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Syntaxonomy and diversity of acidic grasslands in the eastern Rhenish Massif (Western Germany)

Syntaxonomie und Diversität von Silikatmagerrasen im östlichen Rheinischen Schiefergebirge (Westdeutschland)

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Abstract

Colline/submontane acidic grasslands, elements of pre-industrial farming, are declining throughout Central Europe. As they correspond largely to the priority EU habitat type 6230 (Species-rich *Nardus* grasslands), a syntaxonomically sound delimitation is of importance. In the Rhenish Massif (Western Germany), acidic grasslands form diverse and syntaxonomically intricate vegetation patterns. We studied such grasslands in the Lahn-Dill district near Donsbach based on 292 original relevés from 1987. The dataset was classified into nine clusters. The clusters were aligned with syntaxa according to the proportions of diagnostic species. Four associations (with subunits) and one community specified to alliance were distinguished (in brackets corresponding alliances and classes): *Polytricho piliferi-Scleranthetum perennis* (*Hyperico perforati-Scleranthion perennis*, *Sedo-Scleranthetea*), *Airo-Festucetum* (*Thero-Airion*, *Sedo-Scleranthetea*), *Campanulo rotundifoliae-Dianthetum deltoidis* and *Hypericum perforatum-Gnaphalium sylvaticum* community (*Violion caninae*, *Nardetea strictae*), *Arrhenatheretum elatioris ranunculetosum bulbosi* (*Arrhenatherion elatioris*, *Molinio-Arrhenatheretea*). The *Polytricho piliferi-Scleranthetum perennis* and the *Campanulo rotundifoliae-Dianthetum deltoidis*, to our knowledge, are described for the first time for Germany. By NMDS ordination we detected soil fertility and soil acidity as the main drivers for vegetation differentiation followed by moisture-related variables. On average we found 37.7 vascular plant species, 4.3 bryophyte species, and 0.6 lichen species per plot which was on average 15.6 m² in size. Thirty-five threatened vascular plant species, two bryophyte and eight lichen species of the German Red List indicate the area's eminent conservation value. By our study, we extended the national list of syntaxa by two associations and appreciate the diverse acidic grasslands at the eastern edge of the Rhenish Massif.

Keywords: Grassland conservation, habitat type, Hesse, *Molinio-Arrhenatheretea*, *Nardetea*, phytosociology, *Sedo-Scleranthetea*, silicicolous grassland, species-rich grassland, syntaxonomy, vegetation classification

Erweiterte deutsche Zusammenfassung am Ende des Artikels

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1. Introduction

Acidic nutrient-poor grasslands of the colline to submontane zones, also referred to as silicicolous grasslands, are landscape elements of pre-industrial farming systems and in the present rank among the most threatened habitats in Germany and throughout Central Europe (RENNWALD et al. 2002, JANSSEN et al. 2016). Once widespread in the non-calcareous uplands, they have strongly declined due to land-use intensification or abandonment (SCHWABE et al. 2019). Species-rich grasslands in general are increasingly affected by climate change (IPBES 2018, SCHILS et al. 2020). Many acidic perennial grasslands in West and Central Europe are listed as EU priority habitat type 6230 (Species-rich *Nardus* grasslands) which, in the lowland and lower montane zones, is referred to the vegetation alliance *Violion caninae* Schwickerath 1944 (including *Nardo-Galion saxatilis* Preising 1949) (EUROPEAN COMMISSION 2013). Less well-known are *Nardus*-poor acidic grasslands of the *Violion caninae* with varying numbers of species of base-rich sites. They are not uncommon in the drier lee of the mountain ranges in the Rhenish Massif (PEPPLER-LISBACH & PETERSEN 2001). In eastern Central Europe, similar grasslands (with or without *Nardus*) have been studied by, e.g., MORAVEC (1967), ČERNÝ & NEUHÄUSLOVÁ (2006), KRAHULEC et al. (2007), SÁDLO et al. (2007) and ŠKODOVÁ et al. (2015).

Other acidic dry grasslands in the non-calcareous uplands are dominated by taxa of the *Festuca ovina* aggregate. These more or less acid sheep fescue grasslands often show combinations of species considered diagnostic for different syntaxa and, as a consequence, their syntaxonomy has been inconsistent. DENGLER (2004: 315), for instance, listed altogether 26 synonyms for mesic sheep fescue grasslands, while GREGOR (2001) provided a nomenclatural review of 16 association names. Again, the Rhenish Massif is a main area of sheep fescue grasslands in Germany. Local studies were carried out in Central Hesse (BERGMEIER 1987, TEUBER 1998, OTTE et al. 2008, BECKER et al. 2012) as well as in South Westphalia/North Hesse (SCHMITT & FARTMANN 2006) and in adjacent regions (HÜLBUSCH 1982, KORNECK 1993, OBERDORFER 1993a, GREGOR 2001). Beside *Nardus* grasslands and sheep fescue grasslands, the Rhenish Massif is also a priority area of unfertilized mesic meadows which have been studied by NOWAK (1988, 1991, 1992), HIETEL et al. (2004, 2005) and WELLSTEIN et al. (2007).

Many of these studies experienced difficulties when aligning relevés with syntaxa. Therefore, at the class level, BECKER et al. (2012) applied a numeric procedure to align relevés to associations based on the proportions of character species (see also WILLNER 2011, WILLNER et al. 2019). In general, the classification of relevés into entities interpretable as syntaxa is not easy and ambiguous solutions may turn out. There are various reasons for this: (1) Schemes of syntaxa may be incomplete in a given region or out of date. (2) The delineation of syntaxa is geographically context-dependent, i.e., in different regions the same syntaxon may be characterized by different species groups. (3) Below class level, there is no consistent supranational list defining a species' syntaxon-specific diagnostic value. (4) The phytosociological alignment of plant species may differ between regions as a result of differences in frequency, fidelity and local abundance (cover). Standardized methods of assigning relevés to syntaxa have been established (e.g., TICHÝ 2005), but logical definitions may fail to reflect subtle differences, overlaps of communities and dynamic processes in vegetation. In the present study, we extend the numeric approach to align relevés to syntaxa based on the proportions of character species to the order and alliance levels.

Our study area in the Gladenbach Uplands on the eastern edge of the Rhenish Massif is particularly suited for our aim to disentangle and understand acidic grassland communities as it comprises a variety of grassland types, including dry pioneer vegetation, variously acid perennial grasslands and unfertilized mesic meadows. It represents a floristic and syntaxonomical diversity hotspot of acidic grasslands varying in terms of composition and local-scale environmental conditions. Specifically, our research questions are: Which grassland types exist in the area and to which syntaxa do they belong? How valuable are the studied grasslands for nature conservation?

2. Study area

The study area near the village of Donsbach just southwest of Dillenburg in the Lahn-Dill district is located in the Gladenbach Uplands in Central Hesse near the Westphalian border (Fig. 1). The area is located on the eastern edge of the Westerwald in the Rhenish Massif in the German Central Uplands. It is part of the geographical ecoregion *Westerwald-Osthang* or *Dill-Westerwald* (KLAUSING 1988). The 11 study sites (see Table 1) range between 360 and 455 m a.s.l. (mean elevation: 413 m a.s.l.).

The area´s position in the lee of the adjacent ecoregion *Hoher Westerwald* leads to lower precipitation resulting in a moderately warm-temperate suboceanic climate (DEUTSCHER WETTERDIENST 1981). The mean annual precipitation in the area is about 850 mm and the mean annual temperature is about 8 °C. In general, the bedrock of the Rhenish Massif consists of base-poor slate and metamorphic rocks sedimented in the Devonian and Carboniferous (LIPPERT 1970). The study area, however, is located in a 50 km × 40 km large section of the Rhenish Massif where igneous rock such as diabase, picrite and spilite, and more rarely *Schalstein*, commonly occur in addition to slate leading to small-scale alternation of base-rich and acid bedrock (LIPPERT 1970). Locally, Devonian carbonate rock (*Adorf-Plattenkalk*), Devonian sandstone (greywacke) and hematite occur in the area (for exact bedrock names see Table 1). The diversity of rocks causes a variety of soil types supporting highly diverse grasslands. The soil types are mostly shallow brown earth, siliceous initial soils such as leptosol (*Ranker*) and regosol (over Pleistocene frost debris). Rendzic leptosol (*Rendzina*) over limestone occurs in the area, but is rare. Humus forms are mull, mull-moder (the dominant humus form in the grasslands), moder and mor (found under grassland at northern slopes). The potential natural vegetation over igneous rock corresponds to the *Galio odorati-Fagetum* Sougnez et Thill 1959 and the *Mercuriali perennis-Fagetum* Scamoni 1935, and over slate to the *Luzulo luzuloidis-Fagetum* Meusel 1937.

Agriculture and forestry prevail in land use while small-scale mining occurred in the past (GRAFFMANN 2004). Until about the 1980s, agriculture was contingent on smallholder part-time farming, resulting from the prevailing *Realteilung* when land was divided equally among heirs (NOWAK 1988, VOLL 1988). Before World War II, the average farm size was only 2.6 ha and for main livelihood farmers used to work in the local mining and metallurgy (SCHULZE-V. HANXLEDEN 1972). Until World War II or even later, many sites were common land pastured by herds of sheep and cattle. Both ownership and land-use systems ceased step-by-step after the mid-20th century. As from the late 1980s, the grasslands were mostly grazed extensively with sheep or cattle (often Highland cattle) in paddocks without using mineral fertilizer. Close to the village, arable land was used for forage root crop cultivation, potatoes, oats and rye.

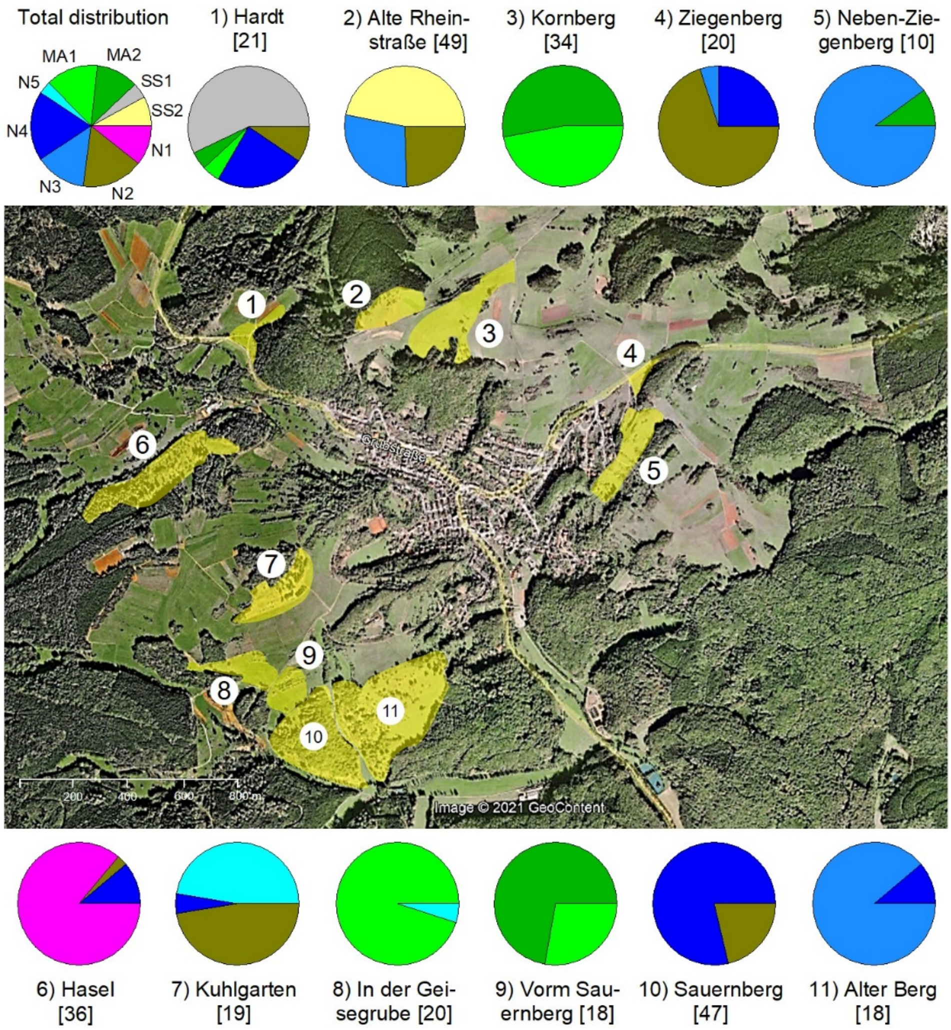

Fig. 1. The study area with the 11 study sites (highlighted in yellow), and the proportions of syntaxa based on relevé numbers per study site: SS1 = *Polytricho piliferi-Scleranthetum perennis*; SS2 = *Airo-Festucetum*; N1–4 = *Campanulo rotundifoliae-Dianthetum deltoidis*: N1 = *Potentilla erecta* variant, N2–4 = *Carex caryophyllea* variant, N2 = *Cladonia arbuscula* subvariant, N3 = *Ranunculus bulbosus* subvariant, N4 = *Trifolium alpestre* subvariant; N5 = *Hypericum perforatum-Gnaphalium sylvaticum* community; MA1–2 = *Arrhenatheretum elatioris ranunculetosum bulbosi*: MA1 = *Bromus erectus* variant, MA2 = *Festuca pratensis* variant. Relevé numbers in square brackets. Google Earth aerial image from 30.06.2002.

Abb. 1. Das Untersuchungsgebiet mit den 11 Untersuchungsflächen (hervorgehoben in Gelb) und den Anteilen der nachgewiesenen Syntaxa auf Basis der angefertigten Aufnahmen pro Untersuchungsfläche. Die Bedeutung der Cluster/Syntaxa-Kürzel geht aus der englischen Abbildungsunterschrift hervor. In eckigen Klammern die Anzahl der Aufnahmen pro Fläche. Google Earth-Luftbild vom 30.06.2002.

Table 1. Geographic overview of the 11 study sites with bedrock, prevailing soils and grassland types. NSG = Nature conservation area, FFH = Natura 2000 site. For the syntaxa abbreviations see Table 2. [1)] Site centre, [2)] mean value across relevés.

Tabelle 1. Geographische Übersicht der 11 Teilgebiete mit ihren Substraten, Böden und Rasentypen. NSG = Naturschutzgebiet, FFH = Schutzgebiet der Fauna-Flora-Habitat-Richtlinie. Zur Bedeutung der Syntaxa-Kürzel siehe Tabelle 2. [1)] Flächenmitte, [2)] Mittelwert über die Aufnahmen.

Study site	WGS coordinates	Altitude m a.s.l.	Slope (°)	Parent rock type (in order of decreasing frequency)	Soil type	Protection status	# re-levés	Syntaxa (no. of relevés)
1 Hardt	N 50.728207° E 8.226185°	420	21	Hemberg red-slate, Nehden slate, Dasberg slate, spilite	Siliceous proto-leptosol	–	21	SS1 (12), N2 (2), N4 (5), MA1 (1), MA2 (1)
2 Alte Rheinstraße	N 50.728832° E 8.233839°	420	6	Hemberg red-slate, Dasberg slate, spilite	Siliceous leptosol, regosol	NSG, FFH	49	SS2 (23), N2 (12), N4 (14)
3 Kornberg	N 50.728504° E 8.236970°	454	10	Dillenburg slate layers, Adorf Plattenkalk, spilite, diabase	Shallow to middle-deep brown earth/regosol, rendzic leptosol	–	34	MA1 (16), MA2 (18)
4 Ziegenberg	N 50.726661° E 8.246846°	440	10	Hemberg red-slate, Dasberg slate	Shallow brown earth	–	20	N2 (14), N3 (1), N4 (5)
5 Neben-Ziegenberg	N 50.724088° E 8.246247°	440	3	Diabase, Dasberg slate, Hangen-berg slate	Siliceous leptosol, shallow brown earth	–	10	N3 (9), MA2 (1)
6 Hasel	N 50.723183° E 8.221211°	390	13	Dasberg slate, Diabase, Hemberg red-slate	Siliceous leptosol-brown earth, brown earth	NSG, FFH	36	N1 (31), N2 (1), N4 (4)
7 Kuhlgarten	N 50.719594° E 8.228119°	435	7	Hemberg red-slate, *Bomben* silt-stone, hematite	Shallow brown earth	FFH	19	N2 (9), N4 (1), N5 (9)
8 In der Geisegrube	N 50.716849° E 8.226364°	390	7	Hemberg red-slate, diabase	Regosol	FFH	20	N5 (1), MA1 (19)
9 Vorm Sauernberg	N 50.715859° E 8.228023°	360	4	Hemberg red-slate, Nehden slate, Dasberg slate, spilite	Shallow to middle-deep brown earth	FFH	18	MA1 (5), MA2 (13)
10 Sauernberg	N 50.714497° E 8.229514°	390	9	Diabase, Dasberg slate, Alaun slate	Siliceous leptosol, shallow brown earth	NSG, FFH	47	N2 (10), N4 (37)
11 Alter Berg	N 50.715441° E 8.233638°	408	12	Diabase, Dasberg slate, Alaun slate	Siliceous leptosol, shallow brown earth	NSG, FFH	18	N3 (2), N4 (16)

Several study sites belong to the Natura 2000 site *Wald und Grünland um Donsbach* (FFH code 5215-308, 230 ha), which includes three nature conservation areas: *Hasel bei Donsbach* (NSG code 1532035, 8 ha), *An der alten Rheinstraße* (NSG code 1532030, 24 ha) and *Alteberg und Sauernberg* (NSG code 1532029, 40 ha) (see Table 1).

3. Methods

3.1 Vegetation records and soil analyses

Between May and August 1987, 292 relevés were sampled including vascular plants, bryophytes and lichens (if present) using the Braun-Blanquet method (DIERSCHKE 1994). The relevés were roughly evenly distributed across the grassland area with the aim to have all main grassland types represented by sufficient sample units. The number of relevés per site ranged from 10 to 49 (mean: 26.5 relevés per site) (see Table 1). Since the area of acidic grasslands was relatively large, the relevés of similar habitats were widely scattered to avoid autocorrelation. Most vegetation plots were visited at least twice to spot late-flowering species. The size of the plots was adapted to sections of homogenous vegetation of 0.5–10 m² (mean: 3.2 m²) in annual-dominated vegetation and 2–25 m² (mean: 17 m²) in perennial grasslands. During the time of sampling, most grasslands were managed but about 10% of the plots were in abandoned sites. The taxonomy of the vascular plants, bryophytes and lichens follows HAND et al. (2022), KOPERSKI et al. (2000) and WIRTH et al. (2011), respectively. In selected plots, the soil profile was checked using a spade and in 166 of the plots, the top soil was sampled (a mixed composite of five subsamples each) to measure pH in H_2O and KCl using a standard pH meter.

3.2 Vegetation classification

Bryophytes and lichens were included in the data set for classification while juvenile trees and shrubs were excluded. In the vegetation tables, however, trees and shrubs were included for the sake of completeness. A three-stage procedure was used to classify the relevés: First, a cluster analysis was carried out using the program PC-ORD 6.0 (MCCUNE & MEFFORD 2011). The Braun-Blanquet cover values were converted into median percentages of the corresponding cover degree and log $(x + 1)$ transformed in order to avoid the process being dominated by a few highly abundant species. The Sørensen coefficient was used as distance measure and the flexible β method with $\beta = -0.25$ as the cluster algorithm. In the second step, the cut level in the cluster tree (and thus the number of clusters) was determined using hierarchical cluster analysis with stepwise increasing the number of clusters from two to 12 clusters. The quality of the 11 cluster analyses was determined by indicator species analysis (PC-ORD; MCCUNE & GRACE 2002) according to the number of significant ($p < 0.05$) indicator species and the mean p value of all species. Finally, the cluster analysis with the lowest mean p value was selected.

The third step of our classification involved a standardized syntaxonomic assignment of the groups of relevés (clusters) by a top-down "summarised presence" approach. Eleven alliances, nine orders and six classes were preselected according to the structure and general floristic composition of the studied vegetation following the German conspectus of vegetation types (BERGMEIER 2020) in line with the European Vegetation Checklist (EuroVegChecklist; MUCINA et al. 2016) (Supplement E1). The fringe vegetation of the *Trifolio-Geranietea* was included (divided in orders on acidic and base-rich soil, respectively) as it may be relevant in abandoned grasslands. *Calluno-Ulicetea* heathland communities were included as a potentially important component associated with acidic grasslands. The class *Festuco-Brometea* was included as calcareous grasslands have species in common with acidic grass-lands and because it appeared possible that some stands might be affiliated to this class. Then, the syntaxonomic affiliation of the species in the relevés was assigned following pertinent standard works, OBERDORFER (1993b, 2001), BERG et al. (2001, 2004), PEPPLER-LISBACH & PETERSEN (2001) (for the *Nardetalia*), and JÄGER (2017), and own expertise of T.B. and E.B., with the syntaxonomy adapted to the EuroVegChecklist (MUCINA et al. 2016) (Supplement E2). Generally, the species' syntaxonomic affiliation differed relatively little between the sources and if so, an expert-based decision was taken. If a species was diagnostic for more than one syntaxon, it was included proportionally (e.g., with 0.5 each in the case of two syntaxa involved or 0.333 in the case of three; BAYINDIR 2016). We calculated sums of diagnostic species weighted and not weighted by cover class but, since the results did not differ much, only the unweighted sums were used. Finally, we determined *phi* values of species within clusters, vegetation classes and a number of overarching groups. Species with $phi \geq 0.5$ were considered to be highly diagnostic and those with $phi \geq 0.25$ as diagnostic (CHYTRÝ 2002), provided the concentration was significant according to Fisher's exact test at $\alpha = 0.05$.

3.3 Environmental and vegetation variables

Slope and aspect were measured in the field using inclinometer and compass. The circular scale of aspect was transformed into a linear scale (0–180°) named 'southernness'. Information on geology was obtained from geological maps, scale 1:25 000 (LIPPERT 1970). We calculated mean unweighted Ellenberg indicator values (EIVs) for light, temperature, continentality, moisture, soil reaction and nutrients (ELLENBERG et al. 2001), and mean cover-weighted grassland management values (GMVs) for trampling tolerance, cutting tolerance, grazing tolerance, and fodder quality (BRIEMLE et al. 2002). Unweighted EIVs and cover-weighted GMVs produced most convincing results (cf. BRIEMLE et al. 2002, BECKER & BECKER 2010). Finally, we assessed occurrences of threatened plants per plot, based on the Red Lists of vascular plants, bryophytes and lichens of Germany (WIRTH et al. 2011, CASPARI et al. 2018, METZING et al. 2018) and Hesse (HMILFN 1996, HMUELV 2013, HLNUG 2019).

3.4 Further statistics

Floristic gradients were studied by non-metric multidimensional scaling (NMDS) with 250 runs using PC-ORD 6.0 (MCCUNE & GRACE 2011). Cover values were transformed in the same way as for cluster analysis. The Sørensen coefficient (Bray-Curtis) was used as distance metrics. A Monte-Carlo permutation test resulted highly significant ($p < 0.01$) in small stress. The final stress for the two-dimensional NMDS solution was 12.1. Relationships between NMDS gradients and environmental or vegetation variables were analysed by pairwise correlations with SPSS 22 (IBM 2013). The environmental/vegetation variables were plotted post-hoc on the NMDS diagram. The *p* values were corrected after Bonferroni by the number of tests (MILLER 1981). Differences of variables among the syntaxa were tested by simple ANOVA with subsequent Tukey post hoc tests using SPSS 22. Normal distribution of the residuals was checked visually by histograms.

4. Results

4.1 Classification

The mean *p*-value of all species after hierarchical cluster analysis with increasing number of clusters was lowest and the number of significant ($p < 0.05$) indicator species according to indicator species analysis was nearly highest at the level of nine clusters, which is why the cluster tree was cut here (see Supplement E3). The first branch of the cluster tree separated the clusters 8–9 (in the following MA1–2, of the *Molinio-Arrhenatheretea*), the second branch separated the clusters 1–2 (SS1–2, *Sedo-Scleranthetea*), and the third and fourth branches divided the remaining clusters into several sub-groups comprising the clusters 3–7 (N1–5, *Nardetea*) (Supplement E4). Based on their proportions of diagnostic species indicating classes, orders and alliances (Fig. 2), the nine clusters were assigned to four associations (in as many alliances and orders) and one community specified to alliance.

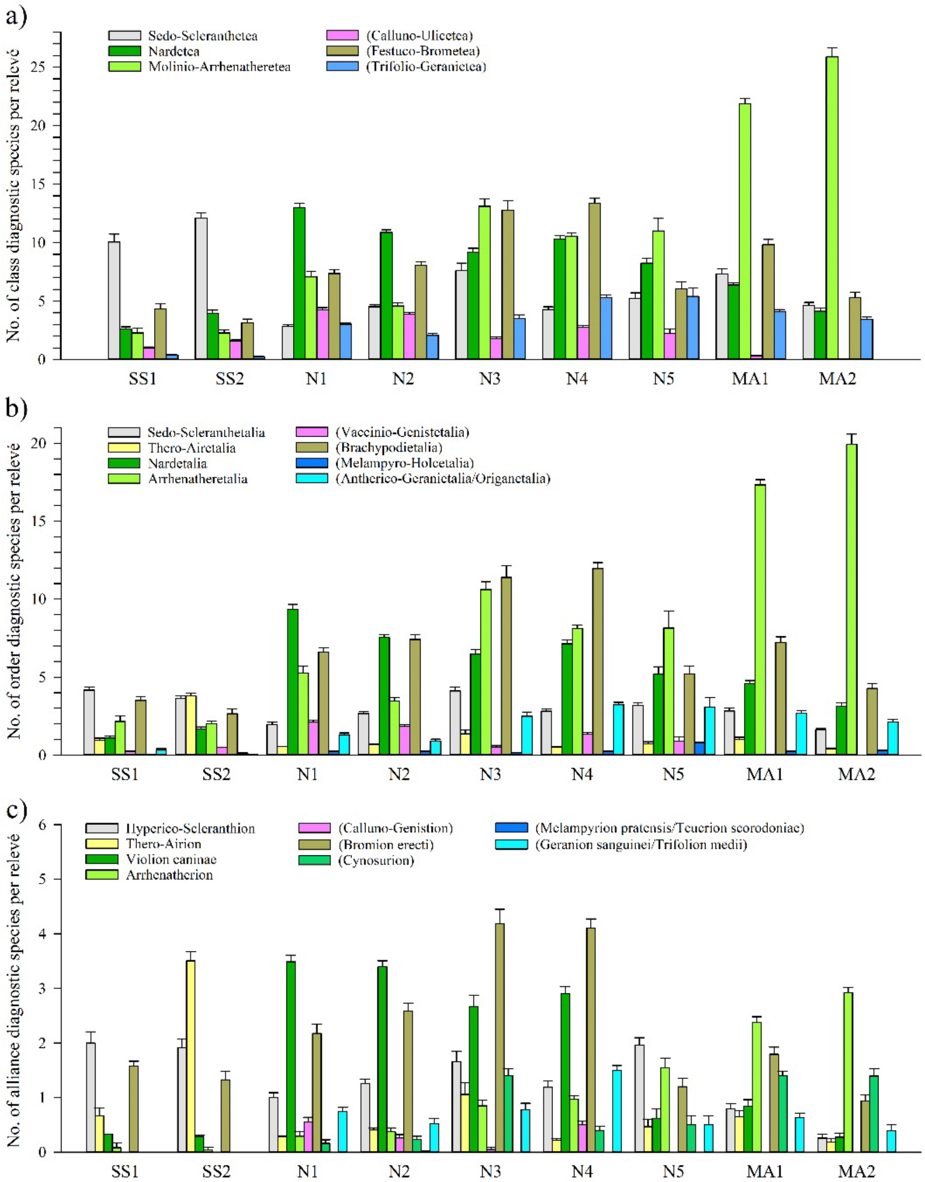

Fig. 2. Sums of diagnostic species of selected (a) classes, (b) orders, and (c) alliances in the nine vegetation clusters based on unweighted species data. Mean values and simple standard errors are shown. Syntaxa in brackets (in the legend) had been evaluated but clusters had not been aligned to these syntaxa. SS1 = *Polytricho piliferi-Scleranthetum perennis*; SS2 = *Airo-Festucetum*; N1–4 = *Campanulo rotundifoliae-Dianthetum deltoidis*: N1 = *Potentilla erecta* variant, N2–4 = *Carex caryophyllea* variant: N2 = *Cladonia arbuscula* subvariant, N3 = *Ranunculus bulbosus* subvariant, N4 = *Trifolium alpestre* subvariant; N5 = *Hypericum perforatum-Gnaphalium sylvaticum* [*Violion caninae*] community; MA1–2 = *Arrhenatheretum elatioris ranunculetosum bulbosi*: MA1 = *Bromus erectus* variant, MA2 = *Festuca pratensis* variant. Because of different plot sizes: Only compare sums of diagnostic species within (not between) vegetation clusters.

Syntaxonomic overview of the nine clusters

Sedo-Scleranthetea Br.-Bl. 1955
Sedo-Scleranthetalia Br.-Bl. 1955
Hyperico perforati-Scleranthion perennis Moravec 1967
Polytricho piliferi-Scleranthetum perennis Moravec 1967 [cl. 1, SS1]

Thero-Airetalia Rivas Goday 1964
Thero-Airion Tx. ex Oberd. 1957
Airo-Festucetum Sommer 1971 [cl. 2, SS2]

Nardetea strictae Rivas Goday et Borja Carbonell in Rivas Goday et Major López 1966
Nardetalia strictae Preising 1950
Violion caninae Schwickerath 1944
Campanulo rotundifoliae-Dianthetum deltoidis Balátová-Tuláčková 1980
– *Potentilla erecta* variant [cl. 3, N1]
– *Carex caryophyllea* variant
– *Cladonia arbuscula* subvariant [cl. 4, N2]
– *Ranunculus bulbosus* subvariant [cl. 5, N3]
– *Trifolium alpestre* subvariant [cl. 6, N4]
Hypericum perforatum-Gnaphalium sylvaticum community [cl. 7, N5]

Molinio-Arrhenatheretea Tx. 1937
Arrhenatheretalia elatioris Tx. 1931
Arrhenatherion elatioris Luquet 1926
Arrhenatheretum elatioris ranunculetosum bulbosi Knapp 1954
– *Bromus erectus* variant [cl. 8, MA1]
– *Festuca pratensis* variant [cl. 9, MA2]

4.1.1 *Polytricho piliferi-Scleranthetum perennis* (cl. 1, SS1, Supplement E5)

Floristic characterisation: This community with on average 20.9 species of vascular plants, bryophytes and lichens per 0.8 m² (Supplement E6) was found to be characterized by its distinct suite of *Sedo-Scleranthetea* species including mainly perennial species and lichens of the *Sedo-Scleranthetalia* and *Hyperico-Scleranthion*, while annual species of the *Thero-Airetalia* were scarce (Fig. 2). The association, although poorly equipped with character species, is identified by its overall species combination as well as by the absence of diagnostic species of other syntaxa (Table 2). The most prominent perennial grass was *Festuca guestfalica*, a taxon of the *F. ovina* group. Typically, but infrequently, a few species

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Abb. 2. Summen der diagnostischen Arten ausgewählter (a) Klassen, (b) Ordnungen und (c) Verbände in den neun Vegetationsclustern auf der Basis von ungewichteten Artdaten. Mittelwerte und einfache Standardfehler sind dargestellt. Syntaxa in Klammern (in der Legende) wurden zwar untersucht, aber die Cluster nicht diesen Syntaxa zugewiesen. Die Bedeutung der Cluster/Syntaxa-Kürzel geht aus der englischen Abbildungsunterschrift hervor. Wegen unterschiedlicher Plotgrößen: Vergleiche die Summen der diagnostischen Arten nur innerhalb der Vegetationscluster (nicht zwischen den Vegetationsclustern).

Table 2. Vegetation types of the nutrient-poor grasslands around Donsbach classified according to a cluster analysis. Percent constancy values and fidelity degrees are shown $\phi > 0.5 \rightarrow$ **, $\phi > 0.25 \rightarrow$ *, $\phi > 0.0 \rightarrow$ °. Species with > 50% constancy and highest fidelity in boldface. Local character species of the classes are highlighted in dark grey, of the associations and an equally-ranked community in middle grey, and of variants and subvariants (and groups of these) in light grey. Only species with $\phi > 0.0$ in at least one group are shown. The diagnostic species are arranged within groups according to decreasing constancy. Species that are diagnostic for more than one unit are listed under the unit with the higher *phi*-value. SS1 = *Polytricho piliferi-Scleranthetum perennis*; SS2 = *Airo-Festucetum*; N1–4 = *Campanulo rotundifoliae-Dianthetum deltoidis*: N1 = *C.-D., Potentilla erecta* variant; N2 = *C.-D., Carex caryophyllea* variant, *Cladonia arbuscula* subvariant; N3 = *C.-D., Carex caryophyllea* variant, *Ranunculus bulbosus* subvariant; N4 = *C.-D., Carex caryophyllea* variant, *Trifolium alpestre* subvariant; N5 = *Hypericum perforatum-Gnaphalium sylvaticum* community; MA1–2 = *Arrhenatherum elatioris ranunculetosum bulbosi*: MA1 = *A. r., Bromus erectus* variant; MA2 = *A. r., Festuca pratensis* variant.

Tabelle 2. Gesellschaften der Silikatmagerrasen um Donsbach geordnet nach einer Clusteranalyse. Angegeben sind Prozentstetigkeiten und Treuegrade $\phi > 0{,}5 \rightarrow$ **, $\phi > 0{,}25 \rightarrow$ * und $\phi > 0{,}0 \rightarrow$ °. Höchsttreue Arten mit Stetigkeit > 50% sind fett dargestellt. Die lokalen Kennarten der Klassen sind dunkelgrau hinterlegt, die der Assoziationen und einer gleichrangigen Gesellschaft mittelgrau und die der Varianten und Subvarianten sowie Gruppen davon hellgrau. Nur Arten mit einem ϕ-Wert > 0,0 in mindestens einer Gruppe sind dargestellt. Die diagnostischen Arten sind innerhalb der Gruppen nach abnehmender Stetigkeit angeordnet. Arten, die für mehr als eine Einheit diagnostisch sind, wurden in der Einheit mit dem/den höheren *phi*-Wert/en aufgeführt. Zur Bedeutung der Cluster/Syntaxa-Kürzel siehe die englische Tabellenüberschrift.

Cluster	SS1	SS2	N1	N2	N3	N4	N5	MA1	MA2
Number of relevés	12	23	31	48	40	54	10	41	33
Mean relevé size (m²)	0.8	4.5	17	15	17	16	22	17	22
Mean cover vascular plants (%)	34	65	89	78	88	87	94	97	99
Mean cover bryophytes and lichens (%)	40	62	87	77	77	57	44	37	22
Mean species richness vascular plants per relevé	15.4	17.2	35.7	30.5	44.0	44.6	36.5	47.0	42.1
Mean species richness bryophytes per relevé	2.1	4.4	4.5	5.0	5.0	4.7	6.2	3.5	3.1
Mean species richness lichens per relevé	3.4	2.3	0.1	1.2	0.3	0.2	0.4	0.0	0.0
Sedo-Scleranthetea									
Cladonia furcata	**100 ****	**87 ***	**3**	**38 °**	**18**	**13**	**20**	**2**	**.**
Hypnum lacunosum	**92 ****	**91 ****	**.**	**.**	**22**	**.**	**.**	**.**	**.**
Cetraria aculeata	**42**	**57 ****	**.**	**.**	**2**	**.**	**.**	**.**	**.**
Ceratodon purpureus	42 *	52 *	.	6	2	4	.	2	.
Polytricho piliferi-Scleranthetum perennis									
Petrosedum rupestre	**92 ****	**.**	**.**	**4**	**8**	**6**	**.**	**.**	**.**
Sedum acre	**75 ****	**.**	**.**	**.**	**.**	**.**	**.**	**.**	**.**
Cladonia rangiformis	**75 ****	**17 °**	**.**	**2**	**5**	**2**	**.**	**.**	**.**
Cladonia foliacea	**67 ****	**30 °**	**.**	**.**	**.**	**.**	**.**	**.**	**.**
Thymus pulegioides	100 *	61	45	67 °	80 °	85 °	20	12	.
Senecio jacobaea	42 *	.	.	4	15	19	10	34 °	12
Trifolium arvense	33 *	.	.	.	8	2	10	5	.
Echium vulgare	25 *	.	.	.	.	.	.	.	.
Petrorhagia prolifera	25 *	.	.	.	.	.	.	.	.
Cladonia fimbriata	25 *	4	.	10 °	.	.	.	2	.
Erodium cicutarium	17 *	.	.	.	.	.	.	.	.
Myosotis stricta	17 *	.	.	2	.	.	.	.	.
Peltigera cf. *Rufescens*	8 *	.	.	.	.	.	.	.	.
Phleum nodosum	8 *	.	.	.	.	.	.	.	.
Airo-Festucetum									
Aira caryophyllea	**.**	**96 ****	**.**	**.**	**8**	**.**	**.**	**.**	**.**
Hypochaeris radicata	**.**	**96 ****	**6**	**40 °**	**50 °**	**6**	**50**	**17**	**.**
Polytrichum juniperinum	**25**	**91 ****	**.**	**40 °**	**12**	**6**	**.**	**2**	**.**

Cluster	SS1	SS2	N1	N2	N3	N4	N5	MA1	MA2
Teesdalia nudicaulis	**.**	**87 ****	**.**	**2**	**15**	**.**	**.**	**.**	**.**
Aira praecox	**.**	**78 ****	**.**	**.**	**8**	**.**	**.**	**.**	**.**
Scleranthus perennis	**.**	**78 ****	**.**	**.**	**8**	**.**	**.**	**2**	**.**
Polytrichum piliferum	**8**	**74 ****	**.**	**2**	**.**	**.**	**.**	**.**	**.**
Rumex acetosella	42	100 *	6	60 °	40	15	40	2	.
Scleranthus polycarpos	.	26 *	.	.	2	.	.	.	.
Poa annua	.	22 *	.	.	2	.	.	.	.
Filago minima	.	13 *	.	.	.	.	.	.	.
Campanulo rotundifoliae-Dianthetum deltoidis									
Galium pumilum	.	.	100 *	62 °	60 °	76 *	30	.	.
Danthonia decumbens	.	.	97 *	96 *	65 °	76 *	10	.	.
Campanula rotundifolia	.	4	100 *	100 *	72	96 *	70	61	24
Viola canina	.	.	100 *	92 *	62	96 *	10	10	.
Helictochloa pratensis	.	.	94 *	81 *	62	94 *	10	10	.
Avenella flexuosa	.	.	100 *	92 *	18	65 °	70	.	.
Pleurozium schreberi	.	22	100 *	100 *	65	89 *	90 *	7	.
Fragaria vesca	.	.	81 *	21	12	69 *	30	2	.
Crataegus spec. juv.	.	4	84 *	48	50	56 °	50	10	24
Cirsium acaulon	.	.	74 *	42	40	67 *	.	12	.
Genista germanica	.	.	55 *	25	5	50 *	.	.	.
Prunus spinosa juv.	.	.	42 *	21	20	48 *	.	2	.
Platanthera bifolia	.	.	16 °	.	.	15 °	.	.	.
C.-D., Potentilla erecta variant									
Hylocomium splendens	**.**	**.**	**90 ****	**17**	**25**	**37 °**	**.**	**2**	**.**
***Ranunculus polyanthemos* s.l.**	**.**	**.**	**87 ****	**2**	**2**	**28 °**	**.**	**.**	**.**
Potentilla erecta	**.**	**.**	**81 ****	**6**	**.**	**26 °**	**.**	**.**	**.**
Carex pilulifera	**.**	**.**	**58 ****	**.**	**.**	**.**	**.**	**.**	**.**
***Corylus avellana* juv.**	**.**	**.**	**55 ****	**10**	**2**	**24 °**	**.**	**.**	**.**
Hieracium lachenalii	.	.	39 *	8	.	4	10	12	.
Luzula multiflora	.	.	26 *	2	.	.	.	.	.
Holcus mollis	.	.	23 *	2	.	.	.	.	.
Arnica montana	.	.	19 *	.	.	2	.	.	.
Rhamnus cathartica juv.	.	.	6 °	.	.	.	.	.	.
C.-D., Potentilla* var. & *Carex* var., *Cladonia subvar.									
Calluna vulgaris	.	.	90 *	92 *	12	41	30	.	.
Veronica officinalis	.	.	97 *	75 *	25	46	40	.	.
Pinus sylvestris juv.	.	4	32 *	50 *	.	6	.	.	.
Hypnum jutlandicum	.	.	45 *	25 °	2	4	10	.	.
Polytrichum formosum	.	.	26 °	27 °	.	.	20	.	.
***C.-D., Carex caryophyllea* var.**									
Polygala vulgaris subsp. *vulgaris et oxyptera*	.	.	23	71 *	58 *	28	.	5	.
Carex caryophyllea	8	17	.	60 °	65 *	81 *	30	12	3
Genista tinctoria	.	.	23	77 *	22	61 *	20	.	.
Helianthemum nummularium ssp. *Obscurum*	.	.	26	62 *	38	74 *	.	.	.
Carpinus betulus juv.	.	.	.	21 *	.	15 °	.	.	.
***C.-D., Carex var., Cladonia arbuscula* subvar.**									
Dicranum scoparium	17	30	35	75 *	42	33	20	10	.
Cladonia arbuscula	.	13	6	31 *	.	2	.	.	.
Antennaria dioica	.	.	.	21 *	.	.	.	.	.
Barbilophozia barbata	.	.	.	12 *	.	.	.	.	.
Ptilidium ciliare	.	.	.	10 *	.	.	.	.	.
Cladonia spec.	.	.	.	8 *	.	.	.	.	.
Cladonia macilenta	.	.	.	8 *	.	.	.	.	.
***C.-D., C. c.* var., *Ranunculus bulbosus* subvar.**									
Taraxacum sect. *Erythrosperma*	.	30 °	.	.	40 *	.	.	37 *	.
Linum catharticum	.	.	.	.	28 *	2	.	.	.

Cluster	SS1	SS2	N1	N2	N3	N4	N5	MA1	MA2
Myosotis discolor	.	9	.	2	20 *	.	.	.	.
Carlina vulgaris	.	.	.	2	20 *	4	.	.	.
Trifolium striatum	.	.	.	.	20 *	.	.	2	.
Prunella vulgaris	.	.	.	.	18 *	.	.	2	.
Carlina acaulis subsp. *Caulescens*	.	.	.	.	10 *	.	.	.	.
***C.-D., Carex var., Ranunculus* subvar. & *Trifolium* subvar.**									
Koeleria pyramidata	8	.	.	12	55 *	67 *	.	5	.
Briza media	.	.	.	12	42 °	69 *	.	46 °	6
Ononis repens subsp. *Procurrens*	.	.	16	25	42 °	59 *	20	27	.
***C.-D., Carex* var., *Trifolium alpestre* subvar.**									
Trifolium alpestre	.	.	.	21	30	63 **	.	.	.
Trifolium medium	.	.	74 °	31	48	87 *	50	63 °	33
Quercus spec. juv.	.	.	23	33 °	12	50 *	.	.	.
Carex flacca	.	.	.	2	5	30 *	.	.	.
Galium aparine	.	.	.	.	.	11 *	.	.	.
Brachypodium sylvaticum	.	.	.	.	.	7 *	.	.	.
***C.-D., Carex var., Ranunculus* subvar. & *Trifolium* subvar. & *Hypericum-Gnaphalium* comm.**									
Pseudoscleropodium purum	.	9	52	35	82 *	89 *	60	2	3
Agrimonia eupatoria	.	.	.	.	45 *	33 °	50 *	5	9
Viola hirta	8	.	.	2	45 *	44 *	10	10	3
***Hypericum perforatum-Gnaphalium sylvaticum* comm.**									
Gnaphalium sylvaticum	.	.	.	2	.	.	80 **	.	.
Solidago virgaurea	.	.	45 *	12	2	17	80 **	.	.
Hieracium laevigatum	.	.	.	12	2	7	70 **	7	3
Campanula rapunculus	.	.	.	.	8	2	70 **	22 °	9
Epilobium angustifolium	.	.	3	2	.	.	60 **	5	.
Clinopodium vulgare	.	.	.	.	.	7	60 **	7	9
Convolvulus arvensis	.	.	.	.	.	.	50 **	.	12 °
Hypericum perforatum	8	35	23	38	40	37	100 *	41	21
Rosa spec. juv.	.	4	13	29 °	18	17	60 *	5	6
Daucus carota	8	.	.	.	28 °	2	40 *	12	9
Verbascum nigrum	.	.	.	.	.	.	20 *	.	.
Jasione montana	.	.	.	6 °	.	.	20 *	.	.
Brachythecium albicans	8	13	.	19	30	4	80 *	61 *	15
Lophocolea bidentata	.	.	.	15	8	7	50 *	27 °	39 °
Salix caprea juv.	.	.	.	.	.	.	10 *	.	.
Rubus idaeus juv.	.	.	.	.	.	.	10 *	.	.
Juncus conglomeratus	.	.	.	.	.	.	10 *	.	.
Plagiothecium spec.	.	.	.	.	.	.	10 *	.	.
Arrhenatherum ranunculetosum bulbosi									
Rhinanthus minor	.	.	.	.	18	4	10	100 **	91 **
Crepis biennis	.	.	.	.	2	.	.	80 **	88 **
Cerastium holosteoides	.	9	6	2	52 °	15	.	98 **	91 *
Veronica arvensis	.	39	.	4	35	.	.	93 *	94 **
Trifolium pratense	.	.	.	.	58 °	7	20	98 **	88 *
Leucanthemum ircutianum	.	.	.	.	28	28	40	95 **	70 *
Galium album	.	.	3	4	18	17	50	71 *	94 **
Saxifraga granulata	8	9	3	2	20	13	.	98 **	61 *
Heracleum sphondylium	.	.	.	.	.	4	10	68 *	76 **
Tragopogon pratensis	17	.	.	.	2	4	.	56 *	82 **
Arrhenatherum elatius	8	4	29	38	68	89 °	100 *	100 *	100 *
Trisetum flavescens	8	4	42	10	88 °	72 °	70	100 *	100 *
Rumex acetosa	.	.	84 °	6	58	76 °	60	98 *	100 *
Dactylis glomerata	8	4	6	.	60 °	46	60	100 *	94 *
Trifolium repens	.	.	10	10	78 *	24	50	95 *	88 *
Holcus lanatus	.	.	16	4	45	26	30	98 *	85 *

Cluster	SS1	SS2	N1	N2	N3	N4	N5	MA1	MA2
Vicia angustifolia	.	.	6	4	48	17	70 *	80 *	97 *
Trifolium dubium	.	4	3	.	50 °	6	10	88 *	85 *
Taraxacum sect. *Ruderalia*	17	.	23	4	52 °	19	10	76 *	91 *
Ranunculus bulbosus	.	17	10	21	95 *	35	.	80 *	70 °
Brachythecium rutabulum	.	.	.	2	2	15	90 *	54 °	88 *
Vicia hirsuta	25	.	3	.	32	6	50	49 °	79 *
Myosotis ramosissima	.	26	.	2	18	4	.	71 *	48 *
Primula veris	.	.	6	2	50 °	61 *	10	78 *	27
Plantago media	.	.	.	.	48 *	17	.	66 *	36 °
Centaurea scabiosa	.	.	.	2	10	6	10	44 *	24 °
Colchicum autumnale	.	.	.	.	.	.	.	27 *	21 *
Campanula glomerata	.	.	.	.	2	2	.	29 *	15 °
Valerianella locusta et *carinata*	.	.	.	.	.	.	.	22 *	18 °
***A. ranunculetosum, Bromus erectus* var.**									
Anthoxanthum odoratum	8	.	87 °	54	78	67	80	100 *	73
Centaurea jacea	8	4	6	42	75 °	76 °	60	90 *	55
Sanguisorba minor	67	.	19	10	65 °	91 *	10	83 *	24
Draba verna	25	22	.	.	18	.	.	49 *	12
Cerastium brachypetalum	.	13	.	2	8	2	.	46 *	18
Alchemilla glaucescens	.	.	.	2	18	11	.	44 *	18
Arabidopsis thaliana	17	4	.	.	10	2	.	34 *	15
Bromus erectus	.	.	.	.	2	.	.	29 *	6
Salvia pratensis	.	.	.	.	.	.	.	20 *	9
Silene nutans	.	.	.	.	.	2	.	15 *	.
***A. ranunculetosum, Festuca pratensis* var.**									
Anthriscus sylvestris	**.**	**.**	**.**	**.**	**10**	**7**	**20**	**46 °**	**91 ****
Poa trivialis	**.**	**.**	**.**	**.**	**.**	**2**	**20**	**27 °**	**88 ****
Festuca pratensis	**.**	**.**	**.**	**.**	**8**	**2**	**.**	**17**	**79 ****
Bromus hordeaceus	**.**	**13**	**.**	**.**	**2**	**.**	**.**	**24 °**	**70 ****
Lathyrus pratensis	**.**	**.**	**.**	**.**	**12**	**.**	**.**	**34 °**	**61 ****
Alopecurus pratensis	**.**	**.**	**.**	**.**	**.**	**.**	**.**	**22 °**	**58 ****
Carum carvi	**.**	**.**	**.**	**.**	**.**	**.**	**.**	**15 °**	**42 ****
Ranunculus repens	**.**	**.**	**.**	**.**	**.**	**.**	**.**	**2**	**30 ****
Veronica chamaedrys	.	.	52	10	58 °	52	30	59 °	85 *
Alchemilla monticola	.	.	3	.	2	31 °	20	12	58 *
Equisetum arvense	.	.	.	.	.	.	.	.	24 *
Ranunculus acris	.	.	.	.	.	.	.	.	24 *
Medicago lupulina	.	.	.	.	.	.	.	2	24 *
Vicia sepium	.	.	.	.	2	2	10	.	21 *
Lolium perenne	.	.	.	.	2	.	.	.	18 *
Cirsium arvense	.	.	.	.	.	2	.	.	15 *
Phleum pratense	.	.	.	.	2	.	.	.	12 *
Cirsium palustre	.	.	.	.	.	2	.	2	12 *
Deschampsia cespitosa	.	.	.	.	.	2	.	2	12 *
Urtica dioica	.	.	.	.	.	.	.	.	9 *
Geranium dissectum	.	.	.	.	.	.	.	.	9 *
Further species									
Pimpinella saxifraga	83	57	97	100 °	100 °	98	100	95	85
Achillea millefolium	67	57	100	94	100 °	96	100	90	97
Plantago lanceolata	50	100	74	81	100 °	100 °	90	100 °	85
Agrostis capillaris	83	100 °	100 °	100 °	95 °	100 °	100	56	39
Festuca guestfalica	100	100 °	100 °	100 °	100 °	94 °	100	37	3
Luzula campestris	.	87	100 °	98 °	100 °	98 °	100	100 °	21
Rhytidiadelphus squarrosus	8	30	94 °	60	95 °	96 °	80	93 °	79
Hieracium pilosella	100 °	87 °	84 °	94 °	85 °	54	80	39	.
Galium verum	8	52	77	83	95 °	98 °	100	63	42

Cluster	SS1	SS2	N1	N2	N3	N4	N5	MA1	MA2
Poa angustifolia	75	.	45	27	88 °	91 °	70	95 °	100 *
Festuca rubra agg.	.	9	97 °	42	60	81 °	100 *	98 *	79
Avenula pubescens	.	.	71	46	90 °	100 *	50	93 °	97 *
Lotus corniculatus	25	4	84 °	71	92 °	94 *	50	66	39
Potentilla verna	100 *	65	39	69	88 °	93 *	20	29	.
Knautia arvensis	8	.	84 °	50	62	89 °	70	88 °	48
Plagiomnium affine	.	17	10	46	78 °	83 °	100 *	83 °	73
Leontodon hispidus	8	.	48 °	10	32	44 °	.	46 °	21
Dianthus deltoides	33	35 °	10	12	20	22	40	2	.
Stellaria graminea	.	.	19	4	25	41 °	10	29	42 °
Vicia cracca	.	.	16	.	.	24 °	30	12	36 °
Euphrasia officinalis subsp. *Pratensis*	.	4	3	21	30 °	26 °	10	.	.
Cerastium arvense	8	4	3	6	28 °	9	.	27 °	.
Trifolium campestre	17	.	.	.	22 °	11	10	2	3
Cladonia pyxidate	17	4	.	12 °	2	.	10	.	.
Leontodon autumnalis	.	.	6	12 °	8	7	.	2	3
Cladonia subulata	8	9	.	8 °	.	2	10	.	.
Malva moschata	.	.	.	.	2	.	10	15 °	6
Geranium pyrenaicum	.	.	.	.	2	.	10	5	15 °
Cytisus scoparius juv.	8	9	.	4	10 °	.	.	.	.
Hypericum maculatum s. str.	.	.	.	.	.	2	.	12 °	9
Cynosurus cristatus	.	.	.	.	10 °	.	.	7	3
Arenaria serpyllifolia	8	.	.	.	10 °	2	.	.	.
Calliergonella cuspidata	.	.	.	.	8	.	.	2	9 °
Thuidium tamariscinum	.	.	.	.	8 °	.	.	.	3
Epilobium montanum	.	.	.	4	.	6 °	.	.	.
Cardamine pratensis	.	.	.	.	.	.	.	2	6 °
Hylotelephium telephium agg.	.	.	.	.	.	.	.	2	6 °
Medicago falcata	.	.	.	.	.	.	.	.	6 °
Koeleria macrantha	.	.	.	.	5 °	.	.	.	.
Prunus domestica agg. juv.	.	.	.	.	.	.	.	5 °	.
Melampyrum pratense	.	.	.	4 °	.	.	.	.	.
Sambucus nigra juv.	.	.	.	4 °	.	.	.	.	.
Betula pendula juv.	.	.	.	.	.	4 °	.	.	.
Fagus sylvatica juv.	.	.	.	.	.	4 °	.	.	.

of base-rich *Brachypodietalia* grasslands tolerating non-calcareous substrates occurred (e.g., *Potentilla verna* and *Thymus pulegioides*), as well as some representatives of mesic *Arrhenatheretalia* grasslands. The perennial succulents *Petrosedum rupestre* and *Sedum acre* and the lichen *Cladonia rangiformis* turned out to be particularly diagnostic. However, the eponymous *Scleranthus perennis* was absent in SS1 but frequent in SS2. The *Polytricho piliferi-Scleranthetum perennis* and the *Airo-Festucetum* (see below) differed from the other grassland communities by various lichens such as *Cetraria aculeata*, *Cladonia foliacea*, *C. furcata* and *C. rangiformis* and the moss *Hypnum lacunosum*. In NMDS, the community was clearly separated from all others (Fig. 3) with one relevé located within the *Airo-Festucetum* cluster due to a slightly divergent floristic composition.

Distribution and ecology: All 11 relevés of the *Polytricho piliferi-Scleranthetum perennis* were collected at the site *Hardt* (Fig. 1), on a steep ridge above the road to Haiger with shallow skeletal ranker soil over bedrocks of slate and spilite (Table 1). The plants root in stony or gravelly initial soil. The mean indicator values of soil fertility and moisture were the lowest among the plant associations found in the area, while the mean indicator value of soil reaction was higher than in the clusters SS2 and N1–2 (Supplement E7–8).

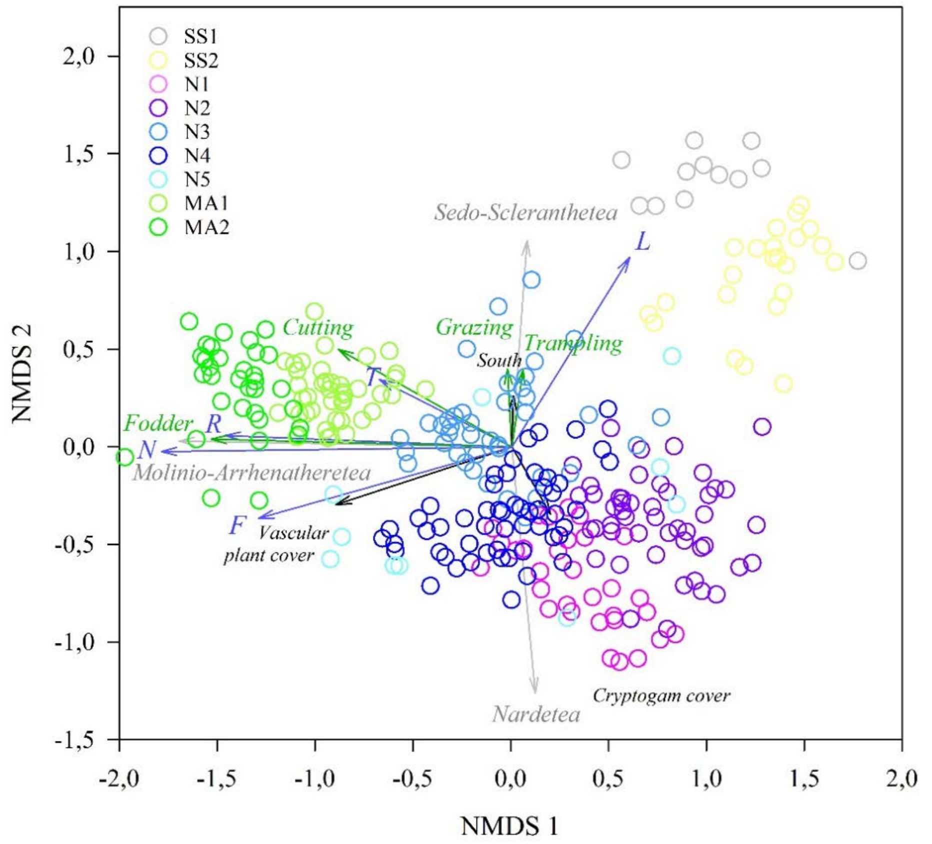

Fig. 3. NMDS ordination of the 292 relevés. The nine vegetation clusters are indicated by colours: SS1 = *Polytricho piliferi-Scleranthetum perennis*; SS2 = *Airo-Festucetum*; N1–4 = *Campanulo rotundifoliae-Dianthetum deltoidis*: N1 = *Potentilla erecta* variant, N2–4 = *Carex caryophyllea* variant, N2 = subvariant with *Cladonia arbuscula*, N3 = subvariant with *Ranunculus bulbosus*, N4 = subvariant with *Trifolium alpestre*; N5 = *Hypericum perforatum-Gnaphalium sylvaticum* [*Violion caninae*] community; MA1–2 = *Arrhenatheretum ranunculetosum bulbosi*: MA1 = *Bromus erectus* variant, MA2 = *Festuca pratensis* variant. Blue vectors indicate mean Ellenberg indicator values for *L* = light, *T* = temperature, *F* = moisture, *R* = reaction, and *N* = nutrients, green vectors mean grassland management values for *cutting* tolerance, *grazing* tolerance, *trampling* tolerance and *fodder* quality, and grey vectors species proportions of *Sedo-Scleranthetea*, *Nardetea* and *Molinio-Arrhenatheretea* species within the vegetation; *south* = slope southernness. Only vectors with $r^2 \geq 0.1$ are shown.

Abb. 3. NMDS-Ordination der 292 Aufnahmen. Die neun Vegetationscluster sind farblich angezeigt. Polygone kennzeichnen Klassen. Die Bedeutung der Cluster/Syntaxa-Kürzel geht aus der englischen Abbildungsunterschrift hervor. Blaue Vektoren zeigen mittlere Ellenberg- Zeigerwerte für *L* = Licht, *T* = Temperatur, *F* = Feuchte, *R* = Reaktion, und *N* = Nährstoffe, grüne Vektoren mittlere Grasland-Nutzwerte für *cutting* = Mahdtoleranz, *grazing* = Weidetoleranz, *trampling* = Tritttoleranz und *fodder* = Futterqualität, und graue Vektoren die Anteile der Arten der *Sedo-Scleranthetea*, *Nardetea* und *Molinio-Arrhenatheretea* in der Vegetation an; *south* = Südlichkeit der Hanglage. Nur Vektoren mit $r^2 \geq 0{,}1$ sind dargestellt.

4.1.2 ***Airo-Festucetum*** (cl. 2, SS2, Supplement E9)

Floristic characterisation: The *Airo-Festucetum* is well-founded and differed from the *Polytricho piliferi-Scleranthetum perennis* mainly by many small annual plants such as *Aira caryophyllea*, *A. praecox* and *Teesdalia nudicaulis* and, according to our data, also by mats of the evergreen perennial mosses *Polytrichum juniperinum* and *P. piliferum* (Table 2, Fig. 4). The moderately species-rich association (on average 31.7 species per 4.5 m²; Supplement E6) was dominated by *Festuca guestfalica* and *Rumex acetosella* in the herb layer and almost always by *Hypnum lacunosum* in the moss layer. Other frequent grasses were the annuals *Aira caryophyllea* and *A. praecox* and the perennials *Agrostis capillaris* and *Luzula campestris*. Typical herbs occurring nearly in all stands were *Galium verum*, *Hieracium pilosella*, *Hypochaeris radicata*, *Scleranthus perennis*, *Teesdalia nudicaulis* and *Thymus pulegioides*. Common mosses were *Ceratodon purpureus*, *Polytrichum juniperinum* and *P. piliferum*, and typical lichens *Cetraria aculeata*, *Cladonia foliacea* and *C. furcata*. Most recorded stands comprise species of the orders *Thero-Airetalia* and *Sedo-Scleranthetalia* showing an intermediate position between annual and perennial pioneer grasslands (Fig. 2).

Distribution and ecology: The 23 relevés were collected at the site *Alte Rheinstraße* on moderately acid, extremely shallow rankers (mean pH H_2O/KCl: 4.40/3.83) over slate and spilite. Nutrient limitation and seasonal drought (indicated by the lowest mean indicator values for soil fertility and moisture found in the area) were important environmental drivers (Table 1, Supplement E7).

Fig. 4. *Airo caryophylleae-Festucetum ovinae* (SS2) at the site Alte Rheinstraße with flowering *Festuca guestfalica*, *Filago minima*, *Rumex acetosella* and *Scleranthus perennis* (Photo: T. Becker, 13.06.2021).

Abb. 4. *Airo caryophylleae-Festucetum ovinae* (SS2) im Teilgebiet Alte Rheinstraße. *Festuca guestfalica*, *Filago minima*, *Rumex acetosella* und *Scleranthus perennis* blühen (Foto: T. Becker, 13.06.2021).

4.1.3 *Campanulo rotundifoliae-Dianthetum deltoidis* (cl. 3–6, N1–4, Supplement E10)

Syn.: *Polygalo vulgaris-Nardetum strictae koelerietosum pyramidatae* Preising 1953

Floristic characterisation: The *Campanulo rotundifoliae-Dianthetum deltoidis* was found to be well-defined by character species of the alliance *Violion caninae* (*Galium pumilum*, *Polygala vulgaris*, *Danthonia decumbens*, *Viola canina*) and of the classes *Nardetea* and *Calluno-Ulicetea* (such as *Avenella flexuosa* and *Calluna vulgaris*) (Table 2). Others known as alliance character species, such as *Arnica montana*, were restricted to sub-units. The association typically comprised nutrient-poor acidic grasslands dominated by the grasses *Festuca rubra* agg. (most likely with *Festuca nigrescens* prevailing), *Agrostis capillaris* and, with remarkably high frequency, *Helictochloa pratensis* and *Danthonia decumbens*. The association was represented by two variants indicating differences in soil and also in vegetation dynamics. While the *Potentilla erecta* variant (Fig. 5) was well-differentiated by *P. erecta*, *Hylocomium splendens* and others, the *Carex caryophyllea* variant (Fig. 6) was heterogeneous and comprised three subvariants differentiated by species of mostly low frequency. In the *P. erecta* variant and the *Cladonia arbuscula* subvariant of the *C. caryophyllea* variant, diagnostic species of the acidic grassland syntaxa *Nardetea*, *Nardetalia* and *Violion caninae* and the heathland syntaxa *Calluno-Ulicetea* and *Vaccinio-Genistetalia* prevailed while in the *Ranunculus bulbosus* subvariant and *Trifolium alpestre* subvariant of the *C. caryophyllea* variant, the *Festuco-Brometea* (together with the subordinate *Brachypodietalia*) and the *Molinio-Arrhenatheretea* (together with the *Arrhenatheretalia*) reached similarly high proportions as the *Nardetea* and subordinate syntaxa (Fig. 2).

Distribution and ecology: With 173 relevés collected at eight study sites, the *Campanulo rotundifoliae-Dianthetum deltoidis* was the prevailing association in our study area (Fig. 1). There were large differences in abundance between the subunits. While the rare *Potentilla erecta* variant was only found at the site *Hasel*, the *C. caryophyllea* variant was common. At the site level, the three subvariants of the *C. caryophyllea* variant were almost mutually exclusive. The *Cladonia arbuscula* subvariant occurred at the sites *Ziegenberg* and *Kuhlgarten*, the *Ranunculus bulbosus* subvariant at the sites *Neben-Ziegenberg* and *Alter Berg*, and the *Trifolium alpestre* subvariant mainly at the sites *Ziegenberg* and *Sauernberg*.

The *Campanulo rotundifoliae-Dianthetum deltoidis* comprised a variety of nutrient-poor grasslands differing in ecological terms from the two *Sedo-Scleranthetea* communities by less shallow soils and micro-topographical conditions more favourable to vascular plants and pleurocarpous mosses and less favourable to *Cladonia* lichens and acrocarpous mosses. The *P. erecta* variant (cluster N1) and the *C. caryophyllea* variant (clusters N2–4) differed by species indicating soil acidity and moisture. Cluster N1, differentiated chiefly by *P. erecta*, *Hylocomium splendens*, *Carex pilulifera* and *Ranunculus polyanthemos* s.l., occurred on acidic soil derived from slate and diabase, with a mean pH H_2O/KCl of 5.04/4.01 (Table 1, Supplement E7). The *C. caryophyllea* variant, comprising three sub-variants, occurred on often slightly less acidic soil (especially the subvariants N3–4 with a mean pH H_2O/KCl of 5.46/4.50 and less so the subvariant N2 with a mean pH H_2O/KCl of 4.95/4.02), mainly over various slates but also over diabase and spilite. It differed from the *P. erecta* variant by higher frequencies of *C. caryophyllea*, *Genista tinctoria* and *Helianthemum nummularium*, clusters N2 and N3 also by *Polygala vulgaris*, clusters N3 and N4 further by *Koeleria pyramidata*, *Briza media*, *Agrimonia eupatoria*, *Viola hirta* and *Pseudoscleropodium purum*. The grasslands of the *P. erecta* variant may be characterized as more mesic than those of the *C. caryophyllea* variant. The latter could be classified into a subvariant (cluster N2) on open,

Fig. 5. *Campanulo rotundifoliae-Dianthetum deltoidis*, *Potentilla erecta* variant (N1), with flowering *Arnica montana* in the conservation area *Hasel bei Donsbach* (Photo: T. Becker, 13.06.2021).

Abb. 5. *Campanulo rotundifoliae-Dianthetum deltoidis*, *Potentilla erecta*-Variante (N1), mit blühender *Arnica montana* im NSG „Hasel bei Donsbach“ (Foto: T. Becker, 13.06.2021).

Fig. 6. *Campanulo rotundifoliae-Dianthetum deltoidis*, *Carex caryophyllea* variant, subvariant with *Cladonia arbuscula* (N2), at the site Ziegenberg. *Helianthemum nummularium* in flower. In the foreground, *Petrosedum rupestre* with flower buds and in the background stands of *Calluna vulgaris* (Photo: T. Becker, 13.06.2021).

Abb. 6. *Campanulo rotundifoliae-Dianthetum deltoidis*, *Carex caryophyllea*-Variante, *Cladonia arbuscula*-Subvariante (N2) im Teilgebiet Ziegenberg. *Helianthemum nummularium* blüht. Im Vordergrund sind *Petrosedum rupestre* und im Hintergrund ein Bestand von *Calluna vulgaris* zu sehen (Foto: T. Becker, 13.06.2021).

dry, very nutrient-poor and low-grazed ground, poorly differentiated by *Cladonia arbuscula* and *Antennaria dioica*, another subvariant with *Ranunculus bulbosus* (cluster N3) on somewhat more base-rich and less nutrient-poor, dry but sometimes seasonally moist soil, and a third subvariant (cluster N4) with *Trifolium alpestre*, a dry-mesic grassland resembling those of the *P. erecta* variant but on more base-rich soil.

4.1.4 *Hypericum perforatum-Gnaphalium sylvaticum community* (cl. 7, N5, Supplement E11)

Floristic characterisation: This community of the *Violion caninae* alliance likely developed from abandoned stands of the *Campanulo rotundifoliae-Dianthetum deltoidis*. It represents a peculiar mixture of species with wide ecological amplitudes of several classes (Fig. 2, Table 2). The *Nardetea* are represented by, e.g., *Agrostis capillaris*, *Avenella flexuosa*, and the moss *Pleurozium schreberi*, the *Molinio-Arrhenatheretea* by, e.g., *Arrhenatherum elatius*, *Dactylis glomerata*, *Galium album* and *Plantago lanceolata*; and the *Trifolio-Geranietea* by, e.g., *Hypericum perforatum*, *Solidago virgaurea* and *Clinopodium vulgare*. Character species of dry-mesic acidic grasslands were still well represented (e.g., *Dianthus deltoides*, *Festuca guestfalica*, *Galium pumilum*) justifying the assignment of the stands to the *Violion caninae*. In NMDS, the community did not form a distinct cluster but was spread within the *Campanulo rotundifoliae-Dianthetum deltoidis* cluster (Fig. 3). The species richness of the community was moderately high, while the number of red-listed species was low (Supplement E6 and E12, Fig. 7).

Distribution and ecology: The 11 relevés were nearly all collected at the site *Kuhlgarten* in southern exposition along waysides and hedges or around scattered trees. Here, the *Hypericum perforatum-Gnaphalium sylvaticum* community occurred on slate, siltstone, and hematite substrates on moderately acid soil (pH H_2O/KCl of 4.88/3.88) (Table 1, Supplement E7). With 3.9, the mean indicator value for nutrients tended more to *Molinio-Arrhenatheretea* meadows than to the *Nardetea* grasslands.

4.1.5 *Arrhenatheretum elatioris ranunculetosum bulbosi* (cl. 8–9, MA1–2, Supplement E13)

Floristic characterisation: Species-rich *Arrhenatheretum* meadows were found to be well characterized by grasses such as *Arrhenatherum elatius*, *Dactylis glomerata*, *Trisetum flavescens* and *Holcus lanatus* as well as by herbs such as *Rhinanthus minor*, *Saxifraga granulata*, *Crepis biennis*, *Tragopogon pratensis* and *Ranunculus bulbosus* (Table 2). They differ widely from the *Hyperico perforati-Scleranthion perennis* and *Violion caninae* grasslands which are dominated by smaller grasses, namely *Festuca guestfalica* and *F. rubra* agg., respectively. Two variants of *Arrhenatheretum* meadows were distinguished, indicating variation in soil moisture and productivity. The *Bromus erectus* variant (cluster 8) was rather poorly differentiated by *B. erectus*, *Salvia pratensis* and a suite of annuals such as *Draba verna*, *Cerastium brachypetalum* and *Arabidopsis thaliana* indicating sward gaps. The *Festuca pratensis* variant (cluster 9) was easily identified by *Anthriscus sylvestris*, *F. pratensis* and *Bromus hordeaceus*, among others. In both variants, the diagnostic species of the *Molinio-Arrhenatheretea* and the *Arrhenatheretalia* prevailed (Fig. 2). Especially the *Bromus erectus* variant typically had a considerable proportion of the diagnostic species of the *Festuco-Brometea* and its subordinate syntaxa.

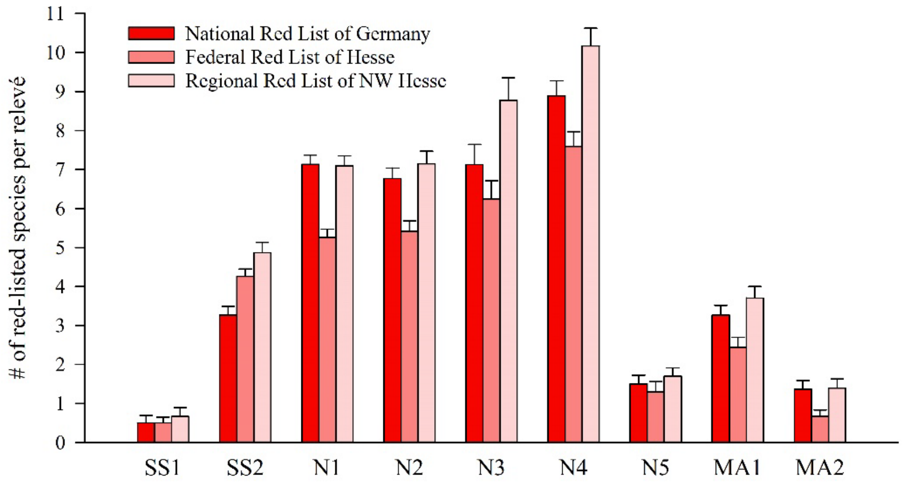

Fig. 7. Number of red-listed species of vascular plants, bryophytes and lichens per relevé according the national, federal, and regional Red Lists. No lichens are included in the regional Red List bars. Mean values and simple standard errors. SS1 = *Polytricho piliferi-Scleranthetum perennis*; SS2 = *Airo-Festucetum*; N1–4 = *Campanulo rotundifoliae-Dianthetum deltoidis*: N1 = *Potentilla erecta* variant, N2–4 = *Carex caryophyllea* variant, N2 = *Cladonia arbuscula* subvariant, N3 = *Ranunculus bulbosus* subvariant, N4 = *Trifolium alpestre* subvariant; N5 = *Hypericum perforatum-Gnaphalium sylvaticum* [*Violion caninae*] community; MA1–2 = *Arrhenatheretum elatioris ranunculetosum bulbosi*: MA1 = *Bromus erectus* variant, MA2 = *Festuca pratensis* variant. For single species see Supplement E12. Note that plot size differs between vegetation types, especially between SS and N/MA communities (see Table 2).

Abb. 7. Anzahl gefährdeter Arten von Gefäßpflanzen, Moosen und Flechten per Aufnahme nach den nationalen, föderalen und regionalen Roten Listen. In den regionalen-Rote-Liste-Balken sind keine Flechten enthalten. Mittelwerte und einfache Standardfehler. Die Bedeutung der Cluster/Syntaxa-Kürzel geht aus der englischen Abbildungsunterschrift hervor. Für die einzelnen Arten, siehe Beilage E12. Es ist zu beachten, dass sich die Größe der Aufnahmeflächen zwischen den Vegetationstypen (v. a. zwischen SS and N/MA-Gesellschaften) unterscheidet (s. Tab. 2).

Distribution and ecology: The *Arrhenatheretum elatioris ranunculetosum bulbosi* was documented by 76 relevés, mainly at the sites *Kornberg* (Fig. 8), *Vorm Sauernberg* and *In der Geisegrube*. At the first two sites, the variants with *Bromus erectus* and *Festuca pratensis* occurred together, while at the latter site, only the variant with *Bromus erectus* was found. The *Arrhenatheretum ranunculetosum* remained undersampled in the area (in relation to short grasslands) and is more widespread than reflected by its proportion of relevés. It occurred on slightly less acid soil (mean pH H_2O/KCl of 5.63/4.58 in MA1, and of 5.99/5.12 in MA2) than most of the grasslands of the *Violion caninae*, chiefly on deep soil over bedrocks of various slates (Table 1, Supplement E7). However, more significant appeared to be differences in water supply and soil fertility. Both factors were more pronounced in the *F. pratensis* variant where a number of soil moisture indicators such as *Ranunculus repens* and *Equisetum arvense* were found.

Fig. 8. Extensive stands of the *Bromus erectus* variant (MA1) and *Festuca pratensis* variant (MA2) of the *Arrhenatheretum elatioris ranunculetosum bulbosi*. View from the *Kornberg* to the *Ziegenberg* which is located back right in front of the forest (Photo: T. Becker, 13.06.2021).

Abb. 8. Ausgedehnte Bestände der *Bromus erectus*-Variante (MA1) und *Festuca pratensis*-Variante (MA2) des *Arrhenatheretum elatioris ranunculetosum bulbosi*. Blick vom Kornberg zum Ziegenberg welcher hinten rechts vor dem Wald liegt (Foto: T. Becker, 13.06.2021).

4.2 Environmental drivers for vegetation differentiation

Two of three vegetation classes were separated along the first NMDS dimension (left: *Molinio-Arrhenatheretea*, central and to the right: *Nardetea*) (Fig. 3). The second NMDS dimension separated the *Sedo-Scleranthetea* from the other classes. The first NMDS dimension was strongly positively correlated with variables indicating soil fertility and base saturation such as pH, EIVs for soil reaction and nutrients, mowing and fodder value (Fig. 3, Table 3). The first NMDS dimension was also (but less strongly) positively correlated with EIVs for temperature and soil moisture indicating favourable growth conditions. Furthermore, there was a negative correlation to cryptogam cover indicating light competition by vascular plants. The second NMDS dimension was negatively correlated with variables of soil fertility such as EIVs for moisture and nutrients, and positively with EIV for light. This suggests that low productivity, dryness and light availability were the main factors for separating the *Sedo-Scleranthetea* grasslands from those of the other classes. This explanation was supported by the positive correlations of the second axis with southernness and inclination of the slope. In addition, each of the variants of the associations *Campanulo rotundifoliae-Dianthetum deltoidis* (clusters N1–4) and *Arrhenatheretum elatioris* (clusters MA1–2) were separated by the second NMDS dimension indicating dryer and moister conditions, respectively.

In the field, vegetation types were spatially clustered. Seven sites were exclusive of, or dominated by, a single vegetation class. This was especially true for the *Molinio-Arrhenatheretea* which occurred either all over the site or not at all (Fig. 1). Four of the nine clusters, including both *Sedo-Scleranthetea* communities SS1 and SS2 and the *Nardetea* community N1, were rare and found in one single site each. In contrast, the *Nardetea* community N2 was relatively widespread across six sites. In general, as outlined above, the distribution of the community types at the class level strongly coincided with the soil conditions, depending mainly on bedrock and topography.

4.3 Plant conservation

We found 227 vascular plant species in the 292 vegetation plots, including 39 graminoid, 168 non-graminoid herbaceous and 20 woody species. Among the 22 plant families, Poaceae and Asteraceae were most abundant with 33 and 31 species, respectively, followed by Fabaceae (23 species, including 8 species of *Trifolium*) and Caryophyllaceae (15 species). The current German Red List classifies as many as 35 vascular plant species, two bryophytes and eight lichens found in 1987 as threatened (Supplement E12). Twelve species were listed as 'Vulnerable' (category 3, e.g., *Arnica montana*, *Genista germanica*, *Gentianella campestris*), twenty-two as 'Near-threatened' (*Vorwarnliste*: e.g., *Carlina acaulis*, *Dianthus deltoides*, *Galium pumilum*), and *Polygala vulgaris* subsp. *oxyptera* was classified as threatened to unknown extent (*Gefährdung unbekannten Ausmaßes*). According to the regional Red List of Hesse, 37 vascular plant species found in the area in 1987 are classified as threatened: *Gentianella campestris* is listed 'Critically endangered', four species (*Aira praecox*, *Antennaria dioica*, *Arnica montana*, *Botrychium lunaria*) are classified as 'Endangered', eight species as 'Vulnerable', and 22 as 'Near-threatened'. Forty-five species were listed on the regional Red List of north-western Hesse: Three species were classified as 'Critically endangered' (*Antennaria dioica*, *Gentianella campestris*, *Orobanche purpurea*), four species as 'Endangered' (*Aira praecox*, *Arnica montana*, *Botrychium lunaria*, *Filago minima*), 11 species as 'Vulnerable' (e.g., *Galium pumilum*, *Genista germanica*, *Teesdalia nudicaulis*, *Trifolium striatum*), and 25 as 'Near-threatened'. In addition, 17 vascular plant taxa are classified as 'Strongly declining' according to the German Red-List (e.g., *Arnica montana*, *Botrychium lunaria*, *Euphrasia officinalis* subsp. *pratensis*), and 22 species as 'Declining'. The most threatened vascular plant species in terms of highest degree of threat and strongest decline was *Gentianella campestris* (not recently found in the area, apparently lost, see below), followed by *Antennaria dioica*, *Arnica montana* and *Botrychium lunaria*.

Among the bryophytes, the national Red List classified *Dicranum bonjeanii* and *Ptilidium ciliare* as 'Vulnerable' and the Hessian Red List these two and *Racomitrium elongatum*. Among the eight red-listed lichen species (according to the German Red List), *Cladonia ciliata* is listed as 'Endangered' and six species as 'Vulnerable' (e.g., *Cetraria aculeata*, *Cladonia foliacea*, *C. uncialis*). *Cladonia arbuscula* is listed as both 'very rare' and 'threatened to an unknown extent'.

The highest richness of red-listed species was observed in the *Trifolium alpestre* subvariant of the *Campanulo rotundifoliae-Dianthetum deltoidis* (Fig. 7). In the *Airo-Festucetum* and in the *Bromus erectus* variant of the mesic *Arrhenatheretum elatioris ranunculetosum bulbosi*, the number of red-listed species was also high. In the *Polytricho piliferi-Scleranthetum perennis*, the *Hypericum perforatum-Gnaphalium sylvaticum* community and the *Festuca pratensis* variant of the *Arrhenatheretum elatioris ranunculetosum bulbosi*, the number of red-listed species was lower.

5. Discussion

5.1 Study limitations and justification

Our study has two obvious limitations, with reference to geography and time. The study area is small and the relevés were collected 35 years ago. We believe that the study is nevertheless valuable, not only for historical reasons. The area around Donsbach, then and now, is a hot spot of rare and threatened plant species (GRAFFMANN 2004), and acidic grasslands have been well preserved since. The original relevés are worth being published as they provide a basis for a resurvey and comparisons across wider areas. The fact that the data are historical does not constitute a limitation for a syntaxonomical study such as ours. However, it should be emphasized that our data do not reflect the status quo of the grasslands. For conclusions regarding nature conservation measures and management, our study cannot be used directly but as historical reference (see discussion in chapter 5.4).

5.2 Vegetation types

Similar species combinations as in our study (but partly described under different community names) were found by others from the eastern Rhenish Massif (BERGMEIER 1987, NOWAK 1988, 1991, 1992, OTTE et al. 2008, BECKER et al. 2012), but hardly in other parts of the Central Uplands (e.g., KORNECK 1974, 1993). In fact, the combination of acidic grasslands of the *Hyperico perforati-Scleranthion perennis*, *Thero-Airion*, *Violion caninae* without *Nardus*, and *Arrhenatherion* found in our area can be regarded characteristic for the eastern Rhenish Massif. Only *Festuco-Brometea* communities, not untypical elsewhere in the eastern Rhenish Massif, do not occur in our area.

***Polytricho piliferi-Scleranthetum perennis*:** This association of the *Hyperico perforati-Scleranthion perennis* described by MORAVEC (1967) has remained largely unnoticed in Germany but is known to be widespread in the Bohemian Massif (SÁDLO et al. 2007). None of the associations described by KORNECK (1993) matches the *Polytricho piliferi-Scleranthetum perennis*; most similar is the *Gageo saxatilis-Veronicetum dillenii* (Oberd. 1957) Korneck 1974 in the alliance *Sedo albi-Veronicion dillenii* (Oberd. 1957) Korneck 1974. The *Gageo saxatilis-Veronicetum dillenii* has been found in the North Palatine Uplands just south of the Rhenish Massif. More recently (DENGLER 2004: 315), all Northwest and Central European dry acidic fescue grasslands have been lumped together in the *Thymo pulegioidis-Festucetum ovinae* Oberd. 1957, but this association is understood by OBERDORFER (1993: 232) as a *Violion caninae* association on dry peat ("*das für ausgetrocknete Torfböden am Rand gestörter Hoch- und Zwischenmoore charakteristisch ist*"). Very similar to the *Polytricho piliferi-Scleranthetum perennis* on outcrops of siliceous rock is the *Sedo-Thymetum pulegioidis* Doing 1963 on sandy ground in the chiefly western European alliance *Sedo-Cerastion arvensis* Sissingh & Tideman 1960 where *Festuca filiformis* and not *F. guestfalica* is the prevailing sheep's fescue (SCHAMINÉE et al. 1996). The *Polytrichum piliferum-Scleranthus perennis* community and the *Sedum album-Scleranthus perennis* community, described by TEUBER (1998) and BERGMEIER (1987), respectively, from the adjacent Gladenbach Uplands, are identical with the *Polytricho piliferi-Scleranthetum perennis*. To our knowledge, the *Polytricho piliferi-Scleranthetum perennis* is described here for the first time as an association in Germany, but the *Hyperico perforati-Scleranthion perennis* is still insufficiently known and further records in the Rhenish Massif are more than likely. Our record is particularly relevant as the association matches the EU habitat type 8230 (Siliceous rock with pioneer vegetation). BECKER et al. (2012) had assigned stands dominated by annuals on abandoned fields on sandy ground in the adjacent Aar valley to the *Jasiono montanae-Festucetum ovinae* Klika 1941 nom. invers. This related association is grass-dominated (*Agrostis capillaris* and *F. ovina* agg.) and differs from the *Polytricho piliferi-Scleranthetum perennis* chiefly by the presence of *Jasione montana* and the absence (or scarceness) of *Scleranthus perennis*.

Airo-Festucetum**:** Annual-rich dry grasslands of the *Airo-Festucetum* occur in Northwest Germany and beyond chiefly in the community context of heathlands on sandy ground (e.g., SOMMER 1971, ROSSKAMP 1992), while in the Rhenish Massif the association occurs on shallow soil over weathered slate in the context of *Violion caninae* grasslands (cf. ČERNÝ et al. 2007 for stands in Bohemia). Such *Aira*-rich vegetation in the Central Uplands is not well known and appears to be widespread only in the suboceanic parts of the Rhenish Massif and the Saar-Nahe Uplands (KORNECK 1993). There is a local record in the Lahn-Dill district by BERGMEIER (1987). The *Airo-Festucetum* of the Rhenish Massif forms part of the EU habitat type 8230 (Siliceous rock with pioneer vegetation).

Campanulo rotundifoliae-Dianthetum deltoidis**:** This *Violion caninae* association is distinguished from the similar *Festuco capillatae-Nardetum strictae* Klika et Šmarda 1944 mainly by the prevalence of *Festuca nigrescens* (in our study under *F. rubra* agg.) and *Agrostis capillaris* and the absence of *Nardus stricta* in most (all in our study area) stands (KRAHULEC et al. 2007). Locally differentiating are, among many others, *Helictochloa pratensis*, *Helianthemum nummularium* (in our area subsp. *obscurum*) and *Cirsium acaulon*. The *Festuco capillatae-Nardetum strictae* occurs mainly on deep, markedly acid soil, while the *Campanulo rotundifoliae-Dianthetum deltoidis* is a community of dry skeletal acidic but moderately base-rich ground (habitat conditions explaining the absence of *Nardus stricta* within our stands) (KRAHULEC et al. 2007). The latter association has been classified as *Polygalo vulgaris-Nardetum strictae koelerietosum pyramidatae* Preising 1953 in the revision by PEPPLER-LISBACH & PETERSEN (2001), but the *Polygalo vulgaris-Nardetum strictae* Oberd. 1957 is a later heterotypic synonym of the *Festuco capillatae-Nardetum strictae*. As this fact was known to PEPPLER-LISBACH & PETERSEN (2001: 27) they proposed the conservation of the younger name against the older, less commonly used name (*Ibid*., p. 28). However, this proposal was unwarranted (the *Festuco capillatae-Nardetum strictae*, under its original name *Nardo-Festucetum capillatae*, has been in use in phytosociological literature outside Germany, e.g., BALÁTOVÁ-TULÁČKOVÁ 1980), and is obsolete at least since the monographic treatment of the *Violion caninae* associations in the Czech Republic by KRAHULEC et al. (2007). The *Festuco capillatae-Nardetum strictae*, *Campanulo rotundifoliae-Dianthetum deltoidis* and *Polygalo vulgaris-Nardetum strictae* have been treated as separate associations of the *Violion caninae* by some authors (e.g. BALÁTOVÁ-TULÁČKOVÁ 1980, ČERNÝ & NEUHÄUSLOVÁ 2006), but PEPPLER-LISBACH & PETERSEN (2001) and KRAHULEC et al. (2007) showed that the *Nardus*-dominated communities hardly differ on a large scale, in contrast to the *Campanulo rotundifoliae-Dianthetum deltoidis* which is more different. ČERNÝ & NEUHÄUSLOVÁ (2006) included the *Campanulo-Dianthetum* as a variant in the *Diantho deltoidis-Galietum veri* Toman 1977 (TOMAN 1977), but the latter represents dry sheep fescue grasslands dominated by *Festuca ovina* agg. and as such has been classified in the *Sedo-Scleranthetea* as *Jasiono montanae-Festucetum ovinae* Klika 1941 of the alliance *Hyperico perforati-Scleranthion perennis* (KRAHULEC et al. 2007: 355). Likewise, in the German Central Uplands, the *Jasiono montanae-Festucetum ovinae* has been found to be widespread but scattered by various authors including GREGOR (2001, named as *Heidenelken-Rotschwingel-Magerrasen* in his table 1) who recorded occurrences in the eastern Hessian Schlitzerland, and BECKER et al. (2012) in the Middle Hessian lower Aar valley not far from the present study area of Donsbach in the eastern Rhenish Massif.

According to PEPPLER-LISBACH & PETERSEN (2001) the *Campanulo rotundifoliae-Dianthetum deltoidis* (as *Polygalo-Nardetum koelerietosum pyramidatae*) is widespread over base-rich siliceous rock in the drier lee of the mountain ranges in the German Central Uplands. The authors provide a detailed description of the habitat range of the community in the country. Eastward, the *Campanulo rotundifoliae-Dianthetum deltoidis* is known from montane regions of central Slovakia (JANIŠOVÁ et al. 2010) through to the Ukrainian Carpathians (ŠKODOVÁ et al. 2015). The variation in our study area is remarkably similar to that in the Czech Republic where the *Campanulo rotundifoliae-Dianthetum deltoidis* occurs throughout the country (KRAHULEC et al. 2007: 303). Our *Potentilla erecta* variant approaches the Czech *Campanula rotundifolia* variant while our *Carex caryophyllea* variant resembles the *Potentilla tabernaemontani* (= *P. verna*) variant. The *C. caryophyllea* variant of the *Campanulo rotundifoliae-Dianthetum deltoidis* resembles in its species composition the moderately dry calcareous grasslands, *Bromion erecti*, of the *Festuco-Brometea* (especially the *Gentiano-Koelerietum agrostietosum* on superficially acidified soil), but the latter alliance differs by high frequencies and often dominances of the grasses *Brachypodium pinnatum* and *Bromus erectus* which are almost absent in the *Campanulo rotundifoliae-Dianthetum deltoidis.*

The overall geographical and ecological variation of the *Campanulo rotundifoliae-Dianthetum deltoidis* should be subject to review (preferably in the context of the entire alliance). The original description of the association by BALÁTOVÁ-TULÁČKOVÁ (1980) from the Žďárské vrchy (Saarer Bergland in the Bohemian-Moravian Uplands, Czech Republic) appears to be somewhat marginal from an ecological point of view. It represents stands on apparently somewhat wet-dry soil (as indicated by high constancies of species such as *Hypericum maculatum* and *Sanguisorba officinalis*), unlike those of the eastern Rhenish Massif (this paper) as well as of most other Czech, Slovakian and West Ukrainian occurrences (KRAHULEC et al. 2007, JANIŠOVÁ et al. 2010, ŠKODOVÁ et al. 2015).

In our study area, acidic grasslands on diabase were aligned with the *Campanulo rotundifoliae-Dianthetum deltoidis* in the *Nardetea strictae*, while a few kilometres away, in the lower Aar valley, acidic grasslands on diabase were identified as *Gentiano-Koelerietum agrostietosum*, a subassociation of calcareous grasslands on superficially acidified soil, syntaxonomically included in the *Bromion erecti* (BECKER et al. 2012). Indeed, in the Aar valley, the proportion of species characteristic for the *Festuco-Brometea* was considerably higher than around Donsbach. As the differences in vegetation cannot apparently be explained by differences in the chemical composition of the diabase in the Aar valley and around Donsbach, climatic factors are the likely drivers of the differences in species composition. The stands in the Aar valley are located at lower elevation (326 m *vs*. 405 m a.s.l., on average) and more south-facing (116 ° *vs*. 83 ° southernness, on average), resulting in warmer and dryer conditions leading to less soil acidification (pH H_2O 6.9 *vs*. 5.5, on average) which seems to be the most relevant factor here. Interestingly, therefore, along the intermediate edaphic conditions being characteristic for the area, subtle mesoclimatic differences matter to determine if grasslands belong to the class *Nardetea strictae* or to the *Festuco-Brometea*.

Despite the absence of *Nardus stricta*, the stands of the *Campanulo rotundifoliae-Dianthetum deltoidis* match the EU priority habitat type 6230 (Species-rich *Nardus* grasslands). In contrast, although arguably aligned with the *Violion caninae*, the ***Hypericum perforatum-Gnaphalium sylvaticum* community** hardly corresponds to the habitat type 6230. Nevertheless, the latter community provides ecosystem services and is of conservation value, especially if in contact to species-rich 6230 grasslands.

***Arrhenatheretum elatioris ranunculetosum bulbosi*:** The division of the *Arrhenatherion* into associations remains under debate. DIERSCHKE (1997) accepts one association and four informal communities for Germany, while ELLMAUER & MUCINA (1993) present seven associations and one informal community for Austria, HAJKOVÁ et al. (2007) four associations for Czechia, and JANIŠOVÁ (2007) five associations for Slovakia. In the present study, we apply the oldest association name available in the alliance, *Arrhenatheretum elatioris*, and refer to its subassociation *ranunculetosum bulbosi*. If ranked as association, its name would be *Ranunculo bulbosi-Arrhenatheretum elatioris* Ellmauer in Mucina et al. 1993. The prevalence of the subassociation *ranunculetosum bulbosi* as in our study area is now quite exceptional in the Central Uplands and is hardly found anywhere in recent literature. As a result of the degradation of hay-meadow vegetation by grassland management intensification, species-rich meadows are declining and in consequence also the subassociation’s differential species. Most notable in the meadows in the study area is the moderate to high frequency of species such as *Saxifraga granulata*, *Rhinanthus minor*, *Tragopogon pratensis*, *Campanula glomerata* and *Carum carvi*. The *Arrhenatheretum elatioris ranunculetosum bulbosi* refers to the EU habitat type 6510 (Lowland hay meadows).

5.3 Numeric procedure of syntaxa alignment

Our approach of syntaxonomic alignment of vegetation plots by diagnostic species proportions has proved to be a useful instrument. In most of the nine communities, the dominant syntaxon was that to which a cluster had been aligned to. Only the N5 cluster (*Hypericum perforatum-Gnaphalium sylvaticum* community representing abandoned *Violion caninae* grasslands, and tentatively assigned to this alliance) was dominated by species of the *Molinio-Arrhenatheretea* and *Arrhenatheretalia*. In addition, our method allows to assess the amount of relevant syntaxa being represented within a community. Relationships to other syntaxa can thus be realized and considered at subordinate syntaxonomic levels. The most important advantage of our approach is probably to create a basis for reproducible syntaxonomical argumentation. In contrast to the “summarised percentage cover approach” by WILLNER (2011) (cf. also WILLNER et al. 2019), our “summarised presence approach” is based only on species presences (not cover). Non-considering cover values can be seen as a disadvantage (due to a lack of information), but does not lead to bias in species that are rare for biological reasons. Our approach is similar to the expert system function implemented within the program JUICE (TICHÝ 2001). This function has been successfully applied in identification of grassland syntaxa in Slovakia (e.g., JANIŠOVÁ et al. 2007, 2010). For Germany, such an expert system is not available yet.

5.4 Conservation importance

Although our data had been collected about 35 years ago, the vegetation types have been confirmed recently by own observation. Considering the enormous socio-economic change during the past decades and its impact on grasslands (HIETEL et al. 2004, 2005), the qualitative continuity of management-dependent vegetation typical of pre-industrial cultural landscapes in our area is remarkable and is attributable to the successful conservation measures (for details see the report by KLEMENT 2012). However, the grassland area around Donsbach has partly declined due to scrub encroachment which becomes visible when comparing new and old aerial images in Google Earth. The floristic composition of the grasslands may have changed too, although there is no evidence for this by recent local studies (but see RAEHSE 1999, DUPRÉ et al. 2010, DIEKMANN et al. 2014, 2019, MAZALLA et al. 2021). In addition, rare plants may have declined or even gone extinct due to habitat deterioration or negative effects of small population size (see below for an example).

The grassland-related EU habitat types listed for the Natura 2000 site *Wald und Grünland um Donsbach* comprise the types 5130 (*Juniperus communis* formations), 6210 (Semi-natural dry grasslands and scrubland facies on calcareous substrates), 6230* (Species-rich *Nardus* grasslands), 6510 (Lowland hay meadows), and 8230 (Siliceous rock with pioneer vegetation). The type 6210 is said to cover 12.7 ha and the type 6230* 2.8 ha (KLEMENT 2012). However, according to our results, calcareous grasslands and thus the habitat type 6210 do not occur in the area and likely mistaken for *Violion* or even *Arrhenatherion* grasslands. As a consequence, the 6210 surface area refers to the priority type 6230* or possibly partly to 6510. Remapping is needed.

This, however, is of little, if any, relevance for the management of the dry-mesic *Violion* grasslands. For the maintenance of the structural and compositional diversity of the grasslands, it is essential to retain the pastoral management (herding mostly with sheep and, if needed, goats) and cutting of the dry-mesic hay-meadows. To maintain the open structure and to prevent scrub encroachment timely cutting and grazing in good time (at least twice a year and as early as from mid-May) is mandatory. As too homogenous management may lead to diversity loss, it has been suggested that the timing of grazing should be slightly modified in every second or third-year to promote coexistence of early and late developing plants (BALOGH et al. 2021, MAZALLA et al. 2021).

Although most red-listed plant species occurring in the Donsbach grasslands were recorded in our vegetation plots at several sites (Supplement E12), a few rare species are missing in our relevés: *Dactylorhiza maculata*, *Galium boreale*, *Noccaea caerulescens*, *Orchis ustulata*, *O. morio* and *Pyrola minor* (GRAFFMANN 2004). The critically endangered *Gentianella campestris*, still recorded in our study area in 1987, has suffered dramatic decline in the Rhenish Massif with only three populations left in Hesse in 2011 (BRUNZEL 2012). The species occurred at the site *Alte Rheinstraße* (relevé no. 82, Supplement E9) in a stand of the *Campanulo rotundifoliae-Dianthetum deltoidis*, subvariant with *Cladonia arbuscula* of the *Carex caryophyllea* variant. Despite a reasonable conservation status of the grassland to date, the occurrence of *G. campestris* could not be reconfirmed in 2010/2011 (BRUNZEL 2012) and on 22 September 2021 (B. Nowak, pers. comm.). The population appears to be lost. The decline of *G. campestris* may be enhanced by spring droughts affecting the germination and establishment of monocarpic biennials with short-lived seeds such as *G. campestris* (MILBERG 1994, LENNARTSSON & OOSTERMEIJER 2001). Other threatened weak competitor species dependent on *Violion caninae* grasslands, such as *Antennaria dioica*, *Arnica montana* and *Botrychium lunaria*, are still extant. As they require nutrient-poor habitats with low vegetation, timely grazing is essential to create safe sites for germination and establishment. Adequate monitoring of the conservation status of the grassland vegetation and the key species, preferably once in a six-year period, is needed.

6. Conclusions

The acidic grasslands of the survey area around Donsbach comprise a wide range of annual-rich (*Airo-Festucetum*) and perennial-rich (*Polytricho piliferi-Scleranthetum perennis*) pioneer grasslands on initial soils as well as dry-mesic perennial acidic grasslands of the *Violion caninae* (mainly *Campanulo rotundifoliae-Dianthetum deltoidis*) and mesic meadows of the *Arrhenatheretum elatioris*, the latter represented by its rare subassociation *ranunculetosum bulbosi*. To our knowledge, the *Polytricho piliferi-Scleranthetum perennis* and the *Campanulo rotundifoliae-Dianthetum deltoidis* are described here for the first time for Germany. Apart from disentangling the local-scale variation in acidic grassland vegetation we could determine the tipping point between *Nardetea strictae* and *Festuco-Brometea*, or *Violion caninae* and *Bromion erecti*, or "acid" and "calcareous" grasslands, over diabase bedrock in the area. Its position can be delineated by elevation, aspect and soil acidity.

The plant communities identified correspond to the EU habitat types 6230 (Species-rich *Nardus* grasslands), 6510 (Lowland hay meadows) and 8230 (Siliceous rock with pioneer vegetation). We suggest the grasslands of the *Campanulo rotundifoliae-Dianthetum deltoidis* to be assigned to the priority habitat type 6230, quite like other *Violion caninae* grasslands. This contradicts the current perception in the Natura 2000 area *Wald und Grünland um Donsbach* (FFH no. 5215-308), where the positioning of most of these grasslands in the habitat type 6210 (Semi-natural dry grasslands and scrubland facies on calcareous substrates) appears to be incorrect.

Although our data had been collected about 35 years ago, the vegetation units and most of the red-listed species then recorded have been confirmed more recently (although it remains an open question whether areal extent or population size equal former numbers), including species being generally in steep decline such as *Arnica montana* and *Antennaria dioica*. An exception is *Gentianella campestris* which appears to be lost. Nevertheless, the qualitative continuity of management-dependent vegetation in the area is remarkable and is attributable to the successful conservation measures over the past decades which have been more than worth the effort. A resurvey is necessary to assess the current condition of the grasslands, especially to verify the area and possible changes in species composition of the grassland types 35 years later.

Erweiterte deutsche Zusammenfassung

Einleitung – Silikatmagerrasen der kollinen und submontanen Stufe gehören als Elemente einer vorindustriell-landwirtschaftlich geprägen Kulturlandschaft zu den stark gefährdeten Vegetationstypen Deutschlands und Europas (JANSSEN et al. 2016). Ihre pflanzensoziologische Zuordnung muss besonders sorgfältig erfolgen, denn Syntaxa sind eine Definitionsgrundlage der Lebensraumtypen der FFH-Richtlinie, zu denen Silikatmagerrasen zählen. Zudem sind die Pflanzengesellschaften der Silikatmagerrasen bisher noch nicht ausreichend untersucht worden und gelten daher syntaxonomisch als kompliziert (BECKER et al. 2012). Wir untersuchten Silikatmagerrasen und -wiesen am Ostrand des Rheinischen Schiefergebirges, wo ähnliche Vegetation bereits früher nachgewiesen wurde (u. a. BERGMEIER 1987, NOWAK 1990, 1991, 1992, SCHMITT & FARTMANN 2006, OTTE et al. 2008, BECKER et al. 2012). Um eine belastbare Basis für ihre syntaxonomische Zuordnung zu schaffen, errechneten und verglichen wir die Summen der in den Beständen vertretenen Arten, die bestimmte Syntaxa indizieren. Diese Methode hatten BECKER et al. (2012) auf dem Klassenniveau bereits praktiziert. Hier wird sie um die Ordnungs- und Verbandsebene erweitert. Konkret fragen wir: Welche Silikatmagerrasen- und Magerwiesen-Syntaxa existierten in dem Gebiet zum Zeitpunkt der Datenaufnahme und wie sind die Bestände aus Naturschutzsicht zu bewerten?

Untersuchungsgebiet – Das Untersuchungsgebiet umfasst die Gemeinde Donsbach in Mittelhessen in einer Höhenlage von 360 bis 455 m NN (Abb. 1). Das Klima ist mit Jahresmitteln von ca. 850 mm bzw. ca. 8 °C temperat-subozeanisch geprägt. In der Region gibt es neben basenarmen Tonschiefern, die den Sockel des Rheinischen Schiefergebirges bilden, auch basenreiche magmatische Gesteine wie Diabas und Spilit. Die Böden stellen flachgründige Braunerden, Ranker und Regosole dar. Die Landnutzung erfolgte lange Zeit durch Kleinstbetriebe, die durch jahrhundertelange Realteilung entstanden waren (NOWAK 1988, GRAFFMANN 2004). Flächen der Allmende wurden mit Schafen und Rindern in Hute beweidet. Heute dienen Mahd und Beweidung auch der Landschaftspflege.

Methoden – Wir bearbeiteten einen Datensatz von 292 Vegetationsaufnahmen, die 1987 nach der Braun-Blanquet-Methode angefertigt wurden (VOLL 1988). In 166 Aufnahmeflächen war der pH-Wert gemessen und in ausgewählten Aufnahmeflächen der Bodentyp bestimmt worden. Zur standörtlichen Charakterisierung der Vegetation errechneten wir mittlere Ellenberg-Zeigerwerte und mittlere Nutzwerte nach Briemle. Die Vegetation der Gefäßpflanzen, Moose und Flechten wurde mittels Clusteranalyse klassifiziert. Die optimale Anzahl an Clustern wurde mit hierarchischer Clusteranalyse bestimmt (Anhang E3). Die syntaxonomische Zuordnung der Aufnahmecluster zu Einheiten gemäß der Übersicht der höheren Rangstufen der Vegetationstypen Deutschlands (BERGMEIER 2020) und Europas (EuroVegChecklist; MUCINA et al. 2016) erfolgte auf Grundlage der Anteile der durch diagnostische Arten angezeigten höheren Syntaxa. Lokale Differentialarten der einzelnen Cluster wurden mithilfe von *phi*-Werten determiniert. Floristische Gradienten wurden mit NMDS untersucht und Zusammenhänge zwischen den NMDS-Dimensionen und Umweltvariablen mit paarweisen Korrelationen analysiert. ANOVA mit Tukeys Post-hoc-Test diente zum Vergleich der Umweltvariablen zwischen den Clustern.

Ergebnisse – Die neun Cluster umfassten vier Assoziationen sowie eine ranglose Gesellschaft. Sie gehören vier Verbänden, vier Ordnungen und drei Klassen an: *Polytricho piliferi-Scleranthetum perennis* (*Hyperico perforati-Scleranthion perennis*, *Sedo-Scleranthetalia*, *Sedo-Scleranthetea*), *Airo-Festucetum* (*Thero-Airion*, *Thero-Airetalia*, *Sedo-Scleranthetea*), *Campanulo rotundifoliae-Dianthetum deltoidis* und *Hypericum perforatum-Gnaphalium sylvaticum*-Gesellschaft (*Violion caninae*, *Nardetalia strictae*, *Nardetea strictae*), *Arrhenatheretum elatioris ranunculetosum bulbosi* (*Arrhenatherion elatioris*, *Arrhenatheretalia elatioris*, *Molinio-Arrhenatheretea*) (Tab. 2, Anhang E4). Die Anteile der für höhere Syntaxa diagnostischen Arten und die daraus folgende pflanzensoziologische Zuordnung waren widerspruchsfrei (Abb. 2). Lediglich einige Brachen (*Hypericum perforatum-Gnaphalium sylvaticum*-Gesellschaft) zeigten hier Abweichungen. In der Ordinationsanalyse erwiesen sich die Bodenfruchtbarkeit und die Bodenreaktion als Hauptfaktoren der Vegetationsdifferenzierung (Abb. 3, Anhang E8). Die Trockenheit der Standorte erwies sich als nachgeordneter Faktor. Insgesamt zählten wir in den 292 Aufnahmen 227 Gefäßpflanzen-, 25 Moos- und 14 Flechtenarten, darunter 35 Gefäßpflanzen-, 2 Moos- und 8 Flechtenarten der Roten Listen Deutschlands (Anhang E12). Der Artenreichtum pro Aufnahmefläche (im Mittel 15,6 m²) lag bei durchschnittlich 37,7 Gefäßpflanzen, 4,3 Moosen und 0,6 Flechten (Anhang E6). Im *Campanulo rotundifoliae-Dianthetum deltoidis* war der Reichtum gefährdeter Arten besonders hoch (7,5 Arten pro 16 m², Abb. 7).

Diskussion – Ähnliche Gesellschaften wie in unserem Gebiet wurden aus angrenzenden Teilen des östlichen Rheinischen Schiefergebirges beschrieben (BERGMEIER 1987, NOWAK 1991, 1992, OTTE et al. 2008, BECKER et al. 2012). Offenbar ist das Gesellschaftsspektrum für die klimabegünstigten Teile des Rheinischen Schiefergebirges charakteristisch. Gleichzeitig handelt es sich um Reliktgesellschaften der vorindustriellen Kulturlandschaft, die als Gesellschaftskomplex kennzeichnend sind für Räume mit früherem Realerbteilungsrecht, die bis weit in die zweite Hälfte des 20. Jahrhunderts eher extensiv kleinlandwirtschaftlich genutzt wurden. Mit dem *Polytricho piliferi-Scleranthetum perennis* und dem *Campanulo rotundifoliae-Dianthetum deltoidis* wurden zwei Assoziationen erstmals für Deutschland nachgewiesen. Die erstere wurde bisher verkannt und die zweite entspricht im Wesentlichen dem zur Assoziation aufgewerteten *Polygalo vulgaris-Nardetum strictae koelerietosum pyramidatae* (PEPPLER-LISBACH & PETERSEN 2001), das kennzeichnend ist für Rotschwingel-reiche Magerrasen des *Violion caninae* (fast) ohne Borstgras. Lokal unterscheiden sie sich von typischen Borstgrasrasen (*Festuco capillatae-Nardetum strictae*) durch Zeiger basenhaltiger Böden wie *Helictochloa pratensis*, *Helianthemum nummularium* und *Cirsium acaulon*. Während das *Festuco capillatae-Nardetum strictae* (außerhalb des Untersuchungsgebiets) auf mehr tiefgründigen, stark sauren Böden wächst, besiedelt das *Campanulo-Dianthetum* mehr oder weniger trockene, skelettreiche, basenreiche Böden. Es handelt sich um eine in Zentraleuropa außerhalb der Kalkgebiete weitverbreitete Assoziation der Mittelgebirgslagen, die bis in die ukrainischen Ost-Karpaten nachgewiesen worden ist (JANIŠOVÁ et al. 2010, ŠKODOVÁ et al. 2015). Der Name *Polygalo vulgaris-Nardetum strictae* Oberd. 1957 (PEPPLER-LISBACH & PETERSEN 2001) ist dagegen ein späteres heterotypisches Synonym des *Festuco capillatae-Nardetum strictae* und steht als Name für diese Borstgrasrasen nicht mehr zur Verfügung.

Mit 35 Gefäßpflanzenarten der Roten Liste Deutschlands in den 292 Aufnahmen ist die Anzahl gefährdeter Arten in unserem Gebiet hoch. Weitere Rote-Liste-Arten kommen im Gebiet in Silikatmagerrasen außerhalb der Aufnahmen vor (GRAFFMANN 2004). Obwohl der in Deutschland stark gefährdete Feld-Enzian *Gentianella campestris* im Gebiet offenbar ausgestorben ist, sollte sich der Naturschutz vorrangig auf die Erhaltung der verschiedenen Varianten des *Campanulo rotundifoliae-Dianthetum deltoidis* konzentrieren, die zum prioritären FFH-Lebensraumtyp 6230 (Artenreiche Borstgrasrasen) gehören und in deren niedrigwüchsigen Ausprägungen der Feld-Enzian vorkam und unter anderen die gefährdeten *Arnica montana*, *Antennaria dioica* und *Botrychium lunaria* noch vorkommen. Naturschutzfachlich bedeutsam sind auch die lokalen Ausprägungen der FFH-Lebensraumtypen 6510 (Extensive Mähwiesen der planaren bis submontanen Stufe) und 8230 (Silikatfelskuppen mit ihrer Pioniervegetation) im Gebiet. Letztere sind im NSG „An der alten Rheinstraße“ mit einem schönen Bestand des *Airo-Festucetum* vertreten (Abb. 5).

Die Zuordnung der Cluster nach den Summen der durch diagnostische Arten angezeigten Syntaxa hat insgesamt gut funktioniert. Meist entsprach dasjenige Syntaxon mit dem größten Anteil der intuitiven Zuordnung des Clusters. Darüber hinaus gibt die Methode Aufschluss darüber, welche relevanten weiteren Syntaxa zu welchen Anteilen innerhalb einer Gesellschaft vertreten sind. So kann die Verwandtschaft mit anderen Syntaxa erkannt und als Subassoziationen, Varianten etc. nachvollziehbar zum Ausdruck gebracht werden.

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Author contribution statement

C.S. née Voll sampled the vegetation as part of her diploma thesis supervised by H.D. while S.B. reanalysed the data as part of her bachelor thesis supervised by T.B. T.B. initiated the publication, contributed to data analysis and wrote the paper together with E.B. All authors revised the drafts and agreed with the final manuscript for publication.

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Supplements

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.

Supplement E1. The preselected 11 alliances, nine orders and six classes which were evaluated in the relevés for standardized syntaxonomic assignment of the clusters.

Anhang E1. Die vorausgewählten 11 Verbände, neun Ordnungen und sechs Klassen, die in den Aufnahmen für die standardisierte syntaxonomische Zuordnung der Cluster evaluiert wurden.

Supplement E2. Syntaxonomic affiliation of the species used as a basis of diagnostic species sums.

Anhang E2. Soziologische Anbindung der Arten als Basis der Summen der diagnostischen Arten.

Supplement E3. Number of significant ($p < 0.05$) indicator species and mean *p*-value of all species after hierarchical cluster analysis with number of clusters stepwise increased.

Anhang E3. Anzahl signifikanter ($p < 0,05$) Indikatorarten und mittlerer *p*-Wert aller Arten nach hierarchischer Clusteranalyse mit schrittweise zunehmender Clusterzahl.

Supplement E4. Cluster tree of the 292 relevés with the most robust cut level at nine clusters identified by hierarchical cluster analysis.

Anhang E4. Clusterbaum der 292 Aufnahmen mit der als robust identifizierten Schnittebene bei neun Clustern.

Supplement E5. Relevé table of the *Polytricho piliferi-Scleranthetum perennis* Moravec 1967.

Anhang E5. Vegetationstabelle *Polytricho piliferi-Scleranthetum perennis* Moravec 1967.

Supplement E6. Species richness of vascular plants, bryophytes and lichens per relevé. Mean values and simple standard errors.

Anhang E6. Artenreichtum von Gefäßpflanzen, Moosen und Flechten per Aufnahme. Mittelwerte und einfache Standardfehler.

Supplement E7. Environmental variables and vegetation characteristics of the nine vegetation types.

Anhang E7. Umweltvariablen und Vegetationsmerkmale der neun Gesellschaften.

Supplement E8. Relationships between the NMDS dimensions and environmental variables/vegetation characteristics.

Anhang E8. Zusammenhänge zwischen NMDS-Dimensionen und Umweltvariablen/Vegetationsmerkmalen.

Supplement E9. Relevé table of the *Airo-Festucetum* Sommer 1971.

Anhang E9. Vegetationstabelle *Airo-Festucetum* Sommer 1971.

Supplement E10. Relevé table of the *Campanulo rotundifoliae-Dianthetum deltoidis* Balátová-Tuláčková 1980.

Anhang E10. Vegetationstabelle *Campanulo rotundifoliae-Dianthetum deltoidis* Balátová-Tuláčková 1980.

Supplement E11. Relevé table of the *Hypericum perforatum-Gnaphalium sylvaticum* community.

Anhang E11. Vegetationstabelle *Hypericum perforatum-Gnaphalium sylvaticum*-Gesellschaft.

Supplement E12. Threatened vascular plants, bryophytes and lichens found in the vegetation plots.

Anhang E12. Gefährdete Gefäßpflanzen, Moose und Flechten in den Vegetationsaufnahmen.

Supplement E13. Relevé table of the *Arrhenatheretum elatioris ranunculetosum bulbosi* Knapp 1954.

Anhang E13. Vegetationstabelle *Arrhenatheretum elatioris ranunculetosum bulbosi* Knapp 1954.

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Supplement E1. The preselected 11 alliances, nine orders and six classes which were evaluated in the relevés for standardized syntaxonomic assignment of the clusters.

Anhang E1. Die vorausgewählten 11 Verbände, neun Ordnungen und sechs Klassen, die in den Aufnahmen für die standardisierte syntaxonomische Zuordnung der Cluster evaluiert wurden.

Class	**Order**	**Alliance**
1. *Sedo-Scleranthetea* Br.-Bl. 1955 incl. *Koelerio-Corynephoretea* Klika in Klika et V. Novák 1941	1.1 *Sedo-Scleranthetalia* Br.-Bl. 1955	1.1.1 *Hyperico perforati-Scleranthion perennis* Moravec 1967
	1.2 *Thero-Airetalia* Rivas Goday 1964	1.2.1 *Thero-Airion* Tx. ex Oberd. 1957
2. *Calluno-Ulicetea* Br.-Bl. et Tx. ex Klika et Hadač 1944	2.1 *Vaccinio myrtilli-Genistetalia pilosae* Schubert ex Passarge 1964	2.1.1 *Calluno-Genistion pilosae* P. Duvigneaud 1945
3. *Nardetea* Rivas Goday et Borja Carbonell in Rivas Goday et Major López 1966	3.1 *Nardetalia* Preising 1950	3.1.1 *Violion caninae* Schwickerath 1944
4. *Festuco-Brometea* Br.-Bl. & Tx. ex Klika & Hadac 1944	4.1 *Brachypodietalia* Korneck 1974	4.1.1 *Mesobromion* Koch 1926
5. *Molinio-Arrhenatheretea* Tx. 1937	5.1 *Arrhenatheretalia* Tx. 1931	5.1.1 *Arrhenatherion* Luquet 1926 5.1.2 *Cynosurion cristati* Tx. 1947
6. *Trifolio-Geranietea sanguinei* T. Müller 1962	6.1 *Melampyro-Holcetalia mollis* Passarge in Theurillat et al. 1995	6.1.1 *Melampyrion pratensis* Passarge 1979 / *Teucrion scorodoniae* de Foucault et al. 1983
	6.2 *Antherico ramosi-Geranietalia sanguinei* Julve ex Dengler in Dengler et al. 2003 / *Origanetalia vulgaris* T. Müller 1962	6.2.1 *Geranion sanguinei* Tx. in T. Müller 1962 / *Trifolion medii* T. Müller 1962

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Supplement E2. Syntaxonomic affiliation of the species used as a basis of diagnostic species sums.

Anhang E2. Soziologische Anbindung der Arten als Basis der Summen der diagnostischen Arten.

	C1. *Sedo-Scleranthetea* incl. *Koelerio-Corynephoretea*	O1.1 *Sedo-Scleranthetalia*	A1.1.1 *Hyperico perforati-Scleranthion perennis*	O1.2 *Thero-Airetalia*	A1.2.1 *Thero-Airion*	**C2. *Calluno-Ulicetea***	O2.1 *Vaccinio-Genistetalia pilosae*	A2.1.1 *Calluno-Genistion pilosae*	**C3. *Nardetea***	O3.1 *Nardetalia*	A3.1.1 *Violion caninae*	**C4. *Festuco-Brometea***	O4.1 *Brachypodietalia*	A4.1.1 *Bromion erecti*	**C5. *Molinio-Arrhenatheretea***	O5.1 *Arrhenatheretalia*	A5.1.1 *Arrhenatherion*	A5.1.2 *Cynosurion*	**C6. *Trifolio-Geranietea***	O6.1 *Melampyro-Holcetalia mollis*	A6.1.1 *Melampyrion pratensis/Teucrion scorodoniae*	O6.2 *Antherico-Geranietalia/Origanetalia*	A6.2.1 *Geranion sanguinei/Trifolion medii*
Graminoids																							
Agrostis capillaris	×	×		×					×	×													
Aira caryophyllea	×			×	×																		
Aira praecox	×			×	×																		
Alopecurus pratensis															×	×							
Anthoxanthum odoratum									×	×					×								
Arrhenatherum elatius															×	×	×						
Avenella flexuosa						×	×		×	×													
Avenula pubescens									×	×					×	×							
Brachypodium pinnatum												×	×										
Brachypodium sylvaticum																							
Briza media												×	×										
Bromus erectus												×											
Bromus hordeaceus															×	×							
Carex caryophyllea												×	×										
Carex flacca												×	×	×									
Carex pilulifera									×	×													
Cynosurus cristatus															×	×		×					
Dactylis glomerata															×	×							
Danthonia decumbens									×	×	×												
Deschampsia cespitosa															×								
Elymus repens																							
Festuca guestfalica	×	×	×									×	×	×									
Festuca pratensis															×	×							
Festuca rubra agg.									×						×								
Helictochloa pratensis												×	×										
Holcus lanatus															×								
Holcus mollis						×	×		×	×									×	×			
Juncus conglomeratus									×														
Koeleria macrantha									×	×		×	×										
Koeleria pyramidata												×	×	×									
Lolium perenne															×	×		×					
Luzula campestris	×								×			×											
Luzula multiflora						×			×														
Phleum nodosum												×			×								
Phleum pratense															×	×	×	×					
Poa angustifolia	×	×										×	×										
Poa annua																							
Poa trivialis															×								
Trisetum flavescens															×	×							
Herbs																							
Achillea millefolium															×	×							
Aegopodium podagraria																							
Agrimonia eupatoria												×	×						×			×	
Ajuga reptans															×								
Alchemilla glaucescens									×	×	×												
Alchemilla monticola									×	×					×	×							
Antennaria dioica									×	×	×	×	×	×									

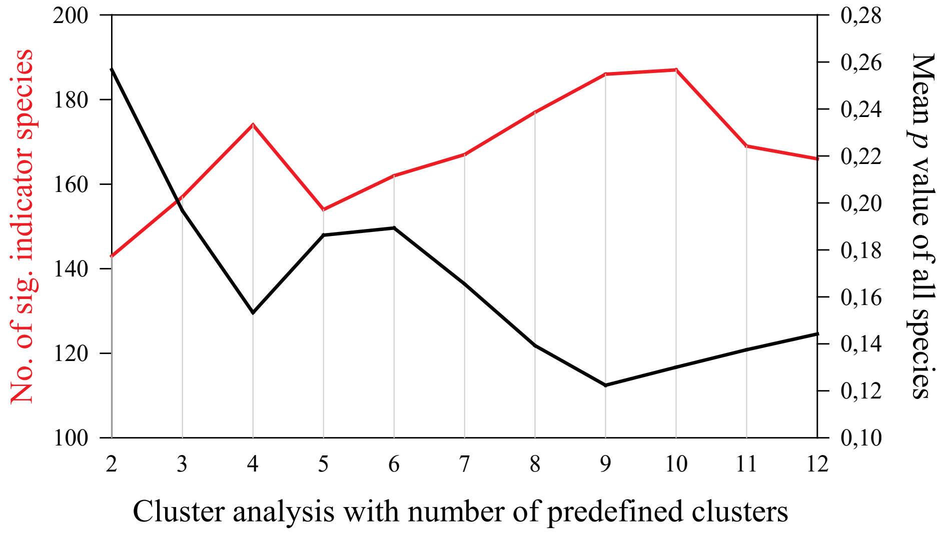
Anthemis arvensis																							
Anthriscus sylvestris														×	×	×							
Anthyllis vulneraria											×	×	×										
Aphanes arvensis																							
Arabidopsis thaliana	×	×		×																			
Arenaria serpyllifolia subsp. *serpyllifolia*	×																						
Arnica montana									×	×													
Astragalus glycyphyllos																			×			×	
Botrychium lunaria									×	×													
Bunias orientalis																							
Calluna vulgaris						×	×		×	×													
Campanula glomerata												×	×										
Campanula rapunculus												×	×	×	×	×	×		×			×	
Campanula rotundifolia									×	×		×	×										
Cardamine pratensis															×								
Carlina acaulis subsp. *caulescens*									×	×	×	×	×	×									
Carlina vulgaris												×	×	×									
Carum carvi															×	×							
Centaurea jacea s. str.															×	×			×			×	
Centaurea scabiosa												×											
Cerastium arvense	×	×																					
Cerastium brachypetalum	×			×	×																		
Cerastium glutinosum	×																						
Cerastium holosteoides															×	×							
Cirsium acaulon												×	×										
Cirsium arvense																							
Cirsium palustre															×								
Cirsium vulgare																							
Clinopodium vulgare																			×			×	
Colchicum autumnale															×								
Convolvulus arvensis																							
Crepis biennis															×	×	×						
Daucus carota												×	×		×	×			×			×	
Dianthus deltoides	×								×														
Draba verna	×																						
Echium vulgare	×																						
Epilobium angustifolium																							
Epilobium montanum																							
Equisetum arvense																							
Erodium cicutarium	×																						
Euphrasia officinalis subsp. *pratensis*	×	×							×	×		×	×										
Filago minima	×			×	×																		
Fragaria vesca																			×				
Galeopsis tetrahit																							
Galium album															×	×			×			×	
Galium aparine																							
Galium pumilum									×	×	×	×	×	×									
Galium verum	×	×							×	×		×	×										
Genista germanica						×	×	×															
Genista tinctoria									×			×							×				
Gentianella campestris									×	×													
Geranium dissectum																							
Geranium molle																							
Geranium pyrenaicum																							
Gnaphalium sylvaticum																							
Helianthemum nummularium subsp. *obscurum*												×	×	×									
Heracleum sphondylium															×	×							
Hieracium lachenalii									×	×													
Hieracium laevigatum									×	×									×	×			
Hieracium murorum																							
Hieracium pilosella	×	×	×	×	×				×	×	×	×	×										
Hieracium spec.																							
Hylotelephium telephium																			×	×			
Hypericum maculatum									×	×	×												
Hypericum perforatum	×	×	×									×	×						×	×			
Hypochaeris radicata	×	×							×	×													
Jasione montana	×	×	×	×	×																		
Knautia arvensis									×			×							×				
Lamium album																							
Lathyrus pratensis															×								
Lathyrus sylvestris																			×			×	
Leontodon hispidus									×	×		×	×										
Leucanthemum ircutianum												×	×		×	×							
Linaria vulgaris																							
Linum catharticum												×	×										
Lotus corniculatus												×	×		×	×							
Lychnis flos-cuculi															×								
Malva moschata															×	×			×			×	
Medicago falcata																			×			×	×

Medicago lupulina												×	×		×	×							
Melampyrum pratense									×	×									×	×			
Myosotis arvensis																							
Myosotis discolor	×			×	×																		
Myosotis ramosissima	×																						
Myosotis stricta	×																						
Ononis repens subsp. *procurrens*												×	×										
Origanum vulgare																			×			×	
Orobanche purpurea												×	×						×			×	
Petrorhagia prolifera	×																						
Petrosedum rupestre	×	×	×																				
Picris hieracioides																							
Pimpinella major															×	×	×						
Pimpinella saxifraga									×	×		×	×										
Plantago lanceolata															×	×							
Plantago media												×	×	×	×	×		×					
Platanthera bifolia									×	×	×												
Polygala vulgaris subsp. *vulgaris* et *oxyptera*									×	×	×												
Potentilla anserina																							
Potentilla argentea	×	×		×																			
Potentilla erecta						×			×														
Potentilla verna	×											×	×	×									
Primula veris												×	×						×			×	
Prunella vulgaris															×	×		×					
Ranunculus acris															×								
Ranunculus bulbosus												×	×	×									
Ranunculus polyanthemos s. l.									×	×	×	×	×	×	×	×							
Ranunculus repens															×								
Rhinanthus minor									×	×		×	×		×	×							
Rubus idaeus																							
Rubus sect. *Rubus*																							
Rumex acetosa															×	×							
Rumex acetosella	×	×				×	×																
Sagina procumbens																							
Salvia nemorosa												×	×										
Salvia pratensis												×							×				
Sanguisorba minor												×											
Sanguisorba officinalis															×								
Saxifraga granulata	×								×			×											
Scleranthus perennis	×	×	×																				
Scleranthus polycarpos	×			×	×																		
Scorzoneroides autumnalis															×	×		×					
Sedum acre	×	×																					
Senecio jacobaea															×	×			×			×	
Silene nutans	×	×							×	×		×	×						×				
Silene vulgaris																			×				
Solidago virgaurea									×	×									×			×	
Spergularia rubra																							
Stellaria gramminea															×								
Tanacetum vulgare																							
Taraxacum sect. *Erythrosperma*	×	×							×	×		×											
Taraxacum sect. *Ruderalia*															×	×							
Teesdalia nudicaulis	×			×	×																		
Teucrium scorodonia						×	×	×											×	×	×		
Thymus pulegioides	×	×										×	×										
Torilis japonica																							
Tragopogon pratensis															×	×							
Trifolium alpestre																			×			×	×
Trifolium arvense	×			×	×																		
Trifolium campestre	×	×	×																				
Trifolium dubium															×	×							
Trifolium medium																			×			×	×
Trifolium pratense															×	×							
Trifolium repens															×	×		×					
Trifolium striatum	×	×	×	×	×																		
Urtica dioica																							
Vaccinium myrtillus						×	×		×	×													
Valeriana pratensis subsp. *angustifolia*																			×				
Valerianella locusta et *carinata*	×	×																					
Verbascum nigrum																							
Verbascum thapsus																							
Veronica arvensis	×																						
Veronica chamaedrys															×	×			×			×	
Veronica officinalis						×	×		×	×													
Veronica serpyllifolia															×	×		×					
Vicia angustifolia	×	×										×	×										
Vicia cracca									×	×					×	×			×	×			
Vicia hirsuta	×																						
Vicia sepium															×	×			×			×	

Viola arvensis																						
Viola canina									×	×	×											
Viola hirta												×	×						×			×
Woody plants																						
Acer campestre juv.																						
Betula pendula juv.																						
Carpinus betulus juv.																						
Corylus avellana juv.																						
Crataegus spec. juv.																						
Cytisus scoparius																						
Fagus sylvatica juv.																						
Juniperus communis																						
Pinus sylvestris juv.																						
Populus tremula juv.																						
Prunus avium juv.																						
Prunus domestica juv.																						
Prunus spinosa juv.																						
Quercus spec. juv.																						
Rhamnus cathartica juv.																						
Rosa spec. juv.																						
Salix caprea juv.																						
Sambucus nigra juv.																						
Sorbus aria juv.																						
Sorbus aucuparia juv.																						
Bryophytes																						
Barbilophozia barbata																						
Brachythecium albicans	×					×			×													
Brachythecium rutabulum															×				×			
Calliergonella cuspidata															×							
Ceratodon purpureus	×																					
Climacium dendroides															×							
Dicranum bonjeanii	×					×																
Dicranum scoparium						×			×													
Hylocomium splendens						×			×										×			
Hypnum jutlandicum						×			×													
Hypnum lancunosum	×								×			×										
Lophocolea bidentata																						
Plagiomnium affine															×				×			
Plagiomnium undulatum																						
Plagiothecium spec.																						
Pleurozium schreberi						×			×													
Polytrichum formosum						×			×													
Polytrichum juniperinum	×					×			×													
Polytrichum piliferum	×																					
Ptilidium ciliare						×			×													
Racomitrium elongatum	×																					
Rhytidiadelphus squarrosus									×						×							
Scleropodium purum						×			×													
Thuidium tamariscinum									×			×										
Lichens																						
Cetraria aculeata	×																					
Cladonia arbuscula						×			×													
Cladonia ciliata	×																					
Cladonia fimbriata	×																					
Cladonia foliacea	×																					
Cladonia furcata	×					×			×													
Cladonia macilenta						×			×													
Cladonia phyllophora	×																					
Cladonia pyxidata subsp. *chlorophaea*	×																					
Cladonia rangiformis	×					×			×			×										
Cladonia spec.																						
Cladonia subulata	×					×			×													
Cladonia unicalis						×			×													
Peltigera cf. *rufescens*	×																					

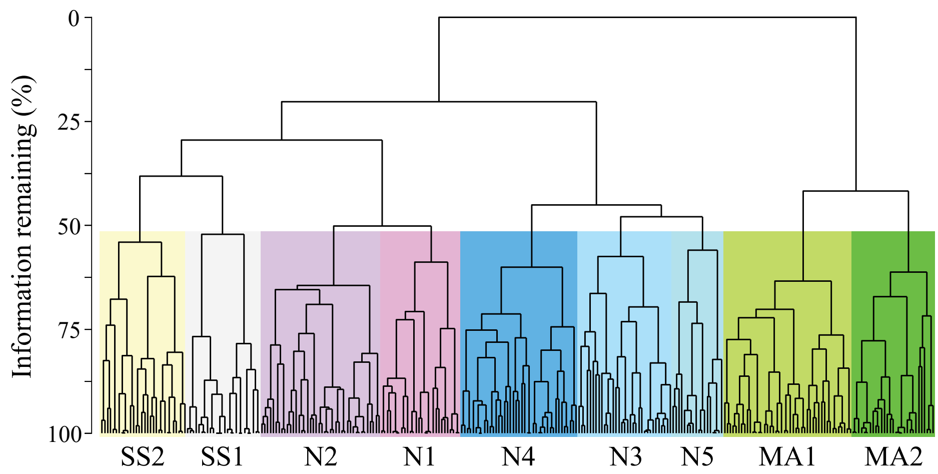
Supplement E3. Number of significant ($p < 0.05$) indicator species and mean *p*-value of all species after hierarchical cluster analysis with number of clusters stepwise increased. The most robust cut level in the cluster tree was identified at nine clusters, where the mean *p* value was lowest and the number of significant indicator species was highest.

Anhang E3. Anzahl signifikanter ($p < 0,05$) Indikatorarten und mittlerer *p*-Wert aller Arten nach hierarchischer Clusteranalyse mit schrittweise zunehmender Clusterzahl. Die optimale Schnittebene in dem Clusterbaum wurde bei neun Clustern identifiziert, da hier der mittlere *p*-Wert am niedrigsten und die Anzahl signifikanter Indikatorarten am höchsten lag.



Supplement E4. Cluster tree of the 292 relevés with the most robust cut level at nine clusters identified by hierarchical cluster analysis SS1 = *Polytricho piliferi-Scleranthetum perennis*; SS2 = *Airo-Festucetum*; N1–4 = *Campanulo rotundifoliae-Dianthetum deltoidis*: N1 = *Potentilla erecta* variant, N2–4 = *Carex caryophyllea* variant, N2 = subvariant with *Cladonia arbuscula*, N3 = subvariant with *Ranunculus bulbosus*, N4 = subvariant with *Trifolium alpestre*; N5 = *Hypericum perforatum-Gnaphalium sylvaticum* [*Violion caninae*] community; MA1–2 = *Arrhenatheretum elatioris ranunculetosum bulbosi*: MA1 = *Bromus erectus* variant, MA2 = *Festuca pratensis* variant.

Anhang E4. Clusterbaum der 292 Aufnahmen mit der als robust identifizierten Schnittebene bei neun Clustern. Die Bedeutung der Cluster/Syntaxa-Kürzel geht aus der englischen Abbildungsunterschrift hervor.



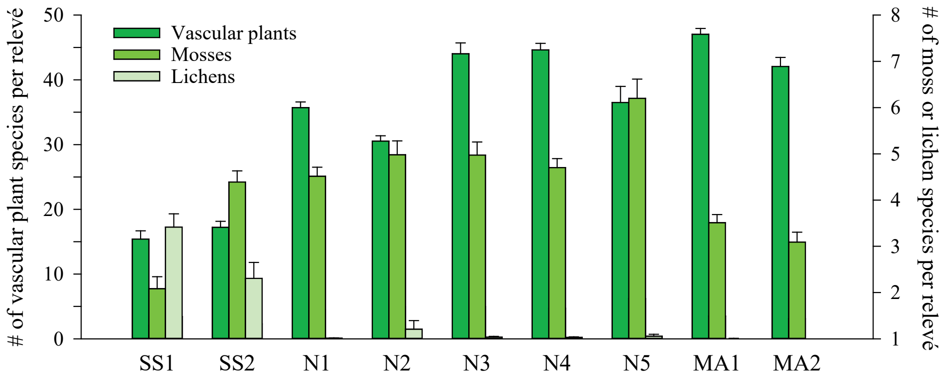
Supplement E5: Relevé table of the *Polytricho piliferi-Scleranthetum perennis* Moravec 1967 (cluster SS1). Delta symbols (Δ) indicate local differential species of the association, and asterisks (*) species that are alligned with further syntaxa (cf. Suppl. E2).

Anhang E5. Vegetationstabelle Polytricho piliferi-Scleranthetum perennis Moravec 1967 (Cluster SS1). Delta-Symbole (Δ) kennzeichnen lokale Differenzialarten der Assoziation und Sterne (*) Arten, die weitere Syntaxa indizieren (cf. Suppl. E2).

Running relevé no.	1	2	3	4	5	6	7	8	9	10	11	12
Cluster	SS1	SS1	SS1	SS1	SS1	SS1	SS1	SS1	SS1	SS1	SS1	SS1
Site	1	1	1	1	1	1	1	1	1	1	1	1
Relevé size (m²)	0,5	0,5	1	1	1	1	1	0,5	1	1	0,5	0,5
Slope exposition	SW	S	S	S	SW	SW	SW	SW	SW	SW	SW	SW
Slope southerness (°)	135	180	180	180	135	135	135	135	135	135	135	135
Slope inclination (°)	29	29	32	34	32	32	32	32	29	34	32	29
Soil pH (H2O)	-	-	-	-	-	-	-	-	-	-	-	-
Soil pH (KCl)	-	-	-	-	-	-	-	-	-	-	-	-
Cover vascular plants (%)	25	35	30	25	50	55	50	40	30	15	20	30
Cover cryptogams (%)	25	60	50	20	60	50	70	40	35	10	35	30
Total species richness	16	18	20	21	20	29	21	32	21	17	16	20
Species richness vascular plants	11	13	15	17	14	24	17	23	14	13	9	15
Species richness bryophytes	1	2	2	1	3	1	2	4	3	2	2	2
Species richness lichens	4	3	3	3	3	4	2	5	4	2	5	3
Hyperico perforati-Scleranthion perennis												
Hieracium pilosella*	2	2	2	2	3	2	3	2	1	+	2	1
Festuca guestfalica*	1	2	+	2	1	2	1	1	1	2	2	2
Δ Petrosedum rupestre	2	2	2	+	+	1	.	1	2	1	1	1
Trifolium campestre	.	.	.	.	.	.	.	+	.	.	.	+
Hypericum perforatum*	.	.	.	.	.	.	.	.	.	.	.	+
Sedo-Scleranthetalia												
Δ Thymus pulegioides*	+	1	+	+	+	+	+	+	1	1	+	+
Agrostis capillaris*	.	+	+	+	+	+	+	+	+	+	+	.
Δ Sedum acre	+	2	+	+	1	+	1	.	+	+	.	.
Poa angustifolia*	+	.	+	.	+	+	+	+	+	+	.	+
Rumex acetosella*	1	.	.	.	.	.	.	.	+	+	+	+
Arabidopsis thaliana*	.	+	.	.	.	+	.	.	.	.	.	.
Galium verum*	.	.	.	.	.	.	.	1	.	.	.	.
Cerastium arvense	.	.	.	.	.	1	.	.	.	.	.	.
Sedo-Scleranthetea incl. Koelerio-Corynephoretea												
Potentilla verna*	1	1	2	1	+	+	2	2	1	+	1	2
Cladonia furcata*	+	3	1	1	1	1	2	1	1	+	1	+
Hypnum lancunosum*	2	2	1	1	3	3	3	2	2	1	.	+
Δ Cladonia rangiformis*	.	.	1	1	.	1	1	1	1	+	1	+
Δ Cladonia foliacea	.	1	3	2	2	2	.	1	1	.	2	.
Ceratodon purpureus	.	.	.	.	.	.	+	.	2	2	2	2
Cetraria aculeata	+	.	.	.	1	+	.	.	1	.	1	.
Dianthus deltoides*	.	.	+	+	.	+	.	.	.	.	.	+
Δ Trifolium arvense	.	.	.	+	+	.	.	+	.	.	.	+
Polytrichum juniperinum*	.	.	.	.	.	.	.	+	1	.	2	.
Draba verna	.	+	.	.	.	+	.	+	.	.	.	.
Δ Cladonia fimbriata	+	+	.	.	.	.	.	.	.	.	.	+
Δ Echium vulgare	.	.	.	+	.	.	.	+	.	.	.	+
Δ Petrorhagia prolifera	.	.	.	.	.	.	+	+	.	+	.	.
Vicia hirsuta	.	+	.	.	.	.	+	+	.	.	.	.
Cladonia pyxidata subsp. chlorophaea	+	.	.	.	.	.	.	.	.	.	+	.
Δ Erodium cicutarium	.	.	.	.	.	.	.	.	.	+	.	+
Δ Myosotis stricta	.	.	.	.	+	.	.	+	.	.	.	.
Racomitrium elongatum	.	.	.	.	.	.	.	2	.	.	.	.
Brachythecium albicans*	.	.	1	.	.	.	.	.	.	.	.	.
Saxifraga granulata*	.	.	.	.	.	+	.	.	.	.	.	.
Cladonia subulata*	.	.	.	.	.	.	.	+	.	.	.	.
Polytrichum piliferum	.	.	.	.	+	.	.	.	.	.	.	.
Arenaria serpyllifolia	.	.	.	.	.	+	.	.	.	.	.	.
Δ Peltigera cf. rufescens	.	.	.	.	.	.	.	+	.	.	.	.
Further species												
Pimpinella saxifraga	+	.	+	1	+	1	1	+	+	+	+	.
Sanguisorba minor	+	.	+	1	1	1	+	+	+	.	.	.
Achillea millefolium	.	1	1	+	+	+	1	+	.	.	.	+
Plantago lanceolata	.	.	2	.	.	.	1	+	1	+	.	1
Δ Senecio jacobaea	+	+	+	+	.	.	.	.	r	.	.	.
Lotus corniculatus	.	.	1	.	.	1	.	.	1	.	.	.
Dicranum scoparium	.	+	.	.	.	.	.	+	.	.	.	.
Taraxacum sect. Ruderalia	.	.	.	+	.	+	.	.	.	.	.	.
Tragopogon pratensis	.	.	.	+	+	.	.	.	.	.	.	.
Anthoxanthum odoratum	.	.	.	.	.	.	+	.	.	.	.	.
Arrhenatherum elatius	.	.	.	+	.	.	.	.	.	.	.	.
Carex caryophyllea	.	.	.	.	.	.	.	+	.	.	.	.
Centaurea jacea	.	.	.	.	.	.	+	.	.	.	.	.
Dactylis glomerata	.	.	.	.	.	.	+	.	.	.	.	.
Daucus carota	.	.	.	.	.	.	.	+	.	.	.	.
Knautia arvensis	.	.	.	.	.	+	.	.	.	.	.	.
Koeleria pyramidata	.	.	.	.	.	+	.	.	.	.	.	.
Leontodon hispidus	.	.	.	.	.	+	.	.	.	.	.	.
Δ Phleum nodosum	.	.	.	.	.	+	.	.	.	.	.	.
Rhytidiadelphus squarrosus	.	.	.	.	+	.	.	.	.	.	.	.
Trisetum flavescens	.	.	.	.	.	+	.	.	.	.	.	.
Viola arvensis	.	.	.	.	.	.	.	+	.	.	.	.
Viola hirta	.	.	.	.	.	.	+	.	.	.	.	.
Cytisus scoparius	.	.	.	.	.	.	.	.	.	.	r	.
Linaria vulgaris	.	.	.	.	.	.	.	r	.	.	.	.
Verbascum thapsus	.	r	.	.	.	.	.	.	.	.	.	.

Supplement E6. Species richness of vascular plants, bryophytes and lichens per relevé. Mean values and simple standard errors. SS1 = *Polytricho piliferi-Scleranthetum perennis*; SS2 = *Airo-Festucetum*; N1–4 = *Campanulo rotundifoliae-Dianthetum deltoidis*: N1 = *Potentilla erecta* variant, N2–4 = *Carex caryophyllea* variant: N2 = *Cladonia arbuscula* subvariant, N3 = *Ranunculus bulbosus* subvariant, N4 = *Trifolium alpestre* subvariant; N5 = *Hypericum perforatum-Gnaphalium sylvaticum* [*Violion caninae*] community; MA1–2 = *Arrhenatheretum elatioris ranunculetosum bulbosi*: MA1 = *Bromus erectus* variant, MA2 = *Festuca pratensis* variant. Note that plot size differs between vegetation types (for plot sizes see Table 2).

Anhang E6. Artenreichtum von Gefäßpflanzen, Moosen und Flechten per Aufnahme. Mittelwerte und einfache Standardfehler. Die Bedeutung der Cluster/Syntaxa-Kürzel geht aus der englischen Abbildungsunterschrift hervor. Es ist zu beachten, dass sich die Größe der Aufnahmeflächen zwischen den Vegetationstypen unterscheidet (s. Flächengrößen in Tabelle 2).



Supplement E7. Environmental variables and vegetation characteristics of the nine vegetation types: SS1 = *Polytricho-Scleranthetum*; SS2 = *Airo-Festucetum*; N1-4 = *Campanulo rotundifoliae-Dianthetum deltoidis*: N1 = *Potentilla erecta* variant, N2–4 = *Carex caryophyllea* variant, N2 = subvariant with *Cladonia arbuscula*, N3 = subvariant with *Ranunculus bulbosus*, N4 = subvariant with *Trifolium alpestre*; N5 = *Hypericum perforatum-Gnaphalium sylvaticum* [*Violion caninae*] community; MA1–2 = *Arrhenatherum elatioris ranunculetosum bulbosi*: MA1 = *Bromus erectus* variant, MA2 = *Festuca pratensis* variant. Mean values and standard errors are shown. Mean values with different letters differ significantly. EIV = mean Ellenberg indicator value, GMV = mean grassland management value.

Anhang E7. Umweltvariablen und Vegetationsmerkmale der neun Gesellschaften (für die Bedeutung der Cluster/Syntaxa-Kürzel siehe die englische Überschrift). Mittelwerte und Standardfehler. Mittelwerte mit ungleichen Buchstaben unterscheiden sich signifikant. EIV = mittlerer Ellenberg-Zeigerwert, GMV = mittlerer Grasland-Nutzwert.

No. of relevés (with pH measurement)	SS1 12 (0)	SS2 23 (10)	N1 31 (19)	N2 48 (38)	N3 40 (14)	N4 54 (34)	N5 10 (6)	MA1 41 (25)	MA2 33 (20)	*p* from ANOVA
Plot size (m^2)	0.8 ± 0.1 ^{a}	4.5 ± 0.9 ^{a}	17.3 ± 0.8 ^{bc}	14.5 ± 0.5 ^{b}	17.2 ± 0.9 ^{bc}	15.8 ± 0.4 ^{b}	21.5 ± 3.3 ^{cd}	17.5 ± 0.9 ^{bc}	22.1 ± 0.9 ^{d}	<0.001
Elevation (m a.s.l.)	420 ± 0 ^{bc}	420 ± 0 ^{bc}	390 ± 0 ^{a}	422 ± 3 ^{c}	420 ± 2 ^{bc}	399 ± 2 ^{ab}	431 ± 5 ^{c}	412 ± 6 ^{bc}	416 ± 8 ^{bc}	<0.001
Slope southernness (°)	146 ± 6 ^{d}	135 ± 0 ^{cd}	39.2 ± 3 ^{a}	79.7 ± 6 ^{ab}	99.2 ± 9 ^{bc}	70.8 ± 4 ^{ab}	171 ± 9 ^{d}	101 ± 11 ^{bc}	50.0 ± 11 ^{a}	<0.001
Slope inclination (°)	31 ± 0.5 ^{e}	4.9 ± 0.3 ^{a}	12.6 ± 0.7 ^{d}	8.7 ± 0.5 ^{bc}	7.7 ± 0.7 ^{abc}	9.3 ± 0.5 ^{cd}	7.0 ± 0.4 ^{abc}	9.4 ± 0.8 ^{cd}	5.6 ± 0.5 ^{ab}	<0.001
Soil pH (H_2O)	–	4.4 ± 0.1 ^{a}	5.0 ± 0.0 ^{b}	5.0 ± 0.0 ^{b}	5.5 ± 0.1 ^{c}	5.5 ± 0.0 ^{c}	4.9 ± 0.1 ^{b}	5.6 ± 0.1 ^{c}	6.0 ± 0.1 ^{d}	<0.001
Soil pH (KCl)	–	3.8 ± 0.0 ^{a}	4.0 ± 0.0 ^{a}	4.0 ± 0.0 ^{a}	4.5 ± 0.1 ^{c}	4.5 ± 0.0 ^{c}	3.9 ± 0.0 ^{a}	4.6 ± 0.1 ^{c}	5.1 ± 0.1 ^{d}	<0.001
Cover vascular plants (%)	33.8 ± 3.6 ^{a}	65.4 ± 3.7 ^{b}	88.6 ± 1.3 ^{de}	77.6 ± 2.2 ^{c}	88.2 ± 1.6 ^{de}	87.2 ± 1.4 ^{cd}	93.8 ± 0.9 ^{def}	96.8 ± 0.6 ^{ef}	99.0 ± 0.4 ^{f}	<0.001
Cover cryptogams (%)	40.4 ± 5.2 ^{bc}	62.2 ± 2.7 ^{de}	87.1 ± 0.9 ^{f}	76.9 ± 2.3 ^{ef}	76.9 ± 2.1 ^{ef}	57.1 ± 3.5 ^{cd}	43.8 ± 9.5 ^{bc}	36.7 ± 4.5 ^{ab}	22.1 ± 3.2 ^{a}	<0.001
Species richness	20.8 ± 1.4 ^{a}	23.9 ± 1.0 ^{a}	40.3 ± 0.9 ^{bc}	36.7 ± 0.9 ^{b}	49.3 ± 1.8 ^{de}	49.5 ± 1.1 ^{de}	43.1 ± 2.3 ^{bcd}	50.6 ± 0.9 ^{e}	45.1 ± 1.5 ^{cde}	<0.001
EIV light (L)	7.6 ± 0.0 ^{e}	7.7 ± 0.0 ^{f}	6.8 ± 0.0 ^{a}	7.0 ± 0.0 ^{cd}	7.1 ± 0.0 ^{d}	7.0 ± 0.0 ^{bc}	6.9 ± 0.0 ^{ab}	7.0 ± 0.0 ^{cd}	6.9 ± 0.0 ^{ab}	<0.001
EIV temperature (T)	5.4 ± 0.1 ^{b}	5.0 ± 0.1 ^{a}	4.9 ± 0.0 ^{a}	5.0 ± 0.0 ^{ab}	5.3 ± 0.0 ^{b}	5.3 ± 0.0 ^{b}	5.1 ± 0.1 ^{a}	5.4 ± 0.0 ^{b}	5.4 ± 0.0 ^{b}	<0.001
EIV continentality (K)	4.0 ± 0.1 ^{a}	3.7 ± 0.0 ^{c}	3.7 ± 0.0 ^{c}	3.8 ± 0.0 ^{bc}	3.8 ± 0.0 ^{bc}	3.8 ± 0.0 ^{bc}	3.9 ± 0.0 ^{b}	3.7 ± 0.0 ^{c}	3.7 ± 0.0 ^{c}	<0.001
EIV moisture (F)	3.3 ± 0.0 ^{a}	3.3 ± 0.0 ^{a}	4.2 ± 0.0 ^{cd}	4.0 ± 0.0 ^{b}	4.1 ± 0.0 ^{b}	4.1 ± 0.0 ^{bc}	4.3 ± 0.0 ^{d}	4.3 ± 0.0 ^{d}	4.7 ± 0.0 ^{e}	<0.001
EIV reaction (R)	5.3 ± 0.1 ^{c}	4.1 ± 0.1 ^{a}	4.6 ± 0.1 ^{b}	4.4 ± 0.1 ^{ab}	5.5 ± 0.1 ^{d}	5.5 ± 0.0 ^{d}	5.2 ± 0.2 ^{d}	6.2 ± 0.0 ^{e}	6.3 ± 0.0 ^{e}	<0.001
EIV nutrients (N)	2.6 ± 0.1 ^{ab}	2.5 ± 0.1 ^{a}	3.2 ± 0.0 ^{c}	2.7 ± 0.0 ^{b}	3.3 ± 0.0 ^{c}	3.3 ± 0.0 ^{c}	3.9 ± 0.1 ^{d}	4.1 ± 0.0 ^{d}	4.8 ± 0.1 ^{e}	<0.001
GMV cutting tolerance	4.7 ± 0.1 ^{a}	6.0 ± 0.1 ^{cd}	4.6 ± 0.1 ^{a}	4.6 ± 0.1 ^{a}	5.6 ± 0.1 ^{c}	5.1 ± 0.1 ^{b}	5.1 ± 0.2 ^{b}	6.1 ± 0.0 ^{d}	6.6 ± 0.1 ^{e}	<0.001
GMV grazing tolerance	5.2 ± 0.2 ^{e}	4.7 ± 0.1 ^{bcd}	4.4 ± 0.1 ^{ab}	4.5 ± 0.1 ^{abc}	4.9 ± 0.1 ^{de}	4.4 ± 0.0 ^{ab}	4.3 ± 0.1 ^{a}	4.8 ± 0.0 ^{cd}	4.4 ± 0.1 ^{a}	<0.001
GMV trampling tolerance	5.2 ± 0.2 ^{d}	4.8 ± 0.1 ^{bc}	4.4 ± 0.0 ^{a}	4.5 ± 0.1 ^{ab}	4.9 ± 0.0 ^{cd}	4.3 ± 0.0 ^{ab}	4.3 ± 0.1 ^{a}	4.5 ± 0.0 ^{ab}	4.3 ± 0.1 ^{a}	<0.001
GMV fodder tolerance	3.7 ± 0.1 ^{a}	3.7 ± 0.1 ^{a}	3.8 ± 0.1 ^{a}	3.5 ± 0.0 ^{a}	4.7 ± 0.1 ^{b}	4.5 ± 0.1 ^{b}	4.7 ± 0.4 ^{b}	5.2 ± 0.1 ^{c}	6.1 ± 0.1 ^{d}	<0.001

Supplement E8. Relationships between the NMDS dimensions and environmental variables/vegetation characteristics. EIV = mean Ellenberg indicator value, GMV = mean Grassland management value. Significant correlations after Bonferroni correction in boldface.

Anhang E8. Zusammenhänge zwischen NMDS-Dimensionen und Umweltvariablen/Vegetationsmerkmalen. EIV = mittlerer Ellenberg-Zeigerwert, GMV = mittlerer Grasland-Nutzwert. Signifikante Korrelationen nach einer Bonferroni-Korrektur sind fettgeduckt.

	NMDS dimension 1		NMDS dimension 2	
	r	*p*	*r*	*p*
Slope southernness	0.15	0.010	**0.40**	**< 0.001**
Slope inclination	**0.25**	**< 0.001**	0.13	0.030
Soil pH (H_2O)	**-0.77**	**< 0.001**	0.21	0.006
Soil pH (KCl)	**-0.72**	**< 0.001**	**0.36**	**< 0.001**
Cover vascular plants	**-0.69**	**< 0.001**	**-0.38**	**< 0.001**
Cover cryptogams	**0.47**	**< 0.001**	**-0.35**	**< 0.001**
EIV light (L)	**0.54**	**< 0.001**	**0.69**	**< 0.001**
EIV temperature (T)	**-0.58**	**< 0.001**	**0.41**	**< 0.001**
EIV continentality (K)	0.14	0.019	0.11	0.064
EIV moisture (F)	**-0.81**	**< 0.001**	**-0.41**	**< 0.001**
EIV reaction (R)	**-0.86**	**< 0.001**	0.16	0.007
EIV nutrients (N)	**-0.94**	**< 0.001**	0.03	0.590
GMV cutting tolerance	**-0.64**	**< 0.001**	**0.48**	**< 0.001**
GMV grazing tolerance	0.07	0.213	**0.45**	**< 0.001**
GMV trampling tolerance	**0.22**	**< 0.001**	**0.45**	**< 0.001**
GMV fodder quality	**-0.89**	**< 0.001**	0.16	0.005
Proportion of *Sedo-Scleranthetea* species	**0.23**	**< 0.001**	**0.71**	**< 0.001**
Proportion of *Molinio-Arrhenatheretea* species	**-0.93**	**< 0.001**	0.14	0.016
Proportion of *Nardetea* species	**0.27**	**< 0.001**	**-0.78**	**< 0.001**

Supplement E9: Relevé table of the *Airo-Festucetum* Sommer 1971 (cluster SS2). Delta symbols (Δ) indicate local differential species of the association, and asterisks (*) species that are alligned with further syntaxa (cf. Suppl. E2).

Anhang E9. Vegetationstabelle *Airo-Festucetum* Sommer 1971 (Cluster SS2). Delta-Symbole (Δ) kennzeichnen lokale Differenzialarten der Assoziation und Sterne (*) Arten, die weitere Syntaxa indizieren (cf. Anhang E2).

Running relevé no.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23
Cluster	SS2	SS2	SS2	SS2	SS2	SS2	SS2	SS2	SS2	SS2	SS2	SS2	SS2	SS2	SS2	SS2	SS2	SS2	SS2	SS2	SS2	SS2	SS2
Site	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
Relevé size (m²)	1	1	1	1	1	1	1	1	1	1	1	1	1	1	10	10	10	10	10	10	10	10	10
Slope exposition	SO	SO	SO	SO	SO	SO	SO	SO	SO	SO	SO	SO	SO	SO	SO	SO	SO	SO	SO	SO	SO	SO	SO
Slope southerness (°)	135	135	135	135	135	135	135	135	135	135	135	135	135	135	135	135	135	135	135	135	135	135	135
Slope inclination (°)	5	5	5	5	5	7	2	4	2	7	7	4	5	7	5	5	5	5	4	5	5	7	7
Soil pH (H2O)	4,3	-	4,3	-	-	4,6	-	4,3	4,5	-	-	-	-	4,3	-	-	-	-	-	4,7	4,5	4,2	4,3
Soil pH (KCl)	3,7	-	3,7	-	-	3,9	-	3,8	3,9	-	-	-	-	3,8	-	-	-	-	-	3,9	4	3,7	3,9
Cover vascular plants (%)	65	60	75	50	40	45	45	50	55	60	50	40	60	65	80	80	85	80	95	95	95	60	75
Cover cryptogams (%)	75	75	80	70	80	35	50	55	60	60	40	65	50	50	70	65	55	70	60	60	50	75	80
Total species richness	21	17	18	22	20	23	25	22	19	23	19	19	23	24	33	33	32	23	28	26	27	27	26
Species richness vascular plants	16	12	12	14	13	18	18	16	13	13	12	12	16	17	23	27	26	17	21	19	23	19	19
Species richness bryophytes	4	4	5	7	5	3	4	4	4	3	3	4	3	3	6	5	6	5	5	6	4	5	3
Species richness lichens	1	1	1	1	2	2	3	2	2	7	4	3	4	4	4	1	0	1	2	1	0	3	4
Thero-Airion																							
Δ Aira caryophyllea	.	+	2	+	1	1	1	2	1	2	2	2	2	1	+	r	+	+	+	+	r	+	+
Hieracium pilosella*	1	.	.	1	.	2	1	2	1	2	+	2	2	2	1	+	+	1	1	1	+	2	1
Δ Teesdalia nudicaulis	2	1	2	1	1	2	.	.	.	1	2	1	1	1	+	1	1	+	+	1	+	+	+
Δ Aira praecox	2	2	2	2	2	1	1	2	2	2	1	2	1	2	+	+	.	.	+	.	.	+	.
Δ Scleranthus polycarpos	2	+	2	2	2	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Δ Filago minima	.	.	.	.	+	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	r	.
Cerastium brachypetalum	.	.	.	.	.	.	+	+	.	.	.	.	.	.	.	.	r	.	.	.	.	.	.
Myosotis discolor	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	+	.	.	.	.	.	.
Thero-Airetalia																							
Agrostis capillaris*	1	1	1	1	2	1	2	1	1	1	1	1	1	1	+	1	2	+	1	1	1	1	1
Arabidopsis thaliana*	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	r	.	.	.	.	.	.
Sedo-Scleranthetea incl. Koelerio-Corynephoretea																							
Festuca guestfalica*	2	2	2	2	2	2	2	2	2	2	2	2	3	2	3	4	4	3	4	3	3	3	3
Δ Rumex acetosella*	2	2	3	2	2	2	2	2	2	2	2	2	2	2	1	2	2	2	1	1	+	1	2
Δ Hypochaeris radicata*	1	.	+	1	+	2	1	1	1	1	+	1	1	1	1	+	+	1	1	1	+	2	+
Hypnum lancunosum*	4	4	2	2	.	2	3	2	2	2	2	1	.	1	2	2	2	+	3	3	3	1	3
Δ Polytrichum juniperinum*	1	1	3	1	3	2	2	2	2	2	2	3	2	1	1	.	.	+	1	1	+	3	2
Luzula campestris*	.	.	1	1	+	1	1	+	1	.	1	+	1	2	+	1	1	1	2	2	2	2	1
Cladonia furcata*	+	.	+	+	+	1	1	1	1	1	1	2	1	2	1	+	.	1	+	+	.	+	+
Δ Scleranthus perennis	1	2	2	.	.	2	2	2	2	2	2	1	1	2	+	+	+	+	.	.	.	+	+
Δ Polytrichum piliferum	1	+	1	1	3	1	1	1	+	1	2	2	2	1	+	.	.	.	.	.	.	1	+
Potentilla verna*	.	2	.	.	.	+	1	r	.	.	.	.	r	1	+	+	+	+	1	+	+	+	+
Thymus pulegioides*	.	.	.	.	.	1	1	1	1	1	+	.	+	.	+	+	.	+	+	.	+	+	+
Cetraria aculeata	.	+	.	.	1	.	1	+	+	1	1	1	1	1	+	.	.	.	.	.	.	1	+
Ceratodon purpureus	2	2	1	4	2	.	.	2	1	.	.	1	.	.	+	+	+	+	.	.	.	.	.
Galium verum*	.	.	.	.	.	+	.	.	.	.	.	r	1	r	+	+	+	+	2	1	+	.	+
Veronica arvensis	+	.	.	.	.	.	+	.	.	.	.	.	.	+	+	+	+	.	+	+	.	.	r
Dianthus deltoides*	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	1	+	1	1	1	1	+	.
Hypericum perforatum*	.	.	.	.	.	r	.	r	1	.	.	.	1	1	.	.	.	.	.	.	+	+	r
Cladonia foliacea	.	.	.	.	.	.	.	.	.	1	1	1	+	2	+	.	.	.	.	.	.	+	.
Taraxacum sect. Erythrosperma*	.	.	.	.	.	+	r	.	.	.	.	.	.	.	+	+	+	+	.	+	.	.	.
Myosotis ramosissima	.	.	.	.	.	.	r	.	.	.	.	.	.	.	+	+	+	.	+	+	.	.	.
Draba verna	.	.	.	.	.	r	+	.	.	.	.	.	.	+	.	r	r	.	.	.	.	.	.
Cladonia rangiformis*	.	.	.	.	.	+	1	.	.	1	1	.	.	.	.	.	.	.	.	.	.	.	.
Brachythecium albicans*	.	.	.	+	1	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.
Racomitrium elongatum	.	.	.	+	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Cladonia subulata*	.	.	.	.	.	.	.	.	.	.	.	.	+	+	.	.	.	.	.	.	.	.	.
Saxifraga granulata*	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	r	.	.	+	.	.	.	.
Euphrasia officinalis subsp. pratensis*	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.
Cladonia fimbriata	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+
Cladonia pyxidata subsp. chlorophaea	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.
Cladonia ciliata	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.
Cerastium arvense	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.
Further species																							
Plantago lanceolata	1	1	2	2	1	1	1	1	1	1	1	1	1	1	2	1	+	+	2	2	2	+	2
Achillea millefolium	.	+	.	1	.	.	.	1	.	+	.	.	.	.	+	+	+	+	2	2	2	+	+
Pimpinella saxifraga	1	.	.	.	.	.	.	r	+	.	.	.	r	.	+	+	+	+	1	1	+	+	+
Dicranum scoparium	.	.	.	.	.	.	.	.	.	.	.	.	.	.	2	+	+	1	1	1	.	+	.
Rhytidiadelphus squarrosus	.	.	+	+	+	.	.	.	.	.	.	.	.	.	.	.	+	.	.	1	+	+	.
Pleurozium schreberi	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	3	2	3	.	.	+	.	.
Δ Poa annua	+	1	1	1	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Carex caryophyllea	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	+	.	1	.	+	.	.
Plagiomnium affine	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	+	.	+	+	.	.	.
Ranunculus bulbosus	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	r	r	.	.	.	+	.	+
Cladonia arbuscula	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	+	.	.	.	+
Bromus hordeaceus	+	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	r	.	.	.	.	.	.
Pseudoscleropodium purum	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	+	.	.	.
Festuca rubra agg.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	+	.	.
Cerastium holosteoides	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	r	.	.	.	.	.	.	.
Cytisus scoparius	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	r
Campanula rotundifolia	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.
Centaurea jacea	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.
Cladonia unicalis	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.
Crataegus spec. juv.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Lotus corniculatus	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Trifolium dubium	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.
Trisetum flavescens	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.
Viola arvensis	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Arrhenatherum elatius	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	r	.	.
Dactylis glomerata	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	r	.	.
Geranium molle	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	r	.	.	.	.	.	.
Pinus sylvestris juv.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	r	.
Rosa spec. juv.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	r	.	.	.	.	.	.	.
Spergularia rubra	.	.	.	.	r	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.

Supplement E10: Relevé table of the *Campanulo rotundifoliae-Dianthetum deltoidis* Balátová-Tuláčková 1980. Cluster N1 = *Potentilla erecta* variant, cl. N2–4 = *Carex caryophyllea* variant, cl. N2: *Cladonia arbuscula* subvariant, cl. N3 = *Ranunculus bulbosus* subvariant, cl. N4 = *Trifolium alpestre* subvariant. Delta symbols (Δ) indicate local differential species of the association and its variants/subvariants, respectively. Asterisks (*) indicate species that are allighed with further syntaxa (cf. Suppl. E2). Local character species of the variants are highlighted in grey.

Anhang E10. Vegetationstabelle *Campanulo rotundifoliae-Dianthetum deltoidis* Balátová-Tuláčková 1980. Cluster N1 = *Potentilla erecta*-Variante, Cl. N2–4 = *Carex caryophyllea*-Variante, Cl. N2 = *Cladonia arbuscula*-Subvariante, Cl. N3 = *Ranunculus bulbosus*-Subvariante, Cl. N4 = *Trifolium alpestre*-Subvariante. Delta-Symbole (Δ) kennzeichnen lokale Differenzialarten der Assoziation oder deren Varianten/Subvarianten und Sterne (*) Arten, die weitere Syntaxa indizieren (cf. Anhang E2). Die lokalen Kennarten der Varianten sind grau hinterlegt.

Running relevé no.	1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45 46 47 48 49 50 51 52 53 54 55 56 57 58 59 60 61 62 63 64 65 66 67 68 69 70 71 72 73 74 75 76 77 78 79
Cluster	N1 N1 N1 N1 N1 N1 N1 N1 N1 N1 N1 N1 N1 N1 N1 N1 N1 N1 N1 N1 N1 N1 N1 N1 N1 N1 N1 N1 N1 N1 N1 N2 N2 N2 N2 N2 N2 N2 N2 N2 N2 N2 N2 N2 N2 N2 N2 N2 N2 N2 N2 N2 N2 N2 N2 N2 N2 N2 N2 N2 N2 N2 N2 N2 N2 N2 N2 N2 N2 N2 N2 N2 N2 N2 N2 N2 N2 N2 N2
Site	6 6 6 6 6 6 6 6 6 6 6 6 6 6 6 6 6 6 6 6 6 6 6 6 6 6 6 6 6 6 6 10 10 10 10 10 10 10 4 4 4 2 4 4 4 4 4 4 4 4 4 4 10 10 10 4 2 2 2 2 2 2 2 2 2 2 2 1 1 2 2 6 7 7 7 7 7 7 7
Relevé size (m²)	15 15 15 10 25 20 25 20 10 20 20 15 15 20 15 20 20 10 15 25 20 20 10 10 20 10 15 20 20 20 15 10 10 15 15 5 5 2 10 10 15 15 15 15 15 15 15 15 15 15 15 15 15 15 20 15 10 15 20 15 20 20 15 20 15 15 15 15 15 15 15 20 15 15 15 15 15 15 15
Slope exposition	NW NW NW NW NW NW NW NW NW NW NW N N N N N NW NW NW NW NW NW NW NW NW NW NW NW NW NW NW SW SO SW SW W W W W NW NW W W NW NW NW NW NW NW NW NW NW NW NO NO NW NW NW NW NW NW NW NW NW NW NW NW NW NW SO S SO S SO S SO SO SO SO
Slope southerness (°)	45 45 45 45 45 45 45 45 45 45 45 0 0 0 0 0 45 45 45 45 45 45 45 45 45 45 45 45 45 45 45 135 135 135 135 90 90 90 90 45 45 90 90 45 45 45 45 45 45 45 45 45 45 45 45 45 45 45 45 45 45 45 45 45 45 45 45 45 45 135 180 135 180 135 180 135 135 135 135
Slope inclination (°)	[illegible]
Soil pH (H2O)	[illegible]
Soil pH (KCl)	[illegible]
Cover vascular plants (%)	98 95 95 95 95 95 90 90 85 90 95 90 90 95 90 70 90 80 90 90 90 95 95 75 95 70 85 80 85 90 80 75 80 55 60 45 40 60 35 45 85 80 75 85 75 80 80 75 80 80 75 45 85 70 80 80 95 80 90 75 95 85 95 95 95 85 95 70 85 85 95 90 90 75 80 90 85 80 80
Cover cryptogams (%)	[illegible]
Total species richness	[illegible]
Species richness vascular plants	[illegible]
Species richness bryophytes	[illegible]
Species richness lichens	[illegible]
Potentilla erecta var. – N1	
Hylocomium splendens - C3*	[illegible]
Ranunculus polyanthemos s. l. - A3.1.1*	[illegible]
Potentilla erecta - C3*	[illegible]
Carex pilulifera - O3.1	[illegible]
Corylus avellana juv.	[illegible]
Hieracium lachenalii - O3.1	[illegible]
Luzula multiflora - C3*	[illegible]
Holcus mollis - O3.1*	[illegible]
Arnica montana - O3.1	[illegible]
Rhamnus cathartica juv.	[illegible]
Potentilla erecta var. & Cladonia arbuscula subvar. of Carex caryophyllea var. – N1-2	
Calluna vulgaris - O3.1*	[illegible]
Veronica officinalis - O3.1*	[illegible]
Pinus sylvestris juv.	[illegible]
Hypnum jutlandicum - O3.1*	[illegible]
Polytrichum formosum - O3.1*	[illegible]
Carex caryophyllea var. – N2-4	
Carex caryophyllea*	[illegible]
Helianthemum nummularium subsp.	[illegible]
Genista tinctoria - C3*	[illegible]
Polygala vulgaris subsp. vulgaris et oxyptera -	[illegible]
Carpinus betulus juv.	[illegible]
Cladonia arbuscula subvar. of Carex caryophyllea var. – N2	
Dicranum scoparium - C3*	[illegible]
Cladonia arbuscula - C3*	[illegible]
Antennaria dioica - A3.1.1*	[illegible]
Barbilophozia barbata	[illegible]
Ptilidium ciliare - C3*	[illegible]
Cladonia spec.	[illegible]
Cladonia macilenta - C3*	[illegible]
Ranunculus bulbosus subvar. of Carex caryophyllea var. – N3	
Taraxacum sect. Erythrosperma - O3.1*	[illegible]
Linum catharticum	[illegible]
Myosotis discolor	[illegible]
Carlina vulgaris	[illegible]
Trifolium striatum	[illegible]
Prunella vulgaris	[illegible]
Carlina acaulis subsp. caulescens - A3.1.1*	[illegible]
Ranunculus bulbosus subvar. & Trifolium alpestre subvar. of Carex caryophyllea var. – N3-4	
Koeleria pyramidata*	[illegible]
Briza media*	[illegible]
Ononis repens subsp. procurrens*	[illegible]
Pseudoscleropodium purum*	[illegible]
Agrimonia eupatoria*	[illegible]
Viola hirta*	[illegible]
Carex caryophyllea var., Trifolium alpestre subvar. – N4	
Trifolium alpestre	[illegible]
Trifolium medium	[illegible]
Quercus spec. juv.	[illegible]
Carex flacca	[illegible]
Galium aparine	[illegible]
Brachypodium sylvaticum	[illegible]
Violion caninae - A3.1.1	
Δ Viola canina	[illegible]
Δ Danthonia decumbens	[illegible]
Hieracium pilosella*	[illegible]
Δ Galium pumilum*	[illegible]
Alchemilla glaucescens	[illegible]
Δ Platanthera bifolia	[illegible]
Hypericum maculatum	[illegible]
Nardetalia - O3.1	
Agrostis capillaris*	[illegible]
Pimpinella saxifraga*	[illegible]
Δ Campanula rotundifolia*	[illegible]
Galium verum*	[illegible]
Avenula pubescens*	[illegible]
Anthoxanthum odoratum	[illegible]
Avenella flexuosa*	[illegible]
Leontodon hispidus*	[illegible]
Hypochaeris radicata*	[illegible]
Euphrasia officinalis subsp. pratensis*	[illegible]
Solidago virgaurea*	[illegible]
Alchemilla monticola*	[illegible]
Vicia cracca*	[illegible]
Hieracium laevigatum*	[illegible]
Rhinanthus minor*	[illegible]
Koeleria macrantha*	[illegible]
Melampyrum pratense*	[illegible]
Vaccinium myrtillus*	[illegible]
Silene nutans*	[illegible]
Gentianella campestris	[illegible]
Botrychium lunaria	[illegible]
Nardetea - C3	
Luzula campestris*	[illegible]
Δ Pleurozium schreberi*	[illegible]
Rhytidiadelphus squarrosus*	[illegible]
Knautia arvensis*	[illegible]
Festuca rubra agg.*	[illegible]
Cladonia furcata*	[illegible]
Dianthus deltoides*	[illegible]
Polytrichum juniperinum*	[illegible]
Brachythecium albicans*	[illegible]
Saxifraga granulata*	[illegible]
Hypnum lacunosum*	[illegible]
Cladonia subulata*	[illegible]
Cladonia rangiformis*	[illegible]
Thuidium tamariscinum*	[illegible]
Further species	
Festuca guestfalica	[illegible]
Achillea millefolium	[illegible]
Plantago lanceolata	[illegible]
Lotus corniculatus	[illegible]
Δ Helictochloa pratensis	[illegible]
Potentilla verna	[illegible]
Thymus pulegioides	[illegible]
Poa angustifolia	[illegible]
Arrhenatherum elatius	[illegible]
Plagiomnium affine	[illegible]
Δ Crataegus spec. juv.	[illegible]
Δ Cirsium acaulon	[illegible]
Centaurea jacea	[illegible]
Rumex acetosa	[illegible]
Trisetum flavescens	[illegible]
Sanguisorba minor	[illegible]
Δ Fragaria vesca	[illegible]
Veronica chamaedrys	[illegible]
Ranunculus bulbosus	[illegible]
Hypericum perforatum	[illegible]
Δ Genista germanica	[illegible]
Δ Prunus spinosa juv.	[illegible]
Primula veris	[illegible]
Rumex acetosella	[illegible]
Trifolium repens	[illegible]
Dactylis glomerata	[illegible]
Stellaria graminea	[illegible]
Taraxacum sect. Ruderalia	[illegible]
Holcus lanatus	[illegible]
Rosa spec. juv.	[illegible]
Cerastium holosteoides	[illegible]
Vicia angustifolia	[illegible]
Plantago media	[illegible]
Trifolium pratense	[illegible]
Leucanthemum ircutianum	[illegible]
Trifolium dubium	[illegible]
Cerastium arvense	[illegible]
Galium album	[illegible]
Senecio jacobaea	[illegible]
Vicia hirsuta	[illegible]
Veronica arvensis	[illegible]
Scorzoneroides autumnalis	[illegible]
Trifolium campestre	[illegible]
Lophocolea bidentata	[illegible]
Daucus carota	[illegible]
Myosotis ramosissima	[illegible]
Brachythecium rutabulum	[illegible]
Draba verna s. str.	[illegible]
Anthriscus sylvestris	[illegible]
Centaurea scabiosa	[illegible]
Sedum rupestre	[illegible]
Teesdalia nudicaulis	[illegible]
Cladonia pyxidata subsp. chlorophaea	[illegible]
Cytisus scoparius	[illegible]
Ceratodon purpureus	[illegible]
Arabidopsis thaliana	[illegible]
Arenaria serpyllifolia	[illegible]
Cerastium brachypetalum	[illegible]
Epilobium montanum	[illegible]
Lathyrus pratensis	[illegible]
Plagiomnium undulatum	[illegible]
Cladonia fimbriata	[illegible]
Cynosurus cristatus	[illegible]
Festuca pratensis	[illegible]
Campanula rapunculus	[illegible]
Clinopodium vulgare	[illegible]
Trifolium arvense	[illegible]
Aira caryophyllea	[illegible]
Aira praecox	[illegible]
Anthyllis vulneraria	[illegible]
Cirsium vulgare	[illegible]
Galeopsis tetrahit	[illegible]
Jasione montana	[illegible]
Scleranthus perennis	[illegible]
Tragopogon pratensis	[illegible]
Calliergonella cuspidata	[illegible]
Brachypodium pinnatum	[illegible]
Campanula glomerata	[illegible]
Epilobium angustifolium	[illegible]
Geranium molle	[illegible]
Heracleum sphondylium	[illegible]
Origanum vulgare	[illegible]
Valeriana pratensis subsp. angustifolia	[illegible]
Vicia sepium	[illegible]
Betula pendula juv.	[illegible]
Fagus sylvatica juv.	[illegible]
Sambucus nigra juv.	[illegible]
Sorbus aucuparia juv.	[illegible]
Racomitrium elongatum	[illegible]
Cladonia ciliata	[illegible]
Bromus erectus	[illegible]
Bromus hordeaceus	[illegible]
Δ Deschampsia cespitosa	[illegible]
Elymus repens	[illegible]
Lolium perenne	[illegible]
Phleum pratense	[illegible]
Poa annua	[illegible]
Poa trivialis	[illegible]
Anthemis arvensis	[illegible]
Astragalus glycyphyllos	[illegible]
Bunias orientalis	[illegible]
Cirsium arvense	[illegible]
Cirsium palustre	[illegible]
Crepis biennis	[illegible]
Geranium pyrenaicum	[illegible]
Gnaphalium sylvaticum	[illegible]
Hieracium murorum	[illegible]
Hieracium spec.	[illegible]
Linaria vulgaris	[illegible]
Malva moschata	[illegible]
Myosotis arvensis	[illegible]
Myosotis stricta	[illegible]
Orobanche purpurea	[illegible]
Potentilla argentea	[illegible]
Sagina procumbens	[illegible]
Scleranthus polycarpos	[illegible]
Teucrium scorodonia	[illegible]
Torilis japonica	[illegible]
Verbascum thapsus	[illegible]
Viola arvensis	[illegible]
Acer campestre juv.	[illegible]
Juniperus communis	[illegible]
Populus tremula juv.	[illegible]
Sorbus aria juv.	[illegible]
Climacium dendroides	[illegible]
Dicranum bonjeanii	[illegible]
Polytrichum piliferum	[illegible]
Cetraria aculeata	[illegible]
Cladonia phyllophora	[illegible]

Supplement E10 continued: Relevé table of the *Campanulo rotundifoliae-Dianthetum deltoidis* Balátová-Tuláčková 1980. Cluster N1 = *Potentilla erecta* variant, cl. N2–4 = *Carex caryophyllea* variant, cl. N2: *Cladonia arbuscula* subvariant, cl. N3 = *Ranunculus bulbosus* subvariant, cl. N4 = *Trifolium alpestre* subvariant. Delta symbols (Δ) indicate local differential species of the association and its variants/subvariants, respectively. Asterisks (*) indicate species that are alligned with further syntaxa (cf. Suppl. E2). Local character species of the variants are highlighted in grey.

Anhang E10, Fortsetzung. Vegetationstabelle *Campanulo rotundifoliae-Dianthetum deltoidis* Balátová-Tuláčková 1980. Cluster N1 = *Potentilla erecta*-Variante, Cl. N2–4 = *Carex caryophyllea*-Variante, Cl. N2 = *Cladonia arbuscula*-Subvariante, Cl. N3 = *Ranunculus bulbosus*-Subvariante, Cl. N4 = *Trifolium alpestre*-Subvariante. Delta-Symbole (Δ) kennzeichnen lokale Differenzialarten der Assoziation oder deren Varianten/Subvarianten und Sterne (*) Arten, die weitere Syntaxa indizieren (cf. Anhang E2). Die lokalen Kennarten der Varianten sind grau hinterlegt.

Running relevé no.	80	81	82	83	84	85	86	87	88	89	90	91	92	93	94	95	96	97	98	99	100	101	102	103	104	105	106	107	108	109	110	111	112	113	114	115	116	117	118	119	120	121	122	123	124	125	126	127	128	129	130	131	132	133	134	135	136	137	138	139	140	141	142	143	144	145	146	147	148	149	150	151	152	153	154	155	156	157	158	159	160	161	162	163	164	165	166	167	168	169	170	171	172	173
Cluster	N3	N3	N3	N3	N3	N3	N3	N3	N3	N3	N3	N3	N3	N3	N3	N3	N3	N3	N3	N3	N3	N3	N3	N3	N3	N3	N3	N3	N3	N3	N3	N3	N3	N3	N3	N3	N3	N3	N3	N3	N4	N4	N4	N4	N4	N4	N4	N4	N4	N4	N4	N4	N4	N4	N4	N4	N4	N4	N4	N4	N4	N4	N4	N4	N4	N4	N4	N4	N4	N4	N4	N4	N4	N4	N4	N4	N4	N4	N4	N4	N4	N4	N4	N4	N4	N4	N4	N4	N4	N4	N4	N4	N4	N4
Site	2	2	2	4	5	11	11	11	11	11	11	11	11	11	11	11	5	5	5	5	5	5	11	11	11	11	11	5	5	2	2	2	2	2	2	2	2	2	2	2	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	11	10	11	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	1	1	1	10	10	1	1	7	4	4	4	4	4	6	6	6	6
Relevé size (m²)	10	10	10	15	15	10	15	20	25	20	20	25	25	25	25	20	20	10	20	10	25	25	25	25	15	5	15	9	15	15	20	10	15	15	15	20	20	25	10	15	15	20	15	15	15	15	20	15	15	10	15	15	15	20	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	20	15	15	15	15	15	15	20	15	20	15	12	15	15	8	15	15	15	15	20	15	20	20	20	25
Slope exposition	SO	NW	NW	W	W	S	S	SW	S	SW	SO	SW	S	SW	SW	SW	NW	W	NW	W	W	NW	SO	-	N	S	SO	W	W	NW	NW	NW	NW	NW	NW	S	S	NW	NW	NW	NW	W	NW	W	W	W	W	W	NW	W	NW	NW	NW	NW	NW	W	W	N	NW	NW	NW	NW	NO	NW	NO	NW	NW	SW	W	W	W	W	W	NW	SW	SW	SW	W	W	W	NO	W	W	W	SO	W	W	NW	NW	NW	NW	NW	NW	NW
Slope southerness (°)	135	45	45	90	90	180	180	135	180	135	135	135	180	135	135	135	45	90	45	90	90	45	135	x	0	180	135	90	90	45	45	45	45	45	45	180	180	45	45	45	45	90	45	90	90	90	90	90	45	90	45	45	45	45	45	90	90	0	45	45	45	45	45	45	45	45	45	135	90	90	90	90	90	45	135	135	135	90	90	90	45	90	90	90	135	90	90	45	45	45	45	45	45	45
Slope inclination (°)	9	2,25	6,75	6,75	2,25	11,25	5,4	13,5	13,5	13,5	13,5	13,5	13,5	13,5	15,75	9	4,5	0,9	9	2,25	2,25	3,6	4,5	-	13,5	13,5	6,75	2,25	2,25	2,25	3,6	9	9	9	9	2,25	2,25	9	9	9	6,75	13,5	8,1	11,25	9	8,1	8,1	8,1	9	15,75	11,25	8,1	9	6,75	8,1	11,25	9	13,5	9	9	9	11,25	4,5	11,25	4,5	2,25	3,6	11,25	9	6,75	11,25	9	9	9	18	15,75	13,5	9	9	11,25	3,6	4,5	6,75	3,6	6,75	9	9	9	9	9	11,25	15,75	15,75	9
Soil pH (H2O)	5,4	5,1	-	5,5	5,9	-	-	-	-	-	-	-	-	-	-	-	-	5,9	6	6	6	-	-	-	-	-	-	-	5,9	-	5,2	4,9	-	-	-	4,8	-	4,9	5	-	-	5,5	-	5,4	5,3	5,5	5,4	5,4	-	5,3	-	5,5	-	-	-	-	-	-	5,6	-	-	-	-	5,2	5,6	5,4	-	-	-	5,6	5,7	5,6	-	5,2	-	5,8	5,7	5,8	5,7	6	5,3	5,5	5,4	5,1	4,9	-	5,5	5,7	5,7	5,1	5,3	5,4	5,3	5,4
Soil pH (KCl)	4,4	4,5	-	4	4,9	-	-	-	-	-	-	-	-	-	-	-	-	4,8	4,9	4,9	4,9	-	-	-	-	-	-	-	4,9	-	4,4	4,1	-	-	-	4,1	-	4,1	4,1	-	-	4,4	-	4,2	4,3	4,6	4,4	4,4	-	4,1	-	4,4	-	-	-	-	-	-	4,5	-	-	-	-	4,2	4,4	4,5	-	-	-	4,5	4,5	4,4	-	4,3	-	4,5	4,6	4,8	4,5	5,4	4,3	4,4	4,6	4,4	4	-	4,7	4,8	4,8	4,3	4,2	4,4	4,2	4,4
Cover vascular plants (%)	98	80	80	85	80	85	80	85	75	80	75	80	90	95	90	90	98	98	100	60	80	80	90	90	80	75	80	80	90	95	90	100	100	98	98	100	98	100	100	100	95	80	85	95	98	95	85	85	70	80	75	50	75	70	90	75	90	75	95	90	85	95	90	80	90	95	95	90	95	85	98	100	100	100	95	95	80	85	90	90	80	60	85	90	95	85	80	80	90	90	95	98	98	95
Cover cryptogams (%)	60	80	80	75	80	90	70	90	85	75	85	80	70	90	85	70	65	75	65	90	90	90	15	60	80	70	85	80	60	80	80	75	85	80	90	85	85	80	75	70	50	30	45	75	5	65	65	65	50	70	45	30	20	40	45	85	15	80	80	90	65	80	70	80	75	85	85	40	30	80	25	10	10	10	30	45	90	80	85	80	70	70	85	80	25	75	85	80	75	75	50	50	10	50
Total species richness	41	53	60	49	40	50	59	62	66	62	67	62	66	58	55	60	55	57	61	54	57	55	53	50	54	48	51	44	43	32	31	39	35	33	40	32	34	35	32	36	46	57	59	47	44	55	54	55	60	55	60	47	49	53	51	66	53	57	60	57	60	52	58	55	59	50	42	44	49	53	44	47	42	42	49	49	49	57	50	57	37	39	32	36	34	44	54	51	61	43	37	40	32	42
Species richness vascular plants	34	43	48	42	36	45	54	53	58	55	61	56	60	55	50	55	50	53	57	48	50	50	50	47	51	44	48	36	40	26	26	35	31	29	34	29	30	32	29	31	42	53	55	43	42	50	49	50	53	51	56	43	45	48	47	56	48	49	56	53	56	47	54	50	53	45	37	39	44	48	41	43	39	39	44	46	42	46	44	48	31	33	29	31	29	38	46	46	55	37	34	37	31	38
Species richness bryophytes	6	7	11	7	3	4	5	7	7	7	6	6	6	3	5	5	5	4	4	6	7	5	3	3	3	4	3	8	3	5	5	4	4	4	6	3	4	3	3	5	4	4	4	4	2	5	5	5	6	4	4	4	4	5	4	7	5	7	4	4	4	5	4	5	6	5	5	5	5	5	3	4	3	3	5	3	5	9	6	8	6	5	3	5	5	6	7	5	6	6	3	3	1	4
Species richness lichens	1	3	1	0	1	1	0	2	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	3	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	2	0	1	0	1	0	0	0	0	1	0	0	0	0	0	0	0
Potentilla erecta var. – N1																																																																																																
Hylocomium splendens - C3*	.	.	1	1	.	.	.	.	.	.	1	+	.	.	.	.	1	.	+	1	1	.	.	.	2	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	+	.	.	1	.	+	.	1	1	2	.	.	.	.	.	1	1	+	+	.	.	.	.	.	.	.	.	.	+	1	.	+	+	.	.	1	.	.	2	+	1	+	.	.	.	.
Ranunculus polyanthemos s. l. - A3.1.1*	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	+	+	.	.	+	+	+	+	+	2	2	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	2	+	1	2
Potentilla erecta - C3*	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	+	+	+	+	+	2	2	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	1	+	+
Carex pilulifera - O3.1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Corylus avellana juv.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	+	.	.	+	+	.	.	.	.	.	.	.	+	+	+	+	+	+	+	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.
Hieracium lachenalii - O3.1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.
Luzula multiflora - C3*	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Holcus mollis - O3.1*	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Arnica montana - O3.1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Rhamnus cathartica juv.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Potentilla erecta var. & Cladonia arbuscula subvar. of Carex caryophyllea var. – N1-2		
Calluna vulgaris - O3.1*	[illegible]
Veronica officinalis - O3.1*	[illegible]
Pinus sylvestris juv.	[illegible]
Hypnum jutlandicum - O3.1*	[illegible]
Polytrichum formosum - O3.1*	[illegible]
Carex caryophyllea var. – N2-4	
Carex caryophyllea*	[illegible]
Helianthemum nummularium subsp.	[illegible]
Genista tinctoria - C3*	[illegible]
Polygala vulgaris subsp. vulgaris et oxyptera -	[illegible]
Carpinus betulus juv.	[illegible]
Cladonia arbuscula subvar. of Carex caryophyllea var. – N2	
Dicranum scoparium - C3*	[illegible]
Cladonia arbuscula - C3*	[illegible]
Antennaria dioica - A3.1.1*	[illegible]
Barbilophozia barbata	[illegible]
Ptilidium ciliare - C3*	[illegible]
Cladonia spec.	[illegible]
Cladonia macilenta - C3*	[illegible]
Ranunculus bulbosus subvar. of Carex caryophyllea var. – N3	
Taraxacum sect. Erythrosperma - O3.1*	[illegible]
Linum catharticum	[illegible]
Myosotis discolor	[illegible]
Carlina vulgaris	[illegible]
Trifolium striatum	[illegible]
Prunella vulgaris	[illegible]
Carlina acaulis subsp. caulescens - A3.1.1*	[illegible]
Ranunculus bulbosus subvar. & Trifolium alpestre subvar. of Carex caryophyllea var. – N3-4	
Koeleria pyramidata*	[illegible]
Briza media*	[illegible]
Ononis repens subsp. procurrens*	[illegible]
Pseudoscleropodium purum*	[illegible]
Agrimonia eupatoria*	[illegible]
Viola hirta*	[illegible]
Carex caryophyllea var., Trifolium alpestre subvar. – N4	
Trifolium alpestre	[illegible]
Trifolium medium	[illegible]
Quercus spec. juv.	[illegible]
Carex flacca	[illegible]
Galium aparine	[illegible]
Brachypodium sylvaticum	[illegible]
Violion caninae - A3.1.1	
Δ Viola canina	[illegible]
Δ Danthonia decumbens	[illegible]
Hieracium pilosella*	[illegible]
Δ Galium pumilum*	[illegible]
Alchemilla glaucescens	[illegible]
Δ Platanthera bifolia	[illegible]
Hypericum maculatum	[illegible]
Nardetalia - O3.1	
Agrostis capillaris*	[illegible]
Pimpinella saxifraga*	[illegible]
Δ Campanula rotundifolia*	[illegible]
Galium verum*	[illegible]
Avenula pubescens*	[illegible]
Anthoxanthum odoratum	[illegible]
Avenella flexuosa*	[illegible]
Leontodon hispidus*	[illegible]
Hypochaeris radicata*	[illegible]
Euphrasia officinalis subsp. pratensis*	[illegible]
Solidago virgaurea*	[illegible]
Alchemilla monticola*	[illegible]
Vicia cracca*	[illegible]
Hieracium laevigatum*	[illegible]
Rhinanthus minor*	[illegible]
Koeleria macrantha*	[illegible]
Melampyrum pratense*	[illegible]
Vaccinium myrtillus*	[illegible]
Silene nutans*	[illegible]
Gentianella campestris	[illegible]
Botrychium lunaria	[illegible]
Nardetea - C3	
Luzula campestris*	[illegible]
Δ Pleurozium schreberi*	[illegible]
Rhytidiadelphus squarrosus*	[illegible]
Knautia arvensis*	[illegible]
Festuca rubra agg.*	[illegible]
Cladonia furcata*	[illegible]
Dianthus deltoides*	[illegible]
Polytrichum juniperinum*	[illegible]
Brachythecium albicans*	[illegible]
Saxifraga granulata*	[illegible]
Hypnum lacunosum*	[illegible]
Cladonia subulata*	[illegible]
Cladonia rangiformis*	[illegible]
Thuidium tamariscinum*	[illegible]
Further species	
Festuca guestfalica	[illegible]
Achillea millefolium	[illegible]
Plantago lanceolata	[illegible]
Lotus corniculatus	[illegible]
Δ Helictochloa pratensis	[illegible]
Potentilla verna	[illegible]
Thymus pulegioides	[illegible]
Poa angustifolia	[illegible]
Arrhenatherum elatius	[illegible]
Plagiomnium affine	[illegible]
Δ Crataegus spec. juv.	[illegible]
Δ Cirsium acaulon	[illegible]
Centaurea jacea	[illegible]
Rumex acetosa	[illegible]
Trisetum flavescens	[illegible]
Sanguisorba minor	[illegible]
Δ Fragaria vesca	[illegible]
Veronica chamaedrys	[illegible]
Ranunculus bulbosus	[illegible]
Hypericum perforatum	[illegible]
Δ Genista germanica	[illegible]
Δ Prunus spinosa juv.	[illegible]
Primula veris	[illegible]
Rumex acetosella	[illegible]
Trifolium repens	[illegible]
Dactylis glomerata	[illegible]
Stellaria graminea	[illegible]
Taraxacum sect. Ruderalia	[illegible]
Holcus lanatus	[illegible]
Rosa spec. juv.	[illegible]
Cerastium holosteoides	[illegible]
Vicia angustifolia	[illegible]
Plantago media	[illegible]
Trifolium pratense	[illegible]
Leucanthemum ircutianum	[illegible]
Trifolium dubium	[illegible]
Cerastium arvense	[illegible]
Galium album	[illegible]
Senecio jacobaea	[illegible]
Vicia hirsuta	[illegible]
Veronica arvensis	[illegible]
Scorzoneroides autumnalis	[illegible]
Trifolium campestre	[illegible]
Lophocolea bidentata	[illegible]
Daucus carota	[illegible]
Myosotis ramosissima	[illegible]
Brachythecium rutabulum	[illegible]
Draba verna s. str.	[illegible]
Anthriscus sylvestris	[illegible]
Centaurea scabiosa	[illegible]
Sedum rupestre	[illegible]
Teesdalia nudicaulis	[illegible]
Cladonia pyxidata subsp. chlorophaea	[illegible]
Cytisus scoparius	[illegible]
Ceratodon purpureus	[illegible]
Arabidopsis thaliana	[illegible]
Arenaria serpyllifolia	[illegible]
Cerastium brachypetalum	[illegible]
Epilobium montanum	[illegible]
Lathyrus pratensis	[illegible]
Plagiomnium undulatum	[illegible]
Cladonia fimbriata	[illegible]
Cynosurus cristatus	[illegible]
Festuca pratensis	[illegible]
Campanula rapunculus	[illegible]
Clinopodium vulgare	[illegible]
Trifolium arvense	[illegible]
Aira caryophyllea	[illegible]
Aira praecox	[illegible]
Anthyllis vulneraria	[illegible]
Cirsium vulgare	[illegible]
Galeopsis tetrahit	[illegible]
Jasione montana	[illegible]
Scleranthus perennis	[illegible]
Tragopogon pratensis	[illegible]
Calliergonella cuspidata	[illegible]
Brachypodium pinnatum	[illegible]
Campanula glomerata	[illegible]
Epilobium angustifolium	[illegible]
Geranium molle	[illegible]
Heracleum sphondylium	[illegible]
Origanum vulgare	[illegible]
Valeriana pratensis subsp. angustifolia	[illegible]
Vicia sepium	[illegible]
Betula pendula juv.	[illegible]
Fagus sylvatica juv.	[illegible]
Sambucus nigra juv.	[illegible]
Sorbus aucuparia juv.	[illegible]
Racomitrium elongatum	[illegible]
Cladonia ciliata	[illegible]
Bromus erectus	[illegible]
Bromus hordeaceus	[illegible]
Δ Deschampsia cespitosa	[illegible]
Elymus repens	[illegible]
Lolium perenne	[illegible]
Phleum pratense	[illegible]
Poa annua	[illegible]
Poa trivialis	[illegible]
Anthemis arvensis	[illegible]
Astragalus glycyphyllos	[illegible]
Bunias orientalis	[illegible]
Cirsium arvense	[illegible]
Cirsium palustre	[illegible]
Crepis biennis	[illegible]
Geranium pyrenaicum	[illegible]
Gnaphalium sylvaticum	[illegible]
Hieracium murorum	[illegible]
Hieracium spec.	[illegible]
Linaria vulgaris	[illegible]
Malva moschata	[illegible]
Myosotis arvensis	[illegible]
Myosotis stricta	[illegible]
Orobanche purpurea	[illegible]
Potentilla argentea	[illegible]
Sagina procumbens	[illegible]
Scleranthus polycarpos	[illegible]
Teucrium scorodonia	[illegible]
Torilis japonica	[illegible]
Verbascum thapsus	[illegible]
Viola arvensis	[illegible]
Acer campestre juv.	[illegible]
Juniperus communis	[illegible]
Populus tremula juv.	[illegible]
Sorbus aria juv.	[illegible]
Climacium dendroides	[illegible]
Dicranum bonjeanii	[illegible]
Polytrichum piliferum	[illegible]
Cetraria aculeata	[illegible]
Cladonia phyllophora	[illegible]

Supplement E11: Relevé table of the *Hypericum perforatum-Gnaphalium sylvaticum* community (cluster N5). Delta symbols (Δ) indicate local differential species of the community, and asterisks (*) species that are alligned with further syntaxa (cf. Suppl. E2).

Anhang E11. Vegetationstabelle *Hypericum perforatum-Gnaphalium sylvaticum*-Gesellschaft (Cluster N5). Delta-Symbole (Δ) kennzeichnen lokale Differenzialarten der Gesellschaft und Sterne (*) Arten, die weitere Syntaxa indizieren (cf. Anhang E2).

Running relevé no.	1	2	3	4	5	6	7	8	9	10
Cluster	N5	N5	N5	N5	N5	N5	N5	N5	N5	N5
Site	7	7	7	7	7	7	7	7	7	8
Relevé size (m²)	15	15	15	15	25	20	20	20	20	50
Slope exposition	S	S	S	S	S	S	S	S	S	W
Slope southerness (°)	180	180	180	180	180	180	180	180	180	90
Slope inclination (°)	5	7	7	7	7	7	9	9	7	7
Soil pH (H2O)	-	-	4,8	4,7	5	5,1	4,8	4,9	-	-
Soil pH (KCl)	-	-	3,8	3,7	4	4	3,9	3,9	-	-
Cover vascular plants (%)	95	90	95	90	98	90	95	95	95	95
Cover cryptogams (%)	15	35	10	8	45	80	75	80	70	20
Total species richness	35	35	39	39	45	41	40	49	58	50
Species richness vascular plants	29	28	33	29	37	35	34	42	51	47
Species richness bryophytes	6	7	6	7	8	6	6	7	6	3
Species richness lichens	0	0	0	3	0	0	0	0	1	0
Δ Hypericum perforatum - 1.1.1*	1	1	1	1	1	2	2	2	2	2
Δ Gnaphalium sylvaticum	+	+	+	+	+	.	+	+	+	.
Violion caninae										
Hieracium pilosella*	1	3	2	3	+	.	+	+	1	.
Galium pumilum*	+	.	.	.	+	+	.	.	.	.
Danthonia decumbens	.	+	.	.	.	.	.	.	.	.
Viola canina	+	.	.	.	.	.	.	.	.	.
Nardetalia										
Agrostis capillaris*	1	2	1	2	2	1	1	1	2	1
Pimpinella saxifraga*	1	1	1	1	1	1	1	1	1	1
Galium verum*	+	+	+	+	1	1	1	1	+	1
Δ Solidago virgaurea*	2	2	2	2	+	.	1	+	1	.
Anthoxanthum odoratum*	1	+	1	+	+	+	.	+	+	.
Avenella flexuosa*	4	2	2	+	1	2	.	.	+	.
Δ Hieracium laevigatum*	2	2	2	2	+	.	1	1	.	.
Campanula rotundifolia*	+	+	+	+	.	+	.	.	+	+
Avenula pubescens*	.	.	+	.	.	1	+	1	.	+
Hypochaeris radicata*	+	+	+	1	.	.	.	.	1	.
Veronica officinalis*	+	+	1	.	+	.	.	.	.	.
Calluna vulgaris*	1	1	2	.	.	.	.	.	.	.
Vicia cracca*	.	.	.	.	.	.	.	+	r	+
Alchemilla monticola*	.	.	.	.	.	.	.	.	+	+
Euphrasia officinalis subsp. pratensis*	.	.	.	1	.	.	.	.	.	.
Hieracium lachenalii	.	.	.	.	.	.	.	.	+	.
Rhinanthus minor*	.	.	.	.	.	.	.	.	.	+
Nardetea										
Festuca rubra agg.*	1	+	+	+	2	1	2	2	3	2
Luzula campestris*	1	1	2	1	+	+	+	+	1	+
Pleurozium schreberi*	2	2	2	+	1	1	+	+	2	.
Rhytidiadelphus squarrosus*	.	1	+	.	2	+	2	2	3	4
Δ Brachythecium albicans*	+	.	+	+	+	2	+	1	+	.
Knautia arvensis*	.	+	.	.	+	1	1	1	+	1
Scleropodium purum*	+	.	.	.	1	1	1	+	+	.
Dianthus deltoides*	.	.	.	.	+	+	+	+	.	.
Polytrichum formosum*	.	2	.	1	.	.	.	.	.	.
Dicranum scoparium*	.	1	1	.	.	.	.	.	.	.
Cladonia furcata*	.	.	.	+	.	.	.	.	+	.
Genista tinctoria*	.	+	.	+	.	.	.	.	.	.
Cladonia subulata*	.	.	.	+	.	.	.	.	.	.
Hypnum jutlandicum*	.	.	.	.	.	.	.	+	.	.
Hypnum lancunosum*	.	.	.	+	.	.	.	.	.	.
Δ Juncus conglomeratus	.	.	.	.	.	.	+	.	.	.
Further species										
Arrhenatherum elatius	1	+	+	+	3	3	3	3	2	3
Plagiomnium affine	2	1	+	+	3	3	3	2	2	2
Festuca guestfalica	1	2	3	3	+	1	+	+	2	1
Achillea millefolium	1	1	+	+	2	+	1	2	1	1
Brachythecium rutabulum	1	+	.	1	1	2	2	2	+	2
Plantago lanceolata	+	.	+	+	+	+	+	1	1	1
Poa angustifolia	.	.	+	.	1	1	1	1	+	2
Vicia angustifolia	.	.	+	.	1	1	+	+	+	+
Δ Campanula rapunculus	.	.	+	+	+	.	+	+	1	+
Trisetum flavescens	+	.	.	+	+	+	+	+	+	.
Δ Clinopodium vulgare	.	.	.	.	1	1	2	2	2	2
Dactylis glomerata	.	.	.	.	1	1	2	2	1	2
Δ Epilobium angustifolium	+	+	.	.	.	.	1	1	+	1
Centaurea jacea	.	.	.	+	+	1	.	+	+	+
Rumex acetosa	+	.	.	+	.	+	+	.	+	1
Δ Rosa spec. juv.	.	+	+	.	+	+	.	+	.	+
Galium album	.	.	.	.	1	+	+	2	.	2
Trifolium medium	.	.	.	.	2	.	+	1	1	1
Agrimonia eupatoria	.	.	.	.	1	1	.	+	+	+
Δ Lophocolea bidentata	1	1	+	+	+	.	.	.	.	.
Vicia hirsuta	.	.	.	.	+	1	+	.	+	1
Lotus corniculatus	+	.	1	+	.	.	.	.	+	+
Trifolium repens	.	.	+	+	.	.	+	.	+	1
Δ Convolvulus arvensis	.	.	.	.	+	+	.	+	+	+
Crataegus spec. juv.	.	+	.	+	+	+	.	.	+	.
Δ Daucus carota	.	.	.	.	.	.	+	+	2	+
Leucanthemum ircutianum	+	.	1	.	.	.	.	+	+	.
Rumex acetosella	+	+	.	+	+	.	.	.	.	.
Fragaria vesca	.	.	.	.	.	+	.	1	+	.
Holcus lanatus	.	+	+	.	.	.	.	.	1	.
Veronica chamaedrys	+	.	.	.	.	+	.	.	1	.
Carex caryophyllea	.	+	.	.	.	.	.	+	.	+
Δ Jasione montana	.	.	+	1	.	.	.	.	.	.
Ononis repens subsp. procurrens	.	.	1	.	.	.	.	.	.	+
Potentilla verna	.	.	.	.	.	1	.	.	+	.
Anthriscus sylvestris	.	.	.	.	.	.	.	+	.	+
Poa trivialis	.	.	.	.	.	+	.	+	.	.
Thymus pulegioides	.	.	.	.	.	+	.	.	.	+
Trifolium pratense	.	.	.	.	.	.	.	.	+	+
Δ Verbascum nigrum	.	.	.	.	.	.	.	+	+	.
Geranium pyrenaicum	.	.	.	.	.	.	.	.	.	1
Malva moschata	.	.	.	.	.	.	.	.	.	1
Picris hieracioides	.	.	.	.	.	.	.	.	1	.
Δ Rubus idaeus	.	.	.	.	.	.	.	1	.	.
Sanguisorba minor	.	.	.	.	.	.	.	.	.	1
Vicia sepium	.	.	.	.	.	.	.	.	.	1
Acer campestre juv.	.	.	.	.	+	.	.	.	.	.
Aphanes arvensis	.	.	.	.	.	.	.	.	+	.
Centaurea scabiosa	.	.	.	.	.	.	.	.	.	+
Cladonia pyxidata subsp. chlorophaea	.	.	.	+	.	.	.	.	.	.
Galeopsis tetrahit	.	.	.	.	.	.	.	+	.	.
Helictochloa pratensis	.	.	+	.	.	.	.	.	.	.
Heracleum sphondylium	.	.	.	.	.	.	.	.	.	+
Linaria vulgaris	.	.	.	.	+	.	.	.	.	.
Myosotis arvensis	.	.	.	.	.	.	.	.	+	.
Δ Plagiothecium spec.	.	.	.	.	+	.	.	.	.	.
Primula veris	.	.	.	.	.	.	.	.	.	+
Rubus sect. Rubus	.	.	.	.	.	.	.	.	.	+
Δ Salix caprea juv.	.	.	.	.	.	.	+	.	.	.
Senecio jacobaea	.	.	.	.	.	.	.	.	+	.
Stellaria gramminea	.	.	.	.	.	.	+	.	.	.
Taraxacum sect. Ruderalia	.	.	.	.	.	.	.	.	.	+
Trifolium arvense	.	.	.	.	.	.	.	.	+	.
Trifolium campestre	.	.	.	.	.	.	.	.	+	.
Trifolium dubium	.	.	+	.	.	.	.	.	.	.
Viola arvensis	.	.	.	.	.	.	.	+	.	.
Viola hirta	.	.	.	.	.	.	+	.	.	.

Supplement E12. Threatened vascular plants, bryophytes and lichens found in the vegetation plots. The threat categories refer to the pertinent national Red Lists (METZING et al. 2018, CASPARI et al. 2018, WIRTH et al. 2011) and the federal/regional Red Lists (HMILFN 1996, HMUELV 2013, HLNUG 2019). For site numbers 1–11 in the study area see Table 1. For community codes see the table footer, moreover Table 2 and the conspectus in the main text.

Anhang E12. Gefährdete Gefäßpflanzen, Moose und Flechten in den Vegetationsaufnahmen. Es liegen die nationalen (METZING et al. 2018, CASPARI et al. 2018, WIRTH et al. 2011) und föderalen/regionalen Roten Listen (HMILFN 1996, HMUELV 2013, HLNUG 2019) zugrunde. Die Angaben zur Verbreitung der Arten beziehen sich auf die Teilflächen 1–11 im Untersuchungsgebiet (siehe Tabelle 1). Die Kürzel der Gesellschaften sind im Tabellenfuß aufgelistet, Näheres siehe in Tabelle 2 und der syntaxonomischen Übersicht im Text.

Name	§	RL G	RL H	RL NWH	Pop situ	Pop trend	Resp	Site	Community
Vascular plants									
Aira caryophyllea	–	V	V	3	mh	<	nb	2	SS2 (22), N3 (3)
Aira praecox	–	V	2	2	mh	<	–	2	SS2 (18), N3 (3)
Alchemilla glaucescens	–	3	V	V	mh	<<	–	3, 5, 8, 9, 10, 11	N2 (1), N3 (7), N4 (6), MA1 (18), MA2 (6)
Antennaria dioica	§	3	2	1	mh	<<	–	2, 4, 10	N2 (10)
Anthemis arvensis	–	V	V	V	h	(<)	–	10	N4 (1)
Anthyllis vulneraria subsp. *carpatica*	–	–	V	V	h	<	–	2, 3, 5	N2 (1), N3 (2), MA1 (1)
Arnica montana	§	3	2	2	mh	<<	!	6, 10	N1 (6), N4 (1)
Botrychium lunaria	§	3	2	2	mh	<<	–	11	N3 (1)
Briza media	–	–	V	V	h	<	–	1, 3, 4, 5, 8, 9, 10, 11	N2 (6), N3 (17), N4 (37), MA1 (19), MA2 (2)
Campanula glomerata	–	3	V	3	mh	<<	–	1, 3, 5, 8	N3 (1), N4 (1), MA1 (12), MA2 (5)
Carex caryophyllea	–	V	–	V	h	<<	–	1, 2, 3, 4, 5, 7, 8, 9, 10, 11	SS1 (1), SS2 (4), N2 (29), N3 (26), N4 (44), N5 (3), MA1 (5), MA2 (1)
Carlina acaulis subsp. *caulescens*	§	V	3	–	s	<	–	11	N3 (4)
Carum carvi	–	–	–	V	h	<	–	3, 8, 9	MA1 (6), MA2 (14)
Cerastium brachypetalum	–	–	–	V	mh	<	–	2, 3, 5, 8, 9, 10	SS2 (3), N2 (1), N3 (3), N4 (1), MA1 (19), MA2 (6)
Cirsium acaulon	–	V	V	V	h	<<	!	1, 2, 3, 4, 6, 7, 10, 11	N1 (23), N2 (20), N3 (16), N4 (36), MA1 (5)
Danthonia decumbens	–	V	–	V	h	<<	–	1, 2, 4, 5, 6, 7, 10, 11	N1 (30), N2 (46), N3 (26), N4 (41), N5 (1)
Dianthus deltoides	§	V	V	V	h	<<	–	1, 2, 3, 4, 6, 7, 10, 11	SS1 (4), SS2 (8), N1 (3), N2 (6), N3 (8), N4 (12), N5 (4), MA1 (1)
Euphrasia officinalis subsp. *pratensis*	–	3	3	3	mh	<<	–	1, 2, 4, 5, 6, 7, 10, 11	SS2 (1), N1 (1), N2 (10), N3 (12), N4 (14), N5 (1)
Filago minima	–	–	V	2	h	<	–	2	SS2 (3)
Galium pumilum	–	V	V	3	mh	<	!!	1, 2, 4, 5, 6, 7, 10, 11	N1 (31), N2 (30), N3 (24), N4 (41), N5 (3)
Genista germanica	§	3	3	3	mh	<<	!	1, 2, 4, 6, 7, 10, 11	N1 (17), N2 (12), N3 (2), N4 (27)
Gentianella campestris	§	3	1	1	s	<	–	2	N3 (1)
Helianthemum nummularium subsp. *obscurum*	–	V	V	V	mh	<	nb	2, 4, 6, 7, 10, 11	N1 (8), N2 (30), N3 (15), N4 (40)
Helictochloa pratensis	–	V	V	V	mh	<	–	1, 2, 3, 4, 5, 6, 7, 8, 10, 11	N1 (29), N2 (39), N3 (25), N4 (51), N5 (1), MA1 (4)
Hypericum maculatum	–	–	–	V	mh	<	–	3, 6, 8, 9	N4 (1), MA1 (5), MA2 (3)
Jasione montana	–	–	V	3	h	<	–	7	N2 (3), N5 (2)
Juniperus communis	–	V	V	V	h	<<	–	10	N4 (1)
Koeleria macrantha	–	V	V	3	mh	<	–	2	N3 (2)
Koeleria pyramidata	–	–	–	V	mh	<	–	1, 3, 4, 5, 10, 11	SS1 (1), N2 (6), N3 (22), N4 (36), MA1 (1)
Linum catharticum	–	–	–	V	h	<	–	1, 2, 4, 5, 11	N3 (11), N4 (1)
Myosotis discolor	–	V	V	V	mh	<	–	2	SS2 (2), N2 (1), N3 (8)
Myosotis stricta	–	–	V	V	h	<	–	1, 10	SS1 (2), N2 (1)
Orobanche purpurea	–	3	3	1	s	<	?	11	N3 (1)
Platanthera bifolia	§	3	3	3	mh	<<	–	6, 10	N1 (5), N4 (8)
Polygala vulgaris subsp. *oxyptera* et *vulgaris*	–	G/V	3/–	3/V	s/h	(<)	–	1, 2, 3, 4, 5, 6, 7, 10, 11	N1 (7), N2 (34), N3 (23), N4 (15), MA1 (2)
Primula veris	–	V	V	V	h	<<	–	1, 3, 4, 5, 6, 8, 9, 10, 11	N1 (2), N2 (1), N3 (20), N4 (33), N5 (1), MA1 (32), MA2 (9)
Ranunculus polyanthemos ssp. *nemorosus* et *polyanthemoides*	–	V/3	–/V	V	mh/s	<	nb/–	4, 6, 10, 11	N1 (27), N2 (1), N3 (1), N4 (15)
Salvia pratensis	–	V	–	–	h	<<	–	3, 8	MA1 (8), MA2 (3)
Sanguisorba officinalis	–	V	–	–	h	<<	–	8, 9	MA1 (1), MA2 (1)
Saxifraga granulata	§	V	–	–	h	<<	–	1, 2, 3, 4, 5, 6, 8, 9, 10	SS1 (1), SS2 (2), N1 (1), N2 (1), N3 (8), N4 (7), MA1 (40), MA2 (20)
Scleranthus perennis	–	V	V	V	mh	<	nb	2, 5, 8, 11	SS2 (18), N3 (3), MA1 (1)
Scleranthus polycarpos	–	–	V	V	mh	<	–	2	SS2 (6), N3 (1)
Taraxacum sect. *Erythrosperma*	–	–	–	V	h	<	–	1, 2, 3, 5, 8, 11	SS2 (7), N3 (16), MA1 (15)
Teesdalia nudicaulis	–	–	3	3	h	<	–	2	SS2 (20), N2 (1), N3 (6)
Trifolium alpestre	–	V	V	V	mh	<	–	1, 4, 5, 7, 10, 11	N2 (10), N3 (12), N4 (34)
Trifolium striatum	–	3	3	3	s	<	–	2, 5, 8, 11	N3 (8), MA1 (1)
Viola canina	–	V	V	V	mh	<	–	1, 2, 3, 4, 5, 6, 7, 8, 10, 11	N1 (31), N2 (44), N3 (25), N4 (52), N5 (1), MA1 (4)
Bryophytes									
Barbilophozia barbata	–	–	3	–	s	<	–	4	N2 (6)
Dicranum bonjeanii	–	3	3	–	mh	<<	–	4	N2 (1)
Ptilidium ciliare	–	3	3	–	mh	<<	–	4	N2 (5)
Racomitrium elongatum	–	–	3	–	mh	=	–	1, 2	SS1 (1), SS2 (2), N3 (2)
Lichens									
Cetraria aculeata	–	3	2	–	s	<	–	1, 2	SS1 (5), SS2 (13), N3 (1)
Cladonia arbuscula	–	G	3	–	ss	(<)	–	1, 2, 4, 6, 10, 11	SS2 (3), N1 (2), N2 (15), N4 (1)
Cladonia ciliata	–	2	3	–	s	<<	–	1, 2, 11	SS2 (1), N4 (2)
Cladonia foliacea	–	3	2	–	s	<	–	1, 2	SS1 (8), SS2 (7)
Cladonia phyllophora	–	3	3	–	s	<	–	4	N2 (1)
Cladonia rangiformis	–	3	–	–	mh	<	–	1, 2, 10, 11	SS1 (9), SS2 (4), N2 (1), N3 (2), N4 (1)
Cladonia uncialis	–	3	3	–	s	<	–	2	SS2 (1)
Peltigera cf. *rufescens*	–	3	2	-	mh	<<	–	1	SS1 (1)

§ = protection status within Germany (*Artenschutz*): § = Protected (*Geschützt*); **RL – Red List status** (*Rote Liste-Status*) within **G = Germany, H = Hesse, NW H = NW Hesse:** 1 = Critically endangered (*Vom Aussterben bedroht*), 2 = Endangered (*Stark gefährdet*), 3 = Vulnerable (*Gefährdet*), V = Near-threatened (*Vorwarnliste*), G = Threatened to an unknown extent (*Gefährdung unbekannten Ausmaßes*); **Pop situ – Current population situation within Germany** (*Aktuelle Bestandssituation in Deutschland*): ss = Very rare (*Sehr selten*), s = Rare (*Selten*), mh = Moderately common (*Mäßig häufig*), h = Common (*Häufig*); **Pop trend – Long-term population trend within Germany** (*Langfristiger Bestandstrend in Deutschland*): <<< = Very strong decline (*Sehr starker Rückgang*), << = Strong decline (*Starker Rückgang*), < = Moderate decline (*Mäßiger Rückgang*), (<) = Declining, extent unknown (*Rückgang, Ausmaß unbekannt*), ? = Insufficient data, responsibility can be possibly assumed (*Daten ungenügend, evtl. höhere Verantwortlichkeit zu vermuten*); **Nat resp – Responsibility status within Germany** (*Nationale Verantwortlichkeit*): !! = Especial high level of responsibility (*In besonders hohem Maße verantwortlich*), ! = High level of responsibility (*In hohem Maße verantwortlich*), ? = Insufficient data, responsibility can be assumed (*Daten ungenügend, evtl. höhere Verantwortlichkeit zu vermuten*), nb = Not evaluated (*Nicht bewertet*), – = General Responsibility (*Allgemeine Verantwortlichkeit*).

Supplement E13: Relevé table of the *Arrhenatheretum elatioris ranunculetosum bulbosi* Knapp 1954. Cluster MA1 = *Bromus erectus* variant, cl. MA2 = *Festuca pratensis* variant. Delta symbols (Δ) indicate local differential species of the MA subassociation (cf. Table 2), and Asterisks (*) species that are alligned with further syntaxa (cf. Suppl. E2).

Anhang E13. Vegetationstabelle *Arrhenatheretum elatioris ranunculetosum bulbosi* Knapp 1954. Cluster MA1 = *Bromus erectus*-Variante, Cl. MA2 = *Festuca pratensis*-Variante. Delta-Symbole (Δ) kennzeichnen lokale Differenzialarten der Subassoziation (vgl. Tabelle 2) und Sterne (*) Arten, die weitere Syntaxa indizieren (cf. Suppl. E2).

Running relevé no.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60	61	62	63	64	65	66	67	68	69	70	71	72	73	74
Cluster	MA1	MA1	MA1	MA1	MA1	MA1	MA1	MA1	MA1	MA1	MA1	MA1	MA1	MA1	MA1	MA1	MA1	MA1	MA1	MA1	MA1	MA1	MA1	MA1	MA1	MA1	MA1	MA1	MA1	MA1	MA1	MA1	MA1	MA1	MA1	MA1	MA1	MA1	MA1	MA1	MA1	MA2	MA2	MA2	MA2	MA2	MA2	MA2	MA2	MA2	MA2	MA2	MA2	MA2	MA2	MA2	MA2	MA2	MA2	MA2	MA2	MA2	MA2	MA2	MA2	MA2	MA2	MA2	MA2	MA2	MA2	MA2	MA2	MA2	MA2
Site	8	8	8	8	8	8	8	8	9	9	3	8	8	8	8	8	8	8	9	1	9	9	8	3	8	3	3	8	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	1	3	9	9	9	9	9	9	9	9	9	9	9	9	9	5	9
Relevé size (m²)	10	15	20	10	20	10	15	20	25	20	10	13	20	15	15	15	15	15	13	10	10	10	10	15	20	25	25	25	25	25	25	25	25	25	10	15	20	20	20	15	15	25	25	25	25	25	25	25	25	25	25	25	25	25	25	25	25	15	10	20	25	25	20	25	25	20	20	10	10	25	20	20	25	10
Slope exposition	S	S	S	S	SW	S	O	S	S	SO	SO	SW	S	S	S	S	S	O	O	W	N	SO	W	S	S	NW	NW	SO	N	W	W	NW	NW	NW	NW	NW	NW	N	NW	NW	N	N	N	N	N	N	N	N	N	NW	NW	NO	NO	NO	NO	NO	NW	N	N	SW	SW	-	-	-	-	-	S	O	S	W	NW	W	NW	SO
Slope southerness (°)	180	180	180	180	135	180	90	180	180	135	135	135	180	180	180	180	180	90	90	90	0	135	90	180	180	45	45	135	0	90	90	45	45	45	45	45	45	0	45	45	0	0	0	0	0	0	0	0	0	45	45	45	45	45	45	45	45	0	0	135	135	-	-	-	-	-	180	90	180	90	45	90	45	135
Slope inclination (°)	9	7	7	7	7	7	11	7	7	4	4	7	7	9	9	5	7	11	5	5	1	5	1	4	14	14	7	7	14	14	14	7	7	11	20	20	20	20	16	20	7	7	5	7	7	9	7	5	11	5	7	5	4	4	7	9	11	5	5	1	[illegible]	-	-	-	-	-	2	5	9	5	2	5	2	5
Soil pH (H2O)	5,5	5,6	5,3	-	-	-	5,5	-	-	6,2	-	-	-	5,6	-	-	5,4	-	5,4	5,5	-	6,1	-	6	6	5,4	5,4	5,7	5,8	5,1	5,5	-	-	5,6	5,4	5,9	5,7	-	5,7	5,6	5,9	6,4	6,4	6,4	5,9	5,3	-	-	5,8	5,3	5,6	5,7	6,6	6,6	6,2	6,4	5,8	5,8	-	-	-	5,8	5,6	6,2	-	5,8	-	-	6,1	-	-	-	-	-
Soil pH (KCl)	4,4	4,4	4,3	-	-	-	4,3	-	-	5,2	-	-	-	4,7	-	-	4,2	-	4,3	4,2	-	5,1	-	5	5	4,6	3,6	4,5	4,6	4,1	4,5	-	-	4,8	4,8	4,9	4,7	-	4,6	4,3	5	5,7	5,8	5,7	5,1	4,3	-	-	4,8	4,5	4,9	4,8	5,7	5,9	5,5	5,7	5,1	5	-	-	-	4,7	4,5	5,2	-	4,6	-	-	4,8	-	-	-	-	-
Cover vascular plants (%)	90	90	95	90	95	95	85	98	98	100	95	95	100	100	98	100	95	98	95	95	100	90	100	100	100	95	100	100	98	100	95	90	98	100	100	98	98	98	100	100	100	100	100	95	98	100	98	100	100	100	100	100	100	95	98	90	95	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	98
Cover cryptogams (%)	45	25	20	30	40	20	10	50	30	80	80	10	20	5	10	5	15	12	15	75	25	70	75	10	5	75	75	20	30	90	85	90	70	70	12	10	35	15	10	20	15	20	15	15	25	20	30	20	10	15	15	10	20	20	20	20	60	25	20	5	20	8	20	20	25	15	8	30	20	5	80	5	3	85
Total species richness	57	52	55	51	51	42	55	56	52	53	53	53	49	50	46	47	52	43	40	38	37	38	42	55	50	58	53	52	52	59	58	61	56	51	45	53	59	52	50	49	49	56	56	50	59	61	50	54	42	45	46	55	46	51	47	50	37	39	32	42	46	43	43	39	45	43	46	31	39	33	39	24	43	55
Species richness vascular plants	54	47	52	45	48	39	50	53	49	50	50	49	45	48	43	44	48	40	39	35	34	35	38	51	47	53	50	49	49	56	55	57	53	48	43	50	53	47	45	42	45	53	52	46	55	57	46	50	38	42	43	50	42	47	43	46	32	34	31	40	44	42	41	38	46	40	44	29	35	30	37	22	41	52
Species richness bryophytes	3	5	3	6	3	3	5	3	3	3	3	4	4	2	3	3	4	3	1	3	3	3	4	4	3	5	3	3	3	3	3	3	3	3	2	3	5	5	5	7	4	3	4	4	4	4	4	4	4	3	3	5	4	4	4	4	5	5	1	2	2	1	2	1	1	3	2	2	4	3	2	2	2	4
Species richness lichens	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Bromus erectus var. – MA1																																																																										
Anthoxanthum odoratum - C5*	2	2	2	2	2	2	2	2	2	2	2	2	1	2	2	2	2	2	2	2	2	2	2	2	1	1	2	2	2	2	2	2	1	2	2	2	2	2	2	1	2	2	1	2	2	1	2	2	1	2	1	2	1	.	.	1	+	2	2	2	1	1	1	.	1	.	1	1	.	.	.	.	1	.
Centaurea jacea - O5.1*	1	1	+	1	1	1	+	1	1	1	1	.	.	1	.	.	1	.	1	1	+	1	1	1	1	.	2	1	1	1	1	+	1	1	2	2	1	1	1	1	1	1	.	.	1	.	1	1	.	+	1	+	1	1	1	1	.	.	.	.	.	.	1	1	.	1	1	.	1	.	+	+	.	+
Sanguisorba minor	2	1	1	2	1	2	1	1	.	2	1	.	.	1	+	1	.	1	.	1	.	.	.	.	1	1	2	2	1	1	1	2	2	1	1	2	2	2	2	2	1	+	+	.	.	+	1	+	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	1	1	.	1	.	.	.	.	1	+	.
Cerastium brachypetalum	1	.	1	1	1	1	+	+	1	.	1	.	.	1	+	+	.	+	1	.	.	.	.	.	.	+	.	.	.	.	.	+	.	.	.	.	+	+	+	.	.	.	.	r	.	.	.	.	.	.	.	.	.	+	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	+	.
Alchemilla glaucescens	.	+	.	.	.	.	.	.	+	+	1	.	1	.	.	+	.	.	.	.	.	.	.	.	1	+	.	.	1	.	1	1	.	1	.	+	1	.	1	+	1	1	+	.	.	+	+	.	.	.	.	.	.	+	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Draba verna	+	1	+	+	1	+	+	+	+	+	.	+	+	.	+	.	.	+	+	+	+	.	.	.	.	.	.	.	.	.	+	+	.	+	.	+	.	.	.	.	.	.	.	r	.	.	.	.	.	.	.	.	.	+	.	r	.	r	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Arabidopsis thaliana	+	+	+	+	1	+	+	+	+	+	.	+	+	+	+	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	r	.	.	.	.	.	.	.	+	.	.	.	.	.	r	+	.	.	.
Bromus erectus	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	2	2	+	+	.	1	1	2	2	3	1	1	+	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Salvia pratensis	.	.	+	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	2	2	1	1	+	1	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Silene nutans	+	.	+	.	.	.	+	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Festuca pratensis var. – MA2																																																																										
Veronica chamaedrys - O5.1*	.	1	1	.	.	.	.	1	1	1	1	.	1	1	1	1	1	.	.	.	.	.	1	.	+	1	+	1	1	+	1	1	1	+	.	1	.	1	.	.	.	1	+	.	1	1	1	+	1	.	1	+	1	1	1	+	.	+	1	1	1	2	1	1	1	1	.	1	+	1	1	1	+	1
Anthriscus sylvestris - A5.1.1	+	+	+	.	.	+	.	.	.	1	.	1	1	1	1	1	1	.	+	.	.	.	.	.	1	1	1	.	.	.	+	.	+	.	.	1	+	.	.	.	1	+	1	2	+	2	1	2	2	2	2	1	1	1	1	1	.	+	2	1	2	1	2	.	2	2	2	2	2	.	2	2	1	2
Poa trivialis - C5	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	+	+	.	+	.	.	.	.	.	.	.	.	.	.	1	1	1	1	1	1	1	1	1	1	1	1	1	1	.	1	.	1	1	1	1	1	1	1	1	1	1	1	.	.	1	2	1
Lathyrus pratensis - C5	.	.	.	.	.	.	1	.	.	.	1	.	.	.	.	1	.	.	.	.	.	.	.	.	+	1	.	.	.	1	+	1	1	1	1	1	1	.	1	.	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	.	1	.	+	1	1	+	1	1	1	1	+	.	1	1	1	.
Festuca pratensis - O5.1	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	1	.	.	1	.	.	.	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	.	1	.	1	1	1	1	1	1	1	1	.	1	1	1	1	.
Bromus hordeaceus - O5.1	.	.	.	.	.	1	1	.	+	.	1	1	.	.	1	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	1	.	1	.	1	+	1	1	+	.	2	2	1	+	+	1	2	2	1	1	.	1	.	1	1	.	1	1	1	1	.	1	.	1	1	3	2
Alopecurus pratensis - O5.1	.	1	.	.	.	.	.	.	.	1	1	.	.	1	.	.	.	.	1	.	.	1	1	+	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	1	1	.	.	.	.	.	1	1	1	2	2	1	2	2	2	4	3	4	1	1
Alchemilla monticola - O5.1*	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	+	1	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	1	1	.	1	.	.	.	1	1	.	1	1	.	.	1	.	+	1	1	1	.	1	1	1	1	1	.	.	.	.	.
Carum carvi - O5.1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	+	+	.	+	.	.	.	.	1	+	+	.	1	+	+	.	1	+	.	.	+	2	1	2	1	.	1	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.
Ranunculus repens - C5	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	+	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Medicago lupulina - O5.1*	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	1	1	+	.	.	.	.	.	.	.	.	2	2	1	1	2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Ranunculus acris - C5	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	1	1	1	1	1	1	.	.	.	.	.	.	1
Equisetum arvense	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	+	.	.	+	+	+	+	.	+	+	.	.	.
Vicia sepium - O5.1*	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	1	1	.	.	.	.	.	.	1	1	.	.	+	.	.	.
Lolium perenne - O5.1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	+	.	.	.	+	+	+	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Cirsium arvense	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	1	1	1	.	+
Cirsium palustre - C5	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	+	.	+
Deschampsia cespitosa - C5	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	+	.	.	.	.	.	+	.
Phleum pratense - A5.1.1*	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	+	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.
Geranium dissectum	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.
Urtica dioica	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	+	.	r	.	.	.	.	.	.
Arrhenatherion - A5.1.1																																																																										
Δ Arrhenatherum elatius	1	1	2	1	1	1	1	1	2	1	1	1	2	2	2	2	2	2	1	2	1	2	1	2	1	1	1	2	1	1	1	2	2	2	2	2	2	1	1	1	1	2	3	2	3	2	2	2	2	2	2	2	+	2	2	2	3	2	2	2	2	2	2	2	2	3	2	3	1	3	2	2	1	+
Δ Crepis biennis	1	1	1	.	.	.	.	.	2	1	1	1	.	.	2	2	2	1	.	1	1	+	2	1	1	1	1	1	1	1	+	1	1	2	1	+	1	1	1	1	1	2	2	2	2	2	2	2	2	2	3	1	2	2	2	2	2	2	1	1	2	1	2	2	1	2	1	1	.	1	.	.	1	.
Campanula rapunculus*	.	.	.	.	.	.	+	+	+	.	1	1	+	+	.	+	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	+	.	.	.	.	.	.	.	.	.	1
Pimpinella major	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.
Arrhenatheretalia - O5.1																																																																										
Δ Trisetum flavescens	2	1	1	1	1	1	1	1	1	1	1	2	1	1	2	1	2	1	2	1	1	1	+	1	1	1	+	+	1	1	2	+	1	1	1	1	1	1	1	1	1	2	2	1	1	2	2	1	2	1	2	2	2	2	2	2	1	1	1	2	1	2	1	2	1	1	1	1	1	1	1	1	1	1
Δ Rumex acetosa	2	1	1	2	2	1	1	1	2	1	1	1	1	2	2	1	1	2	2	1	1	2	2	1	1	2	2	1	1	1	1	2	2	1	1	1	1	1	1	1	1	+	1	1	1	2	1	1	1	2	+	1	1	+	+	+	+	1	1	1	2	2	2	2	2	1	2	1	2	1	1	1	+	1
Δ Dactylis glomerata	1	1	1	1	2	1	1	1	1	1	1	1	1	2	1	2	2	2	1	2	1	2	2	2	2	2	1	1	1	1	1	1	1	2	2	2	1	1	1	1	1	2	1	2	1	1	1	1	1	1	1	1	2	2	2	2	2	2	2	1	1	2	2	2	2	2	.	1	2	1	1	1	3	1
Δ Rhinanthus minor*	1	2	2	1	2	1	1	2	2	1	1	2	1	1	1	1	1	1	1	1	2	1	1	1	1	2	2	2	1	2	2	2	2	2	2	3	1	1	1	1	1	1	1	1	2	1	2	2	1	2	1	2	2	2	1	2	2	1	1	1	1	1	1	1	1	1	1	1	1	1	1	.	.	1
Avenula pubescens*	1	1	2	1	1	2	.	1	1	2	2	1	1	1	1	2	1	1	.	.	2	1	1	2	1	1	2	2	2	1	2	2	2	2	2	2	2	2	1	2	1	1	2	.	1	1	1	1	1	1	1	1	1	1	1	1	1	2	1	1	1	1	1	1	1	1	2	1	1	1	1	1	1	2
Δ Cerastium holosteoides	1	1	1	1	1	1	1	1	1	1	1	+	1	1	1	1	1	1	1	1	1	1	+	1	1	1	1	1	1	+	1	1	1	1	1	1	.	1	1	1	1	1	+	+	1	1	1	1	+	1	+	+	1	1	1	1	1	.	1	1	1	1	1	1	1	1	1	1	1	.	+	.	+	1
Plantago lanceolata	2	2	2	2	2	2	2	2	1	2	2	2	2	2	2	2	2	2	2	2	2	2	2	1	2	2	2	2	2	2	2	2	2	2	2	2	2	1	1	1	1	1	1	1	1	2	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	.	.	.	.	.	+	1
Δ Trifolium pratense	1	1	1	1	1	1	1	1	1	1	1	1	1	2	1	1	1	2	1	2	1	1	1	1	1	1	2	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	2	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	.	2	+	.	.	.	+	1
Achillea millefolium	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	2	1	1	1	1	1	+	1	2	1	1	1	1	+	+	+	1	1	1	1	1	1	2	2	2	2	2	2	2	2	2	1	2	2	2	3	2	2	2	2	1	2	2	1	1	1	1	1	1	1	1	1	1	+	2	.
Δ Trifolium repens	2	2	1	1	1	1	1	2	2	1	1	1	2	2	1	1	1	1	1	+	1	2	.	2	1	1	+	1	1	1	1	1	1	+	1	1	.	1	1	1	1	1	1	1	1	1	1	1	+	.	2	3	2	1	2	1	1	3	+	2	1	2	2	2	2	1	1	1	2	1	.	.	1	1
Δ Trifolium dubium	1	1	1	.	1	1	1	1	1	1	1	2	1	+	1	1	1	1	1	1	1	1	.	+	.	2	1	1	1	1	2	1	2	2	1	1	1	1	1	1	1	1	+	1	2	1	2	1	1	1	1	+	+	+	+	1	1	1	1	1	1	1	.	1	1	1	1	1	1	1	1	.	1	1
Δ Leucanthemum ircutianum*	1	1	1	1	1	.	.	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	+	2	2	1	2	1	2	2	2	1	1	1	1	1	1	1	1	+	2	2	2	1	1	1	1	1	1	1	1	1	1	.	.	1	1	+	.	.	.	.	.	1	1	.	.	.	.	+	1
Δ Taraxacum sect. Ruderalia	1	.	.	.	.	.	.	.	+	1	1	1	1	1	1	1	1	.	.	.	1	1	1	1	1	+	+	1	1	1	+	2	+	1	+	1	1	1	1	1	2	2	2	2	2	2	2	2	2	2	2	1	2	2	2	2	2	2	2	3	2	2	2	2	3	2	2	2	3	.	.	.	+	1
Δ Galium album*	1	+	.	.	.	.	.	.	1	1	1	1	1	1	1	1	1	1	1	1	.	+	2	1	1	1	1	1	1	1	1	+	+	2	+	1	1	1	1	1	2	2	2	2	2	1	1	2	2	.	1	2	2	2	2	3	2	.	1	1	1	1	1	1	1	1	2	2	2	2	1	2	+	+
Δ Heracleum sphondylium	.	.	.	+	.	.	.	.	+	1	.	.	.	1	.	.	.	1	2	1	+	1	1	1	1	2	+	+	+	+	1	2	1	2	2	+	.	.	1	.	1	1	1	1	1	1	1	2	2	2	1	1	+	1	+	+	.	+	1	1	1	1	1	2	1	1	1	1	1	1	1	1	.	1
Δ Tragopogon pratensis	1	1	1	.	1	.	r	.	1	1	1	1	1	1	1	.	1	1	1	.	.	.	2	r	1	.	.	.	1	+	.	.	.	.	+	.	1	+	+	.	.	1	+	1	+	1	1	+	1	1	1	+	1	+	1	1	1	+	1	1	1	1	1	1	1	1	1	1	1	1	1	1	.	.
Lotus corniculatus*	1	2	1	2	2	.	1	1	.	1	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	1	2	2	2	2	1	1	1	1	1	1	1	1	1	1	1	2	.	1	+	2	1	.	+	+	1	.	+	1	+	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Δ Plantago media*	.	.	.	.	.	.	1	1	.	1	1	.	+	.	.	.	+	.	.	1	+	1	1	.	.	1	1	2	1	1	+	+	1	2	2	1	1	1	1	1	1	1	+	1	1	.	+	+	.	.	.	+	1	1	1	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.
Senecio jacobaea*	.	.	+	.	.	+	1	1	.	+	+	.	1	.	.	.	.	+	.	+	.	.	.	.	.	.	+	.	.	.	1	+	+	+	+	.	.	.	.	.	.	+	+	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Vicia cracca*	.	.	.	.	.	.	1	1	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	+	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	1	.	.	1	+	1	1	+	.	1	1	.	1	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.
Daucus carota*	+	.	1	.	1	.	.	1	1	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	1
Malva moschata*	1	.	.	.	+	.	.	1	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.
Cynosurus cristatus	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	1	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Scorzoneroides autumnalis	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Prunella vulgaris	.	.	.	.	.	.	.	.	.	r	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Veronica serpyllifolia	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	r
Molinio-Arrhenatheretea - C5																																																																										
Δ Holcus lanatus	1	1	1	1	.	1	1	1	1	1	1	1	2	2	2	2	2	2	2	2	2	2	3	2	2	1	1	2	2	+	1	+	1	2	1	1	1	1	1	1	1	2	2	1	2	2	2	2	2	2	2	+	.	.	.	.	1	2	2	2	2	2	2	2	2	2	2	2	1	1	1	.	1	1
Festuca rubra agg.	2	2	2	2	1	2	1	2	2	2	2	2	2	1	1	1	2	2	1	1	2	.	1	2	2	2	3	2	2	2	2	2	2	2	2	2	2	2	2	2	2	+	+	1	2	2	2	1	1	.	2	+	+	+	+	.	+	2	1	2	1	1	1	.	1	1	1	1	.	1	1	1	.	.
Rhytidiadelphus squarrosus	2	2	2	3	2	1	1	3	3	4	4	2	2	1	.	1	.	.	1	.	4	2	4	3	2	2	4	4	2	3	5	5	5	4	4	5	2	3	2	2	2	1	1	2	2	2	1	1	1	1	+	1	+	+	+	+	1	3	1	.	1	1	2	+	.	.	.	.	2	1	3	1	.	4
Plagiomnium affine	1	1	1	1	2	+	1	+	+	1	.	1	1	.	1	.	.	+	1	.	1	+	1	1	1	1	1	1	1	+	+	+	+	+	+	.	.	1	1	1	.	2	2	1	2	2	2	+	1	+	+	+	2	1	1	2	1	1	.	.	.	.	.	.	.	.	1	2	1	+	+	.	+	1
Δ Brachythecium rutabulum	.	1	2	.	.	2	2	.	.	1	1	1	1	+	1	2	+	2	.	.	1	+	2	3	1	1	+	.	.	.	.	.	.	.	.	.	.	.	.	1	1	2	2	1	2	1	2	2	2	2	2	.	2	2	2	2	2	2	2	1	2	.	2	2	2	2	1	3	1	1	2	1	.	.
Stellaria graminea	.	.	.	.	.	.	.	.	.	.	1	1	1	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	+	+	1	1	1	1	1	+	.	.	.	.	.	.	1	1	1	.	1	.	.	.	.	.	.	.	.	.	.	.	1	1	1	1	1	1	1	+	+	.	.	.	.	.	+
Δ Colchicum autumnale	.	.	.	.	.	.	.	.	.	2	.	.	.	.	.	.	1	.	.	.	.	.	.	2	2	.	.	.	.	.	.	1	+	+	+	.	+	.	.	+	.	.	.	.	.	.	.	.	.	.	.	+	+	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	1
Calliergonella cuspidata	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	+
Cardamine pratensis	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	+	.	.	.
Ajuga reptans	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1
Lychnis flos-cuculi	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1
Sanguisorba officinalis	.	.	.	.	.	.	.	.	.	.	.	.	r	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1
Climacium dendroides	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Further species																																																																										
Poa angustifolia	1	1	1	1	1	2	1	1	1	1	2	1	1	1	1	1	1	1	1	1	+	1	2	1	1	+	+	1	+	1	.	+	+	+	.	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	2	2	2	1	1	1	1	1	1	1	1	1	2	2	1	2	.	1
Δ Veronica arvensis	+	1	1	+	1	1	1	+	1	1	1	1	1	1	1	1	+	1	1	+	1	1	1	1	.	1	1	.	+	1	1	1	1	1	1	1	1	1	1	1	+	+	+	+	+	+	+	+	+	+	+	+	1	1	1	1	+	+	1	1	1	1	1	1	1	1	1	1	1	1	1	+	1	1
Pimpinella saxifraga	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	.	1	1	1	1	1	2	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	2	1	1	1	+	1	1	1	+	1	1	1	1	1	1	1	1	.	1	1	1	1	1	1	1	1	+	1
Δ Vicia angustifolia	1	1	1	.	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	2	.	1	1	+	1	1	.	.	+	+	.	.	.	.	1	1	1	1	1	1	1	1	2	1	1	1	1	1	2	1	1	1	1	2	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Δ Saxifraga granulata	1	1	1	2	1	1	1	1	1	1	1	1	1	1	1	1	2	1	2	2	1	2	2	1	1	1	1	1	1	1	1	1	+	1	1	1	1	+	2	2	1	2	1	2	1	+	+	1	2	2	+	1	1	1	1	2	1	1	1	2	1	1	1	1	1	1	1	1	1	1	1	+	1	1
Δ Ranunculus bulbosus	2	.	1	1	1	1	.	1	1	.	1	2	+	2	2	1	.	.	.	.	.	1	2	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	1	1	1	1	+	1	+	+	+	+	+	+	+	1	+	1	+	1	1	+	+	.	1	+	.	+	+	.	+	r	+	.	.	+	.	+
Knautia arvensis	1	1	+	1	1	.	1	1	1	1	1	1	1	1	1	+	1	.	1	1	1	2	.	.	.	1	.	1	1	1	1	.	1	1	1	1	.	1	.	1	1	+	.	.	1	1	1	.	1	.	.	1	+	1	+	+	+	.	.	.	.	.	.	.	+	.	.	+	.	+	.	.	.	+
Luzula campestris	1	2	1	1	1	1	2	1	1	1	1	1	1	1	1	1	1	1	1	2	2	1	1	1	.	1	1	1	1	1	.	1	1	1	.	1	1	1	1	1	1	1	.	1	1	1	.	1	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	+	.	.	.	.	+
Δ Vicia hirsuta	.	+	1	.	.	1	1	1	1	1	1	1	.	1	.	.	1	.	.	1	.	.	.	.	.	.	+	.	.	.	+	+	+	+	+	+	.	.	.	.	.	1	1	2	2	+	+	+	+	.	.	+	+	1	1	1	2	1	.	.	+	1	1	1	1	.	.	.	+	1	1	.	.	+
Δ Myosotis ramosissima	+	1	+	1	1	1	1	1	+	.	1	.	1	1	+	+	+	1	1	1	1	.	1	+	.	.	.	+	+	.	+	+	+	.	.	+	+	+	+	+	+	+	+	+	+	+	+	2	+	2	2	.	.	+	+	+	+	+	+	+	+	+	+	+	+	+	.	+	.	+	.	+	+	.
Δ Primula veris	.	.	.	.	.	1	.	1	2	1	.	.	1	1	.	1	1	1	.	.	.	.	1	.	.	1	2	2	1	2	1	2	2	2	2	2	1	2	2	1	1	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Galium verum	1	1	.	1	1	1	.	+	.	.	.	.	1	.	.	.	.	.	.	.	.	.	+	1	1	1	1	+	1	1	1	1	1	1	1	1	1	1	1	1	1	+	.	1	1	1	1	1	+	+	.	.	.	.	.	.	.	.	.	.	.	+	.	.	1	.	.	.	+	.	.	.	.	.
Trifolium medium	1	1	1	1	2	1	.	1	.	.	.	.	.	.	2	.	1	2	1	.	.	.	.	.	1	1	+	1	1	+	1	2	2	1	1	1	.	.	.	.	.	.	.	.	.	.	+	+	.	2	.	+	.	.	.	.	+	+	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Agrostis capillaris	1	+	+	.	.	2	+	1	.	1	.	.	+	+	+	+	+	1	1	1	1	.	.	.	+	.	.	.	.	1	.	1	1	+	1	1	1	+	+	1	.	.	1	1	+	1	+	1	1	2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Campanula rotundifolia	1	1	.	.	.	.	+	1	1	.	.	.	.	.	.	1	1	.	.	.	.	.	.	.	1	1	1	1	1	1	1	1	1	1	.	1	1	1	1	1	+	.	1	1	1	.	1	.	.	1	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Brachythecium albicans	1	1	.	.	1	2	.	1	+	+	.	1	.	+	.	+	+	1	2	2	.	.	.	.	1	.	+	1	.	.	.	.	.	.	+	+	.	+	+	+	+	+	+	.	.	.	.	.	.	.	.	.	.	.	.	.	2	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Leontodon hispidus	1	+	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	+	.	2	2	3	1	+	1	.	.	1	1	1	.	.	1	+	+	3	.	+	+	2	.	.	2	.	.	.	1	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Δ Centaurea scabiosa	.	.	1	.	.	+	+	.	.	.	.	.	.	1	.	.	.	.	.	.	.	1	.	.	.	+	.	.	.	.	+	.	.	.	.	.	+	.	.	.	.	+	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
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Hypericum perforatum	.	.	+	.	.	1	1	1	1	1	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	1	.	+	1	1	+	+	+	+	+	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	1	1	.	.	.	.	1	.	.	.	.	.
Briza media	.	1	.	1	.	.	.	.	1	1	1	1	.	.	.	.	.	1	1	.	.	.	.	.	.	1	1	1	+	.	.	+	.	.	.	.	1	1	.	1	1	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Δ Campanula glomerata	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	+	.	.	+	.	1	1	1	1	1	1	1	1	.	.	+	+	+	2	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Festuca guestfalica	2	2	1	2	2	1	.	.	.	.	1	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Hieracium pilosella	1	1	1	1	1	1	1	1	.	.	.	.	1	.	.	.	.	.	1	.	.	.	.	.	1	.	1	.	.	.	.	.	.	.	.	.	1	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Taraxacum sect. Erythrosperma	1	.	.	1	.	+	.	.	.	.	.	1	1	2	1	1	1	.	2	.	+	.	.	+	1	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Δ Valerianella locusta et carinata	1	.	.	.	.	1	+	.	.	.	1	.	+	+	+	.	.	1	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	r	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1
Potentilla verna	1	.	1	1	1	1	1	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
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Cerastium arvense	.	1	.	1	.	1	1	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	+	.	1	.	.	+	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
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Hypochaeris radicata	1	.	1	1	.	.	.	1	1	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Geranium pyrenaicum	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	+	.	.	.	+	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Carex caryophyllea	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	+	+	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1
Clinopodium vulgare	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	+	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	+	.
Thymus pulegioides	1	1	1	1	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Hieracium lachenalii	.	.	.	.	+	.	1	.	.	.	.	.	.	.	.	.	1	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Agrimonia eupatoria	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1
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Convolvulus arvensis	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.
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Dicranum scoparium	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	1	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
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Hylotelephium telephium	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	r	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.
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Artikel/Article: Syntaxonomy and diversity of acidic grasslands in the eastern Rhenish Massif (Western Germany) Syntaxonomie und Diversität von Silikatmagerrasen im östlichen Rheinischen Schiefergebirge (Westdeutschland) 1-35