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Unambiguous assignment of relevés to vegetation units: the example of the *Festuco-Brometea* and *Trifolio-Geranietea sanguinei*

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Abstract

Many current approaches to the formal definition of vegetation units have the disadvantage of leaving a large amount of relevés unclassified. In this paper I propose a new method for the unambiguous assignment of relevés, which is based on the summarised cover value of diagnostic species. In the first step, a relevé is assigned to the class with the highest cover score. For this purpose, the character and differential species of the class as well as the character species of all subordinated syntaxa are considered diagnostic. Once the class has been determined, the assignment proceeds successively to the lower ranks. This method, which may be called "summarised percentage cover approach", uses solely the diagnostic species of syntaxa for the assignment of relevés to vegetation units, making additional formal definitions unnecessary.

As a test data set, I used 487 relevés of fringe vegetation and grasslands of nutrient-poor sites sampled in the Vienna Woods (Wienerwald), Austria. All relevés were provisorily classified at alliances level, mostly following the assignment of the original authors. TWINSPAN and DCA were applied to evaluate this preliminary classification. Diagnostic species for both the alliance and the class level were identified using the total cover value ratio as fidelity measure.

The subjective classification was largely confirmed by the numerical methods. On basis of the summarised cover of *Trifolio-Geranietea* and *Festuco-Brometea* species, between 64% (*Geranion sanguinei*) and 99% (*Seslerio-Festucion pallentis*) of the relevés were reassigned to the same class as in the original classification.

The fact that a considerable amount of relevés originally classified as *Geranion sanguinei* was reassigned to grasslands reflects the problems in delimiting fringe communities rather than a poor performance of the assignment method. The "summarised percentage cover approach" allows not only for the unequivocal assignment of relevés to an existing classification system, but may also help to improve classifications by clarifying the delimitation of higher syntaxa.

Zusammenfassung: Eindeutige Zuweisung von Aufnahmen zu Vegetationseinheiten: das Beispiel *Festuco-Brometea* und *Trifolio-Geranietea sanguinei*

Viele derzeit gebräuchliche Methoden zur formalen Definition von Vegetationseinheiten haben den Nachteil, zahlreiche Aufnahmen unklassifiziert zu lassen. In dieser Arbeit wird eine neue Methode für die eindeutige Zuordnung von Vegetationsaufnahmen vorgeschlagen, welche auf den Deckungswertsummen der diagnostischen Arten basiert. Im ersten Schritt werden die Aufnahmen jener Klasse zugeordnet, deren diagnostische Arten in Summe den höchsten Deckungswert erreichen. Dabei werden jeweils die Charakter- und Differenzialarten der Klasse sowie die Charakterarten aller untergeordneten Syntaxa berücksichtigt. Anschließend schreitet der Zuordnungsvorgang zur nächstniedrigeren Rangstufe fort. Dieser Ansatz, welcher als „Deckungssummen-Methode" bezeichnet werden könnte, stützt sich ausschließlich auf die diagnostischen Arten der Syntaxa. Zusätzliche formale Definitionen sind daher nicht mehr notwendig.

Als Testdatensatz dienten 487 Aufnahmen von Säumen und Rasen magerer Standorte aus dem Wienerwald (Österreich). Die Aufnahmen wurden subjektiv Verbänden zugeordnet, wobei in der Regel der Einstufung durch den Originalautor gefolgt wurde. Diese vorläufige Klassifikation wurde mit Hilfe einer TWINSPAN-Klassifikation und einer DCA-Ordination evaluiert. Zur Bestimmung der diagnostischen Arten der Verbände und Klassen wurde der Deckungsquotient (*total cover ratio*) als Treuemaß verwendet.

Das Ergebnis der TWINSPAN-Klassifikation und der DCA bestätigte die subjektive Klassifikation im Großen und Ganzen. Auf Basis der aufsummierten Deckungswerte der *Trifolio-Geranietea*- und *Festuco-Brometea*-Arten wurden zwischen 64 % (*Geranion sanguinei*) und 99 % (*Seslerio-Festucion pallentis*) der Aufnahmen der gleichen Klasse wie in der originalen Klassifikation zugewiesen. Die Tat-

sache, dass ein beachtlicher Teil der ursprünglich als *Geranion sanguinei* eingestuften Aufnahmen den Rasen zugeordnet wurde, ist eher auf die Schwierigkeiten bei der Abgrenzung von Säumen zurückzuführen als auf eine Fehlleistung der neuen Methode.

Die „Deckungssummen-Methode" erlaubt nicht nur die eindeutige Zuordnung von Vegetationsaufnahmen zu den Einheiten eines existierenden Systems, sondern kann auch helfen, bestehende Klassifikationen zu verbessern, indem sie zur Klärung der gegenseitigen Abgrenzung von höheren Syntaxa beiträgt.

Keywords: Austria, formal definition of syntaxa, fringe vegetation, dry grassland, syntaxonomy, vegetation classification.
With 1 supplement.

1. Introduction

Despite the long tradition of vegetation classification in Europe, formal definitions of syntaxa providing the unequivocal assignment of relevés to these units have not attracted much attention until the end of the 20th century. Extensive mapping projects, the establishment of national vegetation surveys including lists of diagnostic species and/or synoptic tables, and the availability of databases containing thousands of classified relevés (DENGLER et al. 2011) have stimulated the development of algorithms for the automatic or semi-automatic integration of plot data into an existing classification scheme. Most approaches include the calculation of resemblance values between a given relevé and predefined vegetation units (HILL 1989, TICHÝ 2005, VAN TONGEREN et al. 2008, DE CÁCERES et al. 2009). A potential problem of using similarity measures is the underlying assumption that vegetation units are more or less spherical clusters sprawling around a "typical core". By relying on the full species composition of these "cores", the results are strongly dependent on the quality of the training data set. The criteria used for the definition of vegetation units are often rather obscure or not the same as those for the assignment of new relevés.

BRUELHEIDE (1997, 2000) proposed to formalise syntaxa as unique combinations of species groups using the logical operators AND, OR, and NOT. Thus, relevés are classified by the presence or absence of statistically defined species groups. KOČI et al. (2003) modified this approach (called "Cocktail method") by introducing dominance of single species as additional assignment criterion because pure combinations of species groups were not sufficient to reproduce expert-based classifications. Moreover, KOČI et al. (2003) combined the Cocktail method with a similarity calculation in order to assign relevés that matched the formal definition of more than one syntaxon or no definition at all. According to CHYTRÝ (2007: 40), 50–70% of the relevés usually remain unclassified by the Cocktail method. Given that the original aim of this approach was to provide "complete allocation of relevés" so that "definition gaps within the system can be completely avoided" (BRUELHEIDE 1997), the classification of vegetation by formal logic has not met the expectations. Combining species groups by logical operators has one fundamental flaw: The question "does relevé X contain species group Y" cannot be answered by a simple yes or no. Statistical measures to determine the number of species of a group that must be present in a relevé to consider the whole group to be present turned out to be strongly dependent on the data set structure (KOČI et al. 2003). Therefore, an arbitrary fixed threshold (usually 50%) is used. However, the composition of species groups obtained by the Cocktail method itself is strongly influenced by the data set (KUŽELOVÁ & CHYTRÝ 2004). Using a rather high threshold for the presence of a species group leads to a considerable loss of information. For example, the presence of 40% of the diagnostic species of a vegetation unit is treated equally as the total absence of the same species group. Differences in the cover of diagnostic species are completely neglected.

A less formal approach to enhance the reproducibility of vegetation classification and mapping was to develop determination keys for syntaxa (SCHUBERT et al. 2001, WILLNER & GRABHERR 2007). Although a hierarchical element has recently been introduced into the Cocktail method (JANIŠOVÁ & DÚBRAVKOVÁ 2010), until now only determination keys make use of the full hierarchy of the syntaxonomical system. The determination process starts with the assignment of the relevé to a class and proceeds successively to the lower ranks. This corresponds with the internal logic of the system in which each rank has its own diagnostic species. An obstacle to hierarchical approaches, however, is the well-known experience that relevés usually contain character species of several classes, orders, and alliances. While associations can be unambiguously delimited by differential species of high fidelity (WILLNER 2006), higher syntaxa are mostly defined by character species, which often have a high constancy, but rather low fidelity. DENGLER et al. (2006a) used "importance values" to assign relevés to classes by summing up the transformed cover-abundance values of the diagnostic taxa of each class in each relevé, and the relevé was assigned to the class with the highest score (see also MICHL et al. 2010). In the present paper, I suggest to generalise this approach to syntaxa of all ranks and to use summarised percentage cover instead of transformed ordinal values. This method, which may be called "summarised percentage cover approach", uses solely the diagnostic species of syntaxa for the assignment of relevés to vegetation units, making additional formal definitions unnecessary.

As a test data set, I used fringe vegetation and grasslands of nutrient-poor sites in Eastern Austria. As classical ecotones, fringe communities have strong floristic affinities both to grasslands and forests. However, while the delimitation of forests and fringe communities is rather plain (the latter being herbaceous vegetation *per definitionem*, growing at the margin or outside of forests), the separation of fringes and grasslands is less obvious. Transitions both in space and time can result in mosaics and mixtures, which are difficult to disentangle. Special problems arise from succession processes called *Versaumung*, i.e. the invasion of fringe species into grasslands after abandonment of grazing or mowing (DIERSCHKE & BRIEMLE 2002). In a numerical classification of Pannonian dry grasslands, several clusters contained successional stages of abandoned, formerly grazed sites, which were difficult to incorporate into the syntaxonomical system (DÚBRAVKOVÁ et al. 2010a, 2010b). Regardless of the syntaxonomic rank given to nutrient-poor fringe vegetation (usually known as class *Trifolio-Geranietea sanguinei*), the assignment of individual plots to fringe or grassland, respectively, often remains doubtful, resulting in contradictory concepts of classification. The formal definitions given by CHYTRÝ (2007) for the associations of the *Geranion sanguinei* and *Trifolion medii* are all based on the dominance of a single species, which hardly reflects the real floristic spectrum of fringe communities.

The data set consists of 487 relevés, which were sampled in the Vienna Woods (Wienerwald). This region was selected because it is the only part of Austria from which a sufficient number of fringe vegetation plot data were available.

2. Study area

The Vienna Woods are situated in the north-eastern corner of the Alps, belonging to the Austrian federal states of Lower Austria and Vienna (Fig. 1). The region has a part in two main geological units: the Flysch zone in the north and west, and the Northern Limestone Alps in the south-east, with some areas of molasse at the edges. The altitudinal range is between 200 and 893 m a.s.l. Climatically and biogeographically, the Vienna Woods are a transition zone between the Central European and the Pannonian region. Mean annual temperature ranges from 6 to 10 °C, and the mean annual precipitation ranges from 600 to 900 mm.

About 60% of the study area is covered by forests (mostly beech and oak-hornbeam forests, in the lowest parts also thermophilous oak forests). On steep dolomite slopes, *Pinus nigra* forests are developed, which are interspersed with small patches of *Sesleria albicans* grasslands on rocky outcrops. In the warmest part, adjacent to the Vienna Basin, primary dry grassland dominated by *Festuca stricta* and *Stipa eriocaulis* can be found. Since 2005, the Vienna Woods are protected as UNESCO Biosphere Reserve.

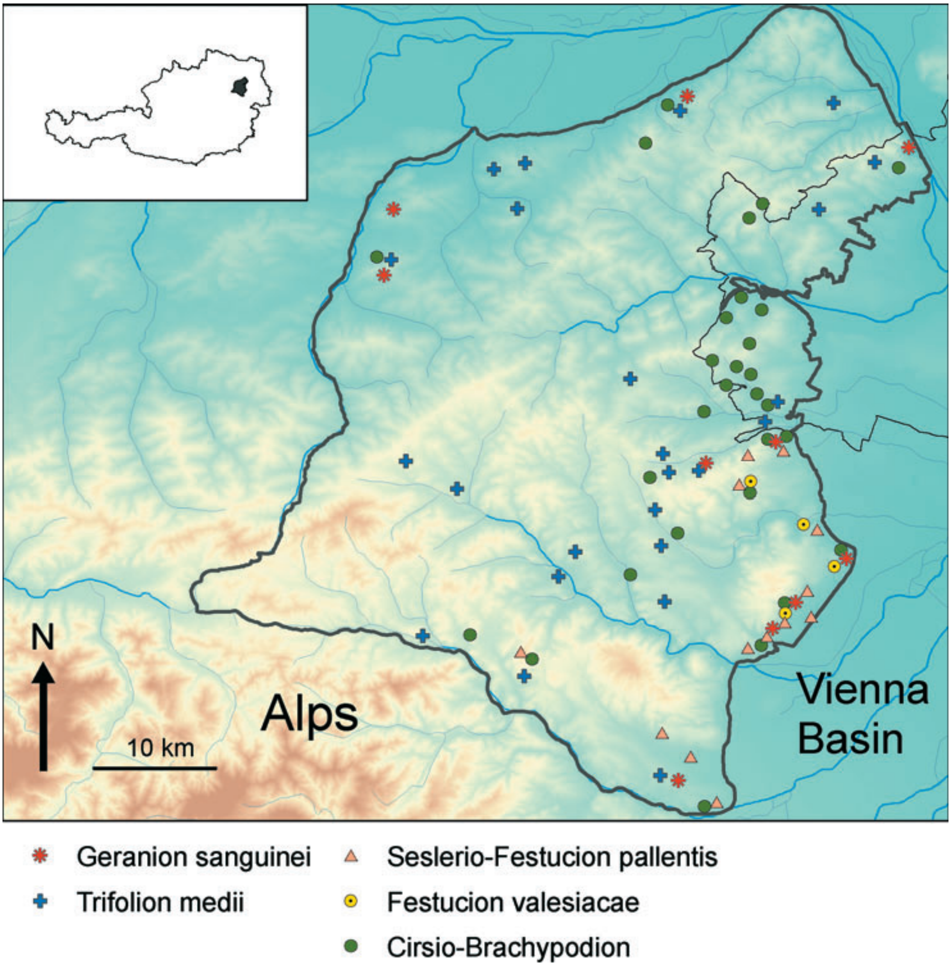

Fig. 1: Map of the study area showing the location of sampling sites (one symbol usually represents several plots). Bold grey line: border of the Biosphere Reserve Vienna Woods. Thin grey line: political border between Vienna and Lower Austria.

Abb. 1: Karte des Untersuchungsgebiets mit Lage der Aufnahmeorte (ein Symbol steht in der Regel für mehrere Vegetationsaufnahmen). Dicke graue Linie: Grenze des Biosphärenparks Wienerwald. Dünne graue Linie: Politische Grenze zwischen Wien und Niederösterreich.

3. Material and methods

3.1. Data selection and preliminary classification

In a first step, I selected all relevés from the study area that were available in the Austrian Vegetation Database (Willner in press; code EU-AT-001 according to Dengler et al. 2011 and www.givd.info) and classified as *Festuco-Brometea* or *Trifolio-Geranietea*. Relevés with plot size < 5 or > 150 m² were excluded. All relevés in the database were provisorily classified at alliance level, mostly following the original assignment of the relevé author. Since the syntaxonomical revision of dry grasslands in Eastern Austria is still in progress (W. Willner in prep.), this provisional assignment to alliances and classes was used as preliminary classification. For fringe vegetation, the recent classification of Pelikan & Willner (2009) could be used. The 487 relevés were thus classified as follows: (1.1) *Geranion sanguinei*: 47 relevés (plot size 10–100 m^2, average 30 m^2), (1.2) *Trifolion medii*: 98 relevés (plot size 10 m^2), (2.1) *Seslerio-Festucion pallentis*: 102 relevés (plot size 5–140 m^2, average 33 m^2), (2.2) *Festucion valesiacae*: 34 relevés (plot size 9–100 m^2, average 33 m^2), (2.3) *Cirsio-Brachypodion*: 206 relevés (plot size 6–150 m^2, average 41 m^2).

3.2. Numerical evaluation of the preliminary classification

To evaluate the subjective assignment to alliances, a TWINSPAN classification and a DCA ordination were conducted with the data set of 487 relevés. The TWINSPAN classification was done with the software package JUICE 7.0 (Tichý 2002). The classical, unmodified TWINSPAN version was used. As cut levels, percentage cover values of 0, 5, and 25 were defined. The ordination was performed using the CANOCO 4.5 program (ter Braak & Šmilauer 2002). Since the vegetation unit labelled as "*Festucion valesiacae*" in the preliminary classification was not reproduced by numerical methods (see below) and a syntaxonomical revision of the 34 relevés belonging to this unit was beyond the scope of the present study, these relevés were excluded from the further analysis.

3.3. Determination of diagnostic species

The diagnostic species of alliances and classes were determined using the preliminary classification. First, species constancy and total cover (i.e. the average cover of a species including zero values; Willner 2006) were calculated at the alliance level. Transformation of the ordinal Braun-Blanquet scale into cover values was done using the average percentage cover corresponding to each value. As fidelity measure, total cover ratio was used. This measure is defined as the ratio between the total cover of the species in the target group and the highest total cover of this species among all other groups of the same rank (Willner et al. 2009). Zero values and total cover values < 0.01% were set to 0.01 in order to avoid division by zero or ratios higher than 1000. At the class level, total cover was defined as the average total cover of a species among the subordinated alliances. Diagnostic species for alliances and classes were determined using the thresholds given in Table 1. With a few exceptions, species were only accepted as diagnostic when they reached a constancy of at least 20% in the respective vegetation unit. Tree, shrub and liana species were not considered because they belong to later successional stages. Non-vascular plants could not be considered due to their very incomplete record in the data.

Table 1: Proposed thresholds for diagnostic species at the alliance and class level.
Tabelle 1: Vorgeschlagene Schwellenwerte für diagnostische Arten auf Verbands- und Klassenebene.

Total Cover Ratio for		Diagnostic value for	
alliance	class	alliance	class
< 2	< 2	-	-
≥ 2, < 10	any	weak	-
≥ 10	any	strong	-
< 2	≥ 2, < 10	-	weak
< 2	≥ 10	-	strong

It should be noted that the context of the fidelity calculation was the combined data set of the *Festuco-Brometea* and *Trifolio-Geranietea*. Some diagnostic species, however, have their optimum in other classes such as the *Molinio-Arrhenatheretea*. These species cannot be considered character species but differential species of the alliances and classes investigated in the present study.

3.4. Reassignment of relevés using the summarised cover of diagnostic species

This method, which is proposed here for the first time, uses the cumulative percentage cover of diagnostic species for the unequivocal assignment of relevés to vegetation units. Unlike other cover-abundance values, percentage cover is an objective quantity like biomass, and it is not much affected by different plot sizes. In the first step, the relevé is assigned to the class with the highest cover score. For this purpose, the character and differential species of the class as well as the character species of all subordinated syntaxa are considered diagnostic. In some cases, the *a priori* separation of woody and non-woody vegetation might be appropriate. Once the class has been determined, the diagnostic species of the next subordinated units are compared. For example, if a class is divided into four orders, the summarised cover of four diagnostic species groups is compared, each group consisting of the character and differential species of the order as well as the character species of its subordinated syntaxa. This process is repeated until the lowest hierarchical level is reached. Additional dominance criteria are not necessary because species cover is an integral part of the determination process.

Three things should be noted: First, the same species may be listed in several diagnostic species groups (in case of shared differential species even at the same hierarchical level). Second, differential species of subordinated syntaxa should not be considered diagnostic at the higher level (e.g., the differential species of alliances do not belong to the diagnostic species of the order). Third, at each but the class level there may be a central syntaxon having no diagnostic species of its own (DIERSCHKE 1981, DENGLER 2003). To account for the fuzzy nature of plant communities, I suggest regarding a summarised cover of < 1% as absence of the diagnostic species. Thus, if no diagnostic species group has a summarised cover of at least 1%, the relevé is assigned to the central syntaxon.

For the present study, a simplified approach had to be used because of the rather restricted test data set. The diagnostic species were divided into two groups, each of which included the diagnostic species of one class as well as the diagnostic species of its subordinated alliances. For each relevé, the percentage cover values of the two species groups were summed up, and the relevé was assigned to the class with the higher summarised cover value. In this way, the whole data set was reassigned to fringe and grassland vegetation, respectively.

3.5. Nomenclature

The names of vascular plants follow FISCHER et al. (2005). Aggregate species are defined according to this flora except for *Galium mollugo* agg. (*G. mollugo*, *G. album*, *G. pycnotrichum*) and *Cerastium pumilum* agg. (*C. pumilum*, *C. glutinosum*, *C. semidecandrum*). The names of syntaxa follow MUCINA et al. (1993), except for the *Seslerio-Festucion pallentis*, which is used in the sense of WILLNER et al. (2004), i.e. including the *Diantho-Seslerion* and *Bromo-Festucion pallentis*.

4. Results

4.1. TWINSPAN classification and DCA ordination

The alliances of the preliminary classification were fairly separated in the DCA diagram except for the "*Festucion valesiacae*", which showed a broad overlap with the *Seslerio-Festucion pallentis*, *Cirsio-Brachypodion*, and *Geranion sanguinei* (Fig. 2). All 34 relevés assigned to the *Festucion valesiacae* are located at the eastern margin of the study area and represent – if at all belonging to this alliance – rather atypical stands of this alliance. To avoid an artificial distortion of diagnostic species, these relevés were excluded from the calculation of diagnostic species.

The main gradient ran from rocky grasslands (*Seslerio-Festucion pallentis*) to the most mesophilous stands of the *Cirsio-Brachypodion* and *Trifolion medii*. The fringe communities were located in the upper part of the diagram, with the *Geranion sanguinei* at the drier and the *Trifolion medii* at the moister end of the gradient. In the TWINSPAN classification,

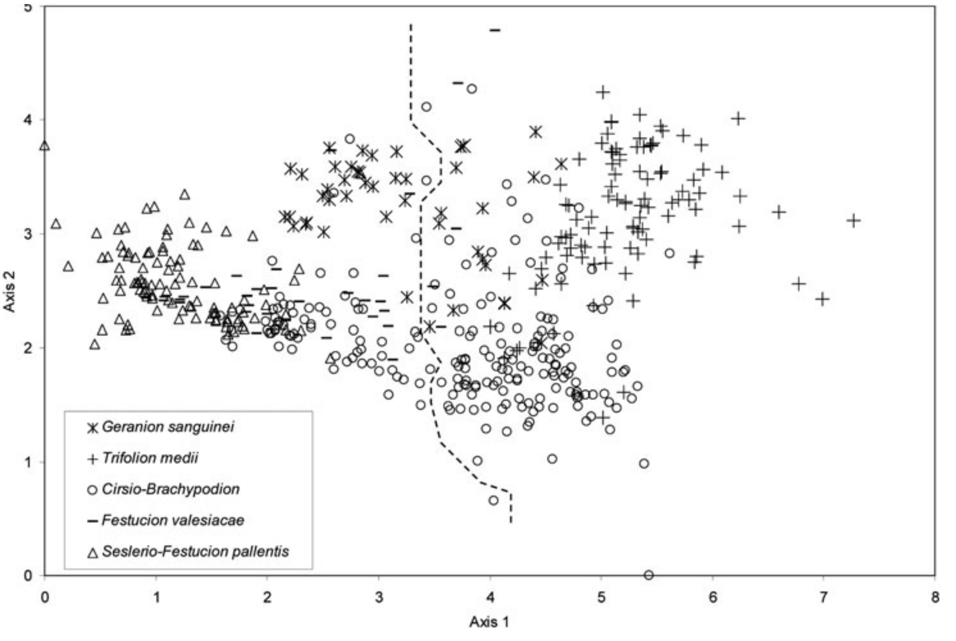

Fig. 2: Detrended correspondence analysis (DCA) of *Festuco-Brometea* and *Trifolio-Geranietea* relevés. The different symbols represent the preliminary, expert-based assignment to alliances. The dashed line shows the approximate location of the first TWINSPAN division.

Abb. 2: Detrended Correspondence Analysis (DCA) von *Festuco-Brometea*- und *Trifolio-Geranietea*-Aufnahmen. Die verschiedenen Symbole geben die vorläufige, subjektive Zuordnung zu Verbänden wieder. Die gestrichelte Linie zeigt den ungefähren Verlauf der ersten TWINSPAN-Teilung.

the first division separated the *Seslerio-Festucion pallentis*, *Geranion sanguinei*, and a part of the *Cirsio-Brachypodion* on the one side from the bulk of the *Cirsio-Brachypodion* and *Trifolion medii* on the other side (Fig. 2). The drier section of the *Cirsio-Brachypodion*, adjacent to the *Seslerio-Festucion pallentis*, represents a community type mostly dominated by *Carex humilis*, which contains a considerable number of rocky grassland species. It has been traditionally classified as *Polygalo majoris-Brachypodietum*, but its syntaxonomical position may be in need of a revision (W. Willner in prep.). The present paper, however, keeps to the traditional assignment to the *Cirsio-Brachypodion*. At the second level of division, the *Seslerio-Festucion pallentis* was separated from the *Geranion sanguinei* and *Carex humilis* grasslands, and the rest of the *Cirsio-Brachypodion* was separated from the *Trifolion medii*. At the third level of division, the *Geranion sanguinei* and *Carex humilis* grasslands were separated.

4.2. Diagnostic species

In the following, a list of the regional diagnostic species of the two classes and four alliances is given. The species are ranked by decreasing total cover ratio. If the species is regarded as character species for any syntaxon in MUCINA et al. (1993), the name of this syntaxon is given in brackets (T-G: *Trifolio-Geranietea*, Ov: *Origanetalia vulgaris*, Gs: *Geranion sanguinei*, Tm: *Trifolion medii*; F-B: *Festuco-Brometea*, B: *Brometalia erecti*, C-B: *Cirsio-Brachypodion*, Fv: *Festucetalia valesiacae* or *Festucion valesiacae*, Sp-Fp: *Stipo pulcherrimae-Festucetalia pallentis*, Bp-Fp: *Bromo pannonici-Festucion pallentis*, D-S: *Diantho lumnitzeri-Seslerion*; M-A: *Molinio-Arrhenatheretea*, A: *Arrhenatheretalia* or *Arrhenatherion*).

Most species are diagnostic also in terms of constancy ratio (DENGLER 2003). This is especially true for the strongly diagnostic species. A synoptic table with the diagnostic species as well as other species with high constancy is presented in the Supplement (Table 2).

Class *Trifolio-Geranietea*
No. of relevés: 145
Diagnostic species: *Peucedanum alsaticum*, *Galium mollugo* agg. (A), *Viola hirta* (Ov), *Origanum vulgare* (Ov).

Alliance *Geranion sanguinei*
No. of relevés: 47
Diagnostic species: *Laser trilobum*, *Elymus hispidus*, *Geranium sanguineum* (Gs), *Coronilla coronata* (Gs), *Peucedanum cervaria* (Gs), *Centaurea triumfettii* (Gs), *Dictamnus albus* (*Geranio-Dictamnetum*), *Vincetoxicum hirundinaria* (Gs), *Clematis recta* (Gs), *Cuscuta epithymum* (F-B), *Aster amellus* (Gs), *Pulsatilla pratensis* subsp. *nigricans* (Fv), *Rhamnus saxatilis* (Bp-Fp), *Tanacetum corymbosum* (Gs).

Alliance *Trifolion medii*
No. of relevés: 98
Diagnostic species: *Fragaria moschata*, *Viola reichenbachiana*, *Melampyrum nemorosum* (Tm), *Viola riviniana*, *Galium odoratum*, *G. aparine* (*Galio-Urticetea*), *Heracleum sphondylium* (M-A), *Hepatica nobilis*, *Geum urbanum* (*Galio-Alliarion*), *Knautia drymeia*, *Agrimonia eupatoria* (Tm), *Ajuga reptans* (M-A), *Vicia sepium* (A), *Calamagrostis epigejos*, *Clinopodium vulgare* (T-G), *Brachypodium pinnatum* (C-B), *Cruciata laevipes* (*Galio-Alliarion*).

Class *Festuco-Brometea*
No. of relevés: 308
Diagnostic species: *Anthyllis vulneraria* (B), *Allium senescens* subsp. *montanum* (Sp-Fp), *Scorzonera purpurea* (C-B), *Muscari neglectum* (Fv), *Globularia punctata* (Sp-Fp), *Senecio jacobaea*, *Thesium linophyllon* (F-B), *Chamaecytisus ratisbonensis* (F-B), *Genista pilosa* (Sp-Fp), *Asperula cynanchica* (F-B), *Dorycnium germanicum* (Sp-Fp), *Festuca rupicola* (Fv), *Scabiosa ochroleuca* (C-B), *Seseli annuum* (C-B), *Centaurea stoebe* s.lat. (Fv).

Alliance *Seslerio-Festucion pallentis*
No. of relevés: 102
Diagnostic species: *Stipa eriocaulis* (Sp-Fp), *Festuca stricta* (*Fumano-Stipetum eriocaulis*), *Allium sphaerocephalon* (Sp-Fp), *Globularia cordifolia* (D-S), *Seseli austriacum* (D-S), *S. osseum* (Sp-Fp), *Hornungia petraea* (*Alysso alyssoidis-Sedion albi*), *Jurinea mollis* (Sp-Fp), *Thymus praecox* (Sp-Fp), *Fumana procumbens* (Bp-Fp), *Onosma visianii* (Sp-Fp), *Campanula sibirica* (Bp-Fp), *Cerastium pumilum* agg. (*Alysso alyssoidis-Sedion albi*), *Poa badensis* (Bp-Fp), *Arenaria serpyllifolia* agg. (*Koelerio-Corynephoretea*), *Stipa capillata* (Fv), *Helianthemum canum* (Bp-Fp), *Jovibarba hirta* (Sp-Fp), *Potentilla incana* (Fv), *Leontodon incanus* (D-S), *Seseli hippomarathrum* (Bp-Fp), *Teucrium montanum* (Sp-Fp), *Linum tenuifolium* (Sp-Fp), *Thlaspi perfoliatum* (*Alysso alyssoidis-Sedion albi*), *Melica ciliata* (Sp-Fp), *Sesleria albicans* (D-S), *Odontites luteus* (Fv), *Scorzonera austriaca* (Bp-Fp), *Orobanche gracilis* (F-B), *Galium lucidum* (D-S), *Allium flavum* (Sp-Fp), *Scabiosa canescens* (Bp-Fp), *Pulsatilla grandis* (Sp-Fp), *Aster linosyris* (Fv), *Carex humilis* (Sp-Fp).

Alliance *Cirsio-Brachypodion*
No. of relevés: 206
Diagnostic species: *Avenula pubescens* (A), *Linum catharticum* (F-B), *Carex caryophyllea* (F-B), *Ononis spinosa* (F-B), *Rhinanthus minor* (B), *Luzula campestris* agg. (*Calluno-Ulicetea*), *Anthoxanthum odoratum* (*Calluno-Ulicetea*), *Festuca pratensis* (M-A), *Onobrychis viciifolia* (*Bromion erecti*), *Leucanthemum vulgare* agg. (M-A), *Carlina acaulis* (B), *Briza media* (B), *Trifolium montanum* (B), *Centaurea jacea*, *Plantago media* (B), *Plantago lanceolata* (M-A), *Lotus corniculatus* agg., *Prunella grandiflora* (B), *Leontodon hispidus* (M-A), *Ranunculus bulbosus* (B), *Bromus erectus* (B), *Dianthus carthusianorum* agg., *Poa angustifolia* (F-B), *Knautia arvensis* (A), *Trifolium pratense* (M-A), *Galium verum* agg. (F-B), *Stellaria graminea* (A), *Eryngium campestre* (F-B), *Tragopogon orientalis* (*Bromion erecti*), *Taraxacum* sect. *Ruderalia*, *Holcus lanatus* (M-A), *Cirsium pannonicum* (C-B), *Achillea millefolium* agg., *Campanula glomerata* (B), *Trisetum flavescens* (M-A), *Salvia pratensis* (F-B), *Centaurea scabiosa* (F-B), *Sanguisorba minor*, *Pimpinella saxifraga* s.str. (F-B), *Securigera varia* (F-B), *Carex flacca*, *Dactylis glomerata* (M-A).

4.3. Reassignment of relevés

On the basis of the summarised cover values of diagnostic species, the following numbers of relevés were reassigned to the same class as in the preliminary classification: *Geranion sanguinei*: 30 relevés (= 64%); *Trifolion medii*: 78 relevés (= 80%); *Seslerio-Festucion pallentis*: 101 relevés (= 99%); *Cirsio-Brachypodion*: 198 relevés (= 96%). The comparatively low percentage of *Geranion sanguinei* relevés that were reassigned to fringe vegetation was mainly caused by plots with a high cover of *Bromus erectus*. Typically, such stands had a high proportion of woody species, but a low cover of fringe species. They can be considered successional stages in direct transition from dry grasslands to woody vegetation, forming only a fragmentary fringe stage. For *Geranion sanguinei* relevés that were reassigned to fringe vegetation, the average summarised cover value of *Trifolio-Geranietea* species was 45.9, the average summarised cover value of *Festuco-Brometea* species was 15.8, and the average plot size was 23 m². In comparison, for *Geranion* relevés that were not reassigned to fringe vegetation, the average summarised cover value of *Trifolio-Geranietea* species was only 18.2, the average summarised cover value of *Festuco-Brometea* species was 40.7, and the average plot size was 11.4 m².

5. Discussion

5.1. Syntaxonomy

In a statistical evaluation of vegetation classes of the Czech Republic, Chytrý & Tichý (2003) found a high floristic similarity between the *Festuco-Brometea* and *Trifolio-Geranietea* and a low number of unique diagnostic species (i.e. character species) for the latter. As a consequence, Chytrý (2007) abandoned the class *Trifolio-Geranietea* and included the alliances *Geranion sanguinei* and *Trifolion medii* into the class *Festuco-Brometea*. Dengler (2003: 190 ff), however, presented a long list of character species for the class *Trifolio-Geranietea* (see also Dengler et al. 2006b). The statistical evaluation of Jarolímek & Šibik (2008) also yielded a higher support for the class.

Fringe vegetation differs from grasslands in several respects: (a) it is neither mown nor grazed, or only occasionally so; (b) it is less exposed to direct sunlight and wind due to adjacent shrubs and trees; (c) it is dominated by mesophilous herbs and broad-leaved grasses, giving fringe communities an appearance quite different from grasslands (Dierschke 1974, Weber 2003). The vegetation plots assigned to *Geranion sanguinei* and *Trifolion medii* were fairly separated from the grassland plots in the DCA diagram (Fig. 2). While the main gradient in the data set reflects the soil conditions determining the different grassland types, from shallow rocky slopes to mesic soils with good water supply, fringe communities occupy their own floristic space, which runs parallel to the grassland communities. Given the peculiar structural and ecological features that separate fringe communities from grasslands, it might be reasonable to maintain the class *Trifolio-Geranietea* despite its close floristic relationship with *Festuco-Brometea*. However, the number of diagnostic species joining the alliances *Geranion sanguinei* and *Trifolion medii* is quite low. This supports the concept of Dengler et al. (2006b), who classified the two alliances within separate orders.

Most character species given in Mucina et al. (1993) for the class *Trifolio-Geranietea* and the order *Origanetalia* (s.lat.) are either absent from the study area, have a very low constancy, are diagnostic for a subordinated alliance, or have equally high presence in grasslands. *Galium mollugo* agg. (in the study area usually *G. album*) is often regarded as *Arrhenatherion* species (e.g. Mucina et al. 1993), but according to Dengler et al. (2006b), it actually is a character species of *Trifolio-Geranietea*. The alliances *Geranion sanguinei* and *Trifolion medii* are both well characterised by diagnostic species. *Cuscuta epithymum*, *Pulsatilla pratensis* subsp. *nigricans* and *Rhamnus saxatilis* are considered character species of *Festuco-Brometea* or subordinated units of this class by Mucina et al. (1993), but have their optimum in *Geranion sanguinei* in the study area. The diagnostic species of *Trifolion medii* are partly differential species having their optimum in forests or nitrophilous fringe communities (*Galio-Urticetea*). *Trifolium medium* and *Campanula persicifolia* are diagnostic for the *Trifolion medii* in terms of constancy ratio, but since both species exhibit high cover values in some *Cirsio-Brachypodion* relevés, they do not reach the threshold for total cover ratio. This might at least partly be an artefact caused by the wide cover range represented by the value "2" in the traditional Braun-Blanquet scale. On the other hand, *Trifolium medium* even reaches the value "3" (i.e. > 25%) in some stands that, according to EBENBERGER (1993), are still mown. Whether this is a sign of some disturbance or succession taking place in the grassland, must be clarified by future research.

Most interesting, however, is the case of *Brachypodium pinnatum*. This species is traditionally considered a character species of the *Cirsio-Brachypodion* or the *Brometalia erecti* (MUCINA et al. 1993, OBERDORFER 1994). DENGLER et al. (2006b) list it as joint diagnostic species of the *Trifolio-Geranietea* and *Festuco-Brometea*. In the study area, *Brachypodium pinnatum* has the highest constancy in the *Trifolion medii* (94%), followed by *Geranion sanguinei* (72%) and *Cirsio-Brachypodion* (62%). High cover of *Brachypodium pinnatum* usually indicates abandonment of grazing or mowing (BOBBINK & WILLEMS 1993). Therefore, it makes sense from an ecological point of view to consider it a fringe rather than a grassland species. On the European scale, however, the species seems to be more frequent in the *Geranion sanguinei* than in the *Trifolion medii* (DENGLER et al. 2006b).

The training data set used in the present study for the determination of diagnostic species admittedly has several shortcomings: Its geographical scope is rather narrow, the plot sizes vary considerably, and the classification was done by expert judgement. Therefore, the results might differ significantly if large-scale datasets were considered and the delimitation of syntaxa was based on a critical revision. On the other hand, datasets covering large areas do not automatically yield more reliable results. If, for instance, fringe vegetation had mainly been sampled in one region and grassland vegetation in some other region, this could have lead to artificial values of fidelity. Therefore, the analysis of comprehensive datasets from restricted regions such as the Vienna Woods may be equally important for studying critical cases like the delimitation of the *Trifolio-Geranietea* and *Festuco-Brometea*.

5.2. Unequivocal assignment of relevés

The reassignment of relevés to fringe and grassland vegetation, respectively, suggests that the "summarised percentage cover approach" is practicable and yields reasonable results. The fact that a considerable amount of relevés originally classified as *Geranion sanguinei* was assigned to grasslands, reflects the problems in delimiting fringe communities rather than a poor performance of the assignment method. The unclear status of several diagnostic species (whether they are character or differential species) and the varying plot sizes seem to have had a rather minor effect. Of course, like in other comparable approaches, the performance of this method depends on the quality of the underlying syntaxonomical classification. The "summarised percentage cover approach" has been designed for the unequivocal assignment of relevés to an existing classification system. It might also help to improve these classifications by clarifying the delimitation of higher syntaxa. The percentage of relevés reassigned to the same unit as in the training data set (i.e. the data set that has been used to calculate the diagnostic species) is a measure for the consistency of the classification. However, the method is not a tool to develop a completely new classification. Traditional expert-defined classifications must be evaluated using both supervised and unsupervised methods (DÚBRAVKOVÁ et al. 2010a). The diagnostic value of species has to be validated using statistically sound data sets covering large geographical areas. Although there is no simple distinction between diagnostic and non-diagnostic species (WILLNER et al. 2009), the proposed assignment method should be fairly robust with respect to varying lists of diagnostic species, except if dominant species are concerned. However, I find it quite natural that changes in the diagnostic value of a dominant species have a major impact on the classification of communities.

A possible modification of the method could be to weight percentage cover with the fidelity of the diagnostic species. Yet such a modification would considerably reduce the simplicity of the approach, a simplicity that I regard as a major advantage. Summarised cover values can easily be calculated with standard spreadsheet software, but may even be estimated in the field. In addition, the method could be incorporated into an expert system for the automatic allocation of relevés. Transitional relevés, such as successional stages of abandoned grasslands, are detectable by an unusual high cover score of other syntaxa (e.g. when fringe or woody species invade a grassland plot). Compared to Cocktail definitions, which use a fixed set of species groups, the method is very flexible, and it enables the unequivocal assignment of (almost) all existing relevés to one and only one syntaxon. Of course, further testing with large data sets including multiple classes and many subordinated syntaxa is required.

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Table 2: Percentage constancy and total cover of vascular plant species at the alliance level as well as fidelity (total cover ratio) at the alliance and class level. Except for some diagnostic species, only species with constancy ≥ 10% in at least one column are given. Diagnostic species are ranked by decreasing fidelity. Constancy and total cover values of diagnostic species are shaded, strong diagnostic species are additionally framed. Total cover ratios ≥ 2 are shaded in light grey, ratios ≥ 10 in dark grey. Abbreviations: Gs: *Geranion sanguinei*, Tm: *Trifolion medii*, S-Fp: *Seslerio-Festucion pallentis*, C-B: *Cirsio-Brachypodion*; T-G: *Trifolio-Geranietea*, F-B: *Festuco-Brometea*; TCR: total cover ratio.

Tabelle 2: Prozentuelle Stetigkeit und Totaler Deckungswert der Gefäßpflanzenarten auf Verbandsebene sowie Treue (Deckungsquotient) auf Verbands- und Klassenebene. Mit Ausnahme einiger diagnostischer Arten sind nur Arten, die zumindest in einer Spalte eine Stetigkeit ≥ 10 % erreichen, dargestellt. Die diagnostischen Arten sind nach abnehmender Treue geordnet. Die Stetigkeitswerte der diagnostischen Arten sind grau hinterlegt, jene der starken diagnostischen Arten zusätzlich umrahmt. Deckungsquotienten ≥ 2 sind hellgrau, solche ≥ 10 dunkelgrau hinterlegt. Abkürzungen: Gs: *Geranion sanguinei*, Tm: *Trifolion medii*, S-Fp: *Seslerio-Festucion pallentis*, C-B: *Cirsio-Brachypodion*; T-G: *Trifolio-Geranietea*, F-B: *Festuco-Brometea*; TCR: Deckungsquotient.

	Constancy				Total Cover				TCR Alliances				TCR Classes	
Syntaxon	Gs	Tm	S-Fp	C-B	Gs	Tm	S-Fp	C-B	Gs	Tm	S-Fp	C-B	T-G	F-B
Number of relevés	47	98	102	206	47	98	102	206	47	98	102	206	145	308
Laser trilobum	15	.	.	.	1,57	.	.	.	157,0				78,5	
Elymus hispidus	36	1	2	2	1,79	0,03	0,02	0,03	59,7				36,4	
Geranium sanguineum	62	2	7	8	9,68	0,02	0,04	0,17	56,9				46,2	
Coronilla coronata	19	.	.	1	0,45	.	.	0,02	22,5				22,5	
Peucedanum cervaria	77	2	12	12	4,89	0,14	0,15	0,28	17,5				11,7	
Centaurea triumfettii	28	2	2	4	0,66	0,01	0,01	0,04	16,5				13,4	
Dictamnus albus	38	.	16	5	1,43	.	0,14	0,12	10,2				5,5	
Vincetoxicum hirundinaria	57	4	19	13	1,62	0,04	0,14	0,19	8,5				5,0	
Clematis recta	28	1	1	3	0,62	0,13	0,01	0,03	4,8				18,8	
Cuscuta epithymum	32	.	10	11	0,41	.	0,12	0,15	2,7				1,5	
Aster amellus	38	.	4	13	0,51	.	0,03	0,20	2,6				2,2	
Pulsatilla pratensis subsp. nigricans	19	1	3	4	0,11	0,01	0,03	0,05	2,2				1,4	
Rhamnus saxatilis	21	.	19	5	0,90	.	0,41	0,10	2,2				1,8	
Tanacetum corymbosum	38	17	3	15	0,55	0,23	0,03	0,27	2,0				2,6	
Fragaria moschata	4	56	.	1	0,02	1,52	.	0,01		76,0			154,0	
Viola reichenbachiana	.	33	.	.	.	0,58	.	.		58,0			29,0	
Melampyrum nemorosum	2	15	.	1	0,02	0,86	.	0,01		43,0			44,0	
Viola riviniana	.	29	.	.	.	0,39	.	.		39,0			19,5	
Galium odoratum	.	24	.	.	.	0,34	.	.		34,0			17,0	
Galium aparine	4	27	.	.	0,01	0,28	.	.		28,0			14,0	
Heracleum sphondylium	4	24	.	5	0,02	0,34	.	0,02		17,0			18,0	
Hepatica nobilis	4	26	1	1	0,04	0,48	0,01	0,01		12,0			52,0	
Geum urbanum	6	36	.	1	0,03	0,34	.	0,01		11,3			37,0	
Knautia drymeia	4	49	.	4	0,04	1,15	.	0,11		10,5			10,8	
Agrimonia eupatoria	2	18	.	4	0,02	0,20	.	0,02		10,0			11,0	
Ajuga reptans	.	40	.	5	.	0,40	.	0,04		10,0			10,0	
Vicia sepium	4	30	.	2	0,04	0,28	.	0,03		7,0			10,7	
Calamagrostis epigejos	6	21	.	7	0,06	0,96	.	0,16		6,0			6,4	
Clinopodium vulgare	15	51	.	24	0,19	1,25	.	0,39		3,2			3,7	
Brachypodium pinnatum	72	94	7	62	8,39	20,36	0,43	7,17		2,4			3,8	
Cruciata laevipes	.	42	.	12	.	0,48	.	0,24		2,0			2,0	
Peucedanum alsaticum	21	19	.	8	0,30	0,48	.	0,10		1,6			7,8	
Galium mollugo agg.	13	72	2	23	0,17	1,02	0,02	0,54		1,9			2,1	
Viola hirta	49	72	2	49	0,49	1,11	0,02	0,78		1,4			2,0	
Origanum vulgare	15	9	1	1	0,23	0,17	0,01	0,19	1,2				2,0	
Stipa eriocaulis	2	.	47	1	0,02	.	7,00	0,01			350,0			350,5
Festuca stricta	2	.	54	2	0,02	.	2,88	0,03			96,0			145,5
Allium sphaerocephalon	.	.	31	1	.	.	0,37	0,01			37,0			18,5
Globularia cordifolia	13	.	72	13	0,13	.	7,57	0,27			28,0			60,3
Seseli austriacum	.	.	27	.	.	.	0,27	.			27,0			13,5
Seseli osseum	.	.	22	.	.	.	0,26	.			26,0			13,0
Hornungia petraea	.	.	26	1	.	.	0,51	0,02			25,5			26,5
Jurinea mollis	2	.	43	1	0,02	.	0,47	0,01			23,5			24,0
Thymus praecox	13	.	64	8	0,15	.	3,18	0,11			21,2			21,9
Fumana procumbens	4	.	64	1	0,13	.	2,60	0,01			20,0			20,1
Onosma visianii	.	.	27	.	.	.	0,19	.			19,0			9,5
Campanula sibirica	.	.	24	1	.	.	0,18	0,01			18,0			9,5
Cerastium pumilum agg.	.	.	26	3	.	.	0,63	0,04			15,8			33,5
Poa badensis	9	1	34	1	0,09	0,01	1,12	0,01			12,4			11,2
Arenaria serpyllifolia agg.	2	.	30	3	0,02	.	0,41	0,05			8,2			23,0
Stipa capillata	.	.	21	3	.	.	0,39	0,05			7,8			22,0
Helianthemum canum	4	.	78	20	0,04	.	5,42	0,75			7,2			154,3
Jovibarba hirta	4	.	40	1	0,02	.	0,44	0,07			6,3			25,5
Potentilla incana	11	.	79	29	0,15	.	3,46	0,62			5,6			27,2
Leontodon incanus	9	.	55	11	0,09	.	0,79	0,18			4,4			10,8
Seseli hippomarathrum	4	.	65	13	0,04	.	0,82	0,20			4,1			25,5
Teucrium montanum	15	.	86	26	0,15	.	2,39	0,59			4,1			19,9
Linum tenuifolium	21	.	66	23	0,26	.	1,12	0,36			3,1			5,7
Thlaspi perfoliatum	2	.	23	7	0,02	.	0,31	0,10			3,1			20,5
Melica ciliata	13	.	44	.	0,21	.	0,63	.			3,0			3,0
Sesleria albicans	34	2	76	25	1,56	0,16	6,08	2,19			2,8			4,8
Odontites luteus	21	.	45	19	0,28	.	1,03	0,40			2,6			5,1
Scorzonera austriaca	21	.	64	14	0,38	.	0,97	0,29			2,6			3,3
Orobanche gracilis	4	.	33	16	.	.	0,25	0,10			2,5			17,5
Galium lucidum	6	.	61	8	0,32	.	0,77	0,11			2,4			2,8
Allium flavum	19	.	23	4	0,15	.	0,34	0,04			2,3			2,5
Scabiosa canescens	9	1	39	19	0,09	0,01	0,85	0,39			2,2			12,4
Pulsatilla grandis	19	.	64	28	0,19	.	0,94	0,45			2,1			7,3
Aster linosyris	38	.	60	24	0,60	.	1,24	0,59			2,1			3,1
Carex humilis	19	.	79	32	2,23	.	11,14	5,54			2,0			7,5
Avenula pubescens	2	2	1	36	0,02	0,02	0,01	1,83				91,5		46,0
Linum catharticum	.	.	1	48	.	.	0,01	0,79				79,0		40,0
Carex caryophyllea	.	.	1	21	.	.	0,01	0,56				56,0		28,5
Ononis spinosa	.	2	.	27	.	0,02	.	0,99				49,5		49,5
Rhinanthus minor	2	4	.	26	0,02	0,01	.	0,92				46,0		30,7
Luzula campestris agg.	.	.	.	27	.	.	.	0,46				46,0		23,0
Anthoxanthum odoratum	.	6	.	29	.	0,05	.	1,58				31,6		31,6
Festuca pratensis	.	2	.	22	.	0,02	.	0,55				27,5		27,5
Onobrychis viciifolia	6	2	.	22	0,04	0,04	.	0,85				21,3		10,6
Leucanthemum vulgare agg.	.	3	2	31	.	0,02	0,03	0,52				17,3		27,5
Carlina acaulis	2	1	5	41	.	0,01	0,05	0,73				14,6		78,0
Briza media	9	17	12	58	0,07	0,11	0,11	1,33				12,1		8,0
Trifolium montanum	17	10	1	57	0,21	0,14	0,01	2,42				11,5		6,9
Centaurea jacea	.	27	.	43	.	0,24	.	2,73				11,4		11,4
Plantago media	6	15	14	74	0,04	0,14	0,16	1,37				8,6		8,5
Plantago lanceolata	15	40	7	72	0,11	0,29	0,06	2,12				7,3		5,5
Lotus corniculatus agg.	32	39	21	75	0,32	0,32	0,27	2,12				6,6		3,7
Prunella grandiflora	.	1	11	24	.	0,01	0,13	0,83				6,4		48,0
Leontodon hispidus	2	29	1	58	0,06	0,28	0,01	1,64				5,9		4,9
Ranunculus bulbosus	15	23	.	30	0,11	0,19	.	1,00				5,3		3,3
Bromus erectus	72	52	52	98	5,56	4,13	3,24	28,40				5,1		3,3
Dianthus carthusianorum agg.	21	5	8	29	0,14	0,02	0,10	0,68				4,9		4,9
Poa angustifolia	11	2	1	21	0,15	0,04	0,03	0,68				4,5		3,7
Knautia arvensis	15	22	.	48	0,15	0,24	.	1,08				4,5		2,8
Trifolium pratense	.	27	.	34	.	0,25	.	1,06				4,2		4,2
Galium verum agg.	28	33	.	49	0,40	0,38	.	1,59				4,0		2,0
Stellaria graminea	.	27	.	21	.	0,16	.	0,60				3,8		3,8
Eryngium campestre	21	.	8	23	0,19	.	0,08	0,70				3,7		4,1
Tragopogon orientalis	26	7	.	43	0,16	0,08	.	0,58				3,6		2,4
Taraxacum sect. Ruderalia	.	16	1	25	.	0,15	0,01	0,52				3,5		3,5
Holcus lanatus	.	22	.	20	.	0,17	.	0,54				3,2		3,2
Cirsium pannonicum	15	22	.	33	0,11	0,36	.	1,06				2,9		2,3
Achillea millefolium agg.	57	69	5	81	0,94	0,65	0,05	2,67				2,8		1,7
Campanula glomerata	11	4	1	22	0,11	0,04	0,01	0,30				2,7		2,0
Trisetum flavescens	13	54	.	39	0,15	0,58	.	1,55				2,7		2,1
Salvia pratensis	66	35	7	61	0,73	0,45	0,05	1,84				2,5		1,6
Centaurea scabiosa	72	24	44	67	1,49	0,93	0,42	3,61				2,4		1,7
Sanguisorba minor	36	6	56	50	0,43	0,02	0,65	1,54				2,4		4,9
Pimpinella saxifraga	28	50	24	66	0,26	0,49	0,22	1,16				2,4		1,8
Securigera varia	21	9	2	20	0,26	0,09	0,01	0,61				2,3		1,8
Carex flacca	4	8	1	24	0,30	0,09	0,01	0,65				2,2		1,7
Dactylis glomerata	30	78	3	72	0,36	1,15	0,02	2,38				2,1		1,6
Anthyllis vulneraria	21	1	55	39	0,34	0,01	4,08	2,96			1,4			20,7
Allium senescens subsp. montanum	4	.	33	13	0,04	.	0,32	0,21			1,5			13,3
Scorzonera purpurea	4	.	10	15	0,02	.	0,10	0,16				1,6		13,0
Muscari neglectum	4	.	12	6	0,02	.	0,13	0,13			1,0	1,0		13,0
Globularia punctata	11	.	25	8	0,09	.	0,68	0,35			1,9			11,4
Senecio jacobaea	4	.	14	13	0,04	.	0,14	0,14			1,0	1,0		7,0
Thesium linophyllon	17	3	47	47	0,26	0,03	0,70	1,25				1,8		6,7
Chamaecytisus ratisbonensis	17	.	37	34	0,17	.	0,40	0,63				1,6		6,1
Genista pilosa	19	.	47	26	0,47	.	1,15	0,82			1,4			4,2
Asperula cynanchica	47	.	71	35	0,42	.	0,99	0,72			1,4			4,1
Dorycnium germanicum	62	.	84	37	1,47	.	2,65	1,88			1,4			3,1
Festuca rupicola	32	53	45	62	0,83	1,67	2,41	4,40				1,8		2,7
Scabiosa ochroleuca	43	3	62	37	0,47	0,02	0,54	0,73				1,4		2,6
Seseli annuum	23	.	21	36	0,28	.	0,22	0,45				1,6		2,4
Centaurea stoebe s.lat.	21	.	36	10	0,26	.	0,37	0,16			1,4			2,0
Cerastium holosteoides	.	33	.	23	.	0,15	.	0,28				1,9		1,9
Bupleurum falcatum	62	.	52	42	0,73	.	0,59	0,74				1,0		1,8
Helianthemum nummularium s.lat.	68	10	51	60	1,45	0,10	1,06	1,69				1,2		1,8
Euphorbia cyparissias	72	16	64	51	1,02	0,19	0,84	1,23				1,2		1,7
Teucrium chamaedrys	89	15	53	53	2,43	0,31	2,09	2,26	1,1					1,6
Rumex acetosa	.	24	.	21	.	0,13	.	0,20				1,5		1,5
Adonis vernalis	28	.	22	19	0,45	.	0,30	0,38	1,2					1,5
Filipendula vulgaris	6	50	.	36	0,11	0,69	.	1,16				1,7		1,5
Prunella vulgaris	.	30	.	15	.	0,22	.	0,30				1,4		1,4
Agrostis capillaris	.	31	.	12	.	0,45	.	0,59				1,3		1,3
Ranunculus acris	.	33	.	17	.	0,30	.	0,35				1,2		1,2
Inula ensifolia	64	1	58	32	3,83	0,03	1,84	2,52	1,5					1,1
Stachys recta	45	2	25	18	0,62	0,04	0,24	0,49	1,3					1,1
Fragaria viridis	21	33	2	43	0,98	0,57	0,04	1,66				1,7		1,1
Trifolium medium	13	35	.	10	0,13	0,98	.	1,20				1,2		1,1
Arrhenatherum elatius	36	70	.	41	1,19	1,44	.	2,78				1,9		1,1
Medicago lupulina	26	22	.	20	0,30	0,22	.	0,54				1,8		1,0
Hypericum perforatum	13	39	6	24	0,11	0,46	0,04	0,55				1,2		1,0
Anthericum ramosum	49	1	61	22	1,89	.	1,16	0,76	1,6					1,0
Inula hirta	28	.	22	17	0,83	.	0,45	0,39	1,8					1,0
Betonica officinalis	13	38	.	24	0,13	0,54	.	0,36		1,5			1,9	
Trifolium alpestre	6	22	1	19	0,32	0,43	0,03	0,39		1,1			1,8	
Veronica chamaedrys agg.	11	55	.	29	0,11	0,51	.	0,38		1,3			1,6	
Colchicum autumnale	.	36	.	20	.	0,49	.	0,36		1,4			1,4	
Polygonatum odoratum	40	1	36	4	1,91	0,01	1,25	0,22	1,5				1,3	
Buphthalmum salicifolium	36	13	3	19	0,53	0,17	0,05	0,52	1,0				1,2	
Lathyrus pratensis	.	53	.	20	.	0,48	.	0,40		1,2			1,2	
Vicia tenuifolia	19	48	.	25	0,23	1,51	.	1,45		1,0			1,2	
Campanula persicifolia	9	29	.	7	0,07	0,23	.	0,25				1,1	1,2	
Lathyrus latifolius	21	4	.	9	0,22	0,04	.	0,22	1,0			1,0	1,2	
Primula veris	19	63	.	38	0,15	0,76	.	0,79				1,0	1,2	
Medicago falcata	60	23	11	48	1,26	0,46	0,10	1,60				1,3	1,0	
Woody species														
Quercus pubescens	40	.	6	5	2,50	.	0,14	0,23	10,9				6,8	
Ligustrum vulgare	38	8	3	1	0,49	0,08	0,08	0,01	6,1				6,3	
Viburnum lantana	32	.	2	1	1,43	.	0,04	0,02	35,8				23,8	
Crataegus monogyna	30	13	5	23	0,71	0,15	0,09	0,29	2,4				2,3	
Cornus sanguinea	23	7	3	5	1,81	0,11	0,15	0,04	12,1				10,1	
Prunus spinosa	21	16	2	6	0,81	1,33	0,01	0,10		1,6			19,5	
Fraxinus excelsior	21	15	2	6	0,06	0,27	0,01	0,02		4,5			11,0	
Acer campestre	21	14	4	9	0,14	0,18	0,02	0,04		1,3			5,3	
Cytisus nigricans	21	2	1	2	0,32	0,01	0,01	0,09	3,6				3,3	
Amelanchier ovalis	19	.	44	4	2,39	.	0,63	0,10	3,8				3,3	
Pinus nigra	11	.	36	7	3,62	.	1,39	0,40	2,6				2,0	
Hedera helix	.	29	.	.	.	0,35	.	.		35,0			17,5	
Rubus fruticosus agg.	2	29	.	1	0,02	0,53	.	0,03		17,7			18,3	
Clematis vitalba	15	28	1	3	0,23	1,21	0,03	0,11		5,3			10,3	