

Knowledge concerning segetal vegetation in Slovakia prior to 1996 was summarized and published by JAROLÍMEK et al. (1997) and by MOCHNACKÝ (1999). Although these authors characterized 21 communities from arable land, the data were not representatively distributed over Slovakia i.e., they originated from only a limited number of orographic units (approximately half of the area of Slovakia). These reports were at least 20 years old. While the study of segetal vegetation had continued in neighbouring countries (e.g. KROPÁČ 2006, LOSOSOVÁ et al. 2009, PINKE 2007, PINKE & PÁL 2008) in Slovakia the study of segetal vegetation significantly declined since the 1980s. Classical phytosociological research is changing to the study of diversity and changes in vegetation, and also to the impact of environmental factors on species' distribution (e.g. LOSOSOVÁ et al. 2004, PYŠEK et al. 2005, ŠILC & ČARNI 2005, FRIED et al. 2008, LOSOSOVÁ & SIMONOVÁ 2008, ANDREASEN & SKOVGAARD 2009, CIMALOVÁ & LOSOSOVÁ 2009, PINKE et al. 2010, 2012, PINKE & PÁL 2009, MÁJEKOVÁ et al. 2010).

The aims of this study are (1) to determine the actual distribution of the segetal communities in Slovakia, (2) to analyze the species composition of the communities (considering the life forms, species origin and invasiveness, representation of threatened species) and (3) to evaluate their relationships with selected environmental factors.

## 2. Materials and methods

### 2.1 Study area

The study area comprises the Slovak Republic (16°50'–22°34' E, 47°44'–49°37' N) and covers an area of 49,035 km<sup>2</sup>. The altitude in the Slovak Republic ranges from 94 to 2,655 m a.s.l. This area is divided into three climatic regions: warm, moderately warm and cold (LAPIN et al. 2002). Almost half the total area of the country is used as agricultural land, which is mainly concentrated in the warm southern areas (STATISTICAL OFFICE OF THE SLOVAK REPUBLIC 2010).

### 2.2 Field sampling

The data set consisted of 508 phytosociological relevés (505 by the authors, 2 by I. Jarolímek and 1 by M. Janišová) made in arable land throughout the entire territory of Slovakia between 2002 and 2008. Sampling was random but focussed on orographic units with missing phytosociological material. Relevés were made from April to November over the whole altitude range of cultivated fields, at 98 to 928 m a.s.l. Relevés were made according to the Zürich-Montpellier school (BRAUN-BLANQUET 1964, WESTHOFF & VAN DER MAAREL 1978) using the 9-degree scale of abundance and dominance (BARKMAN et al. 1964). Plot size was mainly 10 × 10 m in broad-scale fields and 5 × 10 m in fine-scale private fields. Plots were situated in the inner part of the fields to avoid any effects from surrounding vegetation (OPLUŠTILOVÁ 1953, KROPÁČ & HEJNÝ 1975). The following types of cultivated fields were studied: cereals, cereal stubbles, root crops, fodder crops and also young fallow. Relevés were made only on those fields where weed cover was at least 25%, and the vegetation was of the *Stellaria-mediae* class.

### 2.3 Vegetation classification

Relevés were stored in a TURBOVEG database (HENNEKENS & SCHAMINÉE 2001). The following taxa were fused before the analysis: *Chenopodium album* agg. included *C. album*, *C. pedunculare* and *C. strictum*; *Papaver dubium* included *P. dubium* and *P. dubium* subsp. *austromoravicum*; *Vicia cracca* agg. included *V. cracca* and *V. cracca* agg. Cultivated crops, bryophytes and taxa determined only to the genus level were excluded from analysis. On the basis of detrended correspondence analysis (DCA; HILL & GAUCH 1980) in the programme CANOCO (TER BRAAK & ŠMILAUER 2002), one relevé was excluded as an outlier. The remaining 507 relevés were analyzed by cluster analysis using JUICE 7.0 (TICHÝ 2002) and SYN-TAX 2000 (PODANI 2001) programmes. The  $\beta$ -flexible method ( $\beta = -0.25$ ) and Sorensen's similarity index were used in this analysis. The crispness of classification method proposed by BOTTA-DUKÁT et al. (2005) to identify the optimal number of clusters was applied. Each community was characterized by diagnostic, constant and dominant species. The diagnostic species were determined by calculating the fidelity of each species to each cluster, using the phi coefficient of association (SOKAL & ROHLF 1995, CHYTRÝ et al. 2002) in JUICE 7.0 programme (TICHÝ 2002). The phi coefficient was standardized to the equal relevé size of all groups (CHYTRÝ et al. 2006, TICHÝ & CHYTRÝ 2006) and Fisher's exact test was used ( $p < 0.001$ ) for excluding non-significant fidelity values (CHYTRÝ et al. 2002, 2006). The threshold phi value where a species was considered diagnostic was set at 0.25. Constant species comprised those with a presence higher than 50%; and those with a presence higher than 80% are printed in bold type. The dominant species were defined as those having more than 50% cover in at least 3% of the relevés. Diagnostic, constant and dominant species in the text are ordered according to decreasing constancy.

In the association tables, the sequence of the relevés followed the cluster analysis results. Values 2m, 2a, 2b are shortened to m, a, b. Header data contain: relevé number, relevé area, altitude, total cover, moss layer cover, cover of crops, cover of weeds, height of herb layer and the number of species in the relevé. Species are ordered as follows: crops, diagnostic species of the community, species characteristic for alliance, order, subclass, and class, other species and bryophytes. Diagnostic species are ordered according to decreasing fidelity and the remaining species according to decreasing frequency.

The nomenclature of the taxa follows MARHOLD & HINDÁK (1998), except for the species  $\times$ *Triticosecale rimpaui* (Wittm.) Müntzing. The nomenclature of the syntaxa follows JAROLÍMEK et al. (1997) and JAROLÍMEK & ŠIBÍK (2008).

### 2.4 Environmental variables

The main environmental gradients of species composition were analysed by detrended correspondence analysis (DCA) in the programme CANOCO (TER BRAAK & ŠMILAUER 2002). For the ecological interpretation of ordination axes, the average nonweighted Ellenberg indicator values (EIV; ELLENBERG et al. 1992) for the relevés and Shannon-Wiener's index of diversity (HILL 1973) were plotted onto the DCA ordination diagram as supplementary environmental data.

The programme Statistica was used for correlation analyses and construction of Box-Whisker plots. Mean EIVs (ELLENBERG et al. 1992) per relevé, proportion of life forms (after DOSTÁL & ČERVENKA 1991, 1992), species richness, number of threatened species (after FERÁKOVÁ et al. 2001), native species, archaeophytes, neophytes, naturalized, invasive and casual species per relevé (after MEDVECKÁ et al. 2012), altitude, mean annual temperature and precipitation of the locality, month of relevé origin, and soil properties of the locality (soil reaction, content of sand – fraction 0.01–2.0 mm, silt – fraction 0.002–0.01 mm and clay – fraction < 0.002 mm in the topsoil) were compared among the communities using one-way ANOVA and subsequent Fisher LSD post-hoc test ( $p < 0.05$ ) to determine homogenous groups. The variables with not-normal distributions by visually inspecting the distribution of the residuals (QUINN & KEOUGH 2002) were log-transformed at first.

The potential natural vegetation of the sites was defined after the Geobotanical map of Slovakia in a scale of 1 : 200,000 (MICHALKO et al. 1986).

National agricultural soil inventory maps in a 1 : 10,000 scale (NĚMEČEK et al. 1967) were used in the GIS to assign information on soil type, soil parent material and topsoil texture class to each relevé. Each relevé was then coupled with the closest soil profile from the AISOP soil profile database

(LINKEŠ et al. 1988, BIELEK et al. 2005) following both maximum distance and soil classification criteria. Soil profiles served as the data source for soil type, soil parent material, topsoil soil texture class and selected topsoil analytical characteristics in subsequent ecological analyses. Soil type and texture were classified according to WRB (IUSS WORKING GROUP WRB 2006).

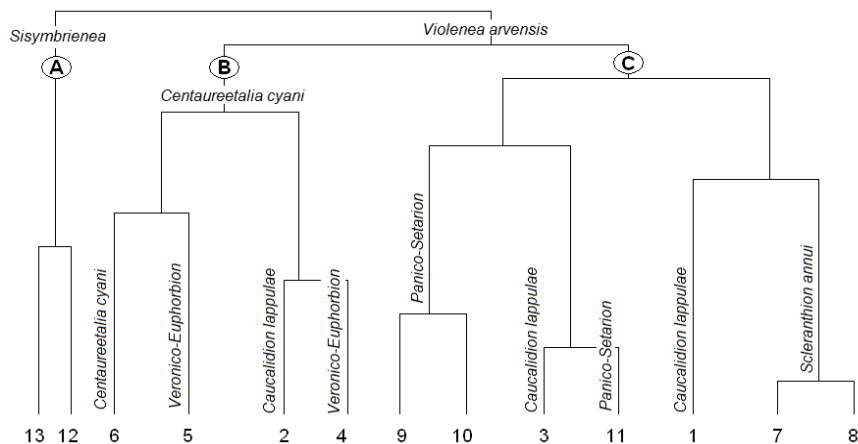
Selected climatic factors were calculated in the GIS software. Air temperature and vertical atmospheric precipitation were produced from rasters of mean annual precipitations for the period 1961 to 1990. Source data was provided by the Slovak Hydro-meteorological Institute, and climatic regions were defined according to LAPIN et al. (2002).

### 3. Results

#### 3.1 Numerical classification

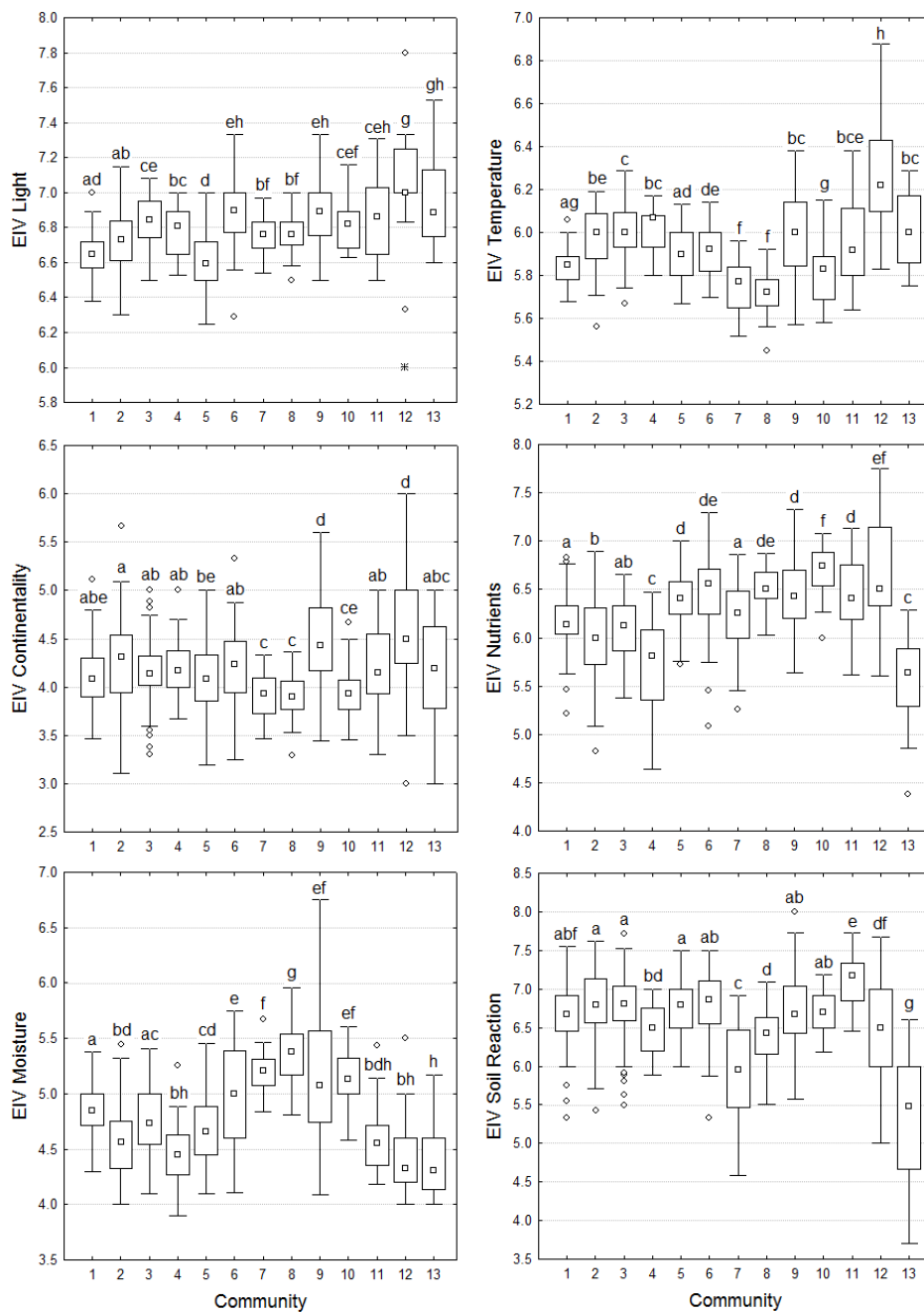
We identified 13 communities from the class *Stellarietea mediae*. Cluster analysis results are summarized in the dendrogram (Fig. 1) and in the synoptic table (Table 1 in the supplement). Vegetation structure and environmental characteristics of the communities are shown in Figures 2–6.

Three main groups, (A, B and C), are distinguished in the dendrogram (Fig. 1). Grouping of the communities is partly by their syntaxonomic classification and partly derived from their ecological demands and time of development (seasonal optimum). Group A (*Portulacetum oleraceae* and *Setario viridis-Erigeronetum canadensis*) is separated at the highest level of dissimilarity. It consists of communities from the alliance *Eragrostion* of the mostly ruderal subclass *Sisymbrienea*. Both communities occur in the warm lowlands of Slovakia, where soils with a dominance of sand fraction in the topsoil are distributed, and they have low species diversity and are poor in threatened species (Figs. 4–6). They differ in nutrients demand and soil reaction. Species in the *Portulacetum* association require more nutrients and higher soil reaction than the *Setario-Erigeronetum* species (Fig. 2).



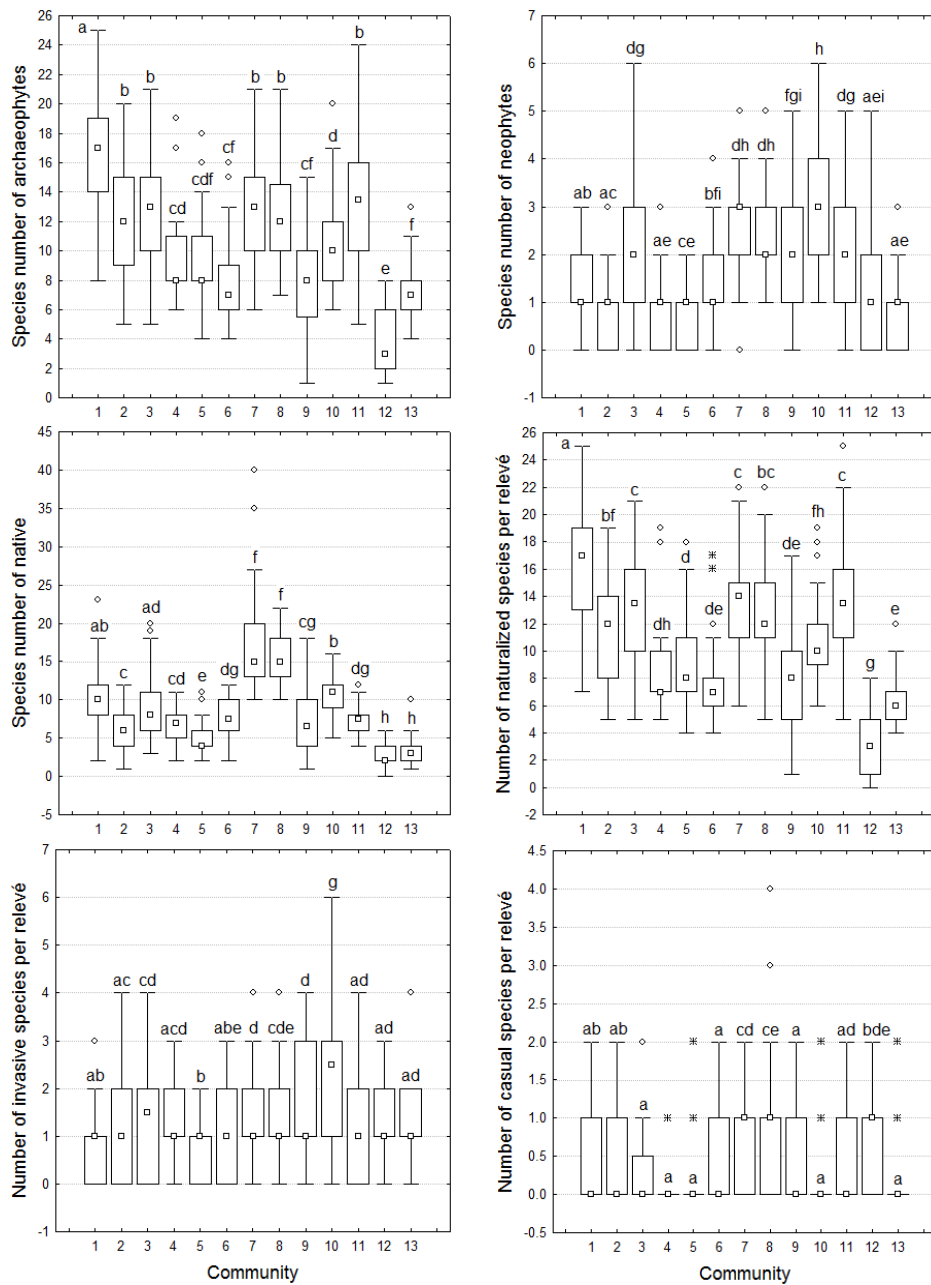
**Fig. 1.** Dendrogram of the numerical classification of the weed communities in Slovakia. The  $\beta$ -flexible method ( $\beta = -0.25$ ) and Sorensen's similarity index were used. The community names (1–13) are given in Table 1 in the supplement.

**Abb. 1.** Dendrogramm der numerischen Klassifikation der Ackerunkraut-Gesellschaften in der Slowakei. Die „ $\beta$ -flexible method“ ( $\beta = -0.25$ ) und der „Sorensen Similarity Index“ wurden verwendet. Zu den Namen der Gesellschaften 1–13, s. Tabelle 1, Beilage.



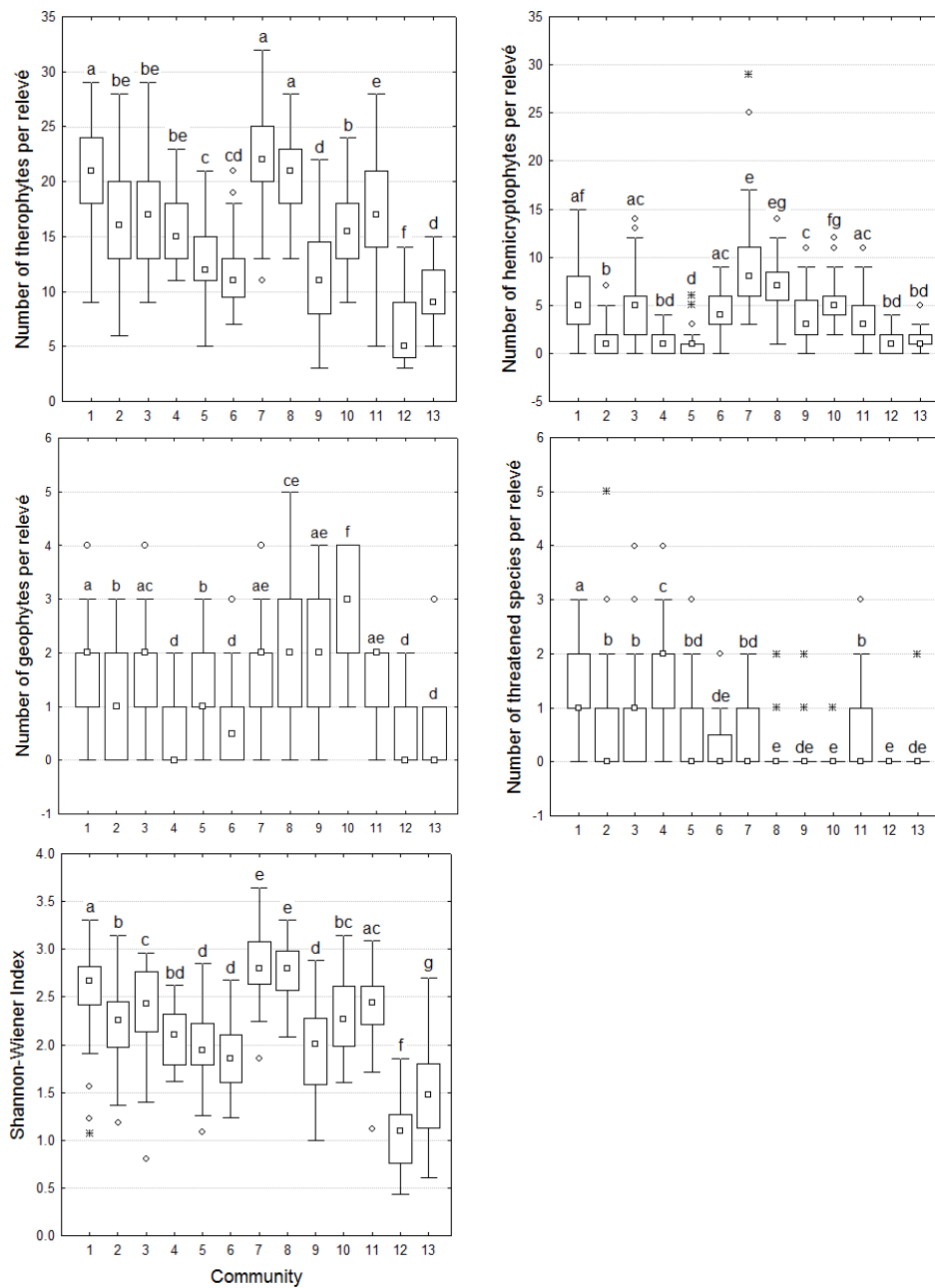
**Fig. 2.** Box-Whisker plots of the Ellenberg's indicator values for individual communities. Different letters indicate significant differences between communities. ANOVA and Fisher LSD post-hoc test,  $p < 0.05$ . Annotations:  $\square$  median,  $\square$  25%–75%, I non-outlier range,  $\circ$  outliers, \* extremes.

**Abb. 2.** Box-Whisker-Plots der Ellenberg-Zeigerwerte für die untersuchten Gesellschaften. Unterschiedliche Buchstaben kennzeichnen signifikante Unterschiede zwischen den Gesellschaften. ANOVA und Fisher LSD post-hoc test,  $p < 0,05$ . Anmerkungen:  $\square$  median,  $\square$  25%–75%, I nicht im Ausreißer-Bereich,  $\circ$  Ausreißer, \* Extreme Ausreißer.



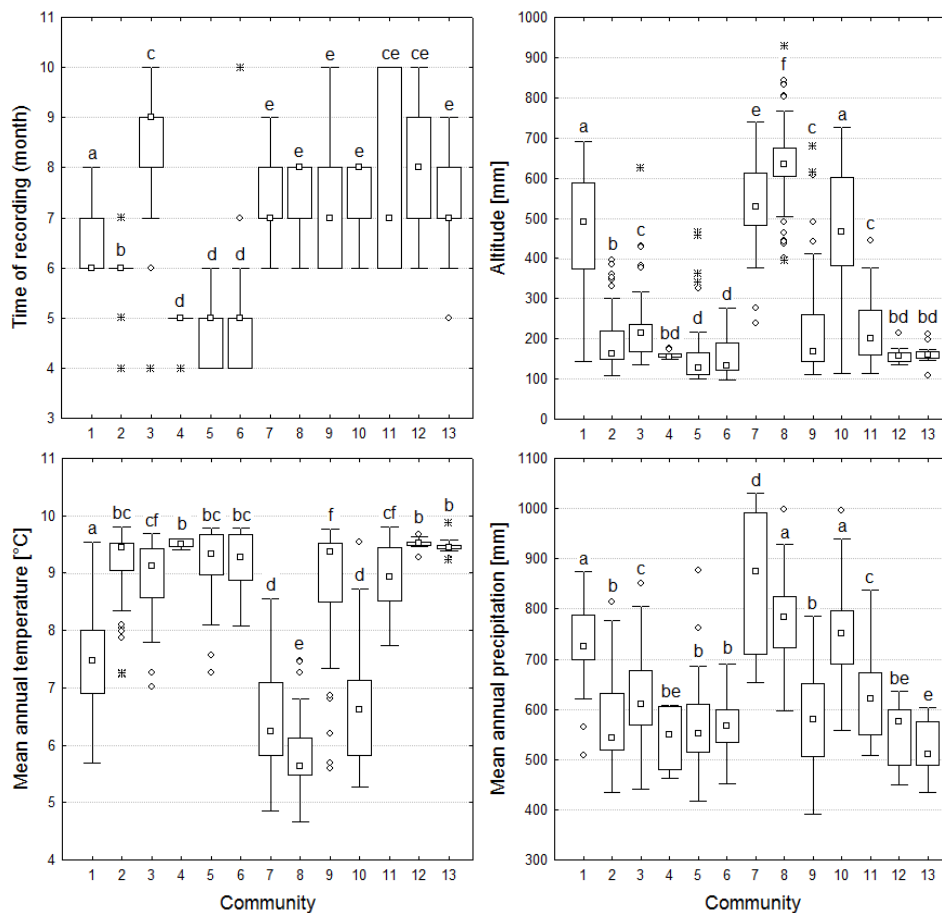
**Fig. 3.** Box-Whisker plots of the representation of archaeophytes, neophytes, native species, naturalised, invasive, and casual species in the individual communities. Different letters indicate significant differences between communities. ANOVA and Fisher LSD post-hoc test,  $p < 0.05$ . Annotations, see Figure 2.

**Abb. 3.** Box-Whisker-Plots des Vorkommens von Archäophyten, Neophyten, heimischen Arten, eingebürgerten, invasiven und unbeständigen Arten in den einzelnen Gesellschaften. Unterschiedliche Buchstaben kennzeichnen signifikante Unterschiede zwischen den Gesellschaften. ANOVA und Fisher LSD post-hoc test,  $p < 0,05$ . Anmerkungen, s. Abbildung 2.



**Fig. 4.** Box-Whisker plots of the representation of therophytes, hemicryptophytes, geophytes, and threatened species in the individual communities, and species diversity of the communities. Different letters indicate significant differences between communities. ANOVA and Fisher LSD post-hoc test,  $p < 0.05$ . Annotations, see Figure 2.

**Abb. 4.** Box-Whisker-Plots des Vorkommens von Therophyten, Hemikryptophyten, Geophyten, bedrohten Arten in den einzelnen Gesellschaften und der Artenvielfalt der Gesellschaften. Unterschiedliche Buchstaben kennzeichnen signifikante Unterschiede zwischen den Gesellschaften. ANOVA und Fisher LSD post-hoc test,  $p < 0,05$ . Anmerkungen, s. Abbildung 2.

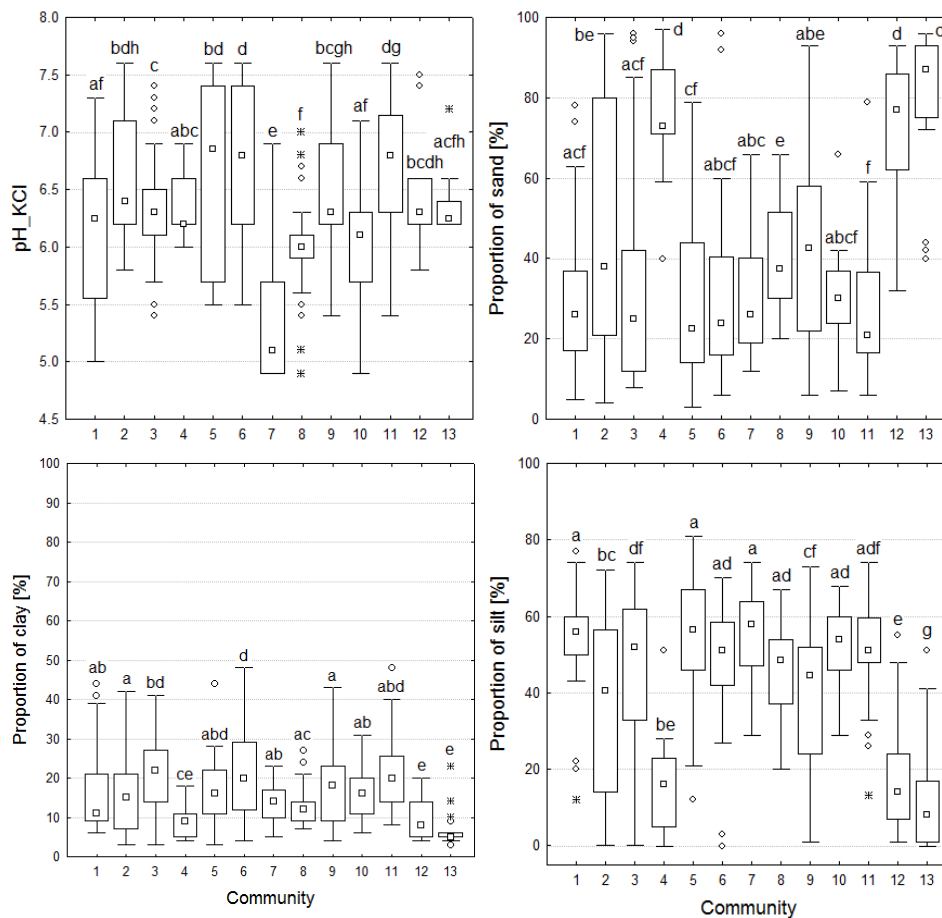


**Fig. 5.** Box-Whisker plots of the relationship of the individual communities to environmental factors. Different letters indicate significant differences between communities. ANOVA and Fisher LSD post-hoc test,  $p < 0.05$ . Annotations, see Figure 2.

**Abb. 5.** Box-Whisker-Plots der Beziehung zwischen den untersuchten Gesellschaften und Umweltfaktoren. Unterschiedliche Buchstaben kennzeichnen signifikante Unterschiede zwischen den Gesellschaften. ANOVA und Fisher LSD post-hoc test,  $p < 0,05$ . Anmerkungen, s. Abbildung 2.

Groups B and C (Fig. 1) include communities of the subclass *Violenea arvensis*, which contains typical arable weed communities (JAROLÍMEK et al. 1997). The second level of division is based on the type of agroecophases, i.e., in development time (Fig. 5). Group B communities are representatives of the spring and spring-summer agroecophase. Associations *Veronicetum trilobae-triphyllidi*, *Lamio amplexicauli-Thlaspietum arvensis* and *Taraxacum* sect. *Ruderalia* community develop as the first segetal communities in early spring. *Consolido-Anthemidetum austriacae* develops a little later and it replaces the *Veronicetum trilobae-triphyllidi* association. Therefore, these communities are placed beside each other in the dendrogram (Fig. 1). All communities in group B are widespread in the warm dry low-





**Fig. 6.** Box-Whisker plots of the relationship of the individual communities to the soil characteristics. Different letters indicate significant differences between communities. ANOVA and Fisher LSD post-hoc test,  $p < 0.05$ . Annotations, see Figure 2.

**Abb. 6.** Box-Whisker-Plots der Beziehung der untersuchten Gesellschaften zu den Bodeneigenschaften. Unterschiedliche Buchstaben kennzeichnen signifikante Unterschiede zwischen den Gesellschaften. ANOVA und Fisher LSD post-hoc test,  $p < 0,05$ . Anmerkungen, s. Abbildung 2.

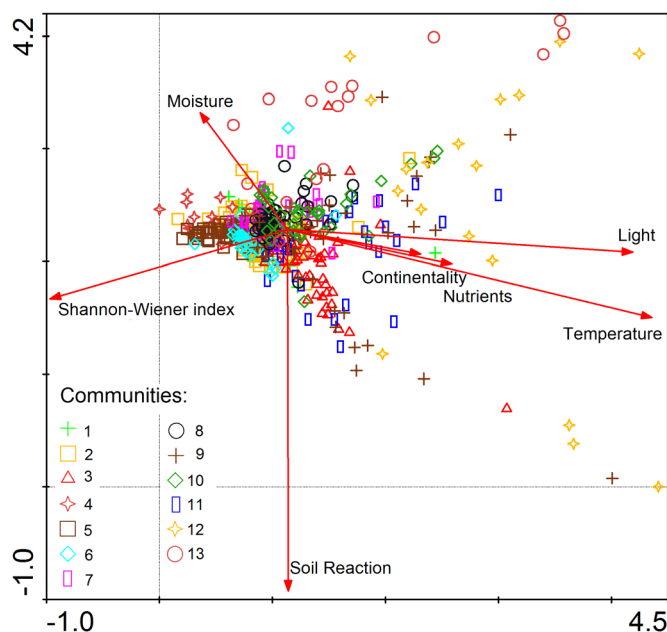
lands of Slovakia (Fig. 5). Stands of *Veronictetum* occur on coarse-textured sandy soils (Fig. 6). *Lamio-Thlaspietum* and *Taraxacum* sect. *Ruderalia* community comprise species with higher demands for soil nutrients than the other two communities (Fig. 2).

Communities in group C (Fig. 1) are typical for the summer and autumn agroecophase. In this studied vegetation, associations *Lathyro tuberosi-Adonidetum aestivalis*, *Spergulo arvensis-Scleranthetum annui*, and *Myosotido-Sonchetum arvensis* are spread at the highest altitudes; these localities are characterized by high precipitation and low temperature (Fig. 5). *Spergulo-Scleranthetum* and *Myosotido-Sonchetum* have the highest species diversity (Fig. 4), and the *Spergulo-Scleranthetum* association is bound to the most acidic substrates (Fig. 6). Stands of *Lathyro-Adonidetum* are typical for cereal fields, whereas the two other communities are typical for cereals and root crops.

The second part of group C (Fig. 1) includes communities at lower altitudes, except for the *Galinsogo-Setarietum* (Fig. 5). This association is more similar in ecological requirements to the previous part of group C, but the species composition is similar to the *Echinochloo-Setarietum pumilae* (Table 1 in the supplement). Therefore, it is next to *Echinochloo-Setarietum* in the dendrogram (Fig. 1). Both occur mainly in root crops. *Euphorbio exiguae-Melandrietum noctiflori* and *Stachyo annui-Setarietum pumilae* are typical for cereals and stubble, and therefore their species are less demanding on soil moisture (Fig. 2).

### 3.2 Gradient analysis

The communities of the segetal vegetation in the ordination diagram (DCA) are partly overlapping (Fig. 7). Nevertheless, a certain trend in the distribution of the communities is visible. The first axis was positively correlated with EIVs for light and temperature and negatively with diversity (Shannon-Wiener index). The second axis was positively correlated with EIV for moisture and negatively with EIV for soil reaction. On the left side of the ordination chart, relevés of the shade- and low temperature-tolerant species are plotted (mainly associations *Veronicetum* and *Lamio-Thlaspietum*). On the right side of the chart, relevés of species demanding light and high temperature are dispersed (e.g., associations *Stachyo-Setarietum* and *Portulacetum*). On the upper side, relevés of the association *Setario-Erigeronetum* formed mostly by acidophilous species are placed. The largest dispersion shows the association *Echinochloo-Setarietum*.



**Fig. 7.** Detrended Correspondence Analysis (DCA) of the segetal vegetation of Slovakia. Eigenvalues axis 1: 0.730, axis 2: 0.563. The average nonweighted Ellenberg indicator values were plotted onto the diagram as vectors. The community names (1–13) are given in chapter 3.3.

**Abb. 7.** Detrended Correspondence Analysis (DCA) der Segetalgesellschaften in der Slowakei. Eigenwerte: 1. Achse: 0,730; 2. Achse: 0,563. Die mittleren ungewichteten Ellenberg-Zeigerwerte sind als Vektoren in das Ordinationsdiagramm projiziert. Namen der Gesellschaften 1–13 s. Kap. 3.3.

### 3.3 List and description of the segetal communities

- Class *Stellarietea mediae* R. Tx., Lohmeyer et Preising in R. Tx. ex von Rochow 1951  
Subclass *Violenea arvensis* Hüppe et Hofmeister ex Jarolímek et al. 1997  
Order *Centaureetalia cyani* R. Tx., Lohmeyer et Preising in R. Tx. ex von Rochow 1951  
All. *Caucalidion lappulae* (R. Tx. 1950) von Rochow 1951  
Ass. 1 *Lathyro tuberosi-Adonidetum aestivalis* Kropáč et Hadač in Kropáč et al. 1971  
Ass. 2 *Consolido-Anthemidetum austriacae* Kropáč et Mochnacký 1990  
Ass. 3 *Euphorbio exiguae-Melandrietum noctiflori* G. Müller 1964  
All. *Veronico-Euphorbion* Sissingh ex Passarge 1964  
Ass. 4 *Veronicetum trilobae-triphyllidi* Slavnić 1951  
Ass. 5 *Lamio amplexicauli-Thlaspietum arvensis* Krippelová 1981  
Other communities of the order *Centaureetalia cyani*  
Comm. 6 *Taraxacum* sect. *Ruderalia* community  
Order *Atriplici-Chenopodietalia albi* R. Tx. (1937) Nordhagen 1940  
All. *Scleranthion annui* (Kruseman et Vlieger 1939) Sissingh in Westhoff et al. 1946  
Ass. 7 *Spergulo arvensis-Scleranthetum annui* Kuhn 1937  
Ass. 8 *Myosotido-Sonchetum arvensis* Passarge in Passarge et Jurko 1975  
All. *Panico-Setarion* Sissingh in Westhoff et al. 1946  
Ass. 9 *Echinochloo-Setarietum pumilae* Felföldy 1942 corr. Mucina 1993  
Ass. 10 *Galinsogo-Setarietum* (R. Tx. et Beck. 1942) R. Tx. 1950  
Ass. 11 *Stachyo annui-Setarietum pumilae* Felföldy 1942 corr. Mucina 1993  
Subclass *Sisymbrienea* Pott 1992  
Order *Eragrostietalia* J. Tx. ex Poli 1966  
All. *Eragrostion* R. Tx. ex Oberd. 1954  
Ass. 12 *Portulacetum oleraceae* Felföldy 1942  
Ass. 13 *Setario viridis-Erigeronetum canadensis* Šomšák 1976

#### **Ass. 1: *Lathyro tuberosi-Adonidetum aestivalis*** (Appendix S2, Fig. 9a)

Diagnostic species: *Cyanus segetum*, *Lapsana communis*, *Neslia paniculata*, *Myosotis arvensis*, *Lithospermum arvense*, *Papaver rhoeas*, *Vicia hirsuta*, *Galium aparine*, *Lathyrus tuberosus*, *Galium spurium*  
Constant species: ***Tripleurospermum perforatum***, ***Viola arvensis***, ***Myosotis arvensis***, ***Galium aparine***, ***Fallopia convolvulus***, *Stellaria media*, *Cirsium arvense*, *Convolvulus arvensis*, *Capsella bursa-pastoris*, *Polygonum aviculare* agg., *Lapsana communis*, *Apera spica-venti*, *Elytrigia repens*, *Cyanus segetum*, *Veronica persica*, *Papaver rhoeas*, *Chenopodium album* agg., *Vicia hirsuta*, *Sonchus arvensis*  
Dominant species: *Apera spica-venti*, *Tripleurospermum perforatum*, *Cyanus segetum*, *Papaver rhoeas*

This community is typical for cereal fields in the summer agroecophase (June–July). More basiphilous species (e.g., *Galium spurium*, *Lathyrus tuberosus*, *Lithospermum arvense*, *Neslia paniculata*) are frequent in the community. The community occurs mainly in the colline (seldom lowland and submontane) belt in the moderately warm climatic region. It is typical for fine-scale fields in the hillside settlement areas of western and central Slovakia (Fig. 8; Biele Karpaty Mts, Borská nížina Lowland, Horehronské podolie, Javorie Mts, Krupinská planina Plain, Liptovská kotlina Basin, Malé Karpaty Mts, Myjavská pahorkatina Hills, Ostrôžky Mts, Poľana Mts, Popradská kotlina Basin, Slovenský kras Karst, Stolické vrchy Mts, Štiavnické vrchy Mts, Trábeč Mts, and Turčianska kotlina Basin). The potential

natural vegetation of these localities is mostly Carpathian oak-hornbeam woods, submontane and montane floodplain woods and beech woods with forb-rich undergrowth. The soil parent material is mostly in-situ weathered or transported intermediate igneous rocks, sedimentary rocks, and alluvial sediments. Dominant soil types are Cambisols (Eutric), Haplic Fluvisols (Eutric), and Rendzic Phaeozems, with prevailing silty soils.

This association was described from the Czech Republic by KROPÁČ et al. (1971), and it has been determined in Slovakia (KROPÁČ 1981, MOCHNACKÝ 1984b, 1996, 1998, 1999, JAROLÍMEK et al. 1997, ZALIBEROVÁ et al. 2004, ZALIBEROVÁ & JAROLÍMEK 2005, KROPÁČ & MOCHNACKÝ 2009) and also in the Czech Republic (KOBLIHOVÁ 1989, OTÝPKOVÁ 2001, LOSOSOVÁ 2004, KROPÁČ 2006, LOSOSOVÁ et al. 2009).

### **Ass. 2: *Consolido-Anthemidetum austriacae*** (Appendix S3)

Diagnostic species: *Papaver rhoeas*, *Cota austriaca*, *Consolida regalis*

Constant species: *Fallopia convolvulus*, *Viola arvensis*, *Tripleurospermum perforatum*, *Polygonum aviculare* agg., *Stellaria media*, *Papaver rhoeas*, *Consolida regalis*, *Apera spica-venti*, *Chenopodium album* agg., *Cirsium arvense*, *Galium aparine*, *Capsella bursa-pastoris*

Dominant species: *Tripleurospermum perforatum*, *Cota austriaca*, *Papaver rhoeas*

This community is typical for the summer agroecophase (June–July). It develops mainly in cereals and more rarely on abandoned fields. The community is spread throughout the warm climatic region in the lowlands and to a lesser extent in the colline belt (Fig. 8; Borská nížina Lowland, Biele Karpaty Mts, Hronská pahorkatina Hills, Ipeľská kotlina Basin, Malé Karpaty Mts, Nitrianska pahorkatina Hills, Podunajská rovina Flat, Považský Inovec Mts, Rožňavská kotlina Basin, Slovenský kras Karst, Stolické vrchy Mts, and Trnavská pahorkatina Hills). Potential natural vegetation in these localities is mainly: elm floodplain woods, submontane and montane floodplain woods and Carpathian and Pannonian oak-hornbeam woods. Soil parent materials are mostly alluvial sediments, eolian sands, and loess, with mollic soil types dominant (Mollic Fluvisols, Haplic Chernozems) – together with initial soils [Haplic Arenosols (Eutric), Haplic Fluvisols (Eutric)]. Here, coarse and medium arenic, silty, and loamy textured soils prevail.

This association has been recorded only in Slovakia and in areas of the Czech Republic (KROPÁČ 1981, 2006, MOCHNACKÝ 1996, 1998, 1999, 2005, KROPÁČ & MOCHNACKÝ 1990, JAROLÍMEK et al. 1997 and ZALIBEROVÁ et al. 2004).

### **Ass. 3: *Euphorbio exiguae-Melandrietum noctiflori*** (Appendix S4, Fig. 9b)

Diagnostic species: *Anagallis arvensis*, *Setaria pumila*, *Tithymalus exiguus*, *Silene noctiflora*, *Kickxia elatine*, *Pastinaca sativa*

Constant species: *Anagallis arvensis*, *Tripleurospermum perforatum*, *Polygonum aviculare* agg., *Cirsium arvense*, *Fallopia convolvulus*, *Chenopodium album* agg., *Viola arvensis*, *Setaria pumila*, *Veronica persica*, *Convolvulus arvensis*, *Taraxacum* sect. *Ruderalia*, *Silene noctiflora*, *Elytrigia repens*, *Echinochloa crus-galli*

Dominant species: *Setaria pumila*, *Anagallis arvensis*

Although this community occurs also in cereal fields, its optimum growth is on stubble. It was found from June to November, but the majority of relevés come from August to September. It mainly consists of two layers; the lower layer is created by low and prostrate species that do not overgrow the mown cereal stems. The physiognomy of these stands differs due to alternating frequent and dominant species. Several species of bryophytes were

also present. This community mainly occurs in the warm climatic region in the lowlands and colline belt in central and western Slovakia (Fig. 8; Borská nížina Lowland, Ipeľská kotlina Basin, Ipeľská pahorkatina Hills, Krupinská planina Plain, Malé Karpaty Mts, Nitrianska pahorkatina Hills, Podunajská rovina Flat, Považské podolie, Strážovské vrchy Mts, Tríbeč Mts, Trnavská pahorkatina Hills, Zvolenská kotlina Basin, and Žitavská pahorkatina Hills). Potential natural vegetation is mainly elm floodplain woods, Carpathian and Pannonian oak-hornbeam woods. Soil parent materials are alluvial sediments, polygenetic loess-like hillslope sediments, eolian sands, and loess, with dominant soil types being Cutanic Luvisols, Mollic Fluvisols, Haplic Fluvisols (Eutric), and Haplic Cambisols (Eutric). Medium textured loamy and siltic soils prevail.

The association was described from Germany by MÜLLER (1964). It is widespread in Slovakia (KROPÁČ 1974, 1981, KRIPPELOVÁ 1981, MOCHNACKÝ 1996, 1998, 1999, JAROLÍMEK et al. 1997, ZALIBEROVÁ & JAROLÍMEK 2005, KROPÁČ & MOCHNACKÝ 2009), in the Czech Republic (KOBLIHOVÁ 1989, OTÝPKOVÁ 2001, 2004, LOSOSOVÁ 2004, KROPÁČ 2006, LOSOSOVÁ et al. 2009), in Austria (HOLZNER 1973, MUCINA 1993), in Germany (SCHUBERT & MAHN 1968, HILBIG 1973, SCHUBERT 1995, 2001), in Poland (KUŹNIEWSKI 1975) and also in Denmark (LAWESSON 2004).

#### **Ass. 4: *Veronicetum trilobae-triphyllidi* (Appendix S5)**

Diagnostic species: *Veronica triphyllus*, *Papaver dubium*, *Veronica sublobata*, *V. hederifolia*, *Erophila verna*, *Papaver argemone*, *Descurainia sophia*, *Holosteum umbellatum*, *Anthemis ruthenica*

Constant species: *Viola arvensis*, *Veronica hederifolia*, *Capsella bursa-pastoris*, *Veronica triphyllus*, *V. sublobata*, *Descurainia sophia*, *Apera spica-venti*, *Stellaria media*, *Fallopia convolvulus*, *Elytrigia repens*, *Consolida regalis*, *Tripleurospermum perforatum*, *Polygonum aviculare* agg., *Papaver dubium*

Dominant species: *Veronica hederifolia*, *Descurainia sophia*, *Viola arvensis*, *Stellaria media*

This is a spring community fully developed in April and May. Stands are typical for winter cereals, but could also develop on young fallow. Winter and annual species from the class *Stellarietea mediae* and also *Sedo-Scleranthetea* are typical for the community. The association is recently recorded only in the warm climatic region of the Borská nížina Lowland in western Slovakia (Fig. 8). Pannonian oak-hornbeam woods are potential natural vegetation in this locality. Soil parent materials are alluvial sediments and eolian sands, with dominant soil types of Haplic Arenosols, Mollic Fluvisols, and Endogleyic Chernozems. Coarse and medium textured arenic and loamy soils prevail.

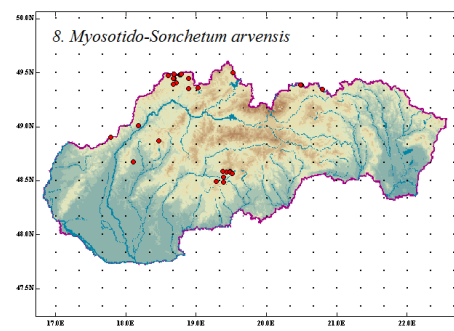
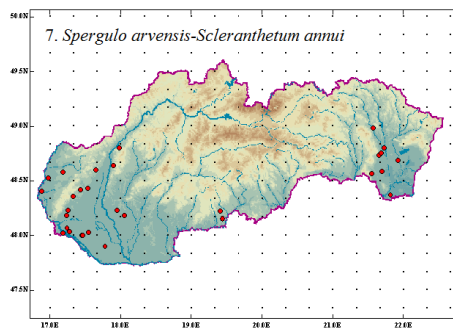
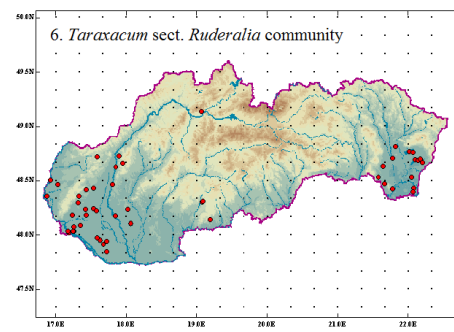
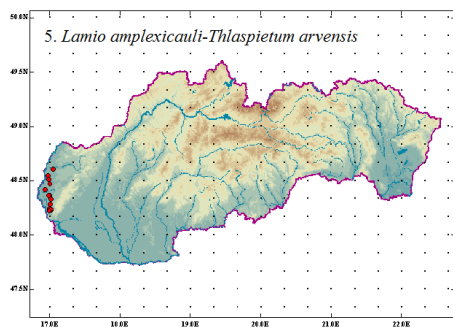
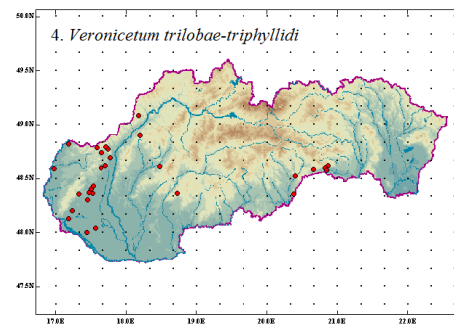
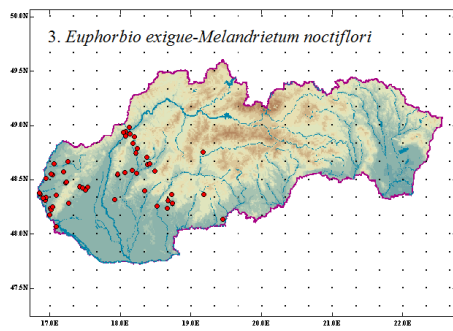
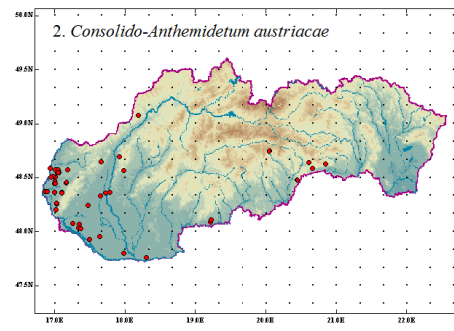
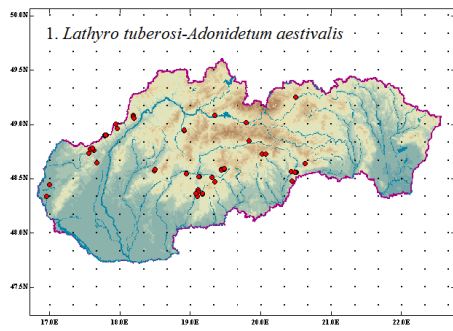
The community was described from the former Yugoslavia by SLAVNIĆ (1951). Authors have recorded it in Slovakia (MOCHNACKÝ 1986, 1996, 1998, 1999, JAROLÍMEK et al. 1997, MÁJEKOVÁ 2004, ZALIBEROVÁ et al. 2004, MÁJEKOVÁ et al. 2010), in the Czech Republic (KROPÁČ 1981, 1997, 2006, LOSOSOVÁ 2004, LOSOSOVÁ et al. 2009), in Austria (HOLZNER 1973, MUCINA 1993), in Hungary (BORHIDI et al. 2012), and also in Slovenia (ŠILC 2005, ŠILC & ČARNI 2005, 2007).

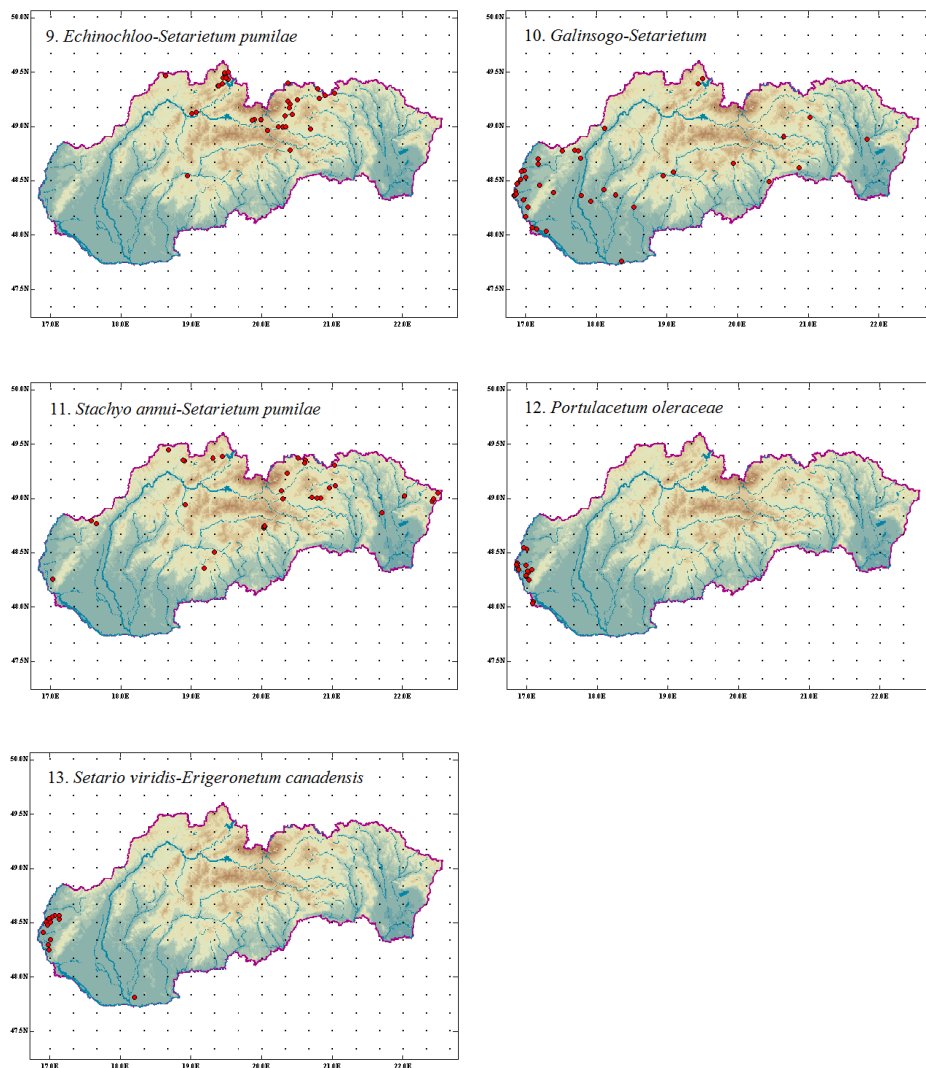
#### **Ass. 5: *Lamio amplexicauli-Thlaspietum arvensis* (Appendix S6)**

Diagnostic species: *Lamium amplexicaule*, *Veronica hederifolia*, *Consolida regalis*

Constant species: *Stellaria media*, *Capsella bursa-pastoris*, *Tripleurospermum perforatum*, *Viola arvensis*, *Galium aparine*, *Cirsium arvense*, *Consolida regalis*, *Lamium amplexicaule*, *Veronica hederifolia*, *V. persica*, *Apera spica-venti*

Dominant species: *Stellaria media*, *Viola arvensis*, *Veronica hederifolia*





**Fig. 8.** Distribution of the segetal communities in Slovakia.

**Abb. 8.** Die Verbreitung der Segetalgesellschaften in der Slowakei.

This community forms a spring aspect in cereal fields. Annuals from the class *Stellariaetea mediae* are the most frequent, and these dominate the vegetation. Stands are bound to warm climatic regions in eastern and southwestern Slovakia. They occur in the lowlands and hills of: Borská nížina Lowland, Ipeľská kotlina Basin, Krupinská planina Plain, Myjavská pahorkatina Hills, Nitrianska pahorkatina Hills, Podunajská rovina Flat, Považský Inovec Mts, Trnavská pahorkatina Hills, Turčianska kotlina Basin, Východoslovenská pahorkatina Hills, Východoslovenská rovina Flat, and Zemplínske vrchy Mts (Fig. 8). Potential natural vegetation of the localities comprises elm and willow-poplar floodplain woods and Carpathian and Pannonian oak-hornbeam woods. Soil parent materials are mostly alluvial sediments,

polygenetic loess-like hillslope sediments and loess. The dominant soil types are Haplic Fluvisols (Eutric), Haplic Chernozems (Calcaric), Mollic Fluvisols (Calcaric) and Albic Cutanic Luvisols, with prevailing medium textured siltic soils.

The association was described from eastern Slovakia by KRIPPELOVÁ (1981), and the community was documented by MOCHNACKÝ (1984a) in Slovakia and by OTÝPKOVÁ (2001) in the Czech Republic.

**Comm. 6: *Taraxacum* sect. *Ruderalia* community** (Appendix S7, Fig. 9c)

Diagnostic species: *Taraxacum* sect. *Ruderalia*, *Lactuca serriola*, *Stenactis annua*, *Veronica polita*, *Stellaria media*

Constant species: *Stellaria media*, *Capsella bursa-pastoris*, *Taraxacum* sect. *Ruderalia*, *Tripleurospermum perforatum*, *Lactuca serriola*, *Veronica polita*, *Elytrigia repens*, *Veronica persica*

Dominant species: *Capsella bursa-pastoris*, *Stellaria media*, *Viola arvensis*, *Tripleurospermum perforatum*, *Taraxacum* sect. *Ruderalia*, *Raphanus raphanistrum*, *Elytrigia repens*

This community is typical for perennial fodder crops; mainly lucerne. Its seasonal optimum is in the spring agroecophase (April–May), before the first removal of the crop. Species of the class *Stellarietea mediae* are well represented in the vegetation, but species of *Artemisietea vulgaris* are also frequent, as the fodder crops are grown in the same place for several years. The community occurs in a warm climatic region in the lowlands of western and eastern Slovakia (Fig. 8; Beskydské predhorie Foothills, Borská nížina Lowland, Ipeľská kotlina Basin, Nitrianska pahorkatina Hills, Podunajská rovina Flat, Považský Inovec Mts, Trnavská pahorkatina Hills, Východoslovenská pahorkatina Hills, and Východoslovenská rovina Flat). Potential natural vegetation in these localities is mainly elm floodplain woods and Carpathian and Pannonian oak-hornbeam woods. Soil parent material is mostly alluvial sediments, loess, and hillslope sediments. Dominant soil types are Mollic Fluvisols (Calcaric), Haplic Chernozems (Calcaric), Eutric Fluvisols (Calcaric), and Cutanic Luvisols, with medium textured siltic soils prevailing.

The *Taraxacum* sect. *Ruderalia* community was described only from warm regions of the Czech Republic by KROPÁČ (2006).

**Ass. 7: *Spergulo arvensis*-*Scleranthetum annui*** (Appendix S8, Fig. 9d)

Diagnostic species: *Anthemis arvensis*, *Stellaria graminea*, *Galeopsis tetrahit*, *Trifolium repens*, *Filaginella uliginosa*, *Galinsoga urticifolia*, *Persicaria maculosa*, *Hylotelephium maximum* agg., *Galeopsis bifida*, *Scleranthus annuus*, *Vicia hirsuta*, *Gypsophila muralis*, *Achillea millefolium* agg., *Myosotis arvensis*, *Ranunculus repens*, *Spergula arvensis*, *Xanthoxalis stricta*, *Chaerophyllum aromaticum*, *Agrostis gigantea*, *Vicia angustifolia*

Constant species: *Fallopia convolvulus*, *Chenopodium album* agg., *Stellaria media*, *Galeopsis tetrahit*, *Myosotis arvensis*, *Trifolium repens*, *Viola arvensis*, *Capsella bursa-pastoris*, *Anthemis arvensis*, *Cirsium arvense*, *Polygonum aviculare* agg., *Persicaria maculosa*, *Galium aparine*, *Vicia hirsuta*, *Galinsoga urticifolia*, *Taraxacum* sect. *Ruderalia*, *Elytrigia repens*, *Plantago uliginosa*, *Persicaria lapathifolia*, *Galeopsis bifida*

Dominant species: *Stellaria media*, *Tripleurospermum perforatum*, *Galinsoga urticifolia*, *Cyanus segetum*

This is a summer community with optimum development in July and August, and it is typical for both root-crops such as potatoes and for cereals. Several acidophilous, hygrophilous and nitrophilous species form this community's composition. It is widespread in



both moderately warm and moderately cold climatic regions in the colline and submontane belt. It is typical for small fields in hillside settlement areas in central and northern Slovakia (Fig. 8; Biele Karpaty Mts, Jablunkovské medzihorie, Javorie Mts, Javorníky Mts, Kysucká vrchovina Upland, Kysucké Beskydy Mts, Ľubovnianska vrchovina Upland, Nitrianska pahorkatina Hills, Ostrôžky Mts, Pieniny Mts, Podbeskydská brázda Furrow, Poľana Mts, Považské podolie, Strážovské vrchy Mts, Turzovská vrchovina Upland, Veporské vrchy Mts, and Zvolenská kotlina Basin). Potential natural vegetation consists of beech and fir woods with forb-rich undergrowth, submontane beech woods with forb-rich undergrowth and Carpathian oak-hornbeam woods. Soil parent materials are mostly in-situ weathered or transported clastic sedimentary rocks and acid igneous rocks and polygenetic hillslope sediments. Dominant soil types are Haplic Cambisols (Eutric) and Haplic Stagnosols (Eutric), with prevailingly medium textured siltic and loamy soils.

The association was described from southern Germany by KUHN (1937) and it has also been recorded in Slovakia (MOCHNACKÝ 1996, 1998, 1999, JAROLÍMEK et al. 1997, KROPÁČ & MOCHNACKÝ 2009), in the Czech Republic (KROPÁČ 2006, OTÝPKOVÁ 2001, 2004, LOSOSOVÁ 2004, LOSOSOVÁ et al. 2009), and in Austria (MUCINA 1993).

**Ass. 8: *Myosotido-Sonchetum arvensis*** (Appendix S9, Fig. 9e)

Diagnostic species: *Matricaria discoidea*, *Galeopsis tetrahit*, *Persicaria hydropiper*, *Galeopsis bifida*, *Potentilla anserina*, *Poa annua*, *Persicaria lapathifolia*, *Mentha arvensis*, *Sonchus arvensis*, *Myosotis arvensis*, *Tithymalus helioscopia*, *Stachys palustris*, *Galium aparine*, *Lapsana communis*, *Geranium dissectum*, *Trifolium repens*, *Veronica arvensis*

Constant species: *Fallopia convolvulus*, *Tripleurospermum perforatum*, *Galium aparine*, *Viola arvensis*, *Elytrigia repens*, *Galeopsis tetrahit*, *Polygonum aviculare* agg., *Myosotis arvensis*, *Chenopodium album* agg., *Veronica persica*, *Stellaria media*, *Cirsium arvense*, *Sonchus arvensis*, *Capsella bursa-pastoris*, *Persicaria lapathifolia*, *Stachys palustris*, *Mentha arvensis*, *Veronica arvensis*, *Matricaria discoidea*, *Tithymalus helioscopia*, *Trifolium repens*, *Equisetum arvense*

Dominant species: *Tripleurospermum perforatum*, *Fallopia convolvulus*, *Chenopodium album* agg.

This community is typical for the late summer agroecophase (July–August) and it develops both in root-crops and cereals. Several therophytes and also hemicryptophytes are represented among the diagnostic species; stands are noticeable mostly by the yellow inflorescences of *Sonchus arvensis*. Hygrophilous and nitrophilous species are common in the community. Private fine-scale fields are typical biotopes for this community, which develops in the moderately cold climatic region and occasionally in moderately warm areas in the colline to submontane belt (Fig. 8; Hornádska kotlina Basin, Levočské vrchy Mts, Liptovská kotlina Basin, Ľubovnianska vrchovina Upland, Nízke Tatry Mts, Ondavská vrchovina Upland, Oravská kotlina Basin, Podbeskydská brázda Furrow, Podbeskydská vrchovina Upland, Popradská kotlina Basin, Spišská Magura Mts, Spišsko-šarišské medzihorie, Štiavnické vrchy Mts, Turčianska kotlina Basin, Turzovská vrchovina Upland, and Volovské vrchy Mts). The potential natural vegetation is mainly submontane and montane floodplain woods and fir and fir-spruce woods. Soil parent materials are mostly in-situ weathered or transported clastic sedimentary rocks and alluvial and polygenetic hillslope sediments. The dominant soil types are Haplic Cambisols (Eutric), Haplic Fluvisols (Eutric), and Haplic Stagnosols (Eutric), with prevailingly medium textured siltic and loamy soils.

The association was described from Slovak territory by PASSARGE & JURKO (1975), and it was also recorded in Slovakia by MOCHNACKÝ (1996, 1998, 1999) and by JAROLÍMEK et al. (1997). However, it has not been reported in other countries.

**Ass. 9: *Echinochloa-Setarietum pumilae* (Appendix S10)**

Diagnostic species: *Xanthium albinum*, *Aster lanceolatus*, *Echinochloa crus-galli*

Constant species: ***Chenopodium album* agg.**, ***Cirsium arvense***, *Elytrigia repens*, *Polygonum aviculare* agg., *Echinochloa crus-galli*, *Fallopia convolvulus*, *Convolvulus arvensis*, *Tripleurospermum perforatum*

Dominant species: *Tripleurospermum perforatum*, *Setaria pumila*, *Echinochloa crus-galli*, *Convolvulus arvensis*, *Chenopodium polyspermum*

Although this community is typical for the summer agroecophase from June to August, it could remain on the fields until October. It develops in different types of agricultural stands: in root-crops, cereals, stubble, fallow and field depressions. Heterogeneity of the crop is reflected in the heterogeneity of the weed vegetation and its structure. Diagnostic species are poorly represented, except for *Echinochloa crus-galli* which is also constant and dominant species on some stands. Several neophytes are frequent in this vegetation (e.g., *Amaranthus blitoides*, *A. powellii*, *A. retroflexus*, *Ambrosia artemisiifolia*, *Aster lanceolatus*, and *Xanthium albinum*). The community is dispersed throughout Slovakia, but mainly occurs in the warm climatic region, in the lowland and colline belt, and occasionally in the submontane belt and orographic units: Bachureň, Borská nížina Lowland, Hornádska kotlina Basin, Hronská pahorkatina Hills, Chvojnická pahorkatina Hills, Ipeľská pahorkatina Hills, Malé Karpaty Mts, Myjavská pahorkatina Hills, Nitrianska pahorkatina Hills, Oravská kotlina Basin, Podunajská rovina Flat, Považské podolie, Slovenský kras Karst, Stolické vrchy Mts, Štiavnické vrchy Mts, Trnavská pahorkatina Hills, Východoslovenská pahorkatina Hills, Zvolenská kotlina Basin, and Žitavská pahorkatina Hills (Fig. 8). The altitude ranges from 112 to 679 m a.s.l. Potential natural vegetation is elm floodplain woods, submontane and montane floodplain woods and Carpathian oak-hornbeam woods. The soil parent material is

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**Fig. 9.** Stands of the following communities **a)** *Lathyro tuberosi-Adonidetum aestivalis* with flowering aspect of *Papaver rhoeas*, *Cyanus segetum* and *Cota austriaca* in the cereal field (*Secale cereale*) in the Krupinská planina Plain; **b)** *Euphorbio exiguae-Melandrietum noctiflori* with aspect of *Anagallis arvensis* and *Sherardia arvensis* in a stubble field; **c)** *Taraxacum* sect. *Ruderalia* community in a lucerne (*Medicago sativa*) field with dominance of *Capsella bursa-pastoris* in the Podunajská nížina Lowland; **d)** *Spergulo arvensis-Scleranthetum annui* in a private oat (*Avena sativa*) field with dominant *Galeopsis tetrahit*; **e)** *Myosotido-Sonchetum arvensis* in a small private potato field in the Liptovská kotlina Basin; **f)** *Galinsogo-Setarietum* with dominant *Galinsoga parviflora* and *G. urticifolia* in a small private potato field; **g, h)** *Stachyo annui-Setarietum pumilae* with dominant *Setaria pumila* in a stubble field (Photos: Jana Májeková).

**Abb. 9.** Bestände der folgenden Gesellschaften **a)** *Lathyro tuberosi-Adonidetum aestivalis* mit Blüh-aspekt von *Papaver rhoeas*, *Cyanus segetum* und *Cota austriaca* im Getreidefeld (*Secale cereale*) im Krupinská planina Flachland; **b)** *Euphorbio exiguae-Melandrietum noctiflori* (Aspekt von *Anagallis arvensis* und *Sherardia arvensis*) in einem Stoppelfeld; **c)** *Taraxacum* sect. *Ruderalia*-Gesellschaft in einem Luzerne-Feld (*Medicago sativa*) mit *Capsella bursa-pastoris* als dominanter Art in der Podunajská nížina Tiefebene; **d)** *Spergulo arvensis-Scleranthetum annui* in einem privaten Hafer-Feld (*Avena sativa*) mit dominantem *Galeopsis tetrahit*; **e)** *Myosotido-Sonchetum arvensis* in einem kleinen privaten Kartoffel-Feld im Liptovská kotlina-Becken; **f)** *Galinsogo-Setarietum* mit den dominanten Arten *Galinsoga parviflora* und *G. urticifolia* in einem kleinen privaten Kartoffel-Acker; **g, h)** *Stachyo annui-Setarietum pumilae* mit dominanter *Setaria pumila* im Stoppelfeld (Fotos: Jana Májeková).



mostly alluvial and proluvial sediments, eolic sands, and loess. Dominant soil types are Haplic Fluvisols (Eutric), Mollic Fluvisols (Eutric), Haplic Chernozems (Calcaric) and Cutanic Luvisols, with prevailingly medium textured loamy soils.

This association was common in Slovakia in the past (KRIPPELOVÁ 1981, MOCHNACKÝ 1996, 1998, 1999, 2005, JAROLÍMEK et al. 1997, ZALIBEROVÁ et al. 2004, ZALIBEROVÁ & JAROLÍMEK 2005). It was described from Hungary by FELFÖLDY (1942), and besides Hungary (SOÓ 1961, BORHIDI 1996, PINKE 2000, 2007, PINKE & PÁL 2008, BORHIDI et al. 2012) it is widespread in the Czech Republic (LOSOSOVÁ 2004, KROPÁČ 2006, LOSOSOVÁ et al. 2009), Austria (MUCINA 1993) and also in Slovenia (ŠILC 2005, ŠILC & ČARNI 2005, 2007).

**Ass. 10: *Galinsoga-Setarietum*** (Appendix S11, Fig. 9f)

Diagnostic species: *Galinsoga urticifolia*, *G. parviflora*, *Sonchus arvensis*, *Equisetum arvense*, *Stachys palustris*, *Lamium purpureum*, *Symphytum officinale*, *Armoracia rusticana*, *Geranium dissectum*, *Persicaria lapathifolia*

Constant species: *Chenopodium album* agg., *Cirsium arvense*, *Convolvulus arvensis*, *Veronica persica*, *Sonchus arvensis*, *Lamium purpureum*, *Stellaria media*, *Fallopia convolvulus*, *Capsella bursa-pastoris*, *Galium aparine*, *Galinsoga parviflora*, *Elytrigia repens*, *Equisetum arvense*, *Stachys palustris*, *Galinsoga urticifolia*, *Echinochloa crus-galli*, *Persicaria lapathifolia*, *Tripleurospermum perforatum*, *Taraxacum* sect. *Ruderalia*

Dominant species: *Galinsoga urticifolia*, *G. parviflora*, *Echinochloa crus-galli*, *Equisetum arvense*

This is a summer association typical for stands in small potato fields. Its optimum is in July and August when diagnostic species are in bloom. While the neophytes *Galinsoga parviflora* and *G. urticifolia* determine vegetation physiognomy (Fig. 9f), the community also contains nitrophilous and hygrophilous species. It is widespread in orographic units in the colline and submontane belt, in moderately warm and moderately cold climatic regions: Bachureň, Borská nížina Lowland, Bukovské vrchy Mts, Hornádska kotlina Basin, Javorie Mts, Krupinská planina Plain, Kysucká vrchovina Upland, Laborecká vrchovina Upland, Myjavská pahorkatina Hills, Ondavská vrchovina Upland, Oravská kotlina Basin, Pieniny Mts, Podbeskydská vrchovina Upland, Popradská kotlina Basin, Spišská Magura Mts, Spiško-šarišské medzihorie, Stolické vrchy Mts, Turčianska kotlina Basin, Turzovská vrchovina Upland, and Východoslovenská pahorkatina Hills (Fig. 8). Potential natural vegetation is mainly submontane and montane floodplain woods and Carpathian oak-hornbeam woods. Soil parent materials are mostly alluvial sediments and in-situ weathered or transported clastic sedimentary rocks. Dominant soil types are Haplic Fluvisols (Eutric), Haplic Cambisols (Eutric), Haplic Stagnosols (Eutric), and Rendzic Phaeozems, with prevailingly medium textured siltic soils.

The association was previously recorded in Slovakia by ELIÁŠ (1974) and MOCHNACKÝ (1984b). It is also spread in Poland (Fijałkowski 1975, ANIOŁ-KWIATKOWSKA & KAČKI 2006, RZYMOWSKA & SKRZYZYŃSKA 2006, MATUSZKIEWICZ 2007, NOWAK 2007), in Germany (PASSARGE 1955, HILBIG 1973, HÜPPE & HOFMEISTER 1990, SCHUBERT 2001), in Denmark (LAWESSON 2004), and in the Ukraine (SOLOMAKHA et al. 1992, SOLOMAKHA 1995).

**Ass. 11: *Stachyo annui-Setarietum pumilae*** (Appendix S12, Fig. 9g, h)

Diagnostic species: *Tithymalus falcatus*, *Sonchus oleraceus*, *Stachys annua*, *Anagallis arvensis*, *Reseda lutea*, *Kickxia spuria*, *K. elatine*, *Linaria vulgaris*, *Anagallis foemina*, *Medicago lupulina*, *Amaranthus retroflexus*, *Solanum nigrum*, *Convolvulus arvensis*, *Atriplex patula*

Constant species: *Viola arvensis*, *Chenopodium album* agg., *Cirsium arvense*, *Capsella bursa-pastoris*, *Convolvulus arvensis*, *Anagallis arvensis*, *Tripleurospermum perforatum*, *Elytrigia repens*, *Stellaria media*, *Polygonum aviculare* agg., *Sonchus oleraceus*

Dominant species: *Chenopodium album* agg., *Tripleurospermum perforatum*, *Artemisia vulgaris*, *Apera spica-venti*

This community occurs in summer (June–July) in cereal fields and occasionally in root crops, and in autumn (September–October) it is found in stubble. The stands are physiognomically different with no common dominant species. In addition to annual species from the class *Stellarietea mediae*, perennials from the class *Artemisietea vulgaris* are also frequently present. The community occurs mainly in the warm climatic region and occasionally also in moderately warm climes. It is spread in the western and southern parts of Slovakia (Fig. 8; Biele Karpaty Mts, Bodvianska pahorkatina Hills, Borská nížina Lowland, Dolnomoravský úval, Hornonitrianska kotlina Basin, Ipeľská pahorkatina Hills, Košická kotlina Basin, Myjavská pahorkatina Hills, Podunajská rovina Plain, Slovenský kras Karst, Strážovské vrchy Mts, and Trnavská pahorkatina Hills). Potential natural vegetation is Carpathian and Pannonian oak-hornbeam woods. Soil parent materials are mostly alluvial sediments, loess, and loess-like polygenetic hillslope sediments. Dominant soil types are Haplic Chernozems (Calcaric), Cutanic Luvisols, Haplic Fluvisols (Eutric) and Mollic Fluvisols (Eutric), with prevalingly medium textured siltic soils.

The association was described from Hungary by FELFÖLDY (1942). It has been recorded in Slovakia (MOCHNACKÝ 1996, 1998, 1999, JAROLÍMEK et al. 1997, KROPÁČ & MOCHNACKÝ 2009), in Hungary (PINKE 2007, PINKE & PÁL 2008, 2009, BORHIDI et al. 2012), in the Czech Republic (KROPÁČ 2006, LOSOSOVÁ et al. 2009) and also in Austria (MUCINA 1993).

#### **Ass. 12: *Portulacetum oleraceae*** (Appendix S13)

Diagnostic species: *Panicum miliaceum*, *Digitaria sanguinalis*, *Setaria viridis*, *Datura stramonium*, *Echinochloa crus-galli*

Constant species: *Chenopodium album* agg., *Echinochloa crus-galli*, *Digitaria sanguinalis*

Dominant species: *Chenopodium album* agg., *Panicum miliaceum*, *Echinochloa crus-galli*, *Datura stramonium*, *Raphanus raphanistrum*, *Conyza canadensis*, *Ambrosia artemisiifolia*, *Amaranthus retroflexus*

This association is the floristically poorest of all recorded segetal communities. It is typical for summer and autumn agroecophases (June–October) and predominantly develops in root-crops and to a lesser extent in cereals, stubblefields and fallow land. The community is characterized by thermophilous annual species which demand high soil nitrogen content. The physiognomy of the vegetation is not united, with several species alternating in dominance. The community was recorded only in western Slovakia (Fig. 8; Borská nížina Lowland and Podunajská rovina Flat) in the warm climatic region. Potential natural vegetation is elm floodplain woods. Soil parent materials are mostly fluvial (alluvial and terrace) sediments and eolian sands. Dominant soil types are Haplic Arenosols and Mollic Fluvisols (Calcaric), with prevalingly coarse and medium textured arenic and loamy soils.

The association has also been recorded in other parts of Slovakia (ELIÁŠ 1982a, MOCHNACKÝ 1984b, 1996, 1998, 1999, JAROLÍMEK et al. 1997), in the Czech Republic (KROPÁČ 1981, 2006, LOSOSOVÁ et al. 2009) and also in Hungary (FELFÖLDY 1942, BORHIDI 1996, BORHIDI et al. 2012).

### Ass. 13: *Setario viridis-Erigeronetum canadensis* (Appendix S14)

Diagnostic species: *Digitaria sanguinalis*, *Anthemis ruthenica*, *Conyza canadensis*, *Raphanus raphanistrum*, *Trifolium arvense*

Constant species: *Fallopia convolvulus*, *Viola arvensis*, *Chenopodium album* agg., *Digitaria sanguinalis*, *Elytrigia repens*, *Conyza canadensis*, *Apera spica-venti*

Dominant species: *Digitaria sanguinalis*, *Raphanus raphanistrum*, *Conyza canadensis*, *Sinapis arvensis*, *Apera spica-venti*

This community is one of the floristically poorest types on arable land. Although it is spread in cereals and on stubble, young fallows are the optimal biotope for its development. It has a rather modified structure in agrocoenoses, with optimum development in summer and autumn when the diagnostic and dominant species of *Digitaria sanguinalis* and *Conyza canadensis* are in bloom. The community's central occurrence is in the warm climatic region in the Borská nížina Lowland, but in one case it was recorded in the Hronská pahorkatina Hills (Fig. 8). Potential natural vegetation is mostly Pannonian oak-hornbeam woods and oak woods with *Potentilla alba*. Soil parent materials are mostly eolian sands. Dominant soil types are Haplic Arenosols and Endogleyic Chernozems (Arenic, Calcaric), with prevalently coarse textured arenic soils.

The association was described by ŠOMŠÁK (1976) as a typical community in young pine plantations, and it has been recorded only in the Borská nížina Lowland of western Slovakia (JAROLÍMEK et al. 1997).

#### 3.4 Species composition and environmental factors

The weed vegetation was represented by 407 plant taxa, with 26 of these bryophytes and 381 vascular plants. Therophytes were dominant (57%), followed by hemicryptophytes (36%), geophytes (4%), phanerophytes (juvenile stage) (2%), and chamaephytes (1%). Native species (56%) prevailed over aliens (44%), and archaeophytes (34%) over neophytes (10%). Most alien flora species were naturalised (82%), followed by invasive (9%) and casual species (9%). There were 32 threatened vascular plant species and four threatened species of bryophytes recorded in the communities (Table 2).

The highest species diversity was recorded in the associations of *Spergulo-Scleranthetum* and *Myosotido-Sonchetum* (Fig. 4). These also constituted the highest number of native species (Fig. 3). In contrast, *Portulacetum* and *Setario-Erigeronetum* registered the lowest species diversity (Fig. 4). The highest number of archaeophytes was recorded in the association *Lathyro-Adonidetum* and the lowest in *Portulacetum*. Neophytes were not strongly represented in the communities. Naturalized species prevailed in *Lathyro-Adonidetum* and invasives prevailed in *Galinsogo-Setarietum*. The number of casuals in all communities was poor (Fig. 3). Therophytes were the most abundant in the associations *Lathyro-Adonidetum*, *Spergulo-Scleranthetum*, and *Myosotido-Sonchetum*, but there were less in *Portulacetum oleraceae*. The highest number of threatened species was recorded in the *Veronicetum* association (Fig. 4).

The association *Portulacetum* contained the most thermophilous species, while *Spergulo-Scleranthetum* and *Myosotido-Sonchetum* species had the lowest demand for temperature (Fig. 2). The *Myosotido-Sonchetum* was spread in the coldest areas, followed by communities *Spergulo-Scleranthetum*, *Galinsogo-Setarietum*, and *Lathyro-Adonidetum*. These communities were typical at the highest altitudes, with segetal vegetation requiring the highest precipitation (Fig. 5).



**Table 2.** Threatened species in the segetal communities (1–13) in Slovakia (according to FERÁKOVÁ et al. 2001 and KUBINSKÁ et al. 2001). Each species is presented by its presence (%) in each community. Endangerment categories (Endang.) are according to IUCN: CR – critically endangered, EN – endangered, VU – vulnerable, LR:nt – lower risk: near threatened, DD – data deficient.

**Tabelle 2.** Gefährdete Arten in den Segetalgesellschaften (1–13) in der Slowakei (nach FERÁKOVÁ et al. 2001 und KUBINSKÁ et al. 2001). Jede Art ist durch ihre Stetigkeit (%) in jeder Gesellschaft repräsentiert. Gefährdungskategorien (Endang.) richten sich nach der Klassifikation der IUCN: CR – vom Aussterben bedroht, EN – stark gefährdet, VU – gefährdet, LR:nt – gering gefährdet, DD – keine ausreichenden Daten.

Taxon	Endang.	Community number												
		1	2	3	4	5	6	7	8	9	10	11	12	13
<b>Vascular plants</b>														
<i>Adonis aestivalis</i>	LR:nt	2	4	5	–	–	–	–	–	2	–	–	–	–
<i>Agrostemma githago</i>	CR	7	9	–	–	–	–	–	–	–	–	–	–	
<i>Aphanes arvensis</i>	EN	4	–	2	6	4	–	–	–	–	–	–	–	
<i>Arenaria leptoclados</i>	VU	–	–	2	–	–	–	–	–	–	–	–	–	
<i>Bifora radians</i>	DD	–	–	2	–	–	–	–	–	–	–	–	–	
<i>Bolboschoenus maritimus</i>	EN	–	–	2	–	–	–	–	–	–	–	–	–	
<i>Bromus commutatus</i>	VU	–	2	–	–	–	–	–	–	–	–	–	–	
<i>Bromus secalinus</i>	EN	2	–	–	–	–	–	–	2	–	–	–	–	
<i>Centaurium pulchellum</i>	VU	–	–	4	–	–	–	–	–	–	–	–	–	
<i>Chamaepitys chia</i> subsp. <i>trifida</i>	LR:nt	–	–	2	–	–	3	–	2	–	10	–	–	
<i>Cyanus segetum</i>	LR:nt	63	23	4	–	15	3	37	8	7	3	3	–	
<i>Dichodon viscidum</i>	VU	–	–	–	6	2	9	–	–	–	–	–	–	
<i>Hibiscus trionum</i>	VU	–	–	–	–	–	–	–	2	–	–	–	–	
<i>Kickxia elatine</i>	LR:nt	–	2	21	–	–	3	–	–	–	–	23	–	
<i>Kickxia spuria</i>	VU	2	–	20	–	–	–	–	2	–	23	–	–	
<i>Logfia minima</i>	VU	–	–	–	–	–	–	–	–	–	–	–	6	
<i>Lolium temulentum</i>	CR	–	–	–	–	–	–	2	4	2	–	–	–	
<i>Lythrum hyssopifolia</i>	VU	–	–	2	–	–	–	–	2	–	–	–	–	
<i>Misopates orontium</i>	VU	4	–	2	–	–	–	–	–	–	10	–	–	
<i>Myosurus minimus</i>	VU	–	2	–	12	7	3	–	–	–	–	–	–	
<i>Papaver argemone</i>	VU	2	2	–	35	–	3	–	–	–	–	–	6	
<i>Papaver dubium</i>	LR:nt	2	–	–	–	–	–	–	–	–	–	–	–	
<i>Papaver dubium</i> subsp. <i>austromoravicum</i>	LR:nt	–	4	–	53	4	–	–	–	–	–	–	–	
<i>Pulicaria dysenterica</i>	LR:nt	–	–	2	–	–	–	–	–	–	–	–	–	
<i>Ranunculus arvensis</i>	LR:nt	14	4	2	–	6	–	2	–	–	–	–	–	
<i>Rumex stenophyllus</i>	VU	2	–	2	–	–	3	2	–	5	–	–	–	
<i>Spergula morisonii</i>	EN	–	–	–	–	–	–	–	–	–	–	–	6	
<i>Tithymalus tommasinianus</i>	DD	2	–	–	–	–	–	–	–	–	–	–	–	
<i>Veronica agrestis</i>	EN	5	–	–	–	–	–	2	6	–	3	–	–	
<i>Veronica anagalloides</i>	EN	–	–	–	–	–	–	–	–	2	–	–	–	
<i>Veronica triloba</i>	EN	–	2	–	–	6	–	–	–	–	–	–	–	
<i>Veronica triphyllos</i>	VU	2	19	–	76	9	–	–	–	–	–	–	–	
<b>Bryophytes</b>														
<i>Anthoceros agrestis</i>	LR:nt	–	–	–	–	–	–	2	–	–	–	–	–	
<i>Eurhynchium praelongum</i>	VU	–	–	–	–	–	3	–	–	–	–	–	–	
<i>Pottia davalliana</i>	LR:nt	–	–	2	–	–	–	–	–	–	–	–	–	
<i>Weissia longifolia</i>	LR:nt	–	–	2	–	–	3	5	–	–	–	–	–	

Continental species were most abundant in *Echinochloo-Setarietum* and *Portulacetum*. The most acidophilous species were represented in the associations *Spergulo-Scleranthetum* and *Setario-Erigeronetum* (Fig. 2), with *Spergulo-Scleranthetum* also occurring in localities with the lowest soil pH (Fig. 6). Species with a low demand for nutrients were most abundant in the associations *Veronicetum* and *Setario-Erigeronetum* (Fig. 2).

The associations *Veronicetum*, *Portulacetum*, and *Setario-Erigeronetum* were typical for sandy soils (Fig. 6).

#### 4. Discussion

Although JAROLÍMEK et al. (1997) published 21 associations in arable land in Slovakia, we did not distinguish all of them. Possible reasons for this discrepancy are: (i) their occurrence was not equally confirmed in the past (for example, ELIÁŠ (1982b) published the occurrence of *Tribulo-Tragetum* without any relevés), (ii) their distribution was very rare or quite localized in the past [*Misopateto-Galeopsietum ladani* was described only from one mountain (KROPÁČ & HEJNÝ 1975) and *Cannabio ruderalis-Silenetum noctiflorae* from one lowland in Slovakia (MOCHNACKÝ 1989)] and (iii) agricultural intensification in the past decades caused huge changes in weed composition (KROPÁČ 1977, 1997, HOLZNER 1978, SKALICKÝ 1981, KROPÁČ & KOPECKÝ 1987, OTÝPKOVÁ 2003, PYŠEK et al. 2005, LOSOSOVÁ & SIMONOVÁ 2008, PINKE & PÁL 2008). On the other hand, it is possible that we did not record all types of vegetation in all types of agrocoenoses, and therefore some rare communities may not have been distinguished in the analyses, and the relevés were assigned to other clusters. For example, we certainly assumed the occurrence of *Erophilo-Arabidopsietum* in Slovakia, but there was insufficient data on this association to be reported in our study.

In addition, we also recorded some communities not characterized by JAROLÍMEK et al. (1997). Although the association *Lamio amplexicauli-Thlaspietum arvensis* was described from eastern Slovakia as a vernal community (KRIPPELOVÁ 1981), this community was not confirmed in further analyses (JAROLÍMEK et al. 1997). Our relevés had similar floristic structure and ecological preferences as the community described from eastern Slovakia and also from the Czech Republic (OTÝPKOVÁ 2001). Although this association had some species in common with *Veronicetum trilobae-triphyllidi*, numerical analysis had explicitly divided these stands. It appears that these associations are ecological vicariants. *Veronicetum* is spread in western Slovakia only in the Borská nížina Lowland where the parent soil material is sandy and poor in nutrients and moisture. *Lamio-Thlaspietum* is mainly typical for other Slovak lowlands, such as in eastern Slovakia. In the past, *Veronicetum* was recorded in both the west and east of the country (MOCHNACKÝ 1986, 1996, 1998, JAROLÍMEK et al. 1997, MÁJEKOVÁ 2004, MÁJEKOVÁ et al. 2010). However, we did not record it recently in the east, and the reason is possibly due to increased intensive agriculture in this area. Moreover, the application of herbicides caused decreases in sensitive species; and this is one reason why *Veronicetum* had more threatened species than *Lamio-Thlaspietum*. It is possible that the association *Lamio-Thlaspietum* is an impoverished form of *Veronicetum* caused by intensive chemical management.

We recorded the *Taraxacum* sect. *Ruderalia* community as being novel for Slovakia, where it forms a well-developed and stable community in perennial fodder crops. This community was described from the Czech Republic in similar biotopes (KROPÁČ 2006).



While that author classified it in the alliance *Caucalidion lappulae*, *Caucalidion* species are very poorly represented in our material. Therefore, we classified this only at the order level.

The association *Galinsogo-Setarietum* was described by TÜXEN (1950), but he synonymized it with *Echinochloo-Setarietum pumilae* (as also did JAROLÍMEK et al. 1997 and KROPÁČ 2006). JAROLÍMEK et al. (1997) also characterized stands with the dominant species *Galinsoga parviflora* as a variant of *Echinochloo-Setarietum*. In our analyses, these communities are placed side by side, but they are strictly divided. *Galinsogo-Setarietum* forms typical growths in potato fields with the dominant species *Galinsoga parviflora* and *G. urticifolia*. *Galinsogo-Setarietum* occurs at higher altitudes in colder climates with higher precipitations and more acidic soil than *Echinochloo-Setarietum*. Diversity and representation of archaeophytes, neophytes and also native species is also higher in the *Galinsogo-Setarietum*. Meanwhile, KRIPPELOVÁ (1981) characterized the association *Echinochloo-Setarietum* as a thermophilous community.

Although associations *Euphorbio-Melandrietum* and *Stachyo-Setarietum* are floristically similar, their syntaxonomical classification is different. They are typical for stubble or cereal fields in autumn, but they are identified also in summer agroecophases. The floristic composition of some relevés overlaps, making their classification very difficult. Our community *Euphorbio-Melandrietum* is very similar to the original description by MÜLLER (1964), with the exception of *Setaria pumila* which exhibits high presence and abundance in our relevés. In contrast, this species is typical for the *Stachyo-Setarietum* (FELFÖLDY 1942), and this grass has expanded in Slovakia in the last decades. The community *Stachyo-Setarietum* is also similar to the association *Kickxietum spuriae* Krusem. et Vlieg. 1939 described from The Netherlands (KRUSEMAN & VLIJGER 1939, HAVEMAN et al. 1998) and also from Poland (MATUSZKIEWICZ 2007), Slovenia (ŠILC & ČARNI 2007), Croatia (HULINA 2002), Denmark (LAWESSON 2004), and from Germany (OBERDORFER 1983). Therefore, these stubble-field communities should be revised on a broader scale range.

The association *Lathyro tuberosi-Adonidetum aestivalis* described by KROPÁČ et al. (1971) was dominated by *Adonis aestivalis*. However, the representation of *A. aestivalis* in our relevés is very poor. There has been a remarkable decline in this species in countries under herbicide pressure and seed cleaning during the last decades (KUŹNIEWSKI 1975, KOBLIHOVÁ 1989, HULINA 2002, 2005, OTÝPKOVÁ 2003). It is still relatively frequent at field margins and in abandoned places in warm parts of Slovakia, but is rare in arable field vegetation. It appears that *Adonis aestivalis* was replaced by *Cyanus segetum* in this community. This species is still very common and abundant in some regions of Slovakia, and it is possibly resistant to herbicide application.

Recorded stands of the *Portulacetum oleraceae* are not in their typical form, but represent only an impoverished form of the community. *Portulaca oleracea* thrives on root crop fields on sandy soils (DEYL 1964). But intensively cultivated maize fields are now increasingly more under chemical treatment than mechanical disturbance, and as dicotyledonous herbicides are used, *Portulaca oleracea* is inhibited and weed grasses prosper. The nomenclature of this community is thus not clear and definitive mainly due to high representation of the species *Digitaria sanguinalis* and *Panicum miliaceum*.

Numerical analysis of our data follows partly syntaxonomical hierarchy and partly ecological preferences of the species. The highest level of dissimilarity separates the subclasses *Sisymbrienea* and *Violenea arvensis*, but the lower division levels do not reflect exactly the syntaxonomic system. The second level of division separates communities by their time of development (i.e., spring and spring-summer communities vs. summer and autumn commu-

nities). This is confirmed also by ordination analysis, where spring communities can be found on the left side of the chart, whereas summer and autumn on the right. Such a trend was recorded also by PINKE & PÁL (2008) in Hungary. Other important factors in the classification of segetal vegetation in Slovakia appeared to be the type of crops and altitude. Different studies suggest that the most important factors for classification of weed vegetation are: sowing season, crop type, soil pH, soil texture, climatic factors and altitude (LOSOSOVÁ et al. 2004, 2006, FRIED et al. 2008, PINKE & PÁL, 2008, ANDREASEN & SKOVGAARD 2009, CIMALOVÁ & LOSOSOVÁ 2009, PINKE et al. 2010, 2011, 2012).

The alliance *Caucalidion lappulae* is most divided and dispersed in different parts in the dendrogram. The alliance includes thermophilous weed species, with a focus occurrence in winter cereals; they occupy basic habitats and are at the edge of their distribution in central Europe (ŠILC et al. 2014). Classification of the associations into this alliance is variable in different countries. For example, the association *Veronicetum trilobae-triphyllidi* is classified in the alliance *Caucalidion* in the Czech Republic, whereas in Slovakia, Hungary, Austria and Slovenia in the alliance *Veronico-Euphorbion*. Similarly, the association *Stachyo annui-Setarietum pumilae* is included in the alliance *Caucalidion* in the Czech Republic and Hungary, but in the alliance *Panico-Setarion* in Slovakia and Austria (cf. MUCINA 1993, JAROLÍMEK et al. 1997, ŠILC & ČARNÍ 2007, LOSOSOVÁ et al. 2009, BORHIDI et al. 2012).

Classification of the weed (segetal) vegetation is sometimes ambiguous because the species composition is markedly influenced by agricultural management, mainly by huge utilization of herbicides and fertilizers. Therefore, classification is more hindered than in natural vegetation. Although weed vegetation is unfavourable in the crop production, these communities have an important role in the landscape – from the view of diversity and conservation, since they host several threatened plant species and offer refuge for the fauna.

## Erweiterte deutsche Zusammenfassung

**Einleitung** – Die ersten Untersuchungen zur Segetalvegetation in der Slowakei sind erst nach dem 2. Weltkrieg durchgeführt worden. Seitdem haben sich verschiedene Autoren mit der Untersuchung dieser Vegetationstypen beschäftigt, dieses Interesse schwand jedoch seit den 1980er Jahren.

Die Ziele dieser Arbeit sind, folgende Aspekte zu untersuchen und zu analysieren: (i) die aktuelle Verbreitung der Segetal-Pflanzengesellschaften in der Slowakei, (ii) die floristische Zusammensetzung der Pflanzengesellschaften (Lebensformen, Herkunft der Sippen und Fragen nach dem Status als invasive Arten, Vorhandensein von gefährdeten Sippen) sowie (iii) ihre Beziehungen zu ausgewählten Umweltfaktoren.

**Material und Methoden** – Das Untersuchungsgebiet umfasst die gesamte Fläche der Slowakischen Republik (Zentraleuropa). Die Datengrundlage umfasst 508 pflanzensoziologische Aufnahmen, die zwischen den Jahren 2002 und 2008 mit den Methoden der Zürich-Montpellier Schule (BRAUN-BLANQUET 1964, WESTHOFF & VAN DER MAAREL 1978) durchgeführt wurden. Hierbei ist die 9-stufige Skala zur Artmächtigkeit von BARKMAN et al. (1964) verwendet worden. Die Probeflächen-Größe war meistens 10 × 10 m (großflächigen Felder) und 5 × 10 m in kleinen privaten Feldern. Die pflanzensoziologischen Aufnahmen wurden mit der Clusteranalyse ausgewertet unter Verwendung der Programme JUICE 7.0 und SYN-TAX 2000. Die “β-flexible method” ( $\beta = -0.25$ ) und „Sorensen’s similarity index” wurden verwendet. Für Korrelationsanalysen und die Erstellung von „Box-Whisker Plots“ verwendeten wir das Programm Statistica. Folgende Daten wurden zwischen den Gesellschaften verglichen und statistisch geprüft (ANOVA und “subsequent Fisher LSD post-hoc test”,  $p < 0.05$ ): mittlere Ellenberg-Indikatorwerte; Anteil der Lebensformen; Artenreichtum; Zahl gefährdeter Arten, einheimischer Arten, Archaeophyten, Neophyten, eingebürgerter, invasiver und nur gelegentlich auftretender Arten pro Aufnahme, ferner Höhenlage, mittlere Jahrestemperatur und Niederschläge im engeren

Gebiet, Aufnahmezeitpunkt (Monat), Bodeneigenschaften (Reaktion, Sand-, Lehm-, Tongehalt im Oberboden). Die Hauptgradienten der Umweltfaktoren wurden mit Hilfe der DCA (Detrended Correspondence Analysis) mit Hilfe des Programms CANOCO (TER BRAAK & ŠMILAUER 2002) dargestellt. Wir verwendeten die mittleren ungewichteten Ellenberg Indikatorwerte (ELLENBERG et al. 1992) und den Diversitätsindex von Shannon-Wiener als ergänzende Daten.

**Ergebnisse und Diskussion** – Wir identifizierten 13 Pflanzengesellschaften der Klasse *Stellarietea mediae*; 11 Gesellschaften wurden der Unterklasse *Violenea arvensis* zugeordnet: *Lathyro tuberosi-Adonidetum aestivalis*, *Consolido-Anthemidetum austriacae*, *Euphorbio exiguae-Melandrietum noctiflori*, *Veronicetum trilobae-triphyllidi*, *Lamio amplexicauli-Thlaspietum arvensis*, *Taraxacum* sect. *Ruderalia*-Gesellschaft, *Spergulo arvensis-Scleranthetum annui*, *Myosotido-Sonchetum arvensis*, *Echinochloo-Setarietum pumilae*, *Galinsogo-Setarietum*, *Stachyo annui-Setarietum pumilae* und 2 der Unterklasse *Sisymbrienea*: *Portulacetum oleraceae*, *Setario viridis-Erigeronetum canadensis*. Einige der Gesellschaften sind neu für die synanthrope Vegetation der Slowakei, wenn man das zusammenfassende Werk JAROLÍMEK et al. (1997) heranzieht; dieses sind die folgenden Typen: *Lamio amplexicauli-Thlaspietum arvensis*, *Galinsogo-Setarietum*, *Taraxacum* sect. *Ruderalia*-Gesellschaft.

Die Ergebnisse der Clusteranalyse wurden im Dendrogramm und in der synoptischen Tabelle dargestellt, desweiteren sind die Gesellschaften mit ihren diagnostischen, konstanten und dominanten Arten sowie ihre Struktur, Ökologie und Verbreitung gekennzeichnet worden. Das Ergebnis dieser Spezifizierung zeigte, dass die wichtigsten Faktoren, die die floristische Zusammensetzung und die Klassifikation der Segetalvegetation beeinflussen, die Zeit ihrer Entwicklung (sog. Agroökophase), die Art der Feldfrucht und die Meereshöhe sind.

Die Segetalvegetation dieser Untersuchung wird durch 407 verschiedene Pflanzensippen gekennzeichnet, darunter 26 Vertreter der Moose und 381 Gefäßpflanzen. Unter diesen Sippen sind Therophyten dominant (57 %), gefolgt von Hemikryptophyten (36%), Geophyten (4 %), Phanerophyten (Jugendstadien) (2 %) und Chamaephyten (1%) (DOSTÁL & ČERVENKA 1991, 1992). Einheimische Arten überwiegen (56%) im Vergleich zu Nicht-Einheimischen (44%). Archäophyten sind stärker vertreten (34 %) als Neophyten (10 %). Die meisten der Nicht-einheimischen sind eingebürgert (82 %), gefolgt von invasiven Arten (9 %) und nur gelegentlich vorkommenden (9%) (MEDVECKÁ et al. 2012). Es konnten 32 gefährdete Gefäßpflanzen und 4 gefährdete Moosarten (FERÁKOVÁ et al. 2001, KUBINSKÁ et al. 2001) nachgewiesen werden.

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## Supplements and Appendices

**Supplement 1.** Table 1. Abridged synoptic table of the segetal communities in Slovakia.

**Beilage 1.** Tabelle 1. Gekürzte Stetigkeitstabelle der Ackerunkraut-Gesellschaften in der Slowakei.

**Additional supporting information may be found in the online version of this article.**

**Zusätzliche unterstützende Information ist in der Online-Version dieses Artikels zu finden.**

**Appendix S1.** List of references about the research of segetal flora and vegetation in Slovakia.

**Anhang S1.** Literaturübersicht zur Erforschung der Segetalflora und –vegetation in der Slowakei.

**Appendix S2–S14.** Relevés of the studied communities.

**Anhang S2–S14.** Vegetationsaufnahmen der untersuchten Pflanzengesellschaften.

- S2. *Lathyro tuberosi-Adonidetum aestivalis*.
- S3. *Consolido-Anthemidetum austriaceae*.
- S4. *Euphorbio exigue-Melandrietum noctiflori*.
- S5. *Veronicetum trilobae-triphyllidi*.
- S6. *Lamio amplexicauli-Thlaspietum arvensis*.
- S7. *Taraxacum* sect. *Ruderalia* community.
- S8. *Spergulo arvensis-Scleranthetum annui*.
- S9. *Myosotido-Sonchetum arvensis*.
- S10. *Echinochloo-Setarietum pumilae*.
- S11. *Galinsogo-Setarietum*.
- S12. *Stachyo annui-Setarietum pumilae*.
- S13. *Portulacetum oleraceae*.
- S14. *Setario viridis-Erigeronetum canadensis*.

**Appendix S15:** Localities of the relevés in Appendices S2–S14.

**Anhang S15:** Lokalitäten der pflanzensoziologischen Aufnahmen in den Anhängen S2–S14.

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**Appendix S1.** List of references about the research of segetal flora and vegetation in Slovakia.

**Anhang S1.** Literaturübersicht zur Erforschung der Segetalflora und –vegetation in der Slowakei.

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Appendix S4. Euphorbia exigue-Melandrium noctiflori. Abbreviations of the syntaxe see Table 1. Anhang S4. Euphorbia exigue-Melandrium noctiflori. Abkürzungen der Syntaxa, s. Tab. 1.

Table with columns for Relevé number, Relevé area (m²), Altitude (m a.s.l.), Cover total (%), Cover of crops (%), Cover of weeds (%), Coverage of trees (%), Height (low) herb layer (cm), Height (high) herb layer (cm), Max. height herb layer (cm), Number of species, and 56 Relevé sites. The table lists various plant species and their presence/absence across the sites, with some cells containing alphanumeric codes (a, b, 1, 3, 4, m, r).



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**Appendix S5.** Veronicetum trilobae-triphyllidi. Abbreviations of the syntaxa see Table 1.**Anhang S5.** Veronicetum trilobae-triphyllidi. Abkürzungen der Syntaxa, s. Tab. 1.

Relevé number	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17		
Relevé area (m <sup>2</sup> )	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100		
Altitude (m a.s.l.)	154	154	161	177	155	156	156	177	150	177	155	162	150	174	162	156	156		
Cover total (%)	95	80	90	100	65	70	95	95	90	70	90	100	100	90	100	95	60		
Cover moss layer (%)	0	0	2	0	0	0	0	0	0	0	0	5	0	0	0	0	0		
Cover of crops (%)	60	55	70	0	50	0	60	85	70	50	75	85	90	80	90	85	50		
Cover weeds (%)	70	70	70	0	30	0	80	80	70	40	65	85	80	65	75	70	35		
Height (low) herb layer (cm)	15	10	20	7	10	15	15	10	10	10	10	15	20	10	10	10	15		
Height (high) herb layer (cm)	30	30	100	30	30	30	50	60	40	35	40	30	65	45	35	30	35		
Max. height herb layer (cm)	0	60	0	80	0	70	0	0	0	0	0	160	0	0	150	150	140	Frequency	
Number of species	14	16	18	22	14	14	17	14	20	20	14	24	16	21	25	29	21	%	
<b>Crops</b>																			
Secale cereale	.	.	5	.	3	a	4	5	.	.	.	5	.	.	5	5	4	53	
Triticum aestivum	.	.	.	.	.	.	.	.	5	4	5	.	5	5	.	.	.	29	
Hordeum vulgare	4	4	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	12	
Brassica napus	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	6	
<b>Diagnostic species of Veronicetum trilobae-triphyllidi</b>																			
Veronica hederifolia (VA)	+	.	+	4	1	a	4	3	4	a	3	1	+	b	.	3	+	88	
Veronica triphyllos	b	1	.	a	1	b	+	3	a	b	1	3	.	+	.	1	.	76	
Descurainia sophia	+	+	+	4	.	.	.	1	1	1	.	+	4	+	+	+	.	71	
Veronica sublobata	b	.	+	.	b	1	+	+	+	.	.	1	+	+	+	+	.	71	
Papaver dubium subsp. austromoravicum	.	.	.	.	.	.	+	+	+	+	+	+	+	a	+	+	.	53	
Erophila verna	+	3	.	.	a	+	+	3	+	.	.	.	.	.	.	.	.	41	
Anthemis ruthenica	a	+	+	1	.	+	.	+	.	.	.	.	.	.	.	.	.	35	
Papaver argemone (Cc)	1	.	+	+	.	+	.	.	.	+	.	+	.	.	.	.	.	35	
Holosteum umbellatum	+	.	.	.	.	.	+	+	+	.	.	.	.	.	.	.	.	24	
<b>Veronico-Euphorbion</b>																			
Lamium purpureum	.	.	.	.	.	.	.	.	.	.	.	.	.	.	a	+	.	12	
<b>Centaureetalia cyani</b>																			
Cota austriaca	1	+	+	1	.	.	.	.	.	1	.	.	1	.	.	.	.	35	
Veronica persica	.	.	.	.	.	.	.	.	.	.	.	.	.	.	3	+	+	18	
Silene noctiflora	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	+	12	
<b>Violenae arvensis</b>																			
Viola arvensis	a	b	4	3	+	b	b	+	+	+	1	3	+	.	1	3	a	94	
Apera spica-venti	.	a	+	.	1	3	a	a	+	.	.	+	1	a	+	.	+	71	
Consolida regalis	.	.	+	+	r	.	.	+	.	1	+	1	.	+	.	b	1	59	
Fallopia convolvulus	.	.	+	+	r	m	m	.	.	m	1	.	.	.	+	+	r	59	
Scleranthus annuus	.	1	+	.	.	.	.	.	.	.	.	.	.	.	.	+	b	24	
Veronica arvensis	.	.	.	.	.	.	+	.	+	.	.	.	.	.	.	+	.	18	
Myosotis arvensis	.	.	m	1	.	.	.	.	.	.	.	.	.	.	.	.	.	12	
Anagallis arvensis	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	6	
Aphanes arvensis	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	6	
Raphanus raphanistrum	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	6	
Sonchus arvensis	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	6	
Xanthoxalis stricta	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	6	
<b>Stellarietea mediae</b>																			
Capsella bursa-pastoris	.	+	+	1	.	.	+	+	a	+	+	a	a	1	1	+	+	82	
Stellaria media	1	.	.	.	.	.	+	.	b	+	+	4	a	3	3	.	+	59	
Tripleurospermum perforatum	.	.	+	b	.	.	.	.	.	.	+	1	1	+	1	+	+	53	
Lamium amplexicaule	.	.	.	1	.	.	+	+	a	1	1	1	.	.	.	+	.	47	
Conyza canadensis	.	.	.	1	.	1	.	.	.	.	.	.	+	+	+	.	.	29	
Thlaspi arvense	.	.	.	+	.	.	.	.	.	.	.	1	.	.	1	+	+	29	
Chenopodium album agg.	.	.	.	+	m	.	.	+	.	.	.	.	.	m	.	.	.	24	
Papaver rhoeas	+	1	.	1	.	.	.	.	.	.	.	.	.	.	.	+	.	24	
Vicia villosa	.	.	.	+	.	+	+	.	.	.	.	.	.	.	.	1	.	24	
Galinsoga parviflora	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	6	
Geranium pusillum	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	6	
Sinapis arvensis	.	.	.	.	r	.	.	.	.	.	.	.	.	.	.	.	.	6	
<b>Other species</b>																			
Elytrigia repens	.	+	.	b	1	+	+	.	.	+	+	.	.	.	1	1	+	59	
Polygonum aviculare agg.	.	.	.	.	.	.	.	.	+	+	+	+	+	+	+	+	+	53	
Arenaria serpyllifolia	.	1	b	.	.	+	.	.	.	.	+	.	.	.	.	.	+	35	
Cirsium arvense	.	.	.	.	.	+	.	.	.	+	+	.	.	+	.	1	.	29	
Ambrosia artemisiifolia	.	.	.	.	.	.	.	.	.	+	.	+	.	.	m	.	+	24	
Artemisia vulgaris	.	.	.	.	.	.	.	.	+	+	.	.	.	+	+	.	.	24	
Arabidopsis thaliana	.	+	.	.	+	.	.	.	.	.	.	+	.	.	.	.	.	18	
Myosotis stricta	+	+	a	.	.	.	.	.	.	.	.	.	.	.	.	.	.	18	
Stachys palustris	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	1	+	18
Veronica polita	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	+	+	18
Convolvulus arvensis	.	.	.	a	.	.	.	.	.	.	.	.	.	.	.	.	+	12	
Myosurus minimus	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	r	.	12	
Trifolium arvense	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	1	12	
Acer pseudoplatanus	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	6	
Anthriscus cerefolium	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	6	
Camelina microcarpa	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	6	
Dichodon viscidum	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	6	
Equisetum arvense	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	6	
Erodium cicutarium	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	6	
Erysimum cheiranthoides	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	6	
Galium aparine	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	6	
Lactuca serriola	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	6	
Medicago lupulina	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	6	
Medicago sp.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	6	
Mentha arvensis	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	6	
Poa annua	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	6	
Ranunculus sardous	.	.	.	.	.	.	.	.	.	.	.	.	.	.	a	.	.	6	
Sisymbrium altissimum	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	6	
Tithymalus esula	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	6	
Vicia angustifolia	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	6	
<b>Bryophytes</b>																			
Barbula unguiculata	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	6	
Bryum argenteum	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	6	
Dicranella staphylina	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	6	
Phascum cuspidatum	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	6	



















**Appendix S14.** *Setario viridis*-*Erigeron* *canadensis*. Abbreviations of the syntaxa see Table 1.**Anhang S14.** *Setario viridis*-*Erigeron* *canadensis*. Abkürzungen der Syntaxa, s. Tab. 1.

Relevé number	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	
Relevé area (m <sup>2</sup> )	20	100	36	36	100	100	100	100	100	100	100	100	100	100	100	100	100	100	
Altitude (m a.s.l.)	172	168	212	151	108	165	158	160	150	160	160	153	200	200	150	165	163	146	
Cover total (%)	90	90	70	85	75	90	95	90	80	90	100	85	95	90	80	80	95	85	
Cover of crops (%)	45	75	0	0	55	0	80	75	40	70	70	65	30	40	0	40	40	35	
Cover of weeds (%)	55	75	0	0	60	0	60	70	75	80	95	70	90	85	0	70	85	75	
Cover moss layer (%)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	15	0	0	
Height (low) herb layer (cm)	30	10	5	40	30	15	20	15	10	30	80	20	0	0	60	0	25	0	
Height (high) herb layer (cm)	60	60	100	100	50	40	120	95	20	100	100	100	25	15	150	20	50	15	
Max. height herb layer (cm)	120	150	0	170	0	90	0	0	30	0	0	0	0	0	0	0	0	0	Frequency
Number of species	11	21	17	11	10	12	17	13	14	15	14	11	10	8	17	12	10	7	%
<b>Crops</b>																			
Secale cereale	3	5	.	.	.	+	5	5	3	4	4	4	3	3	a	3	.	.	72
Avena sativa	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	3	11
Hordeum vulgare	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	3	.	11
Triticum aestivum	.	.	.	.	4	.	.	.	.	.	.	.	.	.	.	.	.	.	6
<b>Diagnostic species of <i>Setario viridis</i>-<i>Erigeron</i> <i>canadensis</i></b>																			
Digitaria sanguinalis (Er)	.	.	m	+	.	1	.	m	+	m	1	3	a	5	+	1	5	4	78
Conyza canadensis (SM)	+	+	4	5	.	3	m	+	+	1	+	.	+	.	3	.	.	.	67
Raphanus raphanistrum	+	1	+	.	.	.	.	+	4	+	.	+	4	+	.	.	.	.	50
Anthemis ruthenica	.	1	+	.	3	.	+	.	+	3	+	.	.	.	.	.	.	.	39
Trifolium arvense	.	.	+	.	.	.	+	.	.	.	r	+	.	+	+	.	.	.	33
<b>Eragrostietalia</b>																			
Panicum miliaceum	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	+	.	11
Setaria viridis	.	.	.	.	.	a	.	.	.	.	.	.	.	.	.	.	.	1	11
<b>Stellarietea mediae</b>																			
Fallopia convolvulus	1	m	+	.	+	.	1	1	+	1	a	1	a	+	1	b	+	+	89
Chenopodium album agg.	.	+	+	+	r	+	r	r	+	+	+	+	.	.	1	1	b	a	83
Viola arvensis	.	1	.	+	a	a	a	1	1	+	+	+	+	.	+	+	+	1	83
Apera spica-venti	.	a	.	+	b	a	+	3	.	a	5	+	.	.	b	.	.	.	56
Setaria pumila	.	.	.	1	.	.	.	.	+	.	.	+	a	+	a	1	1	.	44
Tripleurospermum perforatum	a	.	.	+	r	.	.	+	a	+	+	.	.	.	.	.	.	.	39
Anagallis arvensis	.	.	.	.	.	+	3	+	1	+	.	.	.	.	.	.	.	.	28
Spergula arvensis	.	.	.	.	.	3	+	+	1	.	3	.	.	.	.	.	.	.	28
Cota austriaca	.	.	.	.	.	+	.	.	+	r	.	.	.	.	.	.	.	.	17
Capsella bursa-pastoris	.	.	.	1	+	.	.	.	.	.	.	.	.	.	.	.	.	.	11
Consolida regalis	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	11
Silene noctiflora	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	3	+	.	11
Cyanus segetum	.	b	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	6
Galium spurium	r	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	6
Papaver argemone	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	6
Sinapis arvensis	.	.	.	.	4	.	.	.	.	.	.	.	.	.	.	.	.	.	6
Thlaspi arvense	b	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	6
Xanthoxalis stricta	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	6
<b>Other species</b>																			
Elytrigia repens	b	+	1	1	+	1	1	.	.	.	+	.	1	1	1	+	.	.	67
Polygonum aviculare agg.	.	.	.	.	.	.	.	+	a	.	+	.	+	.	1	.	+	.	33
Equisetum arvense	+	+	.	.	.	.	.	.	.	+	.	.	.	+	.	.	.	.	22
Vicia angustifolia	+	+	+	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	22
Acetosella multifida agg.	.	.	+	.	.	+	.	.	.	.	.	1	.	.	.	.	.	.	17
Erodium cicutarium	.	.	+	.	+	.	r	.	.	.	.	.	.	.	.	.	.	.	17
Lactuca serriola	.	.	.	+	.	.	.	.	.	.	.	.	+	.	+	.	.	.	17
Arenaria serpyllifolia	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	1	.	.	11
Cirsium arvense	.	+	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	11
Echinochloa crus-galli	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	+	11
Agrostis gigantea	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	6
Ambrosia artemisiifolia	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	6
Bromus sterilis	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	6
Convolvulus arvensis	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	6
Descurainia sophia	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	6
Epilobium tetragonum	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	6
Galium aparine	.	a	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	6
Chondrilla juncea	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	6
Leontodon autumnalis	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	6
Logfia minima	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	6
Melilotus officinalis	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	6
Oenothera biennis	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	6
Persicaria dubia	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	6
Phragmites australis	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	6
Plantago uliginosa	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	6
Salsola kali	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	6
Silene latifolia subsp. alba	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	6
Spergula morisonii	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	6
Tithymalus esula	.	a	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	6
Vicia villosa	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	6
<b>Bryophytes</b>																			
Bryum argenteum	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	6
Ceratodon purpureus	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	a	.	.	6

## Májeková & Zaliberová: Arable weed communities in Slovakia

### Appendix S15: Localities of the relevés in Appendices S2–S14.

Data are arranged as follows: Number of relevé in the table, orographic unit, village (locality), longitude, latitude, (aspect, slopes), remarks on the type of field (CHS – chemically sprayed, LF – large field, PF – private field), date, and author (IJ – Ivan Jarolímek, IŠ – Iveta Škodová, JM – Jana Májeková, KH – Katarína Hegedúšová, KV – Katarína Vidékyová, MJ – Monika Janišová, MN – Marta Nižnanská, MS – Marek Slovák, MZ – Marica Zaliberová, and ZB – Zuzana Balážová).

### Anhang S15: Lokalitäten der pflanzensoziologischen Aufnahmen in den Anhängen S2-S14.

Jeder Nachweis ist in der folgenden Reihenfolge gegliedert: Tabellennummer, orographische Einheit, Ort (Lokalität), geografische Länge, geografische Breite, (Exposition, Neigung), Bemerkungen über den Typ des Feldes (CHS – chemisch besprüht, LF – großes Feld, PF – privates Feld), Datum, Autor (s. oben).

### Appendix S2:

- 1 Borská nížina, Malacky, 48°26'43", 17°00'41", fallow, PF, 11.6.2004, JM, MZ.
- 2 Krupinská planina, Dolné Mladonice, 48°20'13", 19°06'47", Z, 2°, PF but relatively large, 4.6.2008, JM.
- 3 Krupinská planina, Krupina, Dolné kopanice, 48°21'51", 19°05'25", CHS, 5.6.2008, JM.
- 4 Krupinská planina, Krupina, Poloma, 48°23'55", 19°07'14", small PF, 5.6.2008, JM.
- 5 Poľana, Hriňová-lazy, Fangov vrch, 48°35'04", 19°28'13", small PF, 21.8.2007, JM.
- 6 Krupinská planina, Senohrad, Opicháčka, 48°21'36", 19°10'55", PF but relatively large, 4.6.2008, JM.
- 7 Ostrôžky, Stará huta, 48°28'17", 19°21'31", small PF, 5.6.2008, JM.
- 8 Krupinská planina, Senohrad, Opicháčka, 48°21'40", 19°10'54", PF, 4.6.2008, JM.
- 9 Krupinská planina, Krupina, between Horné kopanice and Šnierky, 48°22'40", 19°06'48", PF, 5.6.2008, JM.
- 10 Turčianska kotlina, Blatnica, 48°56'21", 18°55'19", CHS, 15.6.2006, JM.
- 11 Borská nížina, Zohor, 48°20'05", 16°58'02", 12.6.2003, MZ.
- 12 Liptovská kotlina, Ružomberok, Španie, 49°04'50", 19°21'31", LF, 26.8.2006, JM, MZ.
- 13 Štiavnické vrchy, Močiar, 48°32'55", 18°57'22", 21.7.2006, JM.
- 14 Javorie, Slatinské lazy, 48°30'31", 19°18'48", CHS, 5.6.2008, JM.
- 15 Myjavská pahorkatina, Stará Turá, Černochoh vrch, 48°45'38", 17°38'34", JV, 5°, PF, CHS, 20.6.2008, JM.
- 16 Slovenský kras, Vidová, 48°33'58", 20°26'46", 8.6.2007, JM.
- 17 Slovenský kras, Drnava, 48°38'16", 20°38'39", PF, 9.6.2007, JM.
- 18 Myjavská pahorkatina, Myjava, 48°43'55", 17°33'50", SZ, 4°, LF, CHS, 20.6.2008, JM.
- 19 Liptovská kotlina, Kráľova Lehota, 49°01'05", 19°48'18", JZ, 2°, LF, CHS, 18.7.2008, JM.
- 20 Popradská kotlina, Toporec, 49°15'04", 20°30'09", 15.7.2008, JM.
- 21 Poľana, Detva-Skljarovo, 48°35'08", 19°26'59", J, 5°, small PF, CHS, 19.7.2006, JM.
- 22 Poľana, Detva-Skljarovo, 48°35'10", 19°26'59", small PF, 19.7.2006, JM.
- 23 Myjavská pahorkatina, Rudník, Rapantovci, 48°45'52", 17°37'22", JZ, 5°, PF, 20.6.2008, JM.
- 24 Krupinská planina, Krupina, Dolné kopanice, 48°21'50", 19°05'18", small PF, 5.6.2008, JM.
- 25 Javorie, Michalková, Mozoľovci, 48°30'58", 19°08'06", Z, 2°, 1-year fallow, small PF, 6.6.2008, JM.
- 26 Javorie, Michalková, Mozoľovci, 48°30'54", 19°08'03", Z, 4°, PF, 6.6.2008, JM.
- 27 Poľana, Detva-Skljarovo, 48°35'02", 19°27'22", Z, 4°, PF, 19.7.2006, JM.
- 28 Myjavská pahorkatina, Stará Myjava, 48°46'36", 17°34'60", Z, 4°, LF, 20.6.2008, JM.
- 29 Poľana, Detva-Majerovo, 48°34'40", 19°27'01", JZ, 5°, PF, 19.7.2006, JM.
- 30 Poľana, Hriňová, Raticov vrch, 48°35'12", 19°29'12", PF, 20.7.2006, JM.
- 31 Poľana, Hriňová, Bystré-Vrátka, 48°35'42", 19°29'13", JV, 6°, PF, 20.7.2006, JM.
- 32 Štiavnické vrchy, Močiar, 48°32'41", 18°57'06", PF, 21.7.2006, JM.
- 33 Horehronské podolie, Polomka, 48°51'01", 19°50'42", 11.8.2004, MZ, JM.
- 34 Turčianska kotlina, Blatnica, 48°56'38", 18°55'34", small PF, 15.6.2006, JM.
- 35 Turčianska kotlina, Blatnica, 48°56'42", 18°55'27", 15.6.2006, JM.
- 36 Biele Karpaty, Nová Bošáca, Grúň, 48°53'54", 17°47'39", PF, 11.7.2006, JM.
- 37 Biele Karpaty, Červený Kameň, 49°04'48", 18°11'34", Z, 6°, PF, 12.7.2006, JM.
- 38 Biele Karpaty, Mikušovce, Babinec, 49°04'20", 18°12'05", small PF, 12.7.2006, JM.
- 39 Biele Karpaty, Mikušovce, 49°03'28", 18°12'37", 12.7.2006, JM.
- 40 Malé Karpaty, Prašník, 48°38'56", 17°40'57", small PF, 21.6.2006, JM.
- 41 Slovenský kras, Silica, 48°33'24", 20°30'51", 9.6.2007, JM.
- 42 Slovenský kras, Silica, 48°33'26", 20°30'29", J, 2°, 9.6.2007, JM.
- 43 Slovenský kras, Silica, 48°33'34", 20°29'50", relatively LF, 10.6.2007, JM.
- 44 Slovenský kras, Silica, 48°33'28", 20°30'14", 10.6.2007, JM.
- 45 Slovenský kras, Kečovo-Domica, 48°28'35", 20°27'28", SV, 2°, 8.6.2007, JM.
- 46 Slovenský kras, Silica, 48°33'36", 20°29'50", SZ, 3°, relatively LF, 10.6.2007, JM.
- 47 Biele Karpaty, Horná Súča, Dúbrava, 48°57'35", 17°58'27", PF, 30.6.2006, JM.
- 48 Myjavská pahorkatina, Poriadie, 48°46'40", 17°36'56", PF, 20.6.2008, JM.
- 49 Biele Karpaty, Nová Bošáca, Grúň, 48°53'51", 17°47'31", JZ, 9°, PF, 11.7.2006, JM.
- 50 Biele Karpaty, Nová Bošáca, Predpoloma, Janegov mlyn, 48°54'05", 17°48'58", Z, 6°, PF, 11.7.2006, JM.
- 51 Biele Karpaty, Horná Súča, Trnávka, Jurinovci, 48°59'57", 17°56'47", small PF, 30.6.2006, JM.
- 52 Biele Karpaty, Nová Bošáca, Grúň, 48°54'08", 17°47'25", PF, 11.7.2006, JM.
- 53 Biele Karpaty, Nová Bošáca, Ondrášovec, 48°53'54", 17°48'17", JV, 8°, 11.7.2006, JM.

- 54 Tríbeč, Radobica, 48°34'31", 18°29'56", S, 9°, LF, CHS, 23.6.2008, JM.  
 55 Tríbeč, Radobica, 48°35'06", 18°30'25", Z, 6°, PF, 23.6.2008, JM.  
 56 Stolické vrchy, Muráň, 48°43'45", 20°01'39", 13.8.2004, MZ, JM.  
 57 Stolické vrchy, Muránska Dlhá Lúka, 48°43'31", 20°04'41", 29.7.2008, MZ.

#### Appendix S3:

- 1 Borská nížina, Jablonové, 48°21'50", 17°06'45", depression in the field, 10.6.2003, JM, MZ.
- 2 Borská nížina, Jablonové, 48°21'50", 17°06'45", 10.6.2003, JM, MZ.
- 3 Borská nížina, Rohožník, 48°27'03", 17°10'36", PF, 10.6.2004, JM.
- 4 Biele Karpaty, Mikušovce, Babinec, 49°04'22", 18°12'01", LF, 12.7.2006, JM.
- 5 Rožňavská kotlina, Lipovník, 48°38'17", 20°37'19", LF, 9.6.2007, JM.
- 6 Slovenský kras, Háj, 48°37'28", 20°51'41", relatively LF, 7.6.2007, JM.
- 7 Slovenský kras, Kečovo-Domica, 48°28'39", 20°27'22", SV, 1°, LF, 8.6.2007, JM.
- 8 Podunajská rovina, Mad, 47°57'08", 17°38'44", 22.4.2008, JM.
- 9 Borská nížina, Jablonové, 48°21'25", 17°06'48", 29.6.2004, JM, MZ.
- 10 Považský Inovec, Hrádok, Dolina, 48°41'43", 17°55'31", Z, 1°, PF, 17.6.2008, JM.
- 11 Stolické vrchy, Muráň, 48°44'41", 20°03'24", 1-year fallow, 18.6.2004, MZ.
- 12 Stolické vrchy, Muráň, 48°44'36", 20°03'16", JV, 5°, 1-year fallow, 18.6.2004, IJ.
- 13 Borská nížina, Húšky, Dubník, 48°34'25", 17°03'12", 20.6.2003, JM, MZ.
- 14 Borská nížina, Závod, Na lúkach, 48°32'35", 17°03'15", 8.7.2003, JM.
- 15 Borská nížina, Malacky, 48°26'43", 17°00'41", fallow, small PF, 11.6.2004, JM.
- 16 Borská nížina, Závod, 48°32'33", 17°03'57", 26.6.2003, MZ.
- 17 Borská nížina, Veľké Leváre, 48°28'23", 17°00'46", 26.6.2003, MZ.
- 18 Borská nížina, Moravský Svätý Ján, 48°34'13", 17°01'09", 17.7.2003, JM, MZ.
- 19 Borská nížina, Veľké Leváre, 48°30'25", 17°01'14", small PF, 21.7.2004, JM.
- 20 Borská nížina, Plavecký Štvrtok, 48°21'41", 17°00'31", 13.5.2004, JM.
- 21 Borská nížina, Lakšárska Nová Ves, 48°34'28", 17°11'31", PF, 30.5.2006, JM.
- 22 Borská nížina, Húšky, 48°34'31", 17°03'20", 10.6.2004, JM.
- 23 Borská nížina, Závod, 48°32'35", 17°03'53", small PF, 5.6.2006, JM.
- 24 Borská nížina, Lakšárska Nová Ves, 48°34'28", 17°11'35", PF, 30.5.2006, JM.
- 25 Borská nížina, Závod, Šišulákov mlyn, 48°32'32", 17°04'02", PF, 5.6.2006, JM.
- 26 Borská nížina, Malacky, 48°26'47", 17°00'49", 11.6.2004, MZ.
- 27 Borská nížina, Závod, 48°32'34", 17°03'33", small PF, 5.6.2006, JM.
- 28 Borská nížina, Záhorská Ves, 48°22'07", 16°52'25", 19.6.2003, JM, MZ.
- 29 Borská nížina, Záhorská Ves, 48°22'10", 16°54'15", 14.7.2004, JM.
- 30 Borská nížina, Veľké Leváre, 48°30'39", 16°59'09", 30.4.2004, JM, MZ.
- 31 Borská nížina, Devínska Nová Ves, 48°12'17", 17°01'27", 24.5.2004, JM, MZ.
- 32 Borská nížina, Malé Leváre, 48°30'15", 16°57'06", 8.6.2004, JM.
- 33 Borská nížina, Malé Leváre, Lúčky, 48°30'20", 16°57'09", 8.6.2004, JM.
- 34 Borská nížina, Moravský Svätý Ján, 48°35'17", 16°57'00", 21.5.2004, JM.
- 35 Podunajská rovina, Trstená na Ostrove, 47°55'36", 17°30'24", PF, 17.4.2007, JM.
- 36 Podunajská rovina, Veľký Grob, 48°14'33", 17°29'16", 18.4.2007, JM.
- 37 Podunajská rovina, Hviezdoslavov, 48°04'08", 17°21'18", large co-operative field, 9.6.2006, JM.
- 38 Borská nížina, Stupava, Mást, 48°15'32", 17°02'04", small PF, 10.7.2003, JM.
- 39 Borská nížina, Stupava, Mást, 48°15'47", 17°02'09", small PF, 1.7.2004, JM.
- 40 Borská nížina, Stupava, Mást, 48°15'54", 17°02'11", small PF, 1.7.2004, JM.
- 41 Malé Karpaty, Prašník, Dúbrava, 48°38'48", 17°40'05", PF, 21.6.2006, JM.
- 42 Malé Karpaty, Prašník, Dúbrava, 48°38'46", 17°40'07", 21.6.2006, JM.
- 43 Slovenský kras, Kečovo-Domica, 48°28'41", 20°27'31", SV, 2°, 8.6.2007, JM.
- 44 Borská nížina, Rohožník, 48°27'25", 17°10'44", PF, 11.6.2004, JM, MZ.
- 45 Nitrianska pahorkatina, Dvorníky, 48°21'43", 17°47'46", JZ, 1°, small PF, 1.6.2007, JM.
- 46 Slovenský kras, Jablonov nad Turňou, 48°35'19", 20°40'03", JV, 2°, 9.6.2007, JM.
- 47 Trnavská pahorkatina, Siladice, 48°21'33", 17°43'54", LF, CHS, 1.6.2007, JM.
- 48 Ipeľská kotlina, Malá Čalomija, 48°05'20", 19°13'14", J, 6°, small PF, CHS, 3.6.2008, JM.
- 49 Ipeľská kotlina, Lesenice, 48°06'20", 19°14'12", LF, CHS, 3.6.2008, JM.
- 50 Považský Inovec, Vozokany, 48°34'02", 17°59'27", JV, 2°, 20.6.2008, JM.
- 51 Podunajská rovina, Dunajská Lužná, 48°04'33", 17°16'12", 9.6.2006, JM.
- 52 Hronská pahorkatina, Virt, 47°45'39", 18°19'01", LF, CHS, 2.6.2008, JM.
- 53 Trnavská pahorkatina, Križovany nad Dudváhom, 48°19'51", 17°39'46", PF, 1.6.2007, JM.
- 54 Trnavská pahorkatina, Križovany nad Dudváhom, 48°19'49", 17°39'54", small PF, 1.6.2007, JM.
- 55 Podunajská rovina, Šámot, 48°01'53", 17°20'46", CHS, 9.6.2006, JM.
- 56 Podunajská rovina, Veľká Paka, Čukárska Paka, 48°01'51", 17°23'03", PF, 9.6.2006, JM.
- 57 Podunajská rovina, Čalovec, 47°48'03", 17°59'29", relatively LF, CHS, 2.6.2008, JM.

#### Appendix S4:

- 1 Borská nížina, Záhorská Ves, 48°22'02", 16°52'28", CHS, 19.6.2003, JM, MZ.
- 2 Borská nížina, Sološnica, 48°28'14", 17°14'22", CHS, 29.6.2004, JM, MZ.
- 3 Borská nížina, Vysoká pri Morave, 48°18'27", 16°56'45", stubble, 24.8.2004, JM.
- 4 Nitrianska pahorkatina, Nitrianska Blatnica, Zarúbanica, 48°32'53", 17°57'59", SZ, 2°, stubble, PF, 21.9.2007, JM.

- 5 Nitrianska pahorkatina, Malé Bedzany, 48°34'58", 18°10'54", stubble, LF, 21.9.2007, JM.
- 6 Borská nížina, Záhorská Bystrica, 48°14'20", 17°00'55", stubble, 30.8.2004, JM.
- 7 Malé Karpaty, Bratislava-Devin, 48°10'22", 17°00'30", stubble, PF, 11.10.2007, JM.
- 8 Podunajská rovina, Jarovce, 48°04'05", 17°05'55", co-operative field, 27.7.2005, JM.
- 9 Krupinská planina, Senohrad, 48°21'40", 19°11'34", JZ, 3°, LF, 4.6.2008, JM.
- 10 Borská nížina, Záhorská Ves, 48°22'02", 16°52'28", 19.6.2003, JM, MZ.
- 11 Ipeľská kotlina, Zombor, 48°08'05", 19°27'17", J, 3°, 1-year fallow, 3.6.2008, JM.
- 12 Nitrianska pahorkatina, Nitrianska Blatnica, Zarúbanica, 48°32'55", 17°58'01", SZ, 2°, stubble, PF, 21.9.2007, JM.
- 13 Borská nížina, Kuklov, 48°38'56", 17°04'12", stubble, 9.9.2004, JM, MZ.
- 14 Borská nížina, Plavecké Podhradie, 48°28'40", 17°14'51", stubble, 9.9.2004, JM, MZ.
- 15 Trnavská pahorkatina, Bohdanovce nad Trnavou, 48°25'55", 17°32'50", stubble, PF, 13.9.2006, JM, MZ.
- 16 Nitrianska pahorkatina, Veľké Zálužie, 48°18'52", 17°55'30", J, 2°, stubble, PF, 20.8.2007, JM.
- 17 Nitrianska pahorkatina, Partizánske, 48°38'17", 18°23'50", J, 5°, stubble, large co-operative field, 8.9.2008, JM.
- 18 Borská nížina, Záhorská Ves, 48°22'29", 16°51'58", 24.6.2003, JM, MZ.
- 19 Borská nížina, Láb, Lábske jazero, 48°20'15", 16°57'05", 14.7.2004, JM.
- 20 Borská nížina, Záhorská Bystrica, 48°13'22", 17°01'56", stubble, 30.8.2004, JM.
- 21 Borská nížina, Závod, Na lúkach, 48°32'46", 17°03'02", 8.7.2003, JM.
- 22 Borská nížina, Záhorská Bystrica, 48°14'48", 17°02'50", stubble, PF, 8.9.2003, JM.
- 23 Ipeľská pahorkatina, Pukanec, 48°22'01", 18°43'55", JV, 4°, stubble, 23.8.2007, JM.
- 24 Borská nížina, Lakšárska Nová Ves, 48°34'31", 17°12'11", 29.6.2004, JM, MZ.
- 25 Borská nížina, Závod, Za Hlbokou mlákou, 48°33'09", 17°01'27", stubble, 4.9.2003, JM, MZ.
- 26 Borská nížina, Malé Leváre, 48°30'43", 16°57'30", stubble, 24.8.2004, JM.
- 27 Trnavská pahorkatina, Dolné Orešany, 48°26'03", 17°26'09", SV, 1°, stubble, LF, 13.9.2006, JM, MZ.
- 28 Nitrianska pahorkatina, Bojná, Malé Dvorany, 48°34'04", 18°04'08", stubble, LF, 21.9.2007, JM.
- 29 Ipeľská pahorkatina, Bátovce, 48°16'47", 18°44'50", stubble, LF, 23.8.2007, JM.
- 30 Ipeľská pahorkatina, Bátovce, 48°16'49", 18°44'53", stubble, relatively LF, 23.8.2007, JM.
- 31 Ipeľská pahorkatina, Pukanec, 48°21'60", 18°44'01", JV, 3°, stubble, LF, 23.8.2007, JM.
- 32 Ipeľská pahorkatina, Starý Tekov, 48°15'22", 18°31'59", stubble, 23.8.2007, JM.
- 33 Ipeľská pahorkatina, Devičany, 48°18'24", 18°41'04", stubble, LF, 23.8.2007, JM.
- 34 Borská nížina, Vysoká pri Morave, 48°19'59", 16°55'04", PF, 19.8.2003, JM, MZ.
- 35 Nitrianska pahorkatina, Bošany, Baštín, 48°33'38", 18°14'11", SV, 2°, stubble, relatively small field, 21.9.2007, JM.
- 36 Trábeč, Radobica, 48°34'43", 18°30'04", S, 5°, stubble, relatively small field, 8.9.2008, JM.
- 37 Trnavská pahorkatina, Zvončín, 48°24'23", 17°30'35", stubble, PF, 13.9.2006, JM, MZ.
- 38 Podunajská rovina, Pezinok, 48°16'52", 17°16'22", stubble, LF, 3.10.2006, JM.
- 39 Trnavská pahorkatina, Košolná, 48°25'24", 17°28'22", stubble, PF, 13.9.2006, JM, MZ.
- 40 Žitavská pahorkatina, Martin nad Žitavou, 48°23'57", 18°20'54", V, 2°, stubble, 20.8.2007, JM.
- 41 Žitavská pahorkatina, Martin nad Žitavou, 48°24'00", 18°20'58", V, 2°, stubble, 20.8.2007, JM.
- 42 Nitrianska pahorkatina, Veľké Kršteňany, 48°38'53", 18°25'22", stubble, small PF, 8.9.2008, JM.
- 43 Nitrianska pahorkatina, Motešice, 48°50'07", 18°11'30", Z, 3°, stubble, LF, 10.9.2008, JM.
- 44 Ipeľská pahorkatina, Zajačia dolina, 48°14'14", 18°40'18", SZ, 2°, stubble, LF, 23.8.2007, JM.
- 45 Strážovské vrchy, Dolné Vestenice, 48°42'23", 18°23'08", JV, 15°, stubble, LF, 8.9.2008, JM.
- 46 Borská nížina, Šajdíkové Humence, 48°39'56", 17°15'52", 22.7.2002, MZ, JM.
- 47 Nitrianska pahorkatina, Horné Ozorovce, 48°44'37", 18°13'44", V, 4°, stubble, LF, 8.9.2008, JM, IŠ, KH, MJ.
- 48 Nitrianska pahorkatina, Timoradza, 48°47'21", 18°14'47", stubble, LF, 10.9.2008, JM.
- 49 Borská nížina, Jablonové, 48°21'14", 17°06'03", stubble, LF, 13.9.2002, MZ, JM.
- 50 Považské podolie, Trenčín, 48°54'05", 18°04'59", JZ, 4°, stubble, LF, 10.9.2008, JM.
- 51 Strážovské vrchy, Trenčianske Teplice, 48°55'05", 18°08'33", stubble, LF, 10.9.2008, JM.
- 52 Považské podolie, Borčice, 48°58'54", 18°07'54", stubble, 9.9.2008, JM.
- 53 Strážovské vrchy, Omšenie, 48°53'48", 18°12'40", stubble, LF, 10.9.2008, JM.
- 54 Považské podolie, Újazd, 48°56'34", 18°04'59", stubble, small PF, 9.9.2008, JM, IŠ, KH, MJ.
- 55 Považské podolie, Skalka nad Váhom, 48°56'14", 18°03'06", stubble, LF, 9.9.2008, JM, IŠ, KH, MJ.
- 56 Zvolenská kotlina, Kynceľová, 48°45'23", 19°10'39", V, 5°, stubble, 4.11.2008, MJ.

#### Appendix S5:

- 1 Borská nížina, Závod, 48°32'40", 16°59'15", 27.4.2004, JM.
- 2 Borská nížina, Závod, 48°32'41", 16°59'10", 25.5.2004, JM.
- 3 Borská nížina, Plavecký Štvrtok, 48°21'45", 17°00'29", 13.5.2004, JM.
- 4 Borská nížina, Borský Svätý Jur, 48°36'28", 17°03'17", 1-year fallow, 10.5.2004, MZ.
- 5 Borská nížina, Malacky, 48°28'15", 17°00'45", 30.4.2004, JM, MZ.
- 6 Borská nížina, Plavecký Štvrtok, 48°22'00", 16°59'46", 1-year fallow, 13.5.2004, JM.
- 7 Borská nížina, Veľké Leváre, 48°30'42", 16°59'42", 30.4.2004, JM, MZ.
- 8 Borská nížina, Borský Svätý Jur, 48°36'28", 17°03'17", 10.5.2004, JM.
- 9 Borská nížina, Jakubov, 48°25'08", 16°56'43", 11.5.2004, JM, MZ.
- 10 Borská nížina, Lozorno, 48°19'48", 17°01'57", PF, 11.5.2004, JM.
- 11 Borská nížina, Záhorská Bystrica, 48°14'40", 17°00'34", CHS, 19.5.2004, JM.
- 12 Borská nížina, Záhorská Bystrica, 48°13'51", 17°01'40", 19.5.2004, JM.
- 13 Borská nížina, Jakubov, 48°25'07", 16°56'44", 11.5.2004, JM, MZ.
- 14 Borská nížina, Stupava, 48°16'51", 17°01'24", PF, 24.5.2004, JM, MZ.
- 15 Borská nížina, Záhorská Bystrica, 48°13'59", 17°01'35", 19.5.2004, JM.

- 16 Borská nížina, Devínska Nová Ves, 48°13'25", 17°00'11", 24.5.2004, JM, MZ.
- 17 Borská nížina, Devínska Nová Ves, 48°13'25", 17°00'11", 24.5.2004, JM, MZ.

#### Appendix S6:

- 1 Borská nížina, Malacky, 48°28'00", 17°02'30", 10.5.2004, JM.
- 2 Podunajská rovina, Mad, 47°57'01", 17°38'22", LF, 22.4.2008, JM.
- 3 Podunajská rovina, Boheľov, 47°54'45", 17°41'09", CHS, 22.4.2008, JM.
- 4 Zemplínske vrchy, Veľká Trňa, 48°28'22", 21°40'32", small PF, 3.5.2007, JM, MZ.
- 5 Trnavská pahorkatina, Dlhá, Za humnami, 48°25'06", 17°26'20", SV, 1°, LF, 29.4.2008, JM.
- 6 Považský Inovec, Nová Lehota, 48°39'33", 17°57'25", J, 5°, co-operative LF, CHS, 12.5.2008, JM.
- 7 Trnavská pahorkatina, Bohdanovce nad Trnavou, 48°25'56", 17°32'55", PF, CHS, 29.4.2008, JM.
- 8 Východoslovenská rovina, Ladmovce, 48°25'17", 21°47'13", 2.5.2007, JM, MZ.
- 9 Trnavská pahorkatina, Ducové, 48°37'44", 17°51'41", small PF, CHS, 12.5.2008, JM.
- 10 Podunajská rovina, Ižop, 47°50'40", 17°43'52", LF, CHS, 2.6.2008, JM.
- 11 Ipeľská kotlina, Kamenné Kosihy, 48°08'30", 19°12'16", 3.6.2008, JM.
- 12 Borská nížina, Vysoká pri Morave, 48°21'25", 16°53'05", 12.6.2003, MZ.
- 13 Východoslovenská pahorkatina, Lúčky, 48°45'58", 22°01'31", CHS, 1.5.2007, JM, MZ.
- 14 Východoslovenská pahorkatina, Nacina Ves, 48°48'54", 21°49'38", LF, CHS, 4.5.2007, JM, MZ.
- 15 Nitrianska pahorkatina, Cabaj-Čápor, Cabaj, Pod vinohradmi, 48°14'15", 18°02'03", PF, 23.4.2008, JM, MZ.
- 16 Trnavská pahorkatina, Šenkvice, 48°17'53", 17°19'56", CHS, 29.4.2008, JM.
- 17 Trnavská pahorkatina, Dubová, 48°21'34", 17°20'04", PF, 29.4.2008, JM.
- 18 Podunajská rovina, Čunovo, 48°01'25", 17°11'35", PF, 16.4.2007, JM.
- 19 Nitrianska pahorkatina, Tvrdošovce, 48°06'17", 18°04'12", CHS, 23.4.2008, JM, MZ.
- 20 Považský Inovec, Koplotovce, 48°27'46", 17°49'05", 12.5.2008, JM.
- 21 Podunajská rovina, Boldog, 48°14'09", 17°26'09", 18.4.2007, JM.
- 22 Podunajská rovina, Pusté Úľany, Tarnok, 48°14'34", 17°32'38", LF, 18.4.2007, JM.
- 23 Trnavská pahorkatina, Pusté Úľany, Poroské, 48°13'26", 17°35'01", LF, 18.4.2007, JM.
- 24 Podunajská rovina, Ivanka pri Dunaji, 48°10'51", 17°14'43", LF, 20.4.2007, JM.
- 25 Podunajská rovina, Mliečany, 47°58'32", 17°36'02", LF, CHS, 22.4.2008, JM.
- 26 Podunajská rovina, Dlhá nad Váhom, Prvý hon, 48°10'35", 17°51'18", 23.4.2008, JM, MZ.
- 27 Podunajská rovina, Čunovo, 48°01'55", 17°11'06", PF, 16.4.2007, JM.
- 28 Podunajská rovina, Dunajská Lužná, 48°04'33", 17°16'12", 17.4.2007, JM.
- 29 Podunajská rovina, Kostolná pri Dunaji, 48°10'56", 17°26'30", 18.4.2007, JM.
- 30 Podunajská rovina, Štvrtek na Ostrove, 48°05'18", 17°21'20", small PF, 20.4.2007, JM.
- 31 Podunajská rovina, Dolný Štal, Pri troch studniach, 47°56'22", 17°43'53", LF, 22.4.2008, JM.
- 32 Podunajská rovina, Dolný Štal, Pri troch studniach, 47°56'23", 17°43'48", LF, 22.4.2008, JM.
- 33 Podunajská rovina, Hamuliakovo, 48°02'14", 17°15'41", PF, 17.4.2007, JM.
- 34 Podunajská rovina, Hamuliakovo, 48°02'14", 17°15'40", 1-year fallow, 17.4.2007, JM.
- 35 Podunajská rovina, Boldog, 48°14'05", 17°26'05", PF, CHS, 18.4.2007, JM.
- 36 Podunajská rovina, Mliečany, 47°58'38", 17°35'53", CHS, 22.4.2008, JM.
- 37 Borská nížina, Malé Leváre, 48°30'12", 16°56'00", 8.6.2004, JM.
- 38 Považský Inovec, Nová Ves nad Váhom, Novianska dolina, 48°43'42", 17°54'28", Z, 2°, CHS, 12.5.2008, JM.
- 39 Východoslovenská rovina, Závadka, 48°45'48", 22°04'23", LF, CHS, 1.5.2007, JM, MZ.
- 40 Východoslovenská rovina, Veľké Kapušany, 48°32'00", 22°03'34", LF, 2.5.2007, JM, MZ.
- 41 Turčianska kotlina, Ratkovo, 49°08'04", 19°04'46", J, 4°, LF, 5.5.2007, JM, MZ.
- 42 Východoslovenská rovina, Kristy, 48°41'16", 22°11'11", PF, CHS, 1.5.2007, JM, MZ.
- 43 Východoslovenská rovina, Plechotice, 48°37'55", 21°38'53", 3.5.2007, JM, MZ.
- 44 Východoslovenská rovina, Čierna, 48°25'55", 22°05'26", CHS, 2.5.2007, JM, MZ.
- 45 Východoslovenská rovina, Veľké Trakany, Kolónia, Trakanská Dlhá, 48°23'45", 22°04'40", LF, 2.5.2007, JM, MZ.
- 46 Východoslovenská pahorkatina, Kazimír, 48°31'44", 21°35'09", PF, 3.5.2007, JM, MZ.
- 47 Krupinská planina, Bzovík, 48°18'07", 19°05'13", S, 1°, 4.6.2008, JM.
- 48 Krupinská planina, Bzovík, 48°18'40", 19°05'44", LF, 4.6.2008, JM.
- 49 Myjavská pahorkatina, Jablonka, Figurovci, 48°43'05", 17°35'56", SV, 5°, LF, 20.6.2008, JM.
- 50 Východoslovenská rovina, Blatná Polianka, Zákľuky, 48°41'45", 22°06'37", PF, 1.5.2007, JM, MZ.
- 51 Východoslovenská rovina, Svätuš, 48°41'06", 22°09'10", 1.5.2007, JM, MZ.
- 52 Východoslovenská rovina, Porostov, 48°42'07", 22°10'37", PF, 1.5.2007, JM, MZ.
- 53 Východoslovenská rovina, Jenkovce, 48°40'07", 22°12'27", LF, 1.5.2007, JM, MZ.
- 54 Východoslovenská rovina, Trhovište, Pláne, 48°42'12", 21°47'18", PF, 3.5.2007, JM, MZ.

#### Appendix S7:

- 1 Borská nížina, Závod, Pri ceste, 48°31'35", 16°59'21", 1-year fallow, 9.6.2003, JM, MZ.
- 2 Borská nížina, Lakšárska Nová Ves, 48°34'34", 17°11'27", small PF, 29.6.2004, JM, MZ.
- 3 Ipeľská kotlina, Glabušovce, 48°09'08", 19°27'04", V, 6°, small PF, 3.6.2008, JM.
- 4 Borská nížina, Suchohrad, Bogdalický vrch, 48°24'15", 16°53'55", 14.7.2004, JM.
- 5 Ipeľská kotlina, Pôtor, Háj, 48°13'22", 19°25'03", SV, 5°, 3.6.2008, JM.
- 6 Trnavská pahorkatina, Dubová, 48°21'30", 17°20'20", stubble, 3.10.2006, JM.
- 7 Trnavská pahorkatina, Kočín-Lančár, Lančár, 48°35'59", 17°39'20", 21.6.2006, JM.
- 8 Podunajská rovina, Okoč, 47°54'00", 17°47'22", 22.4.2008, JM.
- 9 Podunajská rovina, Čunovo, 48°01'16", 17°11'37", small PF, 16.4.2007, JM.

- 10 Podunajská rovina, Čunovo, 48°01'15", 17°11'35", 16.4.2007, JM.
- 11 Podunajská rovina, Kalinkovo, 48°04'04", 17°15'02", 17.4.2007, JM.
- 12 Východoslovenská rovina, Sečovce, Albinov, 48°43'55", 21°39'49", 4.5.2007, JM, MZ.
- 13 Východoslovenská rovina, Višňov, Rómska kolónia, 48°45'15", 21°41'25", 4.5.2007, JM, MZ.
- 14 Trnavská pahorkatina, Dubová, 48°21'27", 17°20'12", LF, CHS, 29.4.2008, JM.
- 15 Považský Inovec, Selec, 48°48'04", 17°59'24", V, 2°, 12.5.2008, JM.
- 16 Podunajská rovina, Šamorín, 48°01'56", 17°17'19", 1-year fallow, LF, 17.4.2007, JM.
- 17 Nitrianska pahorkatina, Mojmírovce, 48°10'56", 18°03'47", LF, 23.4.2008, JM, MZ.
- 18 Podunajská rovina, Chorvátsky Grob, 48°13'52", 17°15'58", LF, 29.4.2008, JM.
- 19 Podunajská rovina, Ivanka pri Dunaji, 48°10'53", 17°14'44", PF, 20.4.2007, JM.
- 20 Trnavská pahorkatina, Dlhá, 48°25'09", 17°26'23", Z, 1°, LF, 29.4.2008, JM.
- 21 Považský Inovec, Modrová, 48°38'14", 17°54'20", JZ, 5°, 12.5.2008, JM.
- 22 Východoslovenská rovina, Veľký Kamenec, 48°22'06", 21°49'26", 2.5.2007, JM, MZ.
- 23 Nitrianska pahorkatina, Močenok, 48°13'48", 17°57'17", 23.4.2008, JM, MZ.
- 24 Trnavská pahorkatina, Bohdanovce nad Trnavou, 48°25'58", 17°32'51", small PF, 29.4.2008, JM.
- 25 Podunajská rovina, Orechová Potôň, 48°01'50", 17°33'12", LF, 20.4.2007, JM, MZ.
- 26 Východoslovenská rovina, Sliepkovce, Okružle, 48°41'03", 21°56'13", LF, 2.5.2007, JM, MZ.
- 27 Východoslovenská pahorkatina, Brezina, Dancov potok, 48°33'49", 21°33'48", small PF, 3.5.2007, JM, MZ.
- 28 Východoslovenská rovina, Trebišov, Čeriaky, 48°35'05", 21°42'26", LF, 3.5.2007, JM, MZ.
- 29 Východoslovenská rovina, Dlhé Klčovo, 48°48'13", 21°44'12", 4.5.2007, JM, MZ.
- 30 Beskydské predhorie, Vyšný Žipov, 48°58'48", 21°34'39", LF, 4.5.2007, JM, MZ.
- 31 Podunajská rovina, Holice, Svätójánsky hon, 48°00'07", 17°28'04", LF, 22.4.2008, JM.
- 32 Podunajská rovina, Holice, Tabovka, 48°00'06", 17°28'08", LF, 22.4.2008, JM.

#### Appendix S8:

- 1 Biele Karpaty, Nová Bošáca, Grúň, 48°54'04", 17°47'28", JZ, 12°, 11.7.2006, JM.
- 2 Nitrianska pahorkatina, Nemečky, 48°40'13", 18°06'47", V, 3°, stubble, PF, 21.9.2007, JM.
- 3 Javorie, Slatinské Lazy, 48°29'41", 19°17'35", small PF, 22.8.2007, JM.
- 4 Považské podolie, Bohunice, 49°00'39", 18°11'28", stubble, 9.9.2008, JM.
- 5 Poľana, Detva-Majerovo, 48°34'41", 19°26'29", Z, 3°, small PF, 21.8.2007, JM.
- 6 Ostrôžky, Detva-Piešť, 48°29'16", 19°23'55", small PF, 22.8.2007, JM.
- 7 Poľana, Detva-Majerovo, 48°34'37", 19°26'23", SZ, 3°, small PF, 21.8.2007, JM.
- 8 Zvolenská kotlina, Detva, 48°32'05", 19°24'09", 19.7.2006, JM.
- 9 Zvolenská kotlina, Detva, 48°32'02", 19°24'09", 19.7.2006, JM.
- 10 Zvolenská kotlina, Hriňová, Veľký Slanec, 48°34'27", 19°30'55", small PF, 20.7.2006, JM.
- 11 Poľana, Hriňová, Raticov vrch, 48°35'10", 19°29'24", JV, 7°, 20.7.2006, JM.
- 12 Zvolenská kotlina, Hriňová, Veľký Slanec, 48°34'29", 19°30'54", J, 6°, small PF, 20.7.2006, JM.
- 13 Zvolenská kotlina, Hriňová, Veľký Slanec, 48°34'29", 19°30'52", J, 7°, 20.7.2006, JM.
- 14 Zvolenská kotlina, Dúbravy, 48°35'15", 19°23'06", JZ, 3°, small PF, 21.8.2007, JM.
- 15 Zvolenská kotlina, Hriňová, Krivec I., 48°34'47", 19°29'17", SZ, 3°, small PF, 21.8.2007, JM.
- 16 Veporské vrchy, Hriňová, Malý Slanec, 48°33'54", 19°31'23", V, 9°, small PF, 21.8.2007, JM.
- 17 Veporské vrchy, Hriňová, Malý Slanec, 48°33'53", 19°31'18", V, 8°, small PF, 21.8.2007, JM.
- 18 Podbeskydská brázda, Rabčice, 49°29'55", 19°31'52", small PF, 10.8.2006, JM, MZ.
- 19 Jablunkovské medzihorie, Svrčinovec, 49°29'14", 18°47'37", JV, 4°, 10.7.2007, JM, MZ.
- 20 Turzovská vrchovina, Staškov, Belkovci, 49°26'45", 18°41'33", J, 2°, small PF, 11.7.2007, JM, MZ.
- 21 Turzovská vrchovina, Staškov, Belkovci, 49°26'45", 18°41'37", JZ, 4°, small PF, 11.7.2007, JM, MZ.
- 22 Turzovská vrchovina, Raková, Korchánovci, 49°28'48", 18°41'48", Z, 8°, small PF, 12.7.2007, JM, MZ.
- 23 Kysucké Beskydy, Oščadnica, Vyšný koniec, 49°26'35", 18°54'03", small PF, 12.7.2007, JM, MZ.
- 24 Kysucké Beskydy, Oščadnica, Vyšný koniec, 49°26'35", 18°54'02", S, 5°, small PF, 12.7.2007, JM.
- 25 Kysucká vrchovina, Nová Bystrica, 49°21'37", 19°02'19", J, 9°, PF, 13.7.2007, JM, MZ.
- 26 Jablunkovské medzihorie, Svrčinovec, Pod grapami, 49°28'44", 18°46'43", V, 5°, relatively LF, 10.7.2007, JM, MZ.
- 27 Kysucká vrchovina, Klubina, 49°21'01", 18°53'50", relatively LF, 13.7.2007, JM, MZ.
- 28 Turzovská vrchovina, Staškov, Prachniarovci, 49°26'41", 18°40'50", V, 2°, small PF, 11.7.2007, JM, MZ.
- 29 Pieniny, Lesnica, Tokárne, 49°23'05", 20°30'10", S, 10°, small PF, 17.7.2008, JM.
- 30 Pieniny, Lesnica, 49°23'16", 20°30'03", JZ, 7°, PF, 17.7.2008, JM, ZB, MN.
- 31 Javorníky, Zákopčie, 49°24'17", 18°43'45", SV, 3°, small PF, 9.7.2007, JM, MZ.
- 32 Jablunkovské medzihorie, Svrčinovec, Pod grapami, 49°28'35", 18°46'59", small PF, 10.7.2007, JM, MZ.
- 33 Jablunkovské medzihorie, Svrčinovec, 49°29'09", 18°47'37", J, 4°, 10.7.2007, JM, MZ.
- 34 Javorníky, Zákopčie, U Kľukov, 49°23'35", 18°40'52", small PF, 9.7.2007, JM.
- 35 Pieniny, Lesnica, 49°23'15", 20°29'57", JZ, 6°, small PF, 17.7.2008, JM, ZB.
- 36 Strážovské vrchy, Temeš, 48°52'13", 18°28'49", SZ, 6°, small PF, CHS, 23.6.2008, JM.
- 37 Eubovnianska vrchovina, Malý Lipník, 49°20'45", 20°48'28", SZ, 5°, small PF, 16.7.2008, JM.
- 38 Turzovská vrchovina, Klokočov, Hlavice, 49°28'11", 18°36'27", small PF, CHS, 11.7.2007, JM, MZ.
- 39 Turzovská vrchovina, Raková, Korcháň, 49°29'17", 18°41'41", JV, 4°, small PF, 12.7.2007, JM, MZ.
- 40 Turzovská vrchovina, Raková, Korcháň, 49°29'18", 18°41'33", JV, 4°, 12.7.2007, JM, MZ.
- 41 Turzovská vrchovina, Raková, Korcháň, 49°29'15", 18°41'28", J, 5°, small PF, 12.7.2007, JM.

#### Appendix S9:

- 1 Štiavnické vrchy, Močiar, 48°32'40", 18°57'14", V, 7°, co-operative LF, 21.7.2006, JM.

- 2 Liptovská kotlina, Východná, 49°03'48", 19°54'20", J, 4°, PF, 18.7.2008, JM.
- 3 Popradská kotlina, Lendak, Rovne, 49°13'52", 20°22'47", J, 4°, PF, 15.7.2008, JM.
- 4 Popradská kotlina, Ľubica, 49°06'43", 20°26'36", 24.8.2006, JM, MZ.
- 5 Hornádska kotlina, Spišské Bystré, Rakytie, 48°59'46", 20°14'51", small PF, 25.8.2006, JM, MZ.
- 6 Popradská kotlina, Ľubica, 49°06'38", 20°26'34", 24.8.2006, JM, MZ.
- 7 Nízke Tatry, Liptovská Teplička, 48°57'50", 20°05'45", S, 3°, small PF, 25.6.2007, JM.
- 8 Liptovská kotlina, Važec, 49°03'33", 19°59'38", SZ, 4°, small PF, 18.7.2008, JM.
- 9 Liptovská kotlina, Važec, 49°03'55", 19°59'37", small PF, 18.7.2008, JM.
- 10 Liptovská kotlina, Východná, 49°03'49", 19°54'07", Z, 4°, small PF, CHS, 18.7.2008, JM.
- 11 Liptovská kotlina, Východná, 49°03'29", 19°52'32", J, 3°, small PF, 18.7.2008, JM.
- 12 Oravská kotlina, Klin, 49°26'59", 19°28'04", SV, 5°, small PF, 8.8.2006, JM, MZ.
- 13 Oravská kotlina, Klin, 49°26'56", 19°28'02", V, 5°, PF, 8.8.2006, JM, MZ.
- 14 Oravská kotlina, Klin, 49°26'54", 19°27'49", V, 3°, PF, 8.8.2006, JM, MZ.
- 15 Podbeskydská vrchovina, Breza, 49°22'27", 19°23'14", PF, 9.8.2006, JM, MZ.
- 16 Podbeskydská vrchovina, Breza, 49°22'29", 19°23'17", PF, 9.8.2006, JM, MZ.
- 17 Podbeskydská brázda, Rabča, 49°29'15", 19°28'55", JV, 3°, 10.8.2006, JM.
- 18 Volovské vrchy, Vlachovo, 48°46'57", 20°24'25", JZ, 4°, LF, 18.6.2008, JM.
- 19 Oravská kotlina, Oravská Jasenica, 49°23'26", 19°27'09", CHS, 11.8.2006, JM.
- 20 Oravská kotlina, Zubrohlava, 49°26'23", 19°30'27", 8.8.2006, JM, MZ.
- 21 Popradská kotlina, Spišská Belá, Myší vrch, 49°12'20", 20°24'52", PF, CHS, 15.7.2008, JM.
- 22 Oravská kotlina, Zubrohlava, 49°26'39", 19°30'04", V, 4°, 10.8.2006, JM, MZ.
- 23 Spišská Magura, Majere, 49°24'01", 20°22'35", relatively LF, CHS, 17.7.2008, JM.
- 24 Levočské vrchy, Holumnica, 49°14'29", 20°30'59", SV, 3°, LF, 15.7.2008, JM.
- 25 Hornádska kotlina, Trst'any, 48°58'34", 20°42'24", JV, 3°, 23.8.2006, JM, MN.
- 26 Turčianska kotlina, Ratkovo, 49°07'58", 19°04'52", small PF, 17.6.2008, JM.
- 27 Lubovnianska vrchovina, Malý Lipník, 49°20'49", 20°48'33", SZ, 5°, small PF, 16.7.2008, JM.
- 28 Turzovská vrchovina, Olešná, 49°28'06", 18°38'35", J, 3°, small PF, 11.7.2007, JM, MZ.
- 29 Spišsko-šarišské medzihorie, Plaveč, 49°15'29", 20°49'40", PF, 16.7.2008, JM.
- 30 Podbeskydská vrchovina, Zubrohlava, 49°27'43", 19°30'12", Z, 3°, PF, 8.8.2006, JM, MZ.
- 31 Hornádska kotlina, Hranovnica, 48°59'31", 20°18'47", PF, 25.8.2006, JM, MZ.
- 32 Oravská kotlina, Bobrov, Breziny, 49°25'52", 19°31'46", 8.8.2006, JM, MZ.
- 33 Podbeskydská vrchovina, Zubrohlava, 49°27'44", 19°30'17", Z, 4°, PF, 8.8.2006, JM, MZ.
- 34 Oravská kotlina, Zubrohlava, 49°26'40", 19°30'12", 10.8.2006, JM, MZ.
- 35 Podbeskydská brázda, Rabča, 49°29'27", 19°28'57", PF, 10.8.2006, JM.
- 36 Spišsko-šarišské medzihorie, Čirč, 49°17'12", 20°54'48", S, 8°, small PF, 16.7.2008, JM.
- 37 Oravská kotlina, Zubrohlava, Hradý, 49°26'49", 19°30'12", PF, 10.8.2006, JM, MZ.
- 38 Oravská kotlina, Zubrohlava, 49°26'46", 19°30'12", 10.8.2006, JM, MZ.
- 39 Turčianska kotlina, Turany, 49°06'52", 19°01'02", PF, 26.8.2006, JM, MZ.
- 40 Podbeskydská vrchovina, Breza, 49°22'26", 19°23'32", LF, 9.8.2006, JM, MZ.
- 41 Podbeskydská vrchovina, Breza, 49°22'29", 19°23'35", JZ, 4°, LF, 9.8.2006, JM, MZ.
- 42 Podbeskydská brázda, Rabčice, 49°29'60", 19°32'12", S, 4°, small PF, 10.8.2006, JM, MZ.
- 43 Oravská kotlina, Oravská Jasenica, 49°23'34", 19°26'59", small PF, 11.8.2006, JM.
- 44 Popradská kotlina, Spišská Belá, 49°12'09", 20°24'37", PF, 24.8.2006, JM, MZ.
- 45 Popradská kotlina, Mlynica, 49°05'55", 20°20'12", co-operative field, 24.8.2006, JM, MZ.
- 46 Hornádska kotlina, Spišský Štiavnik, 48°59'37", 20°20'48", 25.8.2006, JM, MZ.
- 47 Popradská kotlina, Mlynčeky, 49°10'17", 20°24'04", PF, 24.8.2006, JM, MZ.
- 48 Ondavská vrchovina, Lenartov, 49°18'26", 21°02'30", SV, 4°, LF, CHS, 16.7.2008, JM.

#### Appendix S10:

- 1 Borská nížina, Rohožník, 48°27'34", 17°12'22", fallow, 10.6.2003, JM, MZ.
- 2 Borská nížina, Suchohrad, 48°24'22", 16°52'07", depression in the field, 25.6.2003, JM, MZ.
- 3 Borská nížina, Suchohrad, 48°24'22", 16°52'07", depression in the field, 25.6.2003, JM, MZ.
- 4 Oravská kotlina, Oravská Jasenica, 49°23'35", 19°27'04", LF, 11.8.2006, JM.
- 5 Myjavská pahorkatina, Stará Turá-Vankovci, 48°46'34", 17°31'30", JV, 2°, LF, 24.7.2007, JM.
- 6 Považské podolie, Borčice, 48°58'57", 18°07'44", LF, 9.9.2008, JM.
- 7 Bachureň, Uzovské Pekľany, 49°05'04", 21°01'53", small PF, 10.8.2007, JM, MS.
- 8 Borská nížina, Záhorská Ves, 48°22'33", 16°52'26", 24.6.2003, JM, MZ.
- 9 Borská nížina, Gajary, 48°28'39", 16°53'44", 25.6.2003, JM, MZ.
- 10 Borská nížina, Gajary, 48°28'05", 16°52'58", 25.6.2003, JM, MZ.
- 11 Trnavská pahorkatina, Štefanová, 48°23'26", 17°23'49", JZ, 1°, stubble, PF, CHS, 3.10.2006, JM.
- 12 Borská nížina, Borský Mikuláš, 48°39'01", 17°11'13", stubble, 23.9.2002, MZ, JM.
- 13 Slovenský kras, Dlhá Ves, 48°29'23", 20°27'01", Z, 2°, 8.6.2007, JM.
- 14 Myjavská pahorkatina, Stará Turá, 48°46'45", 17°42'06", J, 2°, 24.7.2007, JM.
- 15 Borská nížina, Záhorská Ves, 48°21'56", 16°50'47", 23.7.2002, MZ, JM.
- 16 Borská nížina, Vysoká pri Morave, 48°21'56", 16°50'47", 1-year fallow, 23.7.2002, IJ.
- 17 Oravská kotlina, Zubrohlava, 49°26'25", 19°30'26", 9.8.2006, JM, MZ.
- 18 Stolické vrchy, Tisovec, 48°39'39", 19°56'30", 1.7.2005, MZ, JM.
- 19 Borská nížina, Záhorská Ves, 48°21'57", 16°51'15", 19.6.2003, JM, MZ.
- 20 Borská nížina, Závod, 48°31'44", 17°00'27", 24.7.2003, JM.



- 21 Borská nížina, Zohor, 48°19'17", 16°58'40", 14.8.2003, JM.
- 22 Borská nížina, Záhorská Ves, 48°22'35", 16°52'12", 24.6.2003, JM, MZ.
- 23 Borská nížina, Moravský Svätý Ján, 48°35'29", 16°59'31", 4.9.2003, JM, MZ.
- 24 Ipeľská pahorkatina, Starý Tekov, 48°15'25", 18°32'07", co-operative LF, CHS, 23.8.2007, JM.
- 25 Žitavská pahorkatina, Neverice, 48°22'02", 18°16'59", co-operative LF, CHS, 20.8.2007, JM.
- 26 Borská nížina, Stupava, Mást, 48°15'33", 17°02'05", fallow, small PF, 10.7.2003, JM.
- 27 Trnavská pahorkatina, Čachtice, 48°42'16", 17°46'48", PF, 25.7.2007, JM.
- 28 Myjavská pahorkatina, Lubina, 48°46'32", 17°44'54", PF, 25.7.2007, JM.
- 29 Východoslovenská pahorkatina, Strážske, Povrazy, 48°52'43", 21°50'17", 12.8.2007, JM, MS.
- 30 Borská nížina, Malé Leváre, 48°30'33", 16°56'22", CHS, 9.7.2003, JM.
- 31 Hronská pahorkatina, Radvaň nad Dunajom, 47°45'23", 18°21'49", small PF, 2.6.2008, JM.
- 32 Slovenský kras, Turňa nad Bodvou, Stredné dlhé, 48°37'01", 20°52'47", LF, 7.6.2007, JM.
- 33 Podunajská rovina, Jarovce, Horné Dlhé, 48°03'55", 17°05'55", co-operative field, 27.7.2005, JM.
- 34 Borská nížina, Moravský Svätý Ján, 48°35'17", 16°57'00", depression in the field, 3.8.2004, JM.
- 35 Podunajská rovina, Šamorín, 48°02'15", 17°18'03", stubble, 2.10.2006, JM.
- 36 Podunajská rovina, Rusovce, 48°03'15", 17°09'37", stubble, 4.9.2007, JM.
- 37 Chvojnická pahorkatina, Letničie, 48°41'59", 17°11'03", J, 3°, stubble, 20.9.2007, JM.
- 38 Nitrianska pahorkatina, Dolné Lefantovce, 48°25'12", 18°07'05", SZ, 2°, stubble, PF, 21.9.2007, JM.
- 39 Malé Karpaty, Bratislava-Devin, 48°10'15", 17°00'26", J, 2°, stubble, PF, 11.10.2007, JM.
- 40 Zvolenská kotlina, Zvolen, Západ-Tepličky, 48°34'49", 19°06'06", 21.7.2006, JM.
- 41 Štiavnické vrchy, Močiar, 48°32'41", 18°57'03", small PF, 21.7.2006, JM.
- 42 Hornádska kotlina, Ofše, 48°54'17", 20°39'20", Z, 4°, 17.6.2008, JM.
- 43 Nitrianska pahorkatina, Dvorníky, 48°21'40", 17°47'47", small PF, 1.6.2007, JM.
- 44 Nitrianska pahorkatina, Veľké Zálužie, 48°18'39", 17°55'37", stubble, PF, 20.8.2007, JM.

#### Appendix S11:

- 1 Borská nížina, Stupava, Mást, 48°15'32", 17°02'04", small PF, 10.7.2003, JM.
- 2 Spišsko-šarišské medzihorie, Pečovská Nová Ves, Pri Liptákovi, 49°07'02", 21°03'21", small PF, 10.8.2007, JM.
- 3 Krupinská planina, Senohrad, 48°21'14", 19°11'44", JV, 3°, small PF, 22.8.2007, JM.
- 4 Turčianska kotlina, Blatnica, 48°56'24", 18°55'20", 15.6.2006, JM.
- 5 Pieniny, Litmanová, 49°21'00", 20°37'56", small PF, 16.7.2008, JM.
- 6 Hornádska kotlina, Harakovce, 48°59'58", 20°50'45", J, 4°, PF, 23.8.2006, JM, MN.
- 7 Stolické vrchy, Muránska Lehota, 48°43'41", 20°02'19", 28.7.2008, MZ.
- 8 Hornádska kotlina, Hranovnica, 48°59'36", 20°18'48", PF, 25.8.2006, JM, MZ.
- 9 Hornádska kotlina, Spišské Podhradie, 49°00'30", 20°43'24", JZ, 3°, relatively LF, CHS, 12.8.2007, JM.
- 10 Podbeskydská vrchovina, Lomná, 49°22'06", 19°19'03", 9.8.2006, JM, MZ.
- 11 Popradská kotlina, Poprad-Veľká, 49°04'15", 20°17'02", JZ, 3°, PF, 24.8.2006, JM, MZ.
- 12 Popradská kotlina, Lendak, Rovne, 49°13'56", 20°22'24", J, 5°, small PF, 15.7.2008, JM.
- 13 Hornádska kotlina, Granč-Petrovce, 49°00'11", 20°47'57", PF, 23.8.2006, JM, MN.
- 14 Javorie, Klokoč, 48°30'14", 19°20'02", S, 5°, small PF, 22.8.2007, JM.
- 15 Spišská Magura, Veľký Lipník, 49°22'19", 20°31'15", J, 2°, small PF, 17.7.2008, JM.
- 16 Turzovská vrchovina, Staškov, Prachniarovci, 49°26'42", 18°40'53", V, 5°, small PF, 11.7.2007, JM, MZ.
- 17 Kysucká vrchovina, Stará Bystrica, 49°20'44", 18°54'39", PF, 13.7.2007, JM.
- 18 Kysucká vrchovina, Klubina, 49°21'03", 18°53'46", small PF, 13.7.2007, JM, MZ.
- 19 Oravská kotlina, Oravská Jasenica, 49°23'16", 19°26'53", small PF, 11.8.2006, JM.
- 20 Bukovské vrchy, Ulič, 48°58'19", 22°25'45", small PF, 11.8.2007, JM, MS.
- 21 Laborecká vrchovina, Adidovce, 49°01'23", 22°02'28", PF, 11.8.2007, JM.
- 22 Laborecká vrchovina, Adidovce, 49°01'21", 22°02'27", stubble, PF, 11.8.2007, JM.
- 23 Bachureň, Renčiov, 49°05'48", 20°58'03", small PF, 10.8.2007, JM, MS.
- 24 Myjavská pahorkatina, Stará Turá, Drgoňova dolina, 48°45'56", 17°39'48", Z, 3°, small PF, 24.7.2007, JM.
- 25 Ondavská vrchovina, Lenartov, 49°18'28", 21°02'34", SV, 2°, small PF, 16.7.2008, JM.
- 26 Spišsko-šarišské medzihorie, Kamienka, Do Lávok, 49°19'36", 20°37'25", relatively LF, CHS, 17.7.2008, JM.
- 27 Myjavská pahorkatina, Stará Myjava, 48°47'29", 17°35'15", small PF, 24.7.2007, JM.
- 28 Východoslovenská pahorkatina, Vranov nad Topľou, 48°52'14", 21°43'10", LF, 10.8.2007, JM, MS.
- 29 Bukovské vrchy, Nová Sedlica, 49°02'59", 22°30'48", small PF, 11.8.2007, JM.
- 30 Bukovské vrchy, Uličské Krivé, 48°59'54", 22°26'43", small PF, 11.8.2007, JM.
- 31 Stolické vrchy, Muráň, 48°44'15", 20°02'49", small PF, 13.8.2004, MZ, JM.
- 32 Hornádska kotlina, Muráň, 48°44'22", 20°02'33", small PF, 13.8.2004, MZ, JM.
- 33 Javorie, Klokoč, 48°30'14", 19°20'04", S, 5°, small PF, 22.8.2007, JM.
- 34 Hornádska kotlina, Muráň, 48°44'37", 20°03'05", small PF, 13.8.2004, MZ, JM.

#### Appendix S12:

- 1 Borská nížina, Moravský Svätý Ján, 48°35'33", 16°59'32", 4.9.2003, JM, MZ.
- 2 Trnavská pahorkatina, Biely Kostol, 48°21'38", 17°31'53", 13.9.2006, JM, MZ.
- 3 Trnavská pahorkatina, Ružindol, 48°22'17", 17°28'47", stubble, LF, 3.10.2006, JM.
- 4 Podunajská rovina, Orechová Potôň, 48°02'36", 17°34'41", stubble, 2.10.2006, JM.
- 5 Podunajská rovina, Blatná na Ostrove, 47°59'55", 17°27'12", stubble, 2.10.2006, JM.
- 6 Podunajská rovina, Blatná na Ostrove, 47°59'58", 17°27'14", stubble, 2.10.2006, JM.
- 7 Slovenský kras, Turňa nad Bodvou, Stredné dlhé, 48°37'00", 20°52'48", 7.6.2007, JM.

- 8 Trnavská pahorkatina, Častkovce, 48°41'41", 17°46'48", 25.7.2007, JM.
- 9 Trnavská pahorkatina, Zvončín, 48°24'21", 17°30'40", stubble, PF, 13.9.2006, JM, MZ.
- 10 Trnavská pahorkatina, Bohdanovce nad Trnavou, 48°25'58", 17°32'48", stubble, PF, 13.9.2006, JM, MZ.
- 11 Podunajská rovina, Bratislava, 48°07'44", 17°11'38", stubble, 2.10.2006, JM, KV.
- 12 Trnavská pahorkatina, Kaplná, 48°18'00", 17°27'32", stubble, PF, 3.10.2006, JM.
- 13 Trnavská pahorkatina, Dubová, 48°21'35", 17°20'02", PF, 3.10.2006, JM.
- 14 Podunajská rovina, Ivanka pri Dunaji, 48°12'16", 17°14'58", stubble, LF, 3.10.2006, JM.
- 15 Dolnomoravský úval, Vrádište, 48°49'06", 17°11'47", 8.6.2006, JM.
- 16 Slovenský kras, Jablonov nad Turňou, 48°35'18", 20°40'05", 9.6.2007, JM.
- 17 Bodvianska pahorkatina, Ardovo, 48°31'40", 20°24'33", J, 4°, PF, 8.6.2007, JM.
- 18 Slovenský kras, Dvorníky-Včeláre, Dvorníky, 48°35'58", 20°50'11", 7.6.2007, JM.
- 19 Strážovské vrchy, Omšenie, 48°53'52", 18°12'39", LF, 19.7.2008, JM.
- 20 Košická kotlina, Hostovce, 48°34'33", 20°51'09", LF, 7.6.2007, JM.
- 21 Myjavská pahorkatina, Lubina, 48°46'32", 17°44'51", PF, 25.7.2007, JM.
- 22 Trnavská pahorkatina, Kočín-Lančár, Lančár, 48°35'55", 17°39'15", 21.6.2006, JM.
- 23 Biele Karpaty, Červený Kameň, 49°04'55", 18°11'30", PF, CHS, 12.7.2006, JM.
- 24 Bodvianska pahorkatina, Neparadza, 48°21'16", 20°23'29", co-operative LF, 3.7.2006, JM.
- 25 Ipeľská pahorkatina, Pukanec, 48°22'00", 18°43'59", JV, 3°, LF, 19.6.2008, JM.
- 26 Hornonitrianska kotlina, Horná Ves, 48°36'42", 18°29'31", JZ, 4°, LF, CHS, 23.6.2008, JM.
- 27 Myjavská pahorkatina, Myjava-Poriadie, 48°47'12", 17°36'03", small PF, 24.7.2007, JM.
- 28 Trnavská pahorkatina, Vrbové, 48°37'20", 17°42'38", small PF, 25.7.2007, JM.
- 29 Myjavská pahorkatina, Lubina, 48°47'45", 17°43'14", JZ, 3°, LF, 25.7.2007, JM.
- 30 Myjavská pahorkatina, Hrašné-Babulicov vrch, 48°44'18", 17°39'30", V, 4°, small PF, 25.7.2007, JM.

#### Appendix S13:

- 1 Borská nížina, Lozorno, 48°18'54", 17°01'40", 10.6.2003, JM, MZ.
- 2 Borská nížina, Záhorská Ves, 48°22'31", 16°52'29", 24.6.2003, JM, MZ.
- 3 Borská nížina, Záhorská Bystrica, 48°14'58", 17°02'20", 8.9.2003, JM.
- 4 Borská nížina, Záhorská Bystrica, 48°15'00", 17°02'20", 8.9.2003, JM.
- 5 Borská nížina, Jablonové, 48°20'39", 17°05'02", 20.8.2003, JM, MZ.
- 6 Borská nížina, Závod, 48°32'53", 16°58'13", 8.7.2003, MZ.
- 7 Borská nížina, Suchohrad, 48°24'11", 16°52'15", 25.6.2003, JM, MZ.
- 8 Borská nížina, Závod, 48°32'53", 16°58'13", depression in the field, 8.7.2003, MZ.
- 9 Borská nížina, Plavecký Štvrtok, 48°22'58", 16°59'56", 9.7.2003, JM.
- 10 Borská nížina, Závod, 48°31'59", 17°00'46", fallow, 24.7.2003, JM.
- 11 Borská nížina, Vysoká pri Morave, 48°20'29", 16°53'54", stubble, 19.8.2003, JM, MZ.
- 12 Borská nížina, Lozorno, 48°20'00", 17°00'58", stubble, 20.8.2003, JM, MZ.
- 13 Borská nížina, Stupava, 48°17'15", 16°59'48", 1-year fallow, 8.9.2003, JM.
- 14 Borská nížina, Stupava, 48°17'10", 17°00'05", stubble, 8.9.2003, JM.
- 15 Borská nížina, Stupava, 48°17'26", 16°59'37", 1-year fallow, 21.8.2003, MZ.
- 16 Borská nížina, Záhorská Ves, 48°23'20", 16°51'59", 2.10.2003, MZ.
- 17 Podunajská rovina, Jarovce, 48°02'15", 17°05'15", co-operative field, 1.8.2005, JM.
- 18 Podunajská rovina, Jarovce, Dolné Dlhé, 48°03'03", 17°05'57", co-operative field, 27.7.2005, JM.
- 19 Podunajská rovina, Jarovce, 48°01'55", 17°05'30", co-operative field, 2.8.2005, JM.

#### Appendix S14:

- 1 Borská nížina, Tomky, 48°33'56", 17°04'50", 27.5.2003, JM.
- 2 Borská nížina, Závod, 48°32'14", 17°00'51", 25.5.2004, JM.
- 3 Borská nížina, Studienka, 48°31'59", 17°08'13", fallow, 18.7.2003, MZ, JM.
- 4 Borská nížina, Závod, Pri ceste, 48°31'50", 16°59'10", 1-year fallow, 24.7.2003, JM.
- 5 Hronská pahorkatina, Chotín, 47°48'49", 18°12'45", LF, CHS, 2.6.2008, JM.
- 6 Borská nížina, Závod, 48°33'05", 17°02'11", fallow, 1.7.2002, MZ.
- 7 Borská nížina, Závod, 48°32'28", 17°00'00", 12.7.2004, JM, MZ.
- 8 Borská nížina, Veľké Leváre, 48°30'20", 17°01'17", small PF, 21.7.2004, JM.
- 9 Borská nížina, Malé Leváre, Lúčky, 48°30'20", 16°57'09", stubble, 24.8.2004, JM.
- 10 Borská nížina, Veľké Leváre, 48°30'22", 17°01'15", small PF, 21.7.2004, JM.
- 11 Borská nížina, Veľké Leváre, 48°30'22", 17°01'15", small PF, 21.7.2004, JM.
- 12 Borská nížina, Malé Leváre, 48°28'47", 16°58'36", 21.7.2004, JM.
- 13 Borská nížina, Lakšárska Nová Ves, 48°34'04", 17°08'49", stubble, 8.9.2004, JM.
- 14 Borská nížina, Lakšárska Nová Ves, 48°34'04", 17°08'49", stubble, 8.9.2004, JM.
- 15 Borská nížina, Stupava, 48°17'39", 16°59'18", fallow, 9.9.2004, JM, MZ.
- 16 Borská nížina, Lozorno, 48°20'45", 17°01'10", stubble, 26.8.2004, JM, MZ.
- 17 Borská nížina, Záhorská Bystrica, Nad mlynami, 48°14'54", 16°59'34", stubble, 30.8.2004, JM.
- 18 Borská nížina, Jakubov, 48°24'29", 16°55'05", stubble, 26.8.2004, JM, MZ.