



Montane-subalpine tall-herb vegetation (*Mulgedio-Aconitetea*) in central Europe: large-scale synthesis and comparison with northern Europe

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with 3 figures, 3 tables and 4 appendices

Abstract. Many incompatible classifications have in the past been applied to the class of European montane-subalpine tall-herb communities (*Mulgedio-Aconitetea*). The aim of our paper is to develop a consistent classification of all vegetation types of this class from temperate and boreal Europe, derived from a database of individual relevés. We compiled available relevés from central, western and northern Europe. After excluding plots dominated by woody species, those outside the range of 9–50 m² size, and stands with prevailing diagnostic species of other classes, 993 relevés remained for the classification, mainly from central Europe. We used cluster analysis (group linkage with flexible beta and Sørensen index) to analyse the structure of the dataset, and translated the results into a syntaxonomic system. The major division is between the temperate order *Calamagrostietalia villosae* and the newly described northern European order *Epilobio lactiflori-Geranietalia sylvatici*. The temperate order can be subdivided into five alliances: (i) subalpine tall-forb communities (*Adenostylo-alliariae*), (ii) tall-forb communities of montane-subalpine eutrophic pastures (*Rumicion alpini*), (iii) subalpine tall-forb and tall-grass communities that are closely related to alpine meadows (*Calamagrostion villosae*), (iv) mainly montane tall-grass and fern communities of acidic soils (*Calamagrostion arundinaceae*), and (v) montane tall-forb communities (*Arunco dioici-Petasition albi*). The northern European order was not divided further at present because too few data were available. We characterise all syntaxa from the alliances upwards ecologically and floristically, provide a revision of their nomenclature, and list the included associations. We also discuss the methodological problems any supra-national classification has to face due to the high heterogeneity of such data and the lack of a continent-wide relevé database of all vegetation types. The use of *a priori* lists of diagnostic species for the delimitation of the focal syntaxon and the restriction of the analysis to relevés with similar plot sizes turned out to be crucial to derive consistent results. This study demonstrates that the analysis of a comprehensive supra-national database of individual relevés can provide insights that go beyond what is achievable at a regional scale or by comparison of synoptic tables.

Keywords: *Adenostyletalia alliariae*, *Betulo-Adenostyletea*, *Calamagrostietalia villosae*, methodology, nomenclatural revision, vegetation classification.

Introduction

A sound and consistent large-scale classification of vegetation types is an important tool for ecological studies, for vegetation monitoring, and for developing and implementing conservation strategies and legislation (DENGLER 2003, DENGLER et al. 2008). Thus, the major objective of the international working group “European Vegetation Survey” for nearly two decades has been to initiate and support such large-scale vegetation classifications, preferably using individual relevés stored in national databases (cf. MUCINA et al. 1993, RODWELL et al. 1995, 2002). The ultimate goal is to achieve a consistent classification of vegetation types of the continent. During this period, many relevé databases have emerged throughout Europe (see EWALD 2001) and new numerical tools have been developed to deal with large datasets (reviewed by DENGLER et al. 2008). Also, comprehensive vegetation overviews based on vegetation databases have been published for some countries or large regions, namely the United Kingdom (e.g. RODWELL

1991), the Netherlands (e.g. SCHAMINÉE et al. 1995), Slovakia (e.g. VALACHOVIČ 1995), Mecklenburg-Vorpommern (NE Germany; BERG et al. 2001, 2004), and the Czech Republic (CHYTRÝ 2007). By contrast, classifications based on individual relevés and covering areas larger than a single country have only rarely been conducted so far. There is one single study dealing with a whole vegetation class throughout Europe (ZECHMEISTER & MUCINA 1994), and few other authors analysed a certain higher syntaxon jointly for several countries (e.g. WILLNER 2002, BOTTA-DUKÁT et al. 2005, DENGLER & LÖBEL 2006, DENGLER et al. 2006b).

For the *Mulgedio-Aconitetea* Hadač & Klika in Klika & Hadač 1944, numerous, often incompatible classification concepts have been proposed, but no supra-national analyses on the basis of individual relevés have been conducted thus far. This class comprises European tall-forb, tall-grass, and fern communities of the montane, subalpine, and lower alpine belts (sensu OZENDA 1988). The two main distribution areas are, on the one hand, the mountain ranges

of the temperate and submeridional zone (HORVAT et al. 1974, RIVAS-MARTÍNEZ et al. 1984, KARNER & MUCINA 1993, Kočí 2001), and, on the other hand, northern Europe, where the communities in the northern boreal zone reach down to the lowlands (MCVEAN & RATCLIFFE 1962, DIERSSEN 1996). The communities require humid, cool, and nutrient-rich conditions. Typical habitats are avalanche gullies, ditches, stream banks, clearings and eutrophic alpine pastures (KARNER & MUCINA 1993).

Traditionally, the class, for which often the invalid name *Betulo-Adenostyletea* Br.-Bl. & Tx. 1943 is used, comprises subalpine herbaceous and shrub communities (NORDHAGEN 1943, BRAUN-BLANQUET 1950). It is usually either subdivided into the *Adenostyletalia alliariae* Br.-Bl. 1930 with tall-forb and shrub communities and the *Calamagrostietalia villosae* Pawłowski et al. 1928 with associated tall-grass vegetation (e.g. KARNER & MUCINA 1993, Kočí 2001, KLIMENT et al. 2004) or treated as monotypic (e.g. POTT 1995, THEURILLAT et al. 1995). Northern European tall-herb communities have normally been included in the *Adenostyletalia alliariae* (RODWELL et al. 2002, DIERSSEN 1996), while only BRAUN-BLANQUET (1950) proposed a separate Nordic order. For subalpine tall-herb communities of submeridional Europe, separate alliances within the *Adenostyletalia alliariae*, and for those from Corsica even a separate order, the *Adenostyletalia briquetii* Lacourt in Géhu 1992, have been proposed (HORVAT et al. 1974, RIVAS-MARTINÉZ et al. 2001, RODWELL et al. 2002).

In recent years, some authors have excluded shrub communities from the *Mulgedio-Aconitetea* due to an *a priori* separation of structural types (sensu BERGMEIER et al. 1990). These associations were then classified as *Betulo carpaticae-Alnetea viridis* Rejmánek in Huml et al. 1979 (e.g. THEURILLAT et al. 1995, RIVAS-MARTÍNEZ et al. 2001, BARDAT et al. 2004, Kliment et al. 2007). On the other hand, some authors included the tall-herb vegetation of subalpine-alpine eutrophic pastures (*Rumicion alpini* Rübel ex Scharfetter 1938) into the class, partly within the *Adenostyletalia alliariae* (e.g. KLIKA & HADAČ 1944, HOLUB et al. 1967) and partly as the separate order *Rumicetalia alpini* Karner & Mucina 1993 nom. inval. (KARNER & MUCINA 1993, RODWELL et al. 2002). However, most other authors retain this alliance within the *Artemisieta vulgaris* Lohmeyer et al. ex von Rochow 1951 (e.g. OBERDORFER 1993b, Kočí 2001, BARDAT et al. 2004). In the Carpathians, syntaxa of alpine meadows of the order *Seslerietalia coeruleae* Br.-Bl. in Br.-Bl. & Jenny 1926 have been classified within the *Mulgedio-Aconitetea* by many authors (e.g. HADAČ et al. 1969, KLIMENT et al. 2004). Finally, completely different classes have even been proposed to cover the traditional content of the *Mulgedio-Aconitetea* fully or partly (*Aconito-Cardaminetea* Hadač 1956, *Nardo-Calamagrostietea villosae* Jeník et al. 1980, Stel-

lario nemorum-Geranietea sylvatici Schubert et al. 1995).

This overview shows that many aspects concerning the delimitation of the class and its subdivision into higher syntaxa are still controversial. Furthermore, many local associations have been described, and the assignment of associations to alliances is inconsistent. Recently, syntaxonomical revisions on the basis of original relevé data have been prepared for the class in the Czech Republic (Kočí 2001, 2007) and in Slovakia (KLIMENT et al. 2004, 2007). However, these studies only deal with a small part of the distributional range of the class.

Because large-scale surveys of classes are rare in general and because of still existing syntaxonomical discrepancies concerning the *Mulgedio-Aconitetea* in particular, the aim of this study was to provide a large-scale syntaxonomic review of this class based on a comprehensive dataset of individual relevés. Being part of a series of planned papers, the present article focusses on high-rank syntaxa of the herbaceous *Mulgedio-Aconitetea* communities in central and northern Europe. In particular, we address the following questions: (1) How similar are the central and northern European stands, and how should this be reflected in the syntaxonomic classification? (2) Which major community types can be distinguished in central Europe and how can their interrelation be adequately represented by the syntaxonomic classification? (3) How are the high-rank syntaxa distributed across Europe and what are their ecological requirements? (4) Which are the major methodological problems when attempting a consistent supra-national classification of a major syntaxon based on existing literature data and how can these problems be solved?

Materials and methods

Relevé data

For the analyses, we used the vegetation database of montane-subalpine tall-herb vegetation that is established and maintained by the first author, using TURBOVEG 2.34 (cf. HENNEKENS & SCHAMINÉE 2001). This database covers the western and central part of temperate Europe (Pyrenees, Massif Central, Alps, central European highlands, Carpathians) and northern Europe. It contains published relevés that have been assigned to the target class by their authors, or that appear to have similar species combinations. Additionally, it includes unpublished relevés of the target class from the Czech National Phytosociological Database (cf. CHYTRÝ & RAFAJOVÁ 2003) or made by ourselves in order to cover some underrepresented regions or syntaxa. However, we did not aim to include such unpublished data comprehensively because this would have led to an unbalanced dataset. At the time of our analyses, the database contained 2,731 relevés. The nomenclature of vascular plants

follows "Flora Europaea" (TUTIN et al. 1968–1993). Differing from this source, we use *Festuca picturata* Pils instead of the illegitimate *F. picta* Kit. ex Schultes (cf. PILS 1980). Regarding the *Rumex acetosa* complex, we follow ELVEN et al. (2000), i.e. *R. alpestris* sensu "Flora Europaea" is included in *R. acetosa* and split into ssp. *arifolius* (All.) A. Blytt & O. C. Dahl from central and southeastern Europe and ssp. *lapponicus* Hiitonen from Fennoscandia. For the numerical analyses, we disregarded undetermined species and merged subspecies and varieties at species level. Only the subspecies of *Rumex acetosa* and those of *Aconitum lycoctonum* were treated separately because all occurrences could be assigned unambiguously and because *A. lycoctonum* ssp. *lycoctonum* and *R. acetosa* ssp. *lapponicus* were known to be differential for the northern European relevés. Furthermore, we merged some species into aggregates (agg.) to account for regionally different taxonomic treatments. Apart from *Luzula sylvatica* agg. (*L. sylvatica* + *L. sieberi*), these aggregates correspond to the species groups of "Flora Europaea". We excluded non-vascular plants from the analyses because they had only partly been recorded.

A priori selection

To obtain a consistent dataset for the analyses, we applied three selection criteria to the relevés in the database.

Firstly, we discarded relevés with more than 30% cover of shrub and/or tree layer because we wanted to separate wooded and herbaceous vegetation in the classification *a priori*. This approach has been suggested, for example, by BERGMEIER et al. (1990), DIERSCHKE (1992), and DENGLER (2003) to avoid methodological problems that arise from the combined classification of very different structural vegetation types.

Secondly, we considered the different plot sizes of the remaining relevés because classifications are only reasonable and interpretable for relevés of even-sized plots (JANDT & BRUELHEIDE 2002, DENGLER 2003: 74, DENGLER et al. 2008, 2009). The results of DENGLER (2003: 74) and DENGLER et al. (2009) suggest significant distorting effects on classifications if plots differing in size by much more than a factor of five are included in one analysis. According to this limit, the size range that gave us the best possible dataset in terms of overall number of relevés as well as geographic and syntaxonomic coverage was 9–50 m².

Thirdly, we needed to delimit the *Mulgedio-Aconitetea* consistently against other herbaceous vegetation classes. Following the suggestion of DENGLER et al. (2006c), we did this by using *a priori* lists of diagnostic species for the *Mulgedio-Aconitetea* and all related classes (frequent contact vegetation and other tall-herb vegetation in Europe; see Appendix 1 for lists and sources on which we based our assignment). We mostly followed the concept

of European classes proposed by MUCINA (1997). Only for the classes of tall-herb vegetation other than *Mulgedio-Aconitetea*, we applied the concept of J. DENGLER (partly published in DENGLER et al. 2006a, 2007). As diagnostic species we accepted taxa that were explicitly listed in the literature as character taxa of the class or of its subordinate units (within the accepted delimitation of the classes) or as joint differential species of classes, and we allowed a single species to be listed as diagnostic in more than one class. Then, "affinity values" towards all considered classes were calculated for each relevé by summing up the ordinal transformed cover values (OTV; cf. VAN DER MAAREL 2005: r = 1, + = 2 ... 5 = 9) of the respective diagnostic taxa. Finally, each relevé was subordinated to the class with the highest score (cf. DENGLER et al. 2006c).

Numerical analyses

For the analyses, we transformed the cover-abundance scale to a three-step ordinal scale (cutlevels 5% and 25%) with the program JUICE (version 6.5, cf. TICHÝ 2002). Cluster analyses were done with PC-ORD (version 4, McCUNE & MEFFORD 1999), using the group linkage method with flexible beta (beta parameter –0.25) and the Sørensen (Bray-Curtis) index as distance measure. Firstly, we applied a relatively detailed cluster resolution to identify clusters that apparently represent units at association level. For this purpose, we chose a level at which most of the clusters contained an exclusive concentration of one or several *a priori* diagnostic species of the *Mulgedio-Aconitetea*. Secondly, we identified a lower cluster resolution that allowed us to combine the small sub-units to higher syntaxa due to the occurrence of joint diagnostic species. The dataset was then split into these higher syntaxa, which we re-analysed separately with the same method to subdivide them further into homogeneous relevé groups.

Syntaxonomic classification

Our classification follows the modified BRAUN-BLANQUET approach proposed by DENGLER (2003, cf. DENGLER et al. 2005), which combines the suggestions of BERGMEIER et al. (1990) and the central syntaxon concept of DIERSCHKE (e.g. 1994). The most important features in the context of this study are as follows:

- Character species need to be twice as constant in the characterised syntaxon than in all other syntaxa of equal rank.
- Differential species need to fulfil this criterion only compared to the equal-ranked syntaxa within the next superior syntaxon but have to reach at least 20% presence degree.
- The diagnostic value of species is assessed separately for the two structural types, herbaceous vegetation and woodland vegetation.

- Any syntaxon from association upwards either has to be characterised by character species of its own or must be the central syntaxon within the next higher unit.

For the manual table work, we used the program JUICE. We manually aggregated the detailed homogeneous relevé groups produced by the subsequent cluster analyses until they conformed to the criteria for syntaxa (see above). After this aggregation process, single relevés within some of the derived units appeared to be dominated by diagnostic species of adjacent associations. Because the amount of these relevés was very small and the classification in itself was not affected, we moved these relevés to sharpen the diagnostic values. Since only few relevés in the range from 9–50 m² from boreal Europe were available, we refrained from subdividing them into associations.

To evaluate whether a certain taxon can be considered as a character species, an estimate of its presence degree in syntaxa not treated in this paper was necessary. For this purpose, we consulted comprehensive synoptic tables of herbaceous vegetation types that together largely cover our study area (OBERDORFER 1992, 1993a, b, ZECHMEISTER & MUCINA 1994, DIERSSEN 1996, SCHAMINÉE et al. 1996, 1998, COLDEA 1997, JAROLÍMEK et al. 1997, STORTELEDER et al. 1999, BERG et al. 2001, VALACHOVIČ 2001, JAROLÍMEK et al. 2002, KLIMENT & JAROLÍMEK 2002, KLIMENT et al. 2005, DENGLER et al. 2006a, 2007, CHYTRÝ 2007, KLIMENT & VALACHOVIČ 2007, J. DENGLER unpubl.).

Synoptic tables

In the synoptic table (Table 3), the values given in the columns of higher syntaxa are arithmetical means of the presence degrees of all subordinated associations, but are referred to as “presence degrees”. DENGLER (2003: 83, cf. DENGLER et al. 2005) proposed this way of calculating presence values of superior syntaxa as being more appropriate than calculating these on the basis of individual relevés, as the number of relevés available per association generally is arbitrary but would greatly affect the calculation outcomes. In the synoptic tables, the diagnostic value of species according to DENGLER (2003) is presented following the suggestions of BERG et al. (2001), DENGLER & LÖBEL (2006), and DENGLER et al. (2006a, b, 2007).

Additionally, we calculated phi coefficients of associations (CHYTRÝ et al. 2002). To avoid distorting effects of unequal relevé numbers of the different syntaxonomic units (cf. DENGLER 2003), we used an equalizing approach as suggested by TICHÝ & CHYTRÝ (2006). We treated all associations as if they were represented by the same number of relevés because this way of equalizing seemed to be most meaningful in the present case and it is consistent with the classification philosophy of DENGLER (2003). We determined phi coefficients among all associations included in the study, and accepted species with $\phi >$

0.25 as diagnostic and those with $\phi > 0.50$ as highly diagnostic (CHYTRÝ 2007). Additionally, species with a positive mutual association with a syntaxon but $\phi \leq 0.25$ were marked.

For the calculation of both presence degrees and phi coefficients, we assumed that the northern European alliance consists of five associations distinguishable with the applied methodology. This estimation is based on the overall floristic diversity in boreal compared to temperate stands. However, moderate changes in this figure would have altered our overall assessment of diagnostic values of species only marginally.

Phytosociological nomenclature

The naming of syntaxa follows the International Code of Phytosociological Nomenclature (WEBER et al. 2000; referred to as ICPN). In the conspectus (Table 2), all accepted syntaxa of the Mulgedio-Aconitetea in the study area are listed in hierarchical order with full names and author citations. We added epithets to accepted names of Mulgedio-Aconitetea syntaxa below the class level where permitted (ICPN Recomm. 10C). The Appendix 1 lists the full names and author citations for the adjacent classes. In the text, we only give author citations for syntaxa when they are used for the first time. At the level of association, this publication does not intend to be conclusive and thus we simply present the oldest valid and legitimate names we retrieved in the reviewed literature thus far (Table 2). The description of a new syntaxon for which no valid name was available as well as typifications and applications to the Nomenclature Commission are presented in Appendix 2. A full syntaxonomic revision of the high-rank syntaxa of the Mulgedio-Aconitetea (alliances and above) is provided in Appendix 3, including major synonyms, with an indication of the relevant ICPN Articles according to which they are invalid or illegitimate, and other names of similar content.

Characterisation of syntaxa

The ecological and chorological description of the syntaxa was largely based on information provided in the literature from which the included relevés originated. Additionally, we characterised the associations by box-whisker plots of their altitudinal distribution and of three Ellenberg indicator values (ELLENBERG et al. 2001) representing site conditions (Fig. 2). The mean Ellenberg indicator values per plot were calculated with JUICE for soil reaction, nutrients, and moisture. For 550 (68%) of all 812 species in the dataset indicator values were available. The average proportion of species per relevé with indicator values that could be used for calculation was 61% for soil reaction, 81% for nutrients, and 76% for moisture.

Results

A priori selection

According to the *a priori* selection, 326 relevés from the databank were excluded as belonging to the woody vegetation. The plot sizes were too small (1–8 m²) in 497 cases, too large (60–3,000 m²) in 454, and not indicated in 267 cases. A further 194 relevés were assigned to other herbaceous classes. Within the 993 relevés for the final analyses, 227 came from the Alps, 482 from the central European lower mountains, 192 from the Carpathians, 25 from western Europe, and 67 from northern Europe (see Appendix 4).

Cluster analyses and their translation into a syntaxonomic classification

In the cluster analysis of the whole data set, the 20-cluster resolution apparently more or less corresponded to the association level (Fig. 1). When aggregating these 20 terminal clusters successively, the six-cluster resolution seemed appropriate at the level of alliance because each of the clusters then was well characterised by diagnostic species (Table 1).

Cluster 1 of the six-cluster resolution contains temperate subalpine tall-forb communities. The relevés are often dominated by *Adenostyles alliariae* and/or *Peucedanum ostruthium*. This cluster corresponds to the alliance *Adenostyliion alliariae*.

Cluster 2 contains temperate tall-forb communities of montane-subalpine eutrophic pastures, the relevés were often (co-)dominated by *Rumex alpinus*. This cluster corresponds to the alliance *Rumicion alpini*.

Cluster 3 contains temperate subalpine-alpine tall-grass and tall-forb communities. The relevés are often (co-) dominated by tall-grasses, and species of alpine meadows are frequent (e.g. *Ligusticum mutellina*, *Potentilla aurea*). This cluster corresponds to the alliance *Calamagrostion villosae*.

Cluster 4 contains mainly montane tall-grass and fern communities. Apart from the prevailing relevés from temperate Europe, six species-poor relevés from northern Europe were assigned to this cluster. The relevés are mainly dominated by ferns and tall-grasses, and species indicating acidic soils are frequent. This cluster corresponds to the alliance *Calamagrostion arundinaceae*.

Cluster 5 contains temperate montane tall-forb communities. The relevés are often (co-) dominated by species that are rare in the subalpine zone (e.g. *Oreopteris limbosperma*, *Petasites albus*). This cluster corresponds to the alliance *Arunco dioici-Petasition albi*.

While clusters 1–5 nearly exclusively contain relevés from temperate Europe, all of the relevés of cluster 6 originated from boreal Europe. The latter cluster differs from the previous ones, among others, by high presence degrees of *Calamagrostis purpurea* and *Angelica archangelica*. It corresponds to the alliance *Mulgedion alpini*.

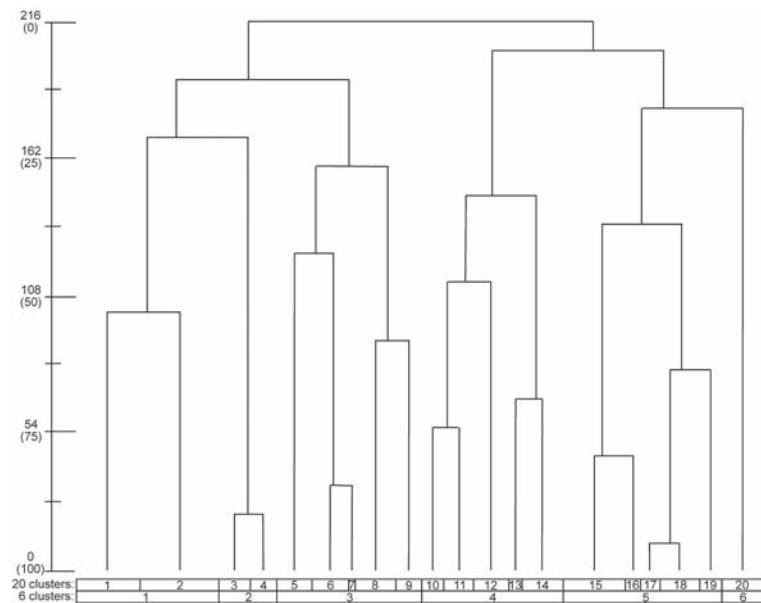


Fig. 1. Dendrogram of the cluster analysis for 993 relevés of the *Mulgedio-Aconitetea* with 20 clusters. The width of the sections below the dendrogram corresponds to the number of relevés. At the six-cluster level, the clusters closely correspond to the deduced higher syntaxa (1 = *Adenostyliion alliariae*, 2 = *Rumicion alpini*, 3 = *Calamagrostion villosae*, 4 = *Calamagrostion arundinaceae*, 5 = *Arunco dioici-Petasition albi*, 6 = *Epilobio lactiflori-Geranietalia sylvatici*). The vertical axis presents Wishart's objective function (first number) and the percentage of remaining information (in round brackets), both indicating loss of information during the clustering process.

Table 1. Six-cluster resolution of the cluster analysis based on 993 relevés of the Mulgedio-Aconitea in form of a synoptic table. Three of the most frequent diagnostic species are shown for each cluster or combination of clusters, with a prevalence for *a priori* diagnostic species of the Mulgedio-Aconitea (marked with * and °, see Appendix 1). Species that differentiate single clusters are at least twice as constant in this cluster than in the others.

| Group No. | 1 | 2 | 3 | 4 | 5 | 6 |
|------------------------------------|-----|----|-----|-----|-----|----|
| No. of relevés | 207 | 83 | 209 | 204 | 229 | 61 |
| Cluster 1–3 | | | | | | |
| <i>Aconitum napellus</i> * | 28 | 24 | 64 | 11 | 9 | . |
| <i>Epilobium alpestre</i> * | 22 | 27 | 18 | 6 | 2 | . |
| <i>Poa alpina</i> | 12 | 16 | 28 | . | . | 2 |
| Cluster 1 | | | | | | |
| <i>Adenostyles alliariae</i> * | 84 | 11 | 32 | 26 | 4 | . |
| <i>Saxifraga rotundifolia</i> * | 38 | 5 | 8 | 1 | 6 | . |
| <i>Knautia dipsacifolia</i> | 18 | . | 1 | 1 | 7 | . |
| Cluster 2 | | | | | | |
| <i>Rumex alpinus</i> * | 6 | 61 | 2 | . | 1 | . |
| <i>Senecio cordatus</i> * | 4 | 51 | 1 | . | 4 | . |
| <i>Poa supina</i> | 2 | 23 | 1 | 1 | 1 | . |
| Cluster 3 | | | | | | |
| <i>Alchemilla glabra</i> * | 6 | 11 | 27 | 2 | 1 | . |
| <i>Festuca carpatica</i> * | . | . | 19 | 1 | . | . |
| <i>Senecio subalpinus</i> * | 2 | . | 15 | 1 | 3 | . |
| Cluster 4 | | | | | | |
| <i>Calamagrostis villosa</i> * | 4 | . | 32 | 69 | 11 | . |
| <i>Gentiana asclepiadea</i> | 5 | . | 12 | 29 | 8 | . |
| <i>Galium saxatile</i> | . | . | 1 | 11 | 5 | . |
| Cluster 4 and 6 | | | | | | |
| <i>Athyrium distentifolium</i> * | 19 | . | 8 | 59 | 8 | 36 |
| <i>Deschampsia flexuosa</i> | 1 | . | 12 | 52 | 8 | 59 |
| <i>Trifolium europaea</i> | . | . | 4 | 40 | 2 | 49 |
| Cluster 5 | | | | | | |
| <i>Petasites albus</i> * | 10 | 8 | 1 | 7 | 46 | . |
| <i>Impatiens noli-tangere</i> | 7 | 1 | 1 | 2 | 38 | . |
| <i>Stachys sylvatica</i> | 3 | 1 | . | . | 20 | 5 |
| Cluster 1–5 | | | | | | |
| <i>Senecio nemorensis</i> ° | 33 | 19 | 18 | 25 | 66 | . |
| <i>Chaerophyllum hirsutum</i> agg. | 43 | 36 | 44 | 2 | 50 | . |
| <i>Heracleum sphondylium</i> | 17 | 17 | 27 | 9 | 11 | . |
| Cluster 6 | | | | | | |
| <i>Calamagrostis purpurea</i> * | 1 | . | . | 1 | . | 70 |
| <i>Angelica archangelica</i> ° | . | . | 3 | 1 | . | 26 |
| <i>Myosotis decumbens</i> * | . | . | . | . | . | 20 |

The cluster analysis indicated that the most important split should be between clusters 1–3 and 4–6 (Fig. 1), with the first three being positively differentiated (Table 1). However, this hierarchical arrangement could not be transformed into a syntaxonomical classification for two reasons. Firstly, regarding the full species list, this suggested split is rather weak and arbitrary because for any other pair or triplet of the six primary clusters similar species groups exist that connect these but are lacking in the remaining clusters (see joint differential species in Table 3). Secondly, regarding the occurrence of potential character species, it seemed more appropriate to draw the major syntaxonomic division between the temperate (clusters 1–5) and the boreal relevés (cluster 6), i.e. to treat them as two separate orders. Cluster 6 alone contains many diagnostic species that could be rated as character species (Tables 1 and 3). Similarly, clusters 1–5 together share many frequent species that are rare or absent in the northern European relevés (Tables 1 and 3). In contrast, the similarity between clusters 6 and 5, indicated by the cluster dendrogram (Fig. 1), had no apparent floristic support (see above), and the similarity between clusters 6 and 4 was mainly supported by differential species and only weakly by potential joint character species (Tables 1 and 3). Since no clear floristic pattern was detectable among the five temperate alliances, we refrained from grouping them into suborders.

The more detailed analyses revealed 18 associations and one provisional unit of equal rank within the alliances of the temperate order (see Table 2 for a syntaxonomic overview). Regarding the 20-cluster resolution of the numerical analysis (Fig. 1), four of the 18 associations were not separated and seven clusters were unsufficiently characterised. Therefore, four of the 20 clusters were subdivided in the detailed analyses to separate different associations, and in three cases unsufficiently characterised clusters had to be combined to form characterised units or central associations.

The resulting synoptic table of the high-rank syntaxa, after exchange of a few relevés among associations (see Methods), is presented in Table 3.

Characterisation of the higher syntaxa

Order 1 – Calamagrostietalia villosae

This order comprises tall-forb, tall-grass, and related fern communities from temperate Europe. The communities occur on nutrient rich and moist soils from the montane to the alpine level. Although the stands of the tall-forb and tall-grass communities have a different physiognomic appearance, they join a large pool of constant species (Table 3), and their habitat conditions are quite similar. Within the studied area, the order contains the five following alliances.

Alliance 1.1 – *Adenostylion alliariae*

A mainly subalpine distribution is characteristic for the tall-forb communities of this alliance (Fig. 2). The habitats are relatively rich in nutrients, not excessively moist (Fig. 2), and lack trees due to landslides and long-lasting snow cover. The alliance is distributed in the western and central European high mountains as well as in some lower mountains with a subalpine belt or with habitats affected by a similar microclimate (Massif Central, Jura Mts., Black Forest, Sudety Mts.; Fig. 3). The alliance contains the central association *Cicerbitetum alpinæ* and two associations of base-rich soils (*Delphinietum elati* and *Aconitetum lycoctoni*).

Alliance 1.2 – *Rumicion alpini*

The tall-forb communities of eutrophic pastures of the montane to subalpine zone are combined in this alliance. Typical sites are dung heaps, depressions with liquid manure, and intensively downtrodden pastures. The analysed relevés originate from the Alps, the Sudety Mts., and the Carpathians (Fig. 3). The alliance contains the widespread central association *Rumicetum alpini*, the *Senecionetum alpini* with a limited distribution in the Alps, and the montane *Geranio phaei-Urticetum dioicae*.

All associations indicate nutritious, basic, and moist soils (Fig. 2).

Alliance 1.3 – *Calamagrostion villosae*

The tall-grass and tall-forb communities of this alliance are floristically related to alpine meadows. Stands thus occur particularly in the subalpine and alpine zones (Fig. 2). Floristically, the *Calamagrostion villosae* is mainly negatively characterised within the order, and thus is considered as the central alliance of the *Calamagrostietalia villosae*. The habitats can be large expanses in the subalpine zone, or smaller, treeless habitats, such as avalanche gullies and bottoms of small depressions near torrents. Areas with long snow cover are preferred, e.g. along the base of cliffs or in the vicinity of snowbeds. The soils are deep, sometimes fine-grained and humus-rich, and, in the Alps, they may also be stony. The alliance is distributed in the Alps, in the Black Forest, in the Sudety Mts., and in the Carpathians (Fig. 3). Two of the communities are distributed only in the Carpathians, namely the *Festucetum carpaticae* of base-rich soils and the *Calamagrostio villosae-Festucetum picturatae* of neutral to slightly acidic soils. The *Poo chaixii-Deschampsietum cespitosae*, which was mainly recorded from the Sudety Mts., is closely related to wet meadows. The

Table 2. Conspectus of the syntaxa of the *Mulgedio-Aconitetea* in central and northern Europe.

***Mulgedio-Aconitetea* Hadač & Klika in Klika & Hadač 1944**

1. *Calamagrostietalia villosae* Pawłowski et al. 1928

1.1 *Adenostylion alliariae* Br.-Bl. 1926

- 1.1.1 *Cicerbitetum alpinæ* Bolleter 1921
- 1.1.2 *Delphinietum elati* Beger ex Sutter 1978
- 1.1.3 *Aconitetum lycoctoni* Bolleter 1921

1.2 *Rumicion alpini* Rübel ex Scharfetter 1938

- 1.2.1 *Rumicetum alpini* Beger 1922
- 1.2.2 *Senecionetum alpini* Bolleter 1921
- 1.2.3 *Geranio phaei-Urticetum dioicae* Hadač et al. 1969

1.3 *Calamagrostion villosae* Pawłowski et al. 1928

- 1.3.1 *Festucetum carpaticae* Domin 1925
- 1.3.2 *Poo chaixii-Deschampsietum cespitosae* Pawłowski & Walas 1949
- 1.3.3 *Calamagrostio villosae-Festucetum picturatae* Pawłowski et al. 1928 nom. corr.
- 1.3.4 *Cirsio spinosissimi-Peucedanetum ostruthii* G. Br.-Bl. 1931

1.4 *Calamagrostion arundinaceae* (Luquet 1926) Oberd. 1957

- 1.4.1 *Crepidio conyzifoliae-Calamagrostietum villosae* Jeník 1961
- 1.4.2 *Digitali ambiguae-Calamagrostietum arundinaceae* Sillinger 1933 nom. invers. et conserv. propos.
- 1.4.3 *Athyriatum filicis-feminae* Wendelberger in Höfler & Wendelberger 1960

1.5 *Aruncio dioici-Petasition albi* Br.-Bl. & Sutter 1977

- 1.5.1 *Prenanthesetum purpureae* Bolleter 1921
- 1.5.2 *Doronico austriaci-Aruncetum vulgaris* Kornaś in Kornaś & Medwecka-Kornaś 1967 nom. invers. propos.
- 1.5.3 *Petasito albi-Cirsietum erisithalis* Br.-Bl. & Sutter 1977
- 1.5.4 *Luzulo luzuloidis-Thelypteridetum limbospermae* Wittig 2000
- 1.5.5 *Lunaria rediviva*-[*Aruncio dioici-Petasition albi*] community
- 1.5.6 *Agropyro canini-Petasitetum kablikiani* Pawłowski & Walas 1949 nom. invers. propos.

2. *Epilobio lactiflori-Geranieta sylvatici* Michl, Dengler & Huck this paper

2.1 *Mulgedion alpini* Nordhagen 1943

[No associations distinguished presently due to a lack of relevé data]

Table 3. Abridged synoptic table of the class *Mulgedio-Aconiteea* in central and northern Europe from the level of association to the level of class. The northern European order *Epilobio lactiflori-Geranieta sylvatici* is not further subdivided. Central syntaxa are indicated by *. In the header data section, the values for plot size, vascular plant richness, and cover values are means of the mean values of the included associations. In the columns, presence degrees are given, with values below 0.5 being represented as 0. The superscript symbols indicate positive phi values ($\circ = 0-0.24$, $*$ = 0.25–0.49, and $** > 0.50$). This calculation was based on equalised relevé numbers per association and assumed five associations in the northern European order (indicated by *). Character species (C) are indicated by grey shading of the characterised syntaxa. Light grey indicates that a taxon is a transgressive character species. Differential species (D) are indicated by frames around the values. Shadings and frames are transferred to all subordinated syntaxa. *A priori* diagnostic species of the class are marked with * or, if they were assumed to be shared with other classes, with o (see Appendix 1). Species that occur in different layers have been merged. Columns based on less than ten relevés are italicised to indicate reduced reliability of presented values. Only companions with at least 4% presence degree at class level are shown.

| Syntaxonomic hierarchy | | Order | | | | | | | | | | Order | | | | | | | | | | Order | | | | | | | | | |
|---|----------|----------|-----|----------|-----|----------|-------|----------|-----|----------|-----|----------|-----|----------|-----|----------|-------|----------|-----|----------|-----|----------|-----|----------|-----|----------|-----|-----|-----|-----|--|
| Syntaxon number | Class | Order | | | | | Order | | | | | Order | | | | | Order | | | | | Order | | | | | | | | | |
| | Alliance | Alliance | | Alliance | | Alliance | | Alliance | | Alliance | | Alliance | | Alliance | | Alliance | | Alliance | | Alliance | | Alliance | | Alliance | | Alliance | | | | | |
| Number of associations | 24* | 19 | 5* | 3 | 3 | 4 | 3 | 6 | · | · | · | · | · | · | · | · | · | · | · | · | · | · | · | · | · | · | | | | | |
| Number of relevés | 993 | 926 | 67 | 190 | 85 | 220 | 213 | 218 | 144 | 8 | 38 | 34 | 45 | 6 | 67 | 61 | 48 | 44 | 69 | 36 | 108 | 140 | 16 | 5 | 18 | 11 | 28 | | | | |
| Mean plot size (m ²) | 25 | 26 | 24 | 34 | 24 | 23 | 20 | 27 | 25 | 42 | 34 | 24 | 18 | 32 | 21 | 18 | 22 | 30 | 20 | 18 | 23 | 20 | 37 | 38 | 20 | 24 | 20 | | | | |
| Mean number of vascular plants | 22 | 21 | 23 | 26 | 14 | 24 | 16 | 24 | 17 | 36 | 25 | 17 | 8 | 18 | 26 | 30 | 23 | 18 | 10 | 19 | 19 | 25 | 46 | 14 | 15 | 24 | 15 | 24 | | | |
| Mean cover of herb layer (%) | 92 | 93 | 90 | 95 | 96 | 94 | 91 | 93 | 100 | 92 | 94 | 99 | 98 | 94 | 90 | 95 | 94 | 85 | 92 | 87 | 86 | 95 | 93 | 98 | 93 | 98 | 93 | 98 | | | |
| Mean cover of moss layer (%) | 9 | 10 | 7 | 8 | 1 | 11 | 14 | 13 | 12 | 0 | 12 | 1 | 1 | 1 | 1 | 19 | 12 | 10 | 5 | 10 | 13 | 18 | 15 | 8 | 15 | 3 | 10 | 25 | | | |
| Class Malgolio-Aconitietae | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| <i>C. Stellaria nemorum</i> * <i>Viola biflora</i> | 41 | 37 | 57° | 42° | 53° | 24 | 18 | 52° | 44° | 75° | 8 | 59° | 33 | 67° | 21 | 25 | 27 | 23 | 6 | 48° | 59° | 31 | 17 | 73° | 79° | 54° | 54° | 54° | | | |
| <i>Oxalis acetosella</i> | 32 | 29 | 43° | 55° | 5 | 52° | 11 | 27 | 21° | 100* | 45° | 3 | 13 | · | 45° | 49° | 63° | 52° | 6 | 14 | 13 | 10 | 31 | 40° | · | · | · | · | | | |
| <i>Silene dioica</i> | 26 | 23 | 37° | 18 | 2 | 5 | 28° | 57* | 33° | 13 | 8 | 3 | 2 | · | 6 | 10 | 2 | 9 | 14 | 61° | 50° | 88* | 40° | 44° | 36° | 36° | 25° | 25° | | | |
| <i>Myosotis sylvatica</i> * | 21 | 18 | 33° | 25° | 17 | 24° | 13 | 17 | 19° | 38° | 18 | 44° | 7 | 31° | 13 | 25° | 23° | 7 | 8 | 24° | 16 | 19 | 20 | · | · | 32° | 32° | 32° | | | |
| <i>Dryopteris filix-mas</i> * | 16 | 17° | 13 | 28° | 13 | 28° | 13 | 5 | 17 | 13° | 63* | 8 | 18° | 2 | 67* | 31° | 3 | 18° | 6 | 9 | 4 | 13 | 40° | · | · | 29° | 29° | 29° | | | |
| <i>Ranunculus platanifolius</i> * | 14 | 18° | 1 | 16° | 6 | 4 | 28° | 35° | 15° | 25° | 23° | 7 | 8 | 2 | 10 | 19° | 54° | 21° | 63* | 17° | 36° | 36° | 36° | 36° | 36° | 36° | 36° | 36° | | | |
| <i>Paris quadrifolia</i> | 14 | 13 | 21° | 8 | 3 | 19° | 21° | 14 | 12° | 11 | 9 | · | 6 | 23° | 42° | 5 | 6 | 50° | 6 | 24° | 6 | 20° | · | 18° | · | · | · | 11 | | | |
| <i>13</i> | 12 | 15° | 13° | · | 8 | 11 | 25° | 7° | 25° | 8 | · | · | 9 | 21° | · | · | · | 3 | 29° | 3 | 31° | 80* | · | · | · | · | · | 11 | | | |
| Order 1 - Calmagrostietalia villosae | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| <i>C. Rumex acetosa</i> ssp. <i>arifolius</i> * | 31 | 39* | · | 55° | 55° | 52° | 47° | 13 | 44° | 75° | 45° | 27 | 88* | 37° | 38° | 83° | 44° | 38° | 42° | 49° | 28 | 63° | 13 | 13 | 20 | 18 | 61° | 61° | | | |
| <i>Senecio nemorensis</i> * | 29 | 36 | · | 51° | 22 | 15 | 30 | 65* | 22 | 89* | 42° | 21 | 89* | 21 | 70° | 71° | 73* | 40° | 7 | 10 | 2 | 42° | 42° | 76° | 19 | 60° | 28 | 82° | 82° | | |
| <i>Aconitum napellus</i> * | 22 | 28* | · | 51* | 18 | 62* | 13 | 8 | 26* | 2 | 18° | 63* | 34° | 26° | 7 | 33° | 56° | 54° | 18° | 35° | 14 | 28° | 6 | 42 | 42 | 42 | 42 | 42 | 25° | 25° | |
| <i>Veratrum album</i> * | 17 | 21° | 1 | 38° | 11 | 40* | 20° | 17° | 35° | 22° | 21° | 3 | 21° | 40° | 30° | 6 | 2 | 9 | 19° | 24° | 23° | 25° | 40° | 67* | · | 18° | 18° | 18° | | | |
| <i>Luzula sylvatica</i> agg. | 15 | 18° | · | 14 | 1 | 20° | 17° | 35° | 17° | 24° | 17° | 53* | 24° | 67* | 22° | 30° | 4 | 9 | 3 | 10 | 1 | 6 | 6 | · | · | 4 | 4 | 4 | | | |
| <i>Erythronium alpestre</i> * | 14 | 17° | · | 42* | 37* | 16° | 4 | 2 | 17° | 25° | 34° | 21° | 9 | 75* | 32° | 3 | 25° | 16° | 8 | 11 | 6 | 38° | 20° | · | · | 29° | 29° | 29° | | | |
| <i>Thlaspium aquilegiifolium</i> * | 12 | 15° | · | 39* | 1 | 6 | 21° | 9 | 17° | 21° | 10 | 16° | · | 27° | 30° | · | 28° | 25° | 26° | 3 | 31° | 40° | 6 | 9 | 11 | 11 | 11 | 11 | | | |
| <i>Polygonatum verticillatum</i> * | 12 | 14° | 4 | 9 | · | 14° | 26° | 20° | 10 | 16° | · | · | · | · | · | · | 28° | 7 | 13° | · | 25° | 19° | 31° | 6 | 25° | 40° | 6 | 14° | 14° | | |
| <i>Gentiana asclepiadoides</i> | 9 | 12° | 5 | · | 12° | 25° | 17° | 3 | 11° | · | · | · | · | · | · | 13° | 11° | · | 3 | 7° | 5 | 6° | 20° | · | · | 32° | 32° | 32° | | | |
| <i>Aconitum variegatum</i> * | 6 | 7° | · | 13° | · | 6° | 13° | 6° | 25° | 8° | · | · | · | · | · | 16° | 26° | 4 | 3 | 25° | 11° | 6° | · | · | 4 | 4 | 4 | | | | |
| <i>Lilium martagon</i> | 6 | 7° | · | 14° | · | 12° | 13° | 2 | 25° | 16° | · | · | · | · | · | 16° | 26° | 4 | 1 | 4 | 13° | 20° | · | · | 39° | 39° | 39° | | | | |
| <i>Leucanthemum vulgare</i> subsp. <i>leucanthemoides</i> * | 5 | 6° | · | 2 | · | 9° | 10° | 5° | · | · | · | · | · | · | · | 7° | 27° | 28° | · | 42* | 6° | 1 | 6° | · | · | 4 | 4 | 4 | | | |
| <i>Digitalis grandiflora</i> | 4 | 5° | · | 4 | · | 7° | 2 | 11° | 11° | · | · | · | · | · | · | 6° | 2 | 21° | · | 3° | 6° | 11° | 13° | · | · | · | · | 29* | | | |
| <i>Hieracium austriacum</i> * | 1 | 1° | · | 3° | · | 2° | 1 | 1 | 8° | 8° | · | · | · | · | · | 7° | 2° | 21° | · | 3° | 6° | 11° | 13° | · | · | · | · | 29* | | | |
| D Chaerophyllo-hirsutum agg. | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| <i>Urtica dioica</i> | 31 | 39* | · | 65° | 48° | 34° | 3 | 43° | 40° | 100* | 56 | 44° | 33 | 67° | 13 | 10 | 50° | 91* | 44° | 100* | 66° | 46° | 17 | 22 | 3 | 3 | 2 | 9 | 96* | | |
| <i>Heracleum sphondylium</i> | 27 | 33* | 4 | 12 | 78* | 10 | 10 | 50* | 13 | 13 | 11 | 18° | 11 | 50° | 42° | 12° | 10 | 88* | 29° | 42° | 41° | 40° | 48° | 25 | 80* | 80* | 64° | 64° | | | |
| <i>Urtula laevigata</i> | 16 | 20° | 1 | 30° | 38° | 27° | 3 | 33° | 12° | 12 | 12 | 10 | 88* | 33° | 61* | 27° | 1 | 22° | 12 | 11 | 22° | 11 | 6 | 40° | 70* | 9 | 9 | 9 | | | |

Table 3. (cont.)

Peucedano ostruthii-Cirsietum spinosissimi is distributed in the Alps, where it occurs in the lower alpine zone and thus shows the highest altitudinal distribution of all *Mulgedio-Aconitetea* associations (Fig. 2).

Alliance 1.4 – Calamagrostion arundinaceae

This alliance comprises mainly montane tall-grass communities of more acidic soils and a related fern community. However, mean indicator values of soil reaction are still moderate (Fig. 2). The habitats are partly wind-exposed clearings and steep slopes with long snow cover, and partly sunny and leeward habitats with thick, but short-time snow cover. The soils

are moist, deep, stony, moderately rich in humus, and loamy. The alliance is distributed in the Pyrenees, the northern Alps, most of the lower mountains of central Europe, and the western Carpathians (Fig. 3). The alliance contains the species-poor central association *Crepidio conyzifoliae-Calamagrostietum villosae* dominated by *Calamagrostis villosa*, the *Digitali ambiguae-Calamagrostietum arundinaceae* of sunny slopes, whose stands are mainly dominated by *Calamagrostis arundinacea*, and the *Athyrietum filicis-feminae*, a fern association, mostly dominated by *Athyrium distentifolium* and/or *Dryopteris filix-mas*.

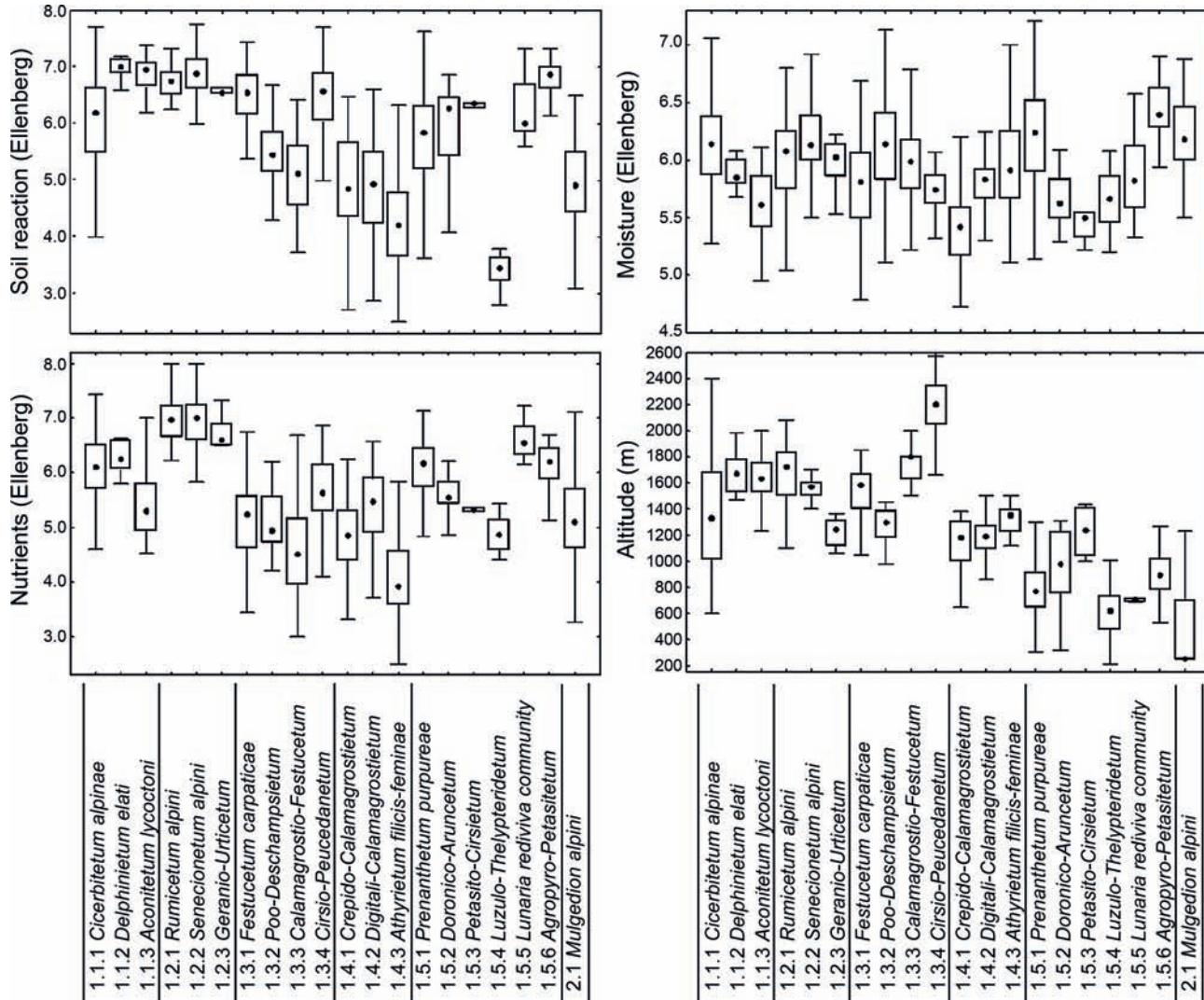


Fig. 2. Box-plots for the distribution of mean Ellenberg indicator values for nutrients, soil reaction, and moisture, as well as altitude for the *Mulgedio-Aconitetea* syntaxa. The extreme values (whiskers), the quartiles (box), and the median values (points) are presented.

Alliance 1.5 – *Arunco dioici-Petasition albi*

This alliance contains montane tall-forb communities. They grow on relatively nutrient rich and moist sites (Fig. 2). Stands occur mainly on stream banks, alongside ditches, on clearings, and along forest tracks. The alliance is distributed in the Massif Central, the Alps, the Carpathians, as well as in most of the lower mountains of central Europe (Fig. 3). The alliance contains the central association *Prenanthesum purpureae*, the *Doronicu austriaci-Aruncetum vulgaris* of shady habitats, the *Petasito albi-Cirsietum erisithalis* of calcareous soils, the *Luzulo luzuloidis-Thelypteridetum limbospermae* of acidic soils at forest edges, the not yet formally described *Lunaria rediviva-[Arunco dioici-Petasition albi]* community of shady forest clearings, and the *Agropyro canini-Petasite-tum kablikiani* of river banks in the Carpathians.

Order 2 – *Epilobio lactiflori-Geranietalia sylvatici*

This order comprises boreal tall-forb, fern and related grass communities. Its habitats are similar to those

of the *Calamagrostietalia villosae*. The included relevés all originate from Fennoscandia (Jämtland, Hordaland, Lapland, Oppland). Similar relevés have been recorded from the Scottish Highlands (MCVEAN & RATCLIFFE 1962), but were not included in the present analyses because of too small plot sizes.

Discussion

Methodological issues

Cluster analyses vs. syntaxonomic classification

In our study, it seemed inappropriate to translate the cluster analyses directly into a syntaxonomic classification. At the highest hierarchical level, for example, the manually re-arranged hierarchy with a temperate and a northern European order was supported by many more character and differential species on each side (Table 3) than had been the opposition of clusters 1–3 against 4–6 as suggested by the cluster analysis (Fig. 1, Table 1). Reasons why the cluster analysis failed to detect this strong floristic differentiation could be the small number of relevés from bo-

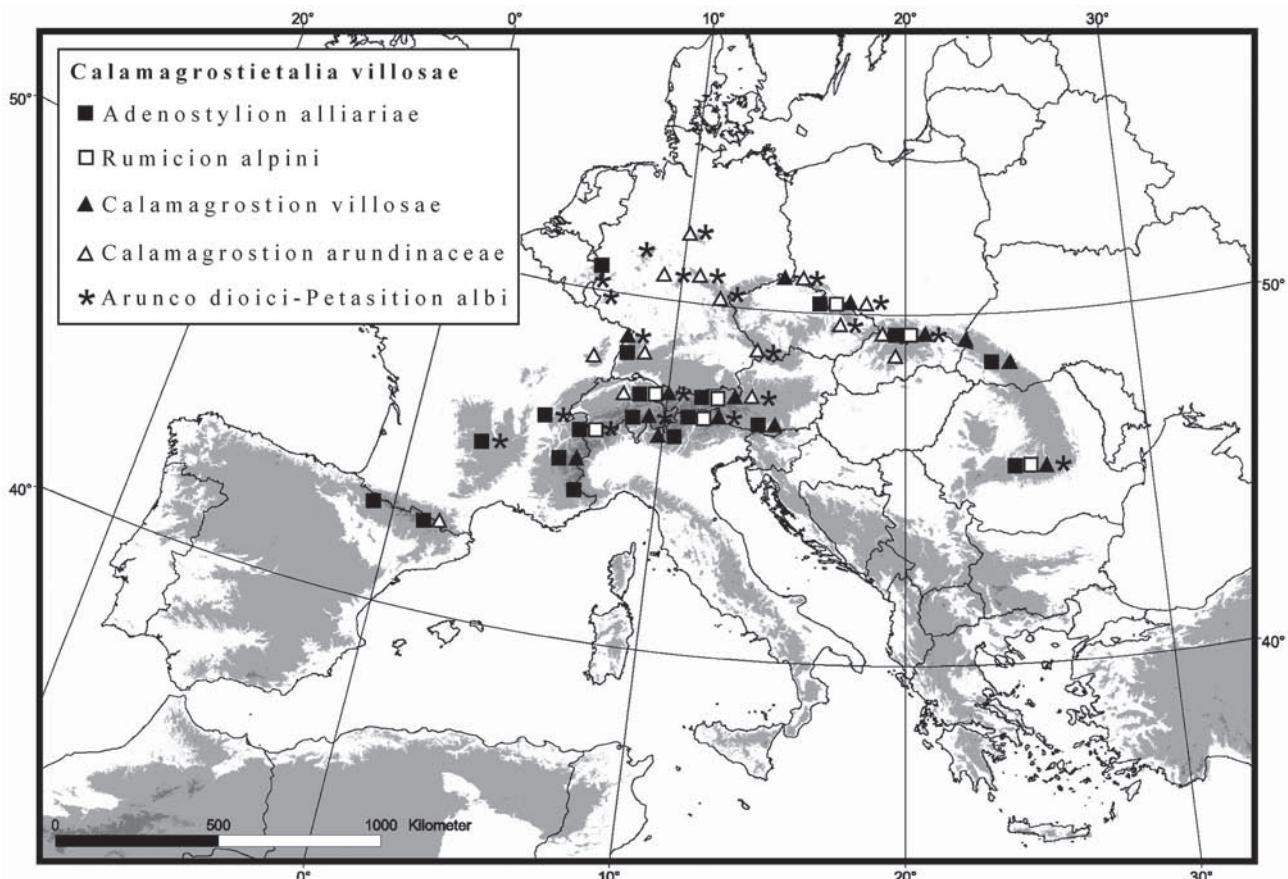


Fig. 3. Distribution of the five alliances of the *Calamagrostietalia villosae* in central and western Europe, based on the relevés included in this study.

real Europe and/or the greater heterogeneity within the relevés from temperate Europe. Other numerical methods, such as TWINSPAN, are also known to be sensitive to unbalanced datasets, which can lead to different hierarchical structuring of the same vegetation type (cf. BRUELHEIDE & CHYTRÝ 2000). Actually, their outcome strongly depends on subjective settings (cluster algorithm, distance measure, etc.), and may completely change when the dataset is only slightly modified. Specifically, none of the available numerical classification approaches is capable of considering information from outside the actual dataset (DENGLER 2003, DENGLER et al. 2008). By contrast, a syntaxonomist can use his knowledge about the distribution of species in other classes in order to decide whether taxa are character or differential species, and weight them accordingly.

Different approaches to fidelity

While we based our study on the fidelity concept of DENGLER (2003, cf. DENGLER et al. 2005), it turned out that the fidelity assessment with one of the most frequently used "modern" fidelity measures, the phi coefficient (CHYTRÝ et al. 2002, CHYTRÝ 2007), yielded very similar results. The vast majority of character and differential species from association to ordinal level also were diagnostic or highly diagnostic according to their phi coefficients (Table 3).

Despite this overall similarity in the results, there are some fundamental differences between these two fidelity concepts. While the calculation of phi coefficients is strongly influenced by the "universe of investigation", this is much less the case in our approach. For example, the phi coefficients would be extremely different if we had calculated them in relation not only to the other *Mulgedio-Aconitetea* associations but to all other associations of the herbaceous vegetation in temperate and boreal Europe. Generally, the phi coefficients of "typical" *Mulgedio-Aconitetea* taxa would increase and those of taxa typical of other classes decrease dramatically when several dozens of other classes were included in the comparison. Such a change of the universe of investigation could easily change a positive into a negative phi coefficient and *vice versa*. By contrast, our approach allows the determination of diagnostic taxa that would remain basically unchanged when all the other herbaceous classes were directly included in the study because we already took the approximative presence degrees of species in other relevant classes into account. Additionally, our approach allows the ecologically and practically meaningful differentiation between character taxa (which are diagnostic compared to all other syntaxa of equal rank) and differential taxa (which are diagnostic only within the next superior syntaxon).

In conclusion, the application of phi coefficients is most meaningful when a comprehensive database of all vegetation types of a certain area is available,

while our approach seems to be superior when the relevant units are only partly available in a digital manner, which will be the case for any supra-national classification in the coming years. While this inability to include "external" data in the evaluation is constitutional for "statistical" fidelity measures, the two other weaknesses pointed out by DENGLER (2003: 66) have found remedies meanwhile. Firstly, an appropriate equalization of relevé numbers (cf. TICHÝ & CHYTRÝ 2006) avoids artifacts in the fidelity assessment due to varying plot sizes. Secondly, while most studies restrict phi coefficients (and other statistical fidelity measures) to the association level and thus fail to reflect the hierarchical structure of plant communities (e.g. CHYTRÝ 2007), this approach can easily be extended to other syntaxonomic levels as demonstrated here (see also RUSINA 2007).

A priori separation of structural types

Two main advantages of separately classifying herbaceous vegetation types and vegetation types of scrubs and forests are structurally homogenous vegetation classes and a gain of potential character species within each of these structural types (e.g. BERGMEIER et al. 1990, DIERSCHKE 1992, DENGLER 2003). However, the most important reason for such an *a priori* separation is that both traditional and numerical fidelity measures are soundly applicable only to identical (or at least similar) plot sizes (DENGLER 2003, DENGLER et al. 2009), what conflicts with the tradition of applying very different plot sizes in herbaceous and woody vegetation (cf. CHYTRÝ & OTÝPKOVÁ 2003). One may think that the latter point does not provide justification for an *a priori* separation of subalpine tall-herb and subalpine scrub communities because typical plot sizes used for these two entities usually do not greatly differ. However, the ultimate consequence of joining these two groups in one class would be that all vegetation types from low-grown herbaceous pioneer vegetation to mature forests had to be classified in a single system. This would require one uniform plot size for all vegetation types (DENGLER et al. 2009), a solution certainly hardly any vegetation scientist would agree with. One consequence of our approach was that we could evaluate some seemingly "typical" forest species, such as *Athyrium filix-femina*, *Oxalis acetosella*, or *Milium effusum*, as class character species of the *Mulgedio-Aconitetea*.

Plot sizes

One serious problem we faced in our study was the very wide range of plot sizes used in former studies of the class, which did not allow for a joint classification. Unfortunately, the different plot sizes were not evenly spread among regions and syntaxa. Thus, our approach to reduce the distorting effects of different plot sizes by including only a limited range of sizes

(see Methods) led to the underrepresentation of several units. For example, there were only few northern European relevés left within the chosen range, making it impossible to classify the *Epilobio lactiflori-Geranietalia sylvatici* down to association level. We also may have missed some of the temperate associations for the same reason.

Thus, it is important for future studies to apply uniform plot sizes for *Mulgedio-Aconitetea* and also all other herbaceous vegetation types. The proposals for standardisation by CHYTRÝ & OTÝPKOVÁ (2003), who recommend 16 m² for most types of herbaceous vegetation, and of DENGLER (2003: 120), who suggests 10 m², may serve as a guideline. From the perspective of *Mulgedio-Aconitetea* communities, which often grow in small, patchy stands, not allowing homogeneous plots larger than 10 m², the second solution would be more appropriate.

A priori delimitation of the class

Doubtlessly, it would have been better to determine the most appropriate delimitation of the class based on a comprehensive vegetation database of all herbaceous vegetation types from all countries included in the study. However, while the first national databases are now available (see Introduction) it is still a long way towards such a database at the European level. Thus, we had to consider a solution that could be applied at present, of which there are several possibilities (cf. DENGLER et al. 2006c). (i) We could have followed the original class assignment. But supposedly, this would have led to an inconsistent delimitation since the concepts of the *Mulgedio-Aconitetea* vary so widely between different authors. Furthermore, we would have been unable to use previously unassigned relevés. (ii) We could have done this selection by manual table work as in classical phytosociological studies. Such a process would have required many subjective and usually undocumented decisions, not allowing exact repetition for another dataset. (iii) We could have applied minimum cover criteria for a few diagnostic species as done by ILLYÉS et al. (2007). This approach, though easily repeatable, obviously would miss much of the traditional content of the class. Moreover, it hardly corresponds to the phytosociological philosophy of taking the full species combination into consideration (cf. DENGLER et al. 2008). (iv) We could have tried to extract the *Mulgedio-Aconitetea* relevés with the species group method (e.g. BRUELHEIDE 2000). However, this approach is strongly influenced by plot size and leaves many relevés unassigned while others are subordinated to more than one unit (cf. DENGLER et al. 2006c). (v) We could have tried a numerical classification approach. But as discussed above, these approaches are highly sensitive to unbalanced datasets and thus it could not be expected that they give reasonable results in a situation when most relevés belong to one class and only few to a range of different other classes.

Our approach of *a priori* diagnostic species avoids some of the major shortcomings of the other solutions: (i) it is clearly documented and repeatable, (ii) it considers the whole species combination, (iii) it is less influenced by plot size because it is based on ratios of species numbers from different groups rather than species numbers themselves, and (iv) it leaves no relevé unassigned. Because our *a priori* assignment of relevés to classes is based on many hundreds of diagnostic species, the overall result would only slightly change when the diagnostic value of single species is changed. Moreover, the delimitation between pairs of classes drawn this way is meaningful as it corresponds to the turnover between two large groups of species.

As the results show, our approach is less circular than it may appear at first glance. On the one hand, we could determine many character species not included in the *a priori* list, on the other hand, we also disregarded some of the *a priori* diagnostic taxa (Table 3). The latter happened either when we regarded a species as similarly or more frequent in other classes or if the species was that rare in our final dataset that no sound assessment seemed possible. For example, only four relevés with *Luzula desvauxii* remained in the final dataset. We thus could not determine whether a separate association *Luzuletum desvauxii* Issler 1936 nom. inval. is justified and whether stands dominated by this species should be assigned to the *Mulgedio-Aconitetea* (e.g. MUCINA 1997) or to the *Salicetea herbaceae* (OBERDORFER 1992, POTT 1995).

Syntaxonomic concept

Separation of the northern *Epilobio lactiflori-Geranietalia sylvatici*

We found that the separation of the northern European communities from those in central Europe at the highest syntaxonomic level (i.e. as order) best reflects the floristic structure of the dataset. This confirms a proposal previously made by BRAUN-BLANQUET (1950) but not followed by subsequent researchers. In the past, authors generally tended to subordinate Fennoscandian plant communities to previously described central European high-rank syntaxa, despite of often striking floristic differences. This may be due to a lack of large-scale syntheses or due to a generally low interest of Fennoscandian geobotanists in formal vegetation classification. Noteworthily, other recent studies also found separate northern European high-rank syntaxa in several vegetation classes for supposedly similar reasons (e.g. Montio-Cardaminetea: ZECHMEISTER & MUCINA 1994, Festuco-Brome-tea: DENGLER et al. 2003, Koelerio-Corynephoretea: DENGLER & LÖBEL 2006).

From the taxa assessed as character species of the northern European order (Table 3), few do not occur in temperate Europe (*Rumex acetosa* ssp. *lapathinus*

ponicus, *Aconitum lycoctonum* ssp. *lycoctonum*, *Epilobium lactiflorum*), some are very rare in temperate Mulgedio-Aconitetea stands (e.g. *Calamagrostis purpurea*, *Cirsium helenioides*), and two are character species of the class but are much more constant in northern European stands (*Geranium sylvaticum*, *Cicerbita alpina*). Additionally, the Epilobio lactiflori-Geranietealia sylvatici are separated by a long list of differential taxa, including typical Molinio-Arrhenatheretea taxa (e.g. *Ranunculus acris*), tall herbs diagnostic of other classes (e.g. *Solidago virgaurea*, *Filipendula ulmaria*, *Epilobium angustifolium*), and mesophytic to slightly acidophytic, low-growing grasses (e.g. *Agrostis capillaris*, *Anthoxanthum odoratum*). By contrast, the temperate order has many more character species, most of them completely lacking in northern Europe (e.g. *Aconitum napellus*, *Adenostyles alliariae*, *Epilobium alpestre*, *Senecio nemorensis*), but only few differential species (Table 3).

We assume that the major floristic difference results from the wide geographic disjunction in combination with different migration histories since the last glaciation. The stands of both orders are separated by a gap of at least 600 km. Northern Europe was completely covered by an ice shield during the last glacial maximum (LANG 1994). Since most of the Mulgedio-Aconitetea tall herbs presumably had refugia in the vicinity of the temperate mountains or on the southern European peninsulas (UTELLI et al. 1999, MICHL et al. 2007), they could easily recolonise the Alps and the other central European mountains. In contrast, only a subset of them apparently managed to reach Fennoscandia or the Scottish Highlands. Perhaps this lower number of specialised taxa is also the reason for the high frequency of taxa from other classes and widespread generalists within the northern European stands (see above). This phenomenon was previously reported for Nordic dry grasslands and forest-edge communities (DENGLER & LÖBEL 2006, DENGLER et al. 2006b, DENGLER & BOCH 2008).

Classification of the tall-grass communities

Our classification of the tall-grass communities differs significantly from former concepts (e.g. KARNER & MUCINA 1993, KLIMENT et al. 2007, KOČÍ 2007). In particular, the content and ecological definition of the Calamagrostion villosae and Calamagrostion arundinaceae is partly reversed.

The Calamagrostion villosae in the present study contains subalpine grassland communities from slightly acidic to basic soils. Deviating from KLIMENT et al. (2007) we also included the Festucetum carpaticae, which these authors placed in the monotypic Festucion carpaticae BĚLOHLÁVKOVÁ & FišEROVÁ 1989. Our supra-regional dataset provided no justification for a separate alliance but demonstrated that the Festucetum carpaticae is well connected to the other associations of the Calamagrostion vil-

losae by the frequent occurrence of several diagnostic species (mainly differential species from alpine meadows; see Table 3). Our proposal deviates even more from KOČÍ (2007), whose Calamagrostion villosae mainly contains species-poor associations of nutrient-poor and acidic soils. His description rather corresponds to the Calamagrostion arundinaceae of the present study. In contrast to KOČÍ (2007), we arranged the species-poor Crepido conyzifoliae-Calamagrostietum villosae within the Calamagrostion arundinaceae, and not within the Calamagrostion villosae. In our approach, we combined all acidophytic tall-grass communities within the Calamagrostion arundinaceae and contrast them to the tall-grass communities of the Calamagrostion villosae, which inhabit subneutral to basic sites. Additionally, the first alliance is mainly montane, whereas the latter is mainly subalpine-alpine. Our classification best reflects the occurrence patterns of joint diagnostic species groups (species from alpine meadows vs. species indicating acidic soils) among the tall-grass associations at supra-national level (see Table 3).

Based on a remarkable floristic affinity (see Table 3), we included one fern association (*Athyrietum filicis-feminae*) within the Calamagrostion arundinaceae. By contrast, KOČÍ (2007) separated such fern-dominated stands as two associations within a discrete alliance [*Dryopterido-Athyriion distentifolii* (HOLUB ex SÝKORA & ŠTURSA 1973) JENÍK et al. 1980], based on bryophytes as diagnostic species. Since we had to exclude bryophytes from the analyses (see Methods), we could neither confirm the subdivision of the fern association, nor its separation from the Calamagrostion arundinaceae at higher syntaxonomical level.

Generally, our classification deviates from many proposals from eastern central Europe by accepting a significantly lower number of associations and alliances (e.g. BORZA 1934, ŠMARDA 1950, KLIMENT et al. 2007, KOČÍ 2007). This difference partly results from our supra-national perspective, from which purely local or regional peculiarities do not seem to merit formal syntaxonomic recognition, and partly from different classification approaches. For example, some authors distinguished associations mainly on the basis of differential species (e.g. KRAJINA 1933, HOLUB et al. 1967, KOČÍ 2007) or dominant species (JENÍK et al. 1980, BĚLOHLÁVKOVÁ & FišEROVÁ 1989). The stands of the two tall-grass alliances can be dominated by different grass species, e.g. *Calamagrostis arundinacea*, *C. villosa*, and *Festuca picturata*, or even *Deschampsia cespitosa*, *Molinia caerulea*, and *Poa chaixii*. These matrix species have wide ecological amplitudes and relatively low diagnostic values. Thus, we usually consider units that are only differentiated by the dominance of one of these grasses as facies within associations characterised by the presence/absence of character species (cf. BARKMAN 1989, DENGLER 2003: 62). If dominance is overestimated, this can lead to the delimitation of a multitude of syntaxa with only

weak ecological differences, and such an approach thus appears to be inappropriate for large-scale vegetation classifications.

Demarcation against lowland tall-herb vegetation

Where to draw the border between the *Mulgedio-Aconitetea* and lowland tall-herb classes, namely the *Artemisietea vulgaris* s.l., and the *Filipendulo-Calystegietea*, the *Trifolio-Geranietea sanguinei* s.l. (in the sense of Appendix 1), is controversial in the literature. While we included the subalpine *Rumicion alpini* in the *Mulgedio-Aconitetea*, this alliance is placed in the *Artemisietea vulgaris* by many authors (e.g. MÜLLER 1983, POTT 1995, cf. Stachurska-Swakoń 2009). Also the *Arunco dioici-Petasition albi* is frequently excluded from the *Mulgedio-Aconitetea* (e.g. KLAUCK 1991, MUCINA 1993). On the other hand, some authors include lowland tall-herb associations (or relevés) into the *Mulgedio-Aconitetea* (e.g. HOLUB et al. 1967, MUCINA & MAGLOCKÝ 1985, KLIMENT & JAROLÍMEK 2002).

Our approach of *a priori* diagnostic species resulted in a delimitation between the relevant classes that is consistent across syntaxa and regions. Accordingly, montane-subalpine prevail over lowland tall-herb species in stands of the *Mulgedio-Aconitetea*, while it is the other way around in the three lowland tall-herb classes. Observational data from several mountain regions show that such a delimitation is reasonable, because the upper distributional limits of many lowland tall-herbs coincide with the lower distributional limits of montane-subalpine tall-herbs in a relatively narrow altitudinal band at approximately 750 m a.s.l. (e.g. Sudety Mts.: KOPECKÝ 1990, Făgărăș Mts./Carpathians: J. DENGLER unpubl., mountains of Germany: T. MICHL unpubl.). Compared to previous concepts, our delimitation thus results in chorologically and ecologically more homogenous classes as requested by PIGNATTI et al. (1995). The two controversial syntaxa *Rumicion alpini* and *Arunco dioici-Petasition albi* fit well into the *Mulgedio-Aconitetea* also from a floristical point of view. On the one hand, they show high presence degrees of character species of the class (e.g. *Stellaria nemorum*, *Geranium sylvaticum*, *Viola biflora*) and of the *Calamagrostietalia villosae* (e.g. *Rumex acetosa* ssp. *arifolius*, *Senecio nemorensis*; Table 3). On the other hand, their own character species are often typical though less constant for the rest of the class, i.e. they are transgressive (e.g. *Carduus personata*, *Athyrium filix-femina*; Table 3).

The *Arunco dioici-Petasition albi* was originally described by BRAUN-BLANQUET & SUTTER (1977a, b) from a small region within the Alps as an explicit montane counterpart of the subalpine *Adenostylium alliariae*. KLAUCK (1991) then extended the geographic concept to mountain ranges

outside the Alps and subordinated the alliance to the *Artemisietea vulgaris*. Similarly, MUCINA (1993) placed the alliance in a lowland tall-herb class (*Galio-Urticetea*), but identified it with the *Petasition officinalis* Sillinger 1933. Other montane tall-herb communities apart from the two associations of BRAUN-BLANQUET & SUTTER (1977a, b) have partly not been recognised as associations at all because they were understood as fragmentary stands of subalpine synaxa (e.g. KARNER & MUCINA 1993) or they have been included into the *Adenostylium alliariae* (e.g. Kočí 2001, 2007, KLIMENT et al. 2007). One of our associations (*Luzulo luzuloidis-Thelypteridetum limbospermae*) was originally assigned to the *Melampyro-Holcetea mollis* (WITTIG 2000).

The turnover in characteristic species between the montane and the subalpine zone and the variety of clearly distinguished montane associations in the present study show that a separate montane alliance is justified. The *Arunco dioici-Petasition albi* is well characterised by several species that are rare in the subalpine zone (e.g. *Aruncus dioicus*, *Oreopteris limbosperma*, *Petasites albus*) and *vice versa* (see Table 3). We assume that this major floristic change corresponds to forest density. The montane zone is naturally characterised by closed forest vegetation (OZENDA 1988), and the tall-herb communities there are restricted to relatively small, treeless sites. By contrast, the subalpine zone is characterised by thinned and krummholz forests (OZENDA 1988). Here, the tall-herb communities are less buffered against temporary drought, frost, and wind than in the montane zone, although they are usually surrounded by single trees and shrubs, or occupy protected topographic positions (Kočí 2001). The separation of a montane alliance thus reflects a considerable ecological difference.

In contrast to MUCINA (1993), KLIMENT & JAROLÍMEK (2002), and KLIMENT et al. (2007) we did not identify the *Arunco dioici-Petasition albi* with the *Petasition officinalis*. Instead, the *a priori* assignment to classes suggested that the *Petasites* communities partly belong to the *Mulgedio-Aconitetea* (*Arunco dioici-Petasition albi*: communities of higher altitudes with *Petasites albus* or *P. kablikianus*) and partly to the *Filipendulo-Calystegietea* (*Petasition officinalis*: communities of lower altitudes with *P. hybridus*).

Conclusions and outlook

This first supra-national classification of the *Mulgedio-Aconitetea* based on individual relevés led to the description or emendation of several of its subordinate syntaxa, even at the ordinal level. This shows that the comparison of synoptic tables alone cannot replace the joint analysis of comprehensive original data if one wants to obtain ecologically and chorologically well defined high-rank syntaxa. With our

approach, we also overcame the inconsistency of different regional classifications and combined similar regional syntaxa into ecologically characterised units at the central European scale.

However, there is still some way to go to develop a consistent, pan-European classification of the class. For this goal, we primarily need data from European regions not covered in the present study, but where *Mulgedio-Aconitetea* communities are known to occur (Scotland, the Iberian Peninsula, Corsica, Italy, the Balkan Peninsula, the Caucasus Mts., the Ural Mts., Iceland). However, more and better data could also provide reasoning for the separation of some additional associations within the already covered regions. Regarding data quality, a uniform plot size is one of the most fundamental prerequisites for a sound vegetation classification. Apart from this, the treatment of non-vascular plants and infraspecific taxa, as applied by Kočí (2001, 2007) and KLIMENT et al. (2004, 2007), is also highly desirable for future studies of the class, because they can hold valuable syntaxonomic information (cf. DENGLER 2003, BERG & DENGLER 2005).

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Appendix

Appendix 1. A priori diagnostic species of the Mulgedio-Aconitetea, other European tall-forb classes, and classes that are usually in contact with stands of the Mulgedio-Aconitetea. Only those species are listed that were present in the reduced dataset after exclusion of the woodland stands and those outside the size range of 9–50 m². The a priori diagnostic species are based on literature data and comprise character and differential species of the classes as well as character species of subordinate syntaxa. Species marked with ° were assumed as diagnostic for two or more of the listed classes. To compile these lists, we appraised comprehensive overviews of diagnostic species of classes (e.g. NORDHAGEN 1943, PAWŁOWSKI & WALAS 1949, UNAR et al. 1984, 1985, OBERDORFER 1992, GRABHERR & MUCINA 1993, MUCINA et al. 1993a, OBERDORFER 1993a, b, DIERSSEN 1996, SCHAMINÉE et al. 1996, COLDEA 1997, JAROLÍMEK et al. 1997, MUCINA 1997, SCHAMINÉE et al. 1998, STORTELEDER et al. 1999, BERG et al. 2001, 2004. Additionally, we appraised analyses of single higher syntaxa (e.g. BRAUN-BLANQUET & SUTTER 1977a, b, ZECHMEISTER & MUCINA 1994, VALACHOVIČ 2001, KLIMENT et al. 2004, 2005, DENGLER et al. 2006a, 2007, KLIMENT et al. 2007).

Mulgedio-Aconitetea Hadač & Klika in Klika & Hadač 1944

Achillea distans, A. macrophylla, Aconitum lycoctonum, A. napellus, A. toxicum, A. variegatum, Adenostyles alliariae, Alchemilla acutiloba, A. glabra, A. subcrenata, Allium victorialis, Angelica archangelica°, Arabis cebennensis, Athyrium distentifolium, A. filix-femina, Calamagrostis arundinacea, C. purpurea, C. villosa, Carduus personata, Cerinthe glabra, Chaerophyllum villarsii, Cicerbita alpina, Cirsium helenioides°, C. spinosissimum, C. waldsteinii, Conioselinum tataricum, Cortusa matthioli, Crepis pyrenaica, Delphinium elatum, Doronicum austriacum, Dryopteris filix-mas, Epilobium alpestre, E. lactiflorum, Eryngium alpinum, Festuca carpatica, Geranium sylvaticum°, Hieracium prenanthoides, Hugueninia tanacetifolia, Laserpitium archangelica, Leucanthemum waldsteinii, Leuzea rhabontica, Luzula desvauxii°, Milium effusum°, Myosotis sylvatica, Oreopteris limbosperma, Petasites albus, Peucedanum ostruthium, Phyteuma ovatum, Poa hybrida, Polygonatum verticillatum, Pulmonaria rubra, Ranunculus aconitifolius°, R. platanifolius, Rumex acetosa ssp. arifolius, R. alpinus, Saxifraga rotundifolia, Scrophularia scopolii, Senecio cacaliaster, S. cordatus, S. nemorensis°, S. subalpinus, Solidago virgaurea°, Stachys alopecuros, Stellaria nemorum, Streptopus amplexifolius, Thalictrum aquilegiifolium, Tozzia alpina, Trisetum fuscum, Trollius europaeus°, Veratrum album.

Artemisietea vulgaris Lohmeyer et al. ex von Rochow 1951 [incl. Epilobietea angustifolii Tx. & Preising ex von Rochow 1951, Galio-Urticetea Passarge ex Kopecký 1969 p.p.]

Aegopodium podagraria, Alliaria petiolata, Anthemis tinctoria, Anthriscus sylvestris°, Arctium minus, A. tomentosum, Armoracia rusticana, Artemisia vulgaris, Brachypodium sylvaticum°, Bromus ramosus, Calamagrostis epigejos, Campanula trachelium°, Cardamine flexuosa, Carex sylvatica, Chaerophyllum aromaticum, C. aureum, Chelidonium majus, Circaeа lutetiana, C. × intermedia, Cirsium eriophorum, C. vulgare, Cruciata laevipes, Digitalis purpurea, Dryopteris carthusiana, Epilobium angustifolium, E. tetragonum, Eupatorium cannabinum°, Fallopia dumetorum, Festuca gigantea, Fragaria vesca°, Galeopsis bifida, G. pubescens, G. speciosa, G. tetrahit,

Galium aparine, *G. odoratum*, *Geranium robertianum*, *Geum urbanum*, *Glechoma hederacea*, *Hypericum hirsutum*, *Impatiens parviflora*, *Isatis tinctoria*, *Lamium album*, *L. maculatum*°, *Lapsana communis*, *Lysimachia nemorum*, *Milium effusum*°, *Moehringia trinervia*, *Mycelis muralis*, *Omalotheca sylvatica*, *Picris hieracioides*, *Poa compressa*, *Rubus caesius*, *Rumex obtusifolius*, *R. sanguineus*, *Sambucus ebulus*, *Scrophularia nodosa*, *Senecio nemorensis*°, *S. sylvaticus*, *Stachys sylvatica*, *Tanacetum vulgare*, *Tussilago farfara*, *Urtica dioica*°, *Verbascum lychnitis*°, *Veronica montana*, *Viola reichenbachiana*.

Calluno-Ulicetea Br.-Bl. & Tx. ex Klika & Hadač 1944

Arnica montana, *Avenula planiculmis*, *Botrychium lunaria*, *Calluna vulgaris*, *Campanula serrata*, *Carex ovalis*, *C. pallescens*, *C. pilulifera*, *Empetrum nigrum*°, *Galium pumilum*, *G. saxatile*, *Genista tinctoria*, *Gentiana lutea*, *Hieracium aurantiacum*, *Juncus conglomeratus*°, *Meum athamanticum*, *Nardus stricta*, *Polygala vulgaris*, *Potentilla erecta*, *Pseudorchis albida*, *Stellaria graminea*°, *Vaccinium myrtillus*, *V. vitis-idaea*, *Veronica officinalis*, *Viola canina*, *V. lutea*.

Caricetea curvulae Br.-Bl. 1948 [= Juncetea trifidi Hadač 1946]

Agrostis agrostiflora, *A. rupestris*, *Alchemilla alpina*, *Avenula versicolor*, *Carex atrata*, *C. bigelowii*, *C. sempervirens*, *Festuca paniculata*, *F. picturata*, *F. versicolor*, *Gentiana purpurea*, *Geum montanum*, *Hypochaeris uniflora*, *Juncus trifidus*°, *Leontodon pyrenaicus*, *Loiseleuria procumbens*°, *Pedicularis recutita*, *Potentilla aurea*, *Pulsatilla alba*, *Senecio abrotanifolius*.

Elyno-Seslerietea Br.-Bl. 1948

Acinos alpinus, *Alchemilla hoppeana*, *Androsace chamaejasme*, *Anemone narcissifolia*, *Anthyllis vulneraria*°, *Aster bellidiastrum*, *Astrantia major*°, *Bartsia alpina*, *Biscutella laevigata*, *Buphthalmum salicifolium*, *Bupleurum longifolium*, *Calamagrostis varia*, *Carduus defloratus*, *C. kernerii*, *Carex ferruginea*, *C. sempervirens*, *Centaura kotschyana*, *C. scabiosa*, *Coeloglossum viride*, *Daphne striata*, *Erigeron atticus*, *Festuca versicolor*, *Galium anisophyllum*, *Gentiana verna*, *Gymnadenia conopsea*, *Helianthemum nummularium*, *Helictotrichon parlatorei*, *Heracleum austriacum*, *Hypericum richeri*, *Juncus trifidus*°, *Leontodon hispidus*°, *Leucanthemum adustum*, *L. atratum*, *L. praecox*°, *L. vulgare*°, *Linum perenne*, *Pedicularis foliosa*, *P. oederi*, *Phleum hirsutum*, *Phyteuma orbiculare*, *Polygala alpestris*, *Potentilla crantzii*, *P. thuringiaca*, *Pulsatilla alpina*, *Saussurea alpina*, *Saxifraga paniculata*, *Scabiosa lucida*, *Selaginella selaginoides*, *Senecio abrotanifolius*, *S. doronicum*, *Sesleria albicans*, *S. sadleriana*, *Thesium alpinum*, *Trifolium badium*.

Filipendulo-Calystegietea Géhu & Géhu-Franck 1987 nom. inval. [incl. Galio-Urticetea Passarge ex Kopecký 1969 p.p.]

Angelica archangelica°, *Cirsium oleraceum*, *Cuscuta europaea*, *Eupatorium cannabinum*°, *Filipendula ulmaria*°, *Humulus lupulus*, *Lamium maculatum*°, *Lysimachia vulgaris*, *Myosoton aquaticum*, *Petasites hybridus*, *Phalaris arundinacea*, *Scirpus sylvaticus*°, *Urtica dioica*°, *Valeriana officinalis*, *V. repens*.

Loiseleurio-Vaccinietea Eggler ex Schubert 1960

Hieracium intybaceum, *Empetrum nigrum*°, *Loiseleuria procumbens*°, *Pedicularis lapponica*.

Molinio-Arrhenatheretea Tx. 1937

Allium schoenoprasum, *Alopecurus pratensis*, *Angelica sylvestris*, *Anthoxanthum odoratum*, *Anthriscus sylvestris*°, *Arrhenatherum elatius*, *Avenula pubescens*, *Bellis perennis*, *Caltha palustris*°, *Campanula patula*, *Cardamine pratensis*°, *Cardaminopsis arenosa*, *C. halleri*, *Carum carvi*, *Centaurea jacea*, *C. phrygia*, *Cerastium fontanum*, *Cirsium heterophyllum*°, *C. oleraceum*, *C. palustre*, *C. rivulare*, *Colchicum autumnale*, *Crepis aurea*, *C. biennis*, *C. mollis*, *Cynosurus cristatus*, *Dactylorhiza majalis*°, *Dianthus superbus*, *Equisetum palustre*°, *Festuca arundinacea*, *F. pratensis*, *Filipendula ulmaria*°, *Galium mollugo* agg.°, *Geranium sylvaticum*°, *Holcus lanatus*, *Inula salicina*°, *Juncus acutiflorus*°, *J. conglomeratus*°, *Knautia arvensis*°, *Lathyrus pratensis*°, *Leontodon autumnalis*, *L. hispidus*°, *Leucanthemum praecox*°, *L. vulgare*°, *Lolium perenne*, *Lotus corniculatus*, *L. pedunculatus*°, *Lysimachia nummularia*, *Myosotis scorpioides* agg., *Phleum alpinum*, *P. pratense*, *Phyteuma nigrum*, *Pimpinella major*, *Plantago alpina*, *P. major*, *Poa pratensis*, *P. supina*, *Polygonum bistorta*, *Prunella vulgaris*, *Ranunculus aconitifolius*°, *R. acris*, *R. repens*, *Rhinanthus minor*, *Rumex acetosa*, *R. crispus*, *Sanguisorba officinalis*, *Scirpus sylvaticus*°, *Stellaria graminea*°, *Tragopogon pratensis*, *Trifolium pratense*, *T. repens*, *Trisetum flavescens*, *Trollius europaeus*°, *Veronica serpyllifolia*, *Vicia cracca*.

Montio-Cardaminetea Br.-Bl. & Tx. ex Klika & Hadač 1944

Caltha palustris°, *Cardamine amara*, *Carex remota*, *Chrysosplenium alternifolium*, *C. oppositifolium*, *Epilobium alsinifolium*, *E. hornemannii*, *Poa alpigena*, *Saxifraga stellaris*, *Silene pusilla*, *Veronica beccabunga*.

Parvo-Caricetea Westhoff ex Den Held & Westhoff in Westhoff & Den Held 1969

Agrostis canina, *Cardamine pratensis*°, *Carex curta*, *C. echinata*, *C. flava* agg., *C. frigida*, *C. nigra*, *C. rostrata*, *Dactylorhiza majalis*°, *Epilobium palustre*, *Equisetum palustre*°, *Eriophorum angustifolium*, *Juncus acutiflorus*°, *J. filiformis*, *Lotus pedunculatus*°, *Parnassia palustris*, *Pinguicula alpina*, *Primula farinosa*, *Selaginella selaginoides*, *Valeriana dioica*, *Viola palustris*.

Salicetea herbaceae Br.-Bl. 1948

Cryptogramma crispa°, *Luzula alpinopilosa*, *L. desvauxii*°, *Omalotheca supina*, *Salix herbacea*, *Sedum alpestre*, *Soldanella carpatica*, *S. pusilla*, *Taraxacum croceum* agg.

Thlaspietea rotundifolii Br.-Bl. 1948

Achillea atrata, *Adenostyles alpina*, *Arabis alpina*, *Campanula alpina*, *C. carpatica*, *C. cochlearifolia*, *C. speciosa*, *Cerastium alpinum*, *Crepis aurea*, *Cryptogramma crispa*°, *Cystopteris montana*, *Delphinium oxysepalum*, *Doronicum columnae*, *D. grandiflorum*, *Gymnocarpium robertianum*, *Oxyria digyna*, *Petasites paradoxus*, *Rumex scutatus*, *Saxifraga carpatica*, *S. cernua*, *Valeriana montana*.

Trifolio-Geranietae sanguinei T. Müller 1962 [incl. Melampyro-Holcetea mollis Passarge 1979 nom. inval.]

Aquilegia vulgaris, *Astrantia major*°, *Brachypodium sylvaticum*°, *Campanula persicifolia*, *C. trachelium*°, *Carex muricata*, *Centaurea triumfetti*, *Chamaecytisus hirsutus*, *Clinopodium vulgare*, *Conopodium majus*, *Coronilla varia*, *Cruciata glabra*, *Fragaria vesca*°, *Galium mollugo* agg.°, *Geranium nodosum*, *Hieracium laevigatum*, *H. muronorum* agg., *Holcus mollis*, *Hypericum montanum*, *H. perforatum*, *H. pulchrum*, *Inula salicina*°, *Knautia arvensis*°, *K. dipsacifolia*, *Laserpitium latifolium*, *L. siler*, *Lathyrus latifolius*, *L. montanus*, *L. pratensis*°, *Melampyrum pratense*, *M. sylvaticum*, *Origanum vulgare*, *Poa nemoralis*, *Polygonatum odoratum*, *Polypodium vulgare*, *Potentilla sterilis*, *Pteridium aquilinum*, *Serratula tinctoria*, *Seseli libanotis*, *Silene nutans*, *Solidago virgaurea*°, *Stellaria holostea*, *Tanacetum corymbosum*, *Teucrium scorodonia*, *Thalictrum minus*, *Trifolium alpestre*, *T. medium*, *Verbascum lychnitis*°, *Veronica chamaedrys*, *Vicia sepium*, *V. sylvatica*, *V. tenuifolia*, *Viola collina*, *V. riviniana*.

Appendix 2. Nomenclaturally relevant decisions and proposals.

New syntaxon

Epilobio lactiflori-Geranieta sylvatici Michl, Dengler & Huck ord. nov. hoc loco

Type: *Mulgedion alpini* Nordhagen 1943: p. 312 [holotypus]

Syn.: *Adenostyletalia* Br.-Bl. 1930 sensu auct. p.p. [typus excl.]

Aconitetalia Nordhagen 1936 p.p. [Art. 8]

Betulo-Aconitetalia Br.-Bl. 1950 p.p. [Art. 8]

For character and differential taxa, see Table 3.

Correction of a name

Calamagrostio villosae-Festucetum picturatae Pawłowski et al. 1928 nom. corr.

Original form: “*Calamagrostis villosa-Festuca picta*-Assoziation” (PAWŁOWSKI et al. 1928: 248–250)

The original name of the association was based on *Festuca picta* Kit. ex Schultes, which according to PILS (1980) is a later homonym of *F. picta* J. F. Gmelin. Following Art. 44 ICPN, the association name thus has to be corrected as in the heading, using the new name *F. picturata* published by PILS (1980) to replace the illegitimate *F. picta* Kit. ex Schultes.

Typifications

Aconito-Cardaminetea Hadač 1956: pp. 16 and 40–60 – lectotypus hoc loco: *Montio-Cardaminetalia* Pawłowski et al. 1928: p. 220

Mulgedio-Aconitetea Hadač & Klika in Klika & Hadač 1944: pp. 283–284 – lectotypus hoc loco: *Adenostyletalia* Br.-Bl. 1930: p. 82

Adenostyletalia Br.-Bl. 1930: p. 82 – lectotypus (Art. 20): *Adenostylion* Br.-Bl. 1930: p. 82

Adenostylion alliariae Zlatník 1926: p. 26–29 – lectotypus hoc loco: *Athyrietum alpestris* Zlatník 1926: p. 26

Alno-Adenostylion Br.-Bl. 1948: pp. 13 and 236–244 – lectotypus hoc loco: *Cicerbitetum alpinae* Bolletter 1921: p. 86–90

Calamagrostion villosae Pawłowski et al. 1928: pp. 247–251 – lectotypus hoc loco: *Calamagrostio villosae-Festucetum pictae* Pawłowski et al. 1928: p. 248

Carduo-Urticion dioicae Hadač ex Hadač et al. 1969: pp. 208–217 – lectotypus hoc loco: *Geranio-Urticetum dioicae* Hadač et al. 1969: p. 212–217

Petasition officinalis Sillinger 1933: pp. 131–137 – lectotypus hoc loco: *Petasitetum officinali-glabratum* Sillinger 1933: p. 131

Petasito-Chaerophyllum Niemann et al. 1973: p. 628 – lectotypus hoc loco: *Chaerophyllo-Filipenduletum* Niemann et al. 1973: pp. 596–600 and 628

Dryopterido-Athyriention distentifolii Holub ex Sýkora & Štursa 1973: pp. 347 and 350–352 – lectotypus hoc loco: *Adenostylo-Athyrietum alpestris* (Zlatník 1928) Jeník 1961

Aconitetum lycoctoni Bolleter 1921: pp. 85–89 – lectotypus hoc loco: Bolleter 1921: table p. 86, relevé 2

Adenostyletum alliariae Aichinger 1933: pp. 156–158 – lectotypus hoc loco: AICHINGER 1933: relevé on pp. 156–157

Calamagrostietum arundinaceae Luquet 1926: pp. 107–112 – neotypus hoc loco: herb layer: *Calamagrostis arundinacea* 4, *Luzula luzuloides* 2, *Poa chaixii* 2, *Teucrium scorodonia* 2, *Angelica sylvestris* 1, *Digitalis grandiflora* 1, *Fragaria vesca* 1, *Knautia dipsacifolia* 1, *Luzula sylvatica* 1, *Vaccinium myrtillus* 1, *Campanula rotundifolia* +, *Centaurea montana* +, *Galium mollugo* agg. (*Galium mollugo*) +, *Leucanthemum vulgare* s.l. (*Chrysanthemum leucanthemum*) +, *Phyteuma spicatum* +, *Ranunculus serpens* +, *Thymus pulegioides* +, *Viola riviniana* +, *Rosa pendulina* r; moss layer: *Hylocomium splendens* 2, *Pleurozium schreberi* 2, *Scleropodium purum* 1, *Ptilidium ciliare* +, *Rhytidiodelphus triquetrus* +, *Rhodobryum roseum* r; cover herb layer: 100%, cover moss layer: 5%; plot size: 10 m²; slope: 45°, 1200 m a.s.l. Belchen, Black Forest, Germany (this relevé was originally published by PHILIPPI [1989: table 7, relevé 8] under the name *Sorbo-Calamagrostietum* Oberd. 1957)

Cirsio spinosissimi-Pucedanetum ostruthii G. Br.-Bl. 1931: pp. 55–56 – lectotypus hoc loco: BRAUN-BLANQUET 1931: p. 56, relevé A

Delphinietum elati Beger ex Sutter 1978: pp. 375 and 381 – lectotypus hoc loco: SUTTER 1978: table between p. 382 and p. 383, relevé 12

Doronico austriaci-Aruncetum vulgaris Kornaś in Kornaś & Medwecka-Kornaś 1967: pp. 216–220 – lectotypus hoc loco: KORNAŚ & MEDWECKA-KORNAŚ 1967: table 13, relevé 8

Geranio phaei-Urticetum dioicae Hadač et al. 1969: pp. 212–217 – lectotypus hoc loco: Hadač et al. 1969: table p. 216, relevé 108

Petasito albi-Cirsietum erisithalis Br.-Bl. in Br.-Bl. & Sutter 1977: pp. 320–321 – lectotypus hoc loco: BRAUN-BLANQUET & SUTTER 1977b: relevé 7 in table

Poo chaixii-Deschampsietum cespitosae Pawłowski & Walas 1949: pp. 142–144 – lectotypus hoc loco: PAWŁOWSKI & WALAS 1949: table 10, relevé 3

Rumicetum alpini Beger 1922: pp. 94–96 – lectotypus hoc loco: BEGER 1922: table p. 95, relevé 5

Proposals to the Committee for Nomina Conservanda, Ambigua, Inversa & Mutata (CNC)

Agropyro canini-Petasitetum kablikiani Pawłowski & Walas 1949 nom. invers. propos.

Original form: “Association à *Petasites kablikanus* et *Agropyrum caninum*” PAWŁOWSKI & WALAS (1949: 149–152)

We propose the inversion of the name according to Art. 42 in combination with Art. 10b ICPN. *Petasites kablikianus* is the dominant species in nearly all stands of the association (original diagnosis: 6 relevés of typical facies: presence degree: 100%, cover value: 5; present study: 28 relevés, presence degree: 100%, cover value: 1–5). *Elymus caninus* is also frequent but usually has much lower cover values (original diagnosis: presence degree: 83%, cover value: 1–3; present study: presence degree: 46%, cover value: + to 2a).

Crepidio conyzifoliae-Calamagrostietum villosae Jeník 1961 nom. conserv. propos.

Calamagrostietum villosae Rübel 1911 nom. rejic. propos.

According to Art. 52 ICPN we propose to conserve the name *Crepido conyzifoliae-Calamagrostietum villosae* Jeník 1961 against the oldest valid name *Calamagrostietum villosae* Rübel 1911 for two reasons. Firstly, this name is more often used for this association (e.g. MATUSZKIEWICZ & MATUSZKIEWICZ 1974, WAGNEROVÁ 1994, Kočí 2007), whereas the latter has hardly ever been used in recent decades. Additionally, the name *Calamagrostietum villosae* is ambiguous, because it has been used as a homonym with a different author citation for other associations, as, for example, the *Festuco picturatae-Calamagrostietum villosae* of the present study (e.g. KRAJINA 1933, BORZA 1934).

Digitali ambiguae-Calamagrostietum arundinaceae Sillinger 1933 nom. invers. et conserv. propos.

Original form: “*Calamagrostis arundinacea-Digitalis ambigua*-asociace” (SILLINGER 1933: 262)

Calamagrostietum arundinaceae Luquet 1926 nom. rejic. propos.

Calamagrostietum arundinaceae Zlatník 1926 nom. rejic. propos.

According to Art. 52 ICPN we propose to conserve the name *Crepido conyzifoliae-Calamagrostietum villosae* Jeník 1961 against the two listed older valid names for two reasons. Firstly, this name is frequently used for this association (OBERDORFER 1993a, KLIMENT 1995, KLIMENT et al. 2004, 2007), while *Calamagrostietum arundinaceae* has not been in use in recent decades. Additionally, the name is ambiguous, because it has been used as a homonym with a different author citation for other associations, as, for example, the *Festuco picturatae-Calamagrostietum villosae* of the present study (SILLINGER 1933). Finally, we propose the inversion of the name according to Art. 42 in combination with Art. 10b ICPN. *Calamagrostis arundinacea* is the dominant species in nearly all stands of the association (original diagnosis: 1 relevé, cover value 4; present study: 36 relevés, presence degree 97%, cover value + to 5), whereas *Digitalis grandiflora* is rarer and usually recorded with low cover values (original diagnosis: 1 relevé, cover value 2b; present study: 36 relevés, presence degree 44%, cover value + to 2b).

Doronico austriaci-Aruncetum vulgaris Kornaś in Kornaś & Medwecka-Kornaś 1967 nom. invers. propos.

Original form: “*Arunco-Doronicetum austriaci*” (KORNAŚ & MEDWECKA-KORNAŚ 1967: 216–220)

We propose the inversion of the name according to Art. 42 in combination with Art. 10b ICPN although in the original diagnosis *Doronicum austriacum* is more frequent and both species have similar cover values ranging from + to 2 (KORNAŚ & MEDWECKA-KORNAŚ 1967). The relevés of this diagnosis originate from a narrow region (Polish Western Carpathians), whereas our analyses show that the association is geographically widespread and occurs also in regions where *D. austriacum* is absent (e.g. parts of the Alps). *Aruncus dioicus* as one of the character species of the association is highly frequent (100%) and often dominant (cover values + to 5 within our dataset), while *D. austriacum* is only character species of the order and much less frequent supraregionally (13%; see Table 3).

Appendix 3. Nomenclatural revision of the high-rank syntaxa of the *Mulgedio-Aconitetea* in central and northern Europe, including basic information on the associations recognised in central Europe. All author citations have been checked and added to the bibliography. In square brackets, the ICPN regulations are listed that rule a certain name as invalid or illegitimate. In the sections "Type" and "Syn." round brackets are used to assign the correct names to illegitimate or later names of type syntaxa. In the section "Syn.", syntaxonomic and nomenclatural synonyms as well as invalid names, pseudonyms, and phantom names are listed chronologically. In the sections "Excl." and "Non", round brackets are used to indicate in which class the respective syntaxon should be placed to our opinion or – if the excluded syntaxon is classified elsewhere within the *Mulgedio-Aconitetea* – the name of the corresponding or next superior syntaxon.

Cl.: *Mulgedio-Aconitetea* Hadač & Klika in Klika & Hadač 1944

| | |
|-------------|---|
| Protologue: | " <i>Mulgedio-Aconitea</i> Hadač-Klika 1944" (KLIKA & HADAČ 1944b: 283–284) |
| Type: | Adenostyletalia Br.-Bl. 1930: 82 (= <i>Calamagrostietalia villosae</i> Pawłowski et al. 1928) [lectotypus designated by MICHL et al. (this paper)] |
| Syn.: | Adenostyletea R. Knapp 1942 [phantom name] Betulo-Adenostyletea Br.-Bl. & Tx. 1943 p.p. [Art. 8] Betulo-Adenostyletea Br.-Bl. 1948 p.p [Art. 3f] <i>Mulgedio-Aconitetea</i> Hadač & Klika in Klika 1948 [Art. 31] <i>Epilobietea angustifolii</i> Tx. & Preising in Tx. 1950 sensu auct. p.p. [Art. 8] <i>Epilobietea angustifolii</i> Tx. & Preising ex von Rochow 1951 sensu auct. p.p. [typus excl.; holotypus: <i>Epilobietalia angustifolii</i> Tx. ex von Rochow 1951] <i>Aconito-Cardaminetea</i> Hadač 1956 p.p. [typus excl.; lectotypus designated by MICHL et al. (this paper); <i>Montio-Cardaminetalia</i> Pawłowski et al. 1928: 220] <i>Stellario nemorum-Geranietea sylvatici</i> Niemann et al. 1973 p.p. [Art. 3b] <i>Cicerbito alpinae-Aconitetea napelli</i> Hadač & Klika in Klika & Hadač 1944 nom. mut. in Julve (1993) [Art. 40a, 45] <i>Stellario nemorum-Geranietea sylvatici</i> Niemann et al. ex Schubert et al. 1995 p.p. [Art. 5] <i>Nardo-Calamagrostietea villosae</i> Jeník et al. 1980 p.p. [Art. 29c; typus incl.; holotypus: <i>Calamagrostietalia villosae</i> Pawłowski et al. 1928] |
| Excl.: | Alnetalia viridis Rübel ex Rejmánek in Huml et al. 1979 (to <i>Betulo carpatica-Alnetea viridis</i>) |
| Notes: | We consider the original diagnosis in KLIKA & HADAČ (1944b) as valid although the authors did not include a direct reference to the protologue of the only order Adenostyletalia Br.-Bl. 1930. However, in the first part of the same publication (KLIKA & HADAČ 1944a: 249), the authors referred to KLIKA & NOVÁK (1941), where BRAUN-BLANQUET (1930) can be found in the reference list. |

Ord. 1: *Calamagrostietalia villosae* Pawłowski et al. 1928

| | |
|-------------|--|
| Protologue: | " <i>Calamagrostidetalia villosae</i> " (PAWŁOWSKI et al. 1928: 245–255) |
| Type: | <i>Calamagrostion villosae</i> Pawłowski et al. 1928 [lectotypus designated by JENÍK et al. (1980: 9)] |
| Syn.: | Adenostyletalia alliariae Br.-Bl. 1926 [phantom name] Adenostyletalia Br.-Bl. 1930 [syntax. syn.; lectotypus (Art. 20): <i>Adenostylon</i> Br.-Bl. 1930: 82 (= <i>Adenostylon alliariae</i> Br.-Bl. 1926)] <i>Adenostyletalia</i> G. Br.-Bl. 1931 [Art. 31; typus incl.; holotypus: <i>Adenostylon</i> G. Br.-Bl. 1931 (= <i>Adenostylon alliariae</i> Br.-Bl. 1926)] <i>Aconitetalia</i> Nordhagen 1936 p.p. [Art. 8] <i>Atropetalia</i> Tx. 1947 p.min.p. sensu auct. [typus excl.; holotypus: <i>Atropion</i> Tx. 1947] <i>Calamagrostietalia arundinaceae</i> Eggler 1952 [Art. 8] <i>Seslerietalia tatrae</i> Hadač ex Hadač et al. 1969 p.p. [typus excl.; lectotypus (Art. 20): <i>Seslerion tatrae</i> Hadač ex Hadač et al. 1969] <i>Petasito-Chaerophylletalia</i> Morariu 1967 [Art. 8] <i>Petasito-Chaerophylletalia</i> Morariu ex Kopecký 1969 p.min.p. [typus excl.; holotypus: <i>Petasition officinalis</i> Sillinger 1933] <i>Geranio sylvatici-Filipenduletalia</i> Julve 1993 p.p. [Art. 8] <i>Rumicetalia alpini</i> Mucina in Karner & Mucina 1993 p.p. [Art. 8] |
| Excl.: | <i>Alnion viridis</i> Aichinger 1933 (to <i>Betulo carpatica-Alnetea viridis</i>) <i>Epilobion angustifolii</i> Rübel 1933 [Art. 8] (to <i>Artemisieta vulgaris</i>) <i>Aconition septentrionalis</i> Nordhagen 1936 [Art. 8] (to <i>Epilobio lactiflori-Geranietalia sylvatici</i>) <i>Salicion pentandrae</i> Br.-Bl. 1950 [Art. 8] (to <i>Betulo carpatica-Alnetea viridis</i>) <i>Calamagrostion variae</i> Sillinger 1932 sensu Kliment et al. 2007 (to <i>Elyno-Seslerietea</i>) |

Salicion silesiacae Rejmánek et al. 1971 (to *Betulo carpaticae-Alnetea viridis*)
Salicion waldsteinianae Oberd. 1978 (to *Betulo carpaticae-Alnetea viridis*)

All. 1.1: *Adenostylium alliariae* Br.-Bl. 1926

- Protologue: "Adenostylium" (BRAUN-BLANQUET 1926: 37–38)
- Type: *Adenostylo alliariae-Cicerbitetum alpinae* Br.-Bl. 1926 (= *Cicerbitetum alpinae* Bolleter 1921) [holotypus]
- Syn.: *Adenostylium* Br.-Bl. 1925 [phantom name]
Adenostylium Luquet 1926 [Art. 33; lectotypus (Art. 20): *Adenostyletum alliariae* Luquet 1926: 113 (= *Cicerbitetum alpinae* Bolleter 1921)]
Aconition firmi Krajina 1933 [syntax. syn.; lectotypus (Art. 20): *Aconitetum firmi* Pawłowski et al. 1928: 254 (= *Cicerbitetum alpinae* Bolleter 1921)]
Alno-Adenostylium Br.-Bl. & Tx. 1943 p.p. [Art. 8]
Alno-Adenostylium Br.-Bl. 1948 [syntax. syn; lectotypus designated by MICHL et al. (this paper): *Cicerbitetum alpinae* Bolleter 1921]
Petasition doerfleri Lakušić 1968 [syntax. syn.; holotypus: *Doronico-Wulffenieta* blecici Lakušić 1968 (= *Cicerbitetum alpinae* Bolleter 1921)]
Excl.: *Salicetum lapporum* Zlatník 1928 (to *Betulo carpaticae-Alnetea viridis*)
Dryopteridi-Athyriention distentifolii Holub ex Sýkora & Štursa 1973 (to *Calamagrostion arundinaceae*)
- Non: *Adenostylium alliariae* Zlatník 1926 [Art. 33] (= *Calamagrostion arundinaceae*)
Adenostylium alliariae Aichinger 1933 [Art. 32a] (= *Arunco dioici-Petasition albi*)
Adenostylium de Bannes-Puygiron 1933 [Art. 31] (to *Thlaspietea rotundifolii* Br.-Bl. 1948)
- Notes: *Adenostylium alliariae* Sillinger 1933 [Art. 32a] (= *Arunco dioici-Petasition albi*)
In 1926, BRAUN-BLANQUET, LUQUET, and ZLATNÍK independently published valid descriptions of the *Adenostylium alliariae*. However, ZLATNÍK's name refers to communities of the present alliance *Calamagrostion arundinaceae*. Moreover, in phytosociological literature *Adenostylium* Br.-Bl. 1926 is used more often than *Adenostylium* Luquet 1926 (cf. Kočí 2001). Thus, Kočí (2007) decided to give prevalence to BRAUN-BLANQUET's name over that of LUQUET according to Art. 33 ICPN, and we suggest to do the same in relation to ZLATNÍK's name.

Ass. 1.1.1: *Cicerbitetum alpinae* Bolleter 1921

- Protologue: "Cicerbitetum alpinae" (BOLLETER 1921: 86–90)
Type: BOLLETER (1921): Table p. 86, relevé 7 [lectotypus designated by KARNER & MUCINA (1993: 472)]

Ass. 1.1.2: *Delphinietum elati* Beger ex Sutter 1978

- Protologue: "Delphinietum elati" (SUTTER 1978: 375, 381)
Type: SUTTER (1978): table between p. 382 and p. 383, relevé 12 [lectotypus designated by MICHL et al. (this paper)]

Ass. 1.2.3: *Aconitetum lycoctoni* Bolleter 1921

- Protologue: "Aconitetum lycoctoni" (BOLLETER 1921: 85–89)
Type: BOLLETER (1921): Table p. 86, relevé 2 [lectotypus designated by MICHL et al. (this paper)]

All. 1.2: *Rumicion alpini* Rübel ex Scharfetter 1938

- Protologue: "Rumicion alpini" (SCHARFETTER 1938: 261–262)
Type: *Rumici alpini-Aconitetum napelli* Aichinger 1933: 158 (= *Rumicetum alpini* Beger 1922) [holotypus]
- Syn.: *Rumicion alpini* Rübel 1933 [Art. 8]
Adenostylium alliariae Aichinger 1933 p.p. [Art. 32a; typus excl.]
Petasition officinalis Sillinger 1933 p.p. [typus excl., lectotypus designated by MICHL et al. (this paper): *Petasitetum officinali-glabrati* Sillinger 1933: 131]
Chenopodion subalpinum Br.-Bl. ex Oberd. 1950 [Art. 34a; typus incl., lectotypus (Art. 20): *Chenopodieturn subalpinum* Br.-Bl. ex Oberd. 1950: 54 (= *Rumicetum alpini* Beger 1922)]
Carduo-Urticion dioicae Hadač 1962 [Art. 8]
Carduo-Urticion dioicae Hadač ex Hadač et al. 1969 [syntax. syn.; lectotypus designated by MICHL et al. (this paper): *Geranio-Urticetum dioicae* Hadač et al. 1969: 212]
Rumicion pseudalpini Rübel ex Scharfetter 1938 corr. Loidi & Biurrun 1996 [Art. 45]

Ass. 1.2.1: Rumicetum alpini Beger 1922

Protologue: "Rumicetum alpini" (BEGER 1922: 94–96)

Type: BEGER (1922): Table p. 95, relevé 5 [lectotypus designated by MICHL et al. (this paper)]

Ass. 1.2.2: Senecionetum alpini Bolleter 1921

Protologue: "Senecietum alpini" (BOLLETER 1921: 90)

Type: BOLLETER (1921: 90): relevé p. 90 [holotypus]

Ass. 1.2.3: Geranio phaei-Urticetum dioicae Hadač et al. 1969

Protologue: "Geranio-Urticetum dioicae" (HADAČ et al. 1969: 212–217)

Type: HADAČ et al. (1969): Table p. 216, relevé 108 [lectotypus designated by MICHL et al. (this paper)]

All. 1.3: Calamagrostion villosae Pawłowski et al. 1928

Protologue: "Calamagrostidion villosae" (PAWŁOWSKI et al. 1928: 247–251)

Type: Calamagrostio villosae-Festucetum picturatae Pawłowski et al. 1928: 248 [lectotypus designated by MICHL et al. (this paper)]

Syn.: Calamagrostion variae Sillinger 1932 p.p. [typus excl., lectotypus (Art. 20): Calamagrostietum variae Sillinger 1932: 19]

Trisetion fusci Krajina 1933 [syntax. syn.; lectotypus (Art. 20): Trisetetum fusci Krajina 1933: 933 (= Calamagrostio villosae-Festucetum picturatae Pawłowski et al. 1928)]

Deschampsion cespitosae Borza 1934 [Art. 29c, 31]

Delphinion elati Hadač 1962 [Art. 8]

Delphinion elati Hadač ex Hadač et al. 1969 p.p. [syntax. syn.; lectotypus designated by KLIMENT et al. (2004: 109): Petasito kablikiani-Senecionetum nemorensis Hadač et al. 1969 (= Festucetum carpaticae Domin 1925: 1)]

Seslerion tatrae Hadač ex Hadač et al. 1969 p.p. [typus excl.; lectotypus (Art. 20): Seslerietum tatrae Šmarda 1956]

Poo chaixii-Deschampsion cespitosae Jeník et al. 1980 [Art. 29c]

Phleo alpini-Deschampsion Csűrös et al. 1985 [Art. 5]

Festucion carpaticae Bělohlávková & Fišerová 1989 [syntax. syn.; holotypus designated by BĚLOHLÁVKOVÁ & FIŠEROVÁ (1989: 12): Festucetum carpaticae Domin 1925: 1]

Excl.: Deschampsio cespitosae-Salicetum helveticae Dúbravcová & Šeffer 1992 (to Betulo carpaticae-Alnetea viridis)

Ass. 1.3.1: Festucetum carpaticae Domin 1925

Protologue: "Festucetum carpaticae" (DOMIN 1925: 1–25)

Type: DOMIN (1925): Table p. 8, relevé 3 [lectotypus designated by UNAR et al. (1985: 39)]

Ass. 1.3.2: Poo chaixii-Deschampsietum cespitosae Pawłowski & Walas 1949Protologue: "Association à *Deschampsia caespitosa* et *Poa chaixii* = Poëto-Deschampsietum Pawl. et Wal." (PAWŁOWSKI & WALAS 1949: 142–144)

Type: PAWŁOWSKI & WALAS (1949: table 10, relevé 3 [lectotypus designated by MICHL et al. (this paper)]

Ass. 1.3.3: Calamagrostio villosae-Festucetum picturatae Pawłowski et al. 1928 nom. corr.

Protologue: "Calamagrostis villosa-Festuca picta-Assoziation" (PAWŁOWSKI et al. 1928: 248–250)

Type: PAWŁOWSKI et al. (1928): Table 8, relevé 9 [lectotypus designated by KLIMENT et al. (2004: 96)]

Ass. 1.3.4: Cirsio spinosissimi-Peucedanetum ostruthii G. Br.-Bl. 1931Protologue: "Association à *Cirsium spinosissimum* et *Peucedanum ostruthium*" (BRAUN-BLANQUET 1931: 55–56)

Type: BRAUN-BLANQUET (1931: 56): relevé A, p. 56 [lectotypus designated by MICHL et al. (this paper)]

All. 1.4: Calamagrostion arundinaceae (Luquet 1926) Oberd. 1957

Basionym: "Calamagrostion atlanticum" (LUQUET 1926: 107) [Art. 34a]

Protologue: "Calamagrostidion Luquet 1926" (OBERDORFER 1957: 347–349)

Type: Calamagrostietum arundinaceae Luquet 1926: 107 (= Digitali ambiguae-Calamagrostietum arundinaceae Sillinger 1933 nom. invers. et conserv. propos.) [holotypus]

- Syn.: *Adenostylium alliariae* Zlatník 1926 p.p. [Art. 32a; typus incl.; lectotypus designated by MICHL et al. (this paper); *Athyriatum alpestris* Zlatník 1926: 26; Art. 31 (= *Athyriatum filicis-feminae* Wendelberger in Höfler & Wendelberger 1960)]
Calamagrostion villosae sensu auct. p.p. [typus excl.; lectotypus designated by MICHL et al. (this paper); *Calamagrostio villosae-Festucetum picturatae* Pawłowski et al. 1928: 248]
Calamagrostion arundinaceae Oberd. 1949 [Art. 8]
Calamagrostion arundinaceae Oberd. 1950 [phantom name]
Dryopteridion Eggler 1952 [Art. 8]
Epilobion angustifolii Tx. ex Oberd. 1957 p.min.p. sensu auct. [typus excl., lectotypus designated by DENGLER & WOLLERT in DENGLER et al. (2003: 619); *Epilobio angustifolii-Senecionetum sylvatici* Tx. 1937]
Calamagrostion arundinaceae (Luquet 1926) Jeník 1961 [Art. 32a; typus incl.; holotypus: *Calamagrostietum arundinaceae* Luquet 1926: (= *Digitali ambiguae-Calamagrostietum arundinaceae* Sillinger 1933 nom. conserv. et invers. propos.)]
Dryopterido-Athyriion distentifolii (Holub ex Sýkora & Štursa 1973) Jeník et al. 1980 [syntax. syn.; holotypus (Art. 27a; cf. MICHL et al., this paper); *Adenostylo-Athyriatum alpestris* (Zlatník 1928) Jeník 1961 (Sýkora & Štursa 1973: pp. 347, 350–352) (= *Athyriatum filicis-feminae* Wendelberger in Höfler & Wendelberger 1960)]
Ligustico mutellinae-Luzulion desvauxii Michalet & Philippe 1993 [Art. 5, 8]
Incl.: *Dryopterido-Athyriention distentifolii* Holub ex Sýkora & Štursa 1973
Achilleenion strictae Hadač et al. 1988
Excl.: *Calamagrostio villosae-Salicetum helveticae* Dúbravcová & Šeffer 1992 (to *Betulo carpatica-Alnetea viridis*)

Ass. 1.4.1: Crepido conyzifoliae-Calamagrostietum villosae Jeník 1961

Protologue: “*Crepidio-Calamagrostidetum villosae* (Zlatník 25) Jeník” (JENÍK 1961: 320–325)
Type: JENÍK (1961: 321), table 7, relevé 7 [holotypus]

Ass. 1.4.2: Digitali ambiguae-Calamagrostietum arundinaceae Sillinger 1933 nom. invers. et conserv. propos.

Protologue: “*Calamagrostis arundinacea-Digitalis ambigua-asociace*” (SILLINGER 1933: 262)
Type: SILLINGER (1933): relevé p. 262 [holotypus]

Ass. 1.4.3: Athyrietum filicis-feminae Wendelberger in Höfler & Wendelberger 1960

Protologue: “*Athyriatum filicis-feminae* Wendelb. 1960” (HÖFLER & WENDELBERGER 1960: 140–144)
Type: HÖFLER & WENDELBERGER (1960: 141) Table p. 141, relevé 2 [lectotypus designated by KARNER & MUCINA (1993: 488)]

All. 1.5: Arunco dioici-Petasition albi Br.-Bl. & Sutter 1977

- Protologue: “*Arunco-Petasition*” (BRAUN-BLANQUET & SUTTER 1977a: 313)
Type: *Arunco dioici-Petasitetum albi* Br.-Bl. & Sutter 1977: 313 (= *Doronico austriaci-Aruncetum vulgaris* Kornaš in Kornaš & Medwecka-Kornaš 1967 nom. invers. propos.) [holotypus]
Syn.: *Adenostylium alliariae* Aichinger 1933 p.p. [Art. 32a; typus incl.; lectotypus (Art. 20); *Adenostyletum alliariae* Aichinger 1933: 156; Art. 32a (= *Prenanthesum purpureae* Bolleter 1921)])
Adenostylium alliariae Sillinger 1933 p.p. [Art. 32a; typus incl.; lectotypus (Art. 20); *Adenostyletum alliariae* Sillinger 1933: 257, Art. 32a (= *Prenanthesum purpureae* Bolleter 1921)])
Petasition officinalis Sillinger 1933 p.min.p. [typus excl., lectotypus designated by MICHL et al. (this paper); *Petasitetum officinali-glabrati* Sillinger 1933: 131]
Delphinion elati Hadač 1962 [Art. 8]
Delphinion elati Hadač ex Hadač et al. 1969 p.min.p. [typus excl.; lectotypus designated by KLIMENT et al. (2004: 109); *Petasito kablikiani-Senecionetum nemorensis* Hadač et al. 1969 (= *Festucetum carpatica Domin* 1925: 1)]
Seslerion tatrae Hadač ex Hadač et al. 1969 p.min.p. [typus excl.; lectotypus (Art. 20); *Seslerietum tatrae* Šmarda 1956]
Petasition officinali-albi (Sillinger 1933) Klika 1955 p.p. [Art. 40a; typus excl.]
Telekion Morariu 1967 p.p. [Art. 8]

- Non.: Chaerophyllo-Petasition hybridii Kopecký 1968 [Art. 8]
 Petasito-Chaerophyllion Niemann et al. 1973 p.min.p. [typus excl.; lectotypus designated by MICHL et al. (this paper); Chaerophyllo-Filipenduletum Niemann et al. 1973: 596]
 Filipendulo-Petasition Br.-Bl. ex Duvigneaud 1949 (to Filipendulo-Convolvuletae)
 Petasition officinalis Sillinger 1933 (to Filipendulo-Convolvuletae)
- Note: According to its types, we consider Arunco dioici-Petasition albi Br.-Bl. & Sutter 1977 and Petasition officinalis Sillinger 1933 as non-synonymous. The type association of the latter was typified by KLIMENT & JAROLÍMEK (2002: 107) with the relevé 1 on page 134 of SILLINGER (1933). This relevé can clearly be assigned to the lowland tall-herb communities due to the prevalence of many *a priori* diagnostic species of the Artemisieta vulgaris and Filipendulo-Calystegietea (*Aegopodium podagraria*, *Anthriscus sylvestris*, *Filipendula ulmaria*, *Galium aparine*, *Petasites hybridus*). Therefore, we place it and consequently the Petasition officinalis Sillinger 1933 within the Filipendulo-Calystegietea.

Ass. 1.5.1: Prenanthesetum purpureae Bolleter 1921

- Protologue: "Prenanthesetum purpureae" (BOLLETER 1921: 86–89)
 Type: BOLLETER (1921): Table p. 86, relevé 4 [holotypus]

**Ass. 1.5.2: Doronico austriaci-Aruncetum vulgaris Kornaś & Medwecka-Kornaś 1967
nom. invers. propos.**

- Protologue: "Arunco-Doronicitum austriaci" (KORNAŚ & MEDWECKA-KORNAŚ 1967: 216–220)
 Type: KORNAŚ & MEDWECKA-KORNAŚ (1967): Table 13, relevé 8 [lectotypus designated by MICHL et al. (this paper)]

Ass. 1.5.3: Petasito albi-Cirsietum erisithalis Br.-Bl. in Br.-Bl. & Sutter 1977

- Protologue: "Petasito-Cirsietum erisithalis Br.-Bl." (BRAUN-BLANQUET & SUTTER 1977b: 320–321)
 Type: BRAUN-BLANQUET & SUTTER (1977b): Table, relevé 7 [lectotypus designated by MICHL et al. (this paper)]

Ass. 1.5.4: Luzulo luzuloidis-Thelypteridetum limbospermae Wittig 2000

- Protologue: "Luzulo luzuloidis-Thelypteridetum limbospermae" (WITTIG 2000: 131–140)
 Type: WITTIG (2000: 135): Table 3, relevé 9 [holotypus]

Ass. 1.5.5: Lunaria rediviva-[Arunco dioici-Petasition albi] community

According to our review, no valid name is available for this association. Thus, we use an informal name here but intend to publish a formal association name in a subsequent paper.

Ass. 1.5.6: Agropyro canini-Petasitetum kablikiani Pawłowski & Walas 1949 nom. invers. propos.

- Protologue: "Association à *Petasites kablikanus* et *Agropyrum caninum*" PAWŁOWSKI & WALAS (1949: 149–152)
 Type: PAWŁOWSKI & WALAS (1949): Table 13, relevé 6 [lectotypus designated by KLIMENT & JAROLÍMEK (2003: 103)]

Ord. 2: Epilobio lactiflori-Geranieta sylvatici Michl, Dengler & Huck this paper

- Type: Mulgedion alpini Nordhagen 1943: 312 [holotypus]
 Syn.: Adenostyletalia alliariae Br.-Bl. 1930 sensu auct. p.p. [typus excl., lectotypus (Art. 20): Adenostylium Br.-Bl. 1930: 95 (= Adenostylium alliariae Br.-Bl. 1926)]
 Aconitetalia Nordhagen 1936 p.p. [Art. 8]
 Betulo-Aconitetalia Br.-Bl. 1950 p.p. [Art. 8]

All. 2.1: Mulgedion alpini Nordhagen 1943

- Protologue: "Mulgedion alpini Nordhagen 1942" (NORDHAGEN 1943: 312–385)
 Type: Geranietum sylvatici alpicolum Nordhagen 1943: 326 [Art. 34a; lectotypus designated by DAHL (1987: 473) (= Geranietum sylvatici (Nordhagen 1943) Dahl 1987)]
 Syn.: Adenostylium Br.-Bl. 1926 sensu auct. p.p. [typus excl.; holotypus: Adenostylo alliariae-Cicerbitetum alpinae Br.-Bl. 1926: 38 nom. amb. rejic. propos. (= Cicerbitetum alpinae Bolleter 1921)]
Aconitum septentrionale Nordhagen 1936 [Art. 8]
Lactucion alpinae Nordhagen 1937 [phantom name]
Geranio-Cirsion heterophylli Kalliola 1939 [Art. 8]
Lactucion alpinae Nordhagen 1943 p.p. [Art. 33]

| | |
|--------|---|
| Incl.: | Dryopterido-Calamagrostion purpureae Nordhagen 1943 [Art. 8] Lactucenion alpinae (Nordhagen 1943) Dahl 1987 Athyrienion distentifolii Dahl 1987 |
| Excl.: | Dryopterido-Calamagrostienion purpureae (Nordhagen 1943) Dahl 1987 (to Betulo carpathicae-Alnetea viridis) Betuletum geraniosum subalpinum Nordhagen 1943 [Art. 3e, 34a] (to Betulo carpathicae-Alnetea viridis) Salicetum geraniosum alpicolum Nordhagen 1943 [Art. 3e, 34a] (to Betulo carpathicae-Alnetea viridis) Salicetum ulmariosum alpicolum Nordhagen 1943 [Art. 3e, 34a] (to Betulo carpathicae-Alnetea viridis) Salicetum deschampsiosum alpicolum Nordhagen 1943 [Art. 3e, 34a] (to Betulo carpathicae-Alnetea viridis) |

Appendix 4. Origin of the 993 relevés used for the classification. After the citations, the numbers of included relevés are given. In square brackets, the table or page numbers of the relevés in the sources are given, followed by the original relevé numbers in round brackets. When tables were not numbered in the source, only the relevé numbers are given. When there was only one relevé on a certain page of a source, only the page is given. The sources are included in the bibliography.

Ass. 1.1.1 – Cicerbitetum alpinae (144 relevés)

AICHINGER (1933): 1 (p. 156), BERNHARDT (2000): 12 [table 1 (1, 2, 7–9, 11, 13, 40, 42), table 2 (79, 80, 85)], BRAUN-BLANQUET (1976): 9 [table 1 (2–5, 10, 38–40, 42)], BRAUN-BLANQUET (1948): 6 [table 28 (2, 5, 7, 8, 10, 12)], BRAUN-BLANQUET (1973): 1 (relevé 27), DE FOUCault & DELPECH (1984): 4 [table 1 (1–4)], DELPECH & DE FOUCault (1984): 13 [table 2 (2, 3, 6), table 4 (1–5), table 5 (6, 8, 10, 11), p. 57 (1)], DÜRING & WIERER (1995): 3 [table 17 (21, 23, 25)], GÉHU & GÉHU-FRANCK (1987): 8 [table 4 (1–8)], HAUPTLORENZ, unpublished: 17 [table 2 (24, 25, 29, 30), table 4 (1–5, 7–13), table 5 (55)], HUML et al. (1979): 3 [table 2 (1, 4, 7)], KOČÍ, unpublished: 8 [Czech National Phytosociological Database, cf. CHYTRÝ & RAFAJOVÁ 2003)], KOPECKÝ (1971): 3 (relevé 17–19), LHOTE (1984): 3 [table 1 (8, 12, 13)], MALINOVSKI & KRICKSFALUSY (2000): 4 [table 39 (1, 6, 8, 12)], MURMANN-KRISTEN (1987): 15 [table 19 (1–4, 6, 8, 10–15, 17–19)], OBERDORFER (1938): 1 [table 12 (6)], PEDROTTI (1984): 1 [table 2 (1)], PHILIPPI (1989): 5 [table 8 (2–5, 7)], QUÉZEL & RIOUX (1954): 3 [table 4 (3, 4, 7)], RICHARD (1968): 7 [table 2 (1–7)], RICHARD (1977): 4 [table 12 (1, 3), p. 34 (1, 3)], HÜBL & SCHINDLER (2002): 1 [table 4 (25)], SCHWABE (1987): 7 [table 15 (7–13)], SMETTAN (1981): 3 [table 136 (481, 689, 801)], VIGO I BONADA (1984): 1 [table 3 (3)], WIKUS (1960): 1 [table 17 (1)].

Ass. 1.1.2 – Delphinietum elati (9 relevés)

BRAUN-BLANQUET (1976): 2 [table 1 (36, 43)], RICHARD (1977): 6 [table 12 (5, 7, 8, 11–13)], SUTTER (1978): 1 [table 1 (4)].

Ass. 1.1.3 – Aconitetum lycoctoni (37 relevés)

BERNHARDT (2000): 10 [table 1 (3–6, 10, 14, 15, 43–45)], BRAUN-BLANQUET (1969): 3 (relevé 1, 3, 4), DE BOLÓS (1984): 2 [table 36 (2, 3)], DÜRING & WIERER (1995): 5 [table 17 (14, 15, 17–19)], LACOSTE (1975): 1 [table 30 (3)], LIPPERT (1966): 7 [table 12 (558, 561), table 27 (3–5, 16, 23)], RICHARD (1968): 4 [table 1 (3–5), table 2 (9)], RICHARD (1977): 1 [table 4 (4)], SMETTAN (1981): 3 [table 136 (196, 487, 516)], SUTTER (1978): 1 [table 1 (3)].

Ass. 1.2.1 – Rumicetum alpini (34 relevés)

BERNHARDT (2000): 2 [table 2 (58, 81)], DENGLER, unpublished: 3, HADAČ (1956): 1 (p. 41), HUML et al. (1979): 1 [p. 37], KOPECKÝ & HEJNÝ (1971): 11 [table 4 (34–37, 39–43, 45, 46)], LIPPERT (1966): 7 [table 9 (105, 737, 739, 740, 742, 743, 760)], OBERDORFER (1950): 2 [table 5 (2, 4)], RICHARD (1977): 2 [table 18 (6, 9)], WIKUS (1960): 5 [table 17 (4–6, 9, 10)].

Ass. 1.2.2 – Senecionetum alpini (45 relevés)

BERNHARDT (2000): 29 [table 1 (12, 47), table 2 (56, 57, 59–74, 76–78, 83, 84, 86–89)], DÜRING & WIERER (1995): 11 [table 17 (24, 39, 45, 46, 49, 51, 53–57)], RICHARD (1977): 1 [table 18 (11)], WÖRZ (1989): 4 [table 5 (3, 7, 10, 11)].

Ass. 1.2.3 – Geranio phaei-Urticetum dioicae (6 relevés)

HADAČ et al. (1969): 2 [p. 216 (108, 111)], KLIMENT (1989): 3 [table 1 (1, 2, 7)], KLIMENT (1991): 1 [table 1 (2)].

Ass. 1.3.1 – Festucetum carpaticae (67 relevés)

BĚLOHLÁVKOVÁ & FIŠEROVÁ (1989): 29 [table 4 (1, 3–30)], BOŞCAIU & MIHĂILESCU (1997): 6 [table 1 (3–5, 7–9)], DÚBRAVCOVÁ & HAJDÚK (1986): 2 [p. 46 (1), p. 47 (2)], HADAČ (1956): 2 [table 18 (78, 80)], HADAČ et al. (1969): 14 [p. 93 (193), p. 117 (127), p. 123 (28), p. 143 (263, 264, 271, 272), p. 149 (180, 203, 265, 266), p. 152 (168, 204), p. 154 (173)], KLIMENT et al. (1994): 2 [p. 14 (1), p. 15 (3)], KLIMENT et al. (2004): 2 [table 5 (6, 10)], Kočí, unpublished: 2 [Czech National Phytosociological Database], ŠIBÍK, unpublished: 1 [p. 63], ŠIBÍK et al. (2004): 4 [p. 66 (1, 2), p. 67, p. 68], UNAR et al. (1984): 2 [table 21 (5, 9)], ZLATNÍK (1928): 1 [table 10 (40)].

Ass. 1.3.2 – Poo chaixii-Deschampsietum cespitosae (61 relevés)

HAUPTLORENZ, unpublished: 2 [table 2 (6, 16)], JENÍK et al. (1980): 2 [p. 12 (281), p. 13 (58)], Kočí, unpublished: 57 [Czech National Phytosociological Database].

Ass. 1.3.3 – Calamagrostio villosae-Festucetum picturatae (48 relevés)

BRAUN-BLANQUET (1930): 3 [p. 96 (1), p. 97 (1, 2)], HADAČ (1956): 13 [table 17 (1, 4, 5, 5–, 6, 8, 9, 32, 55, 78), table 19 (48, 52, 53)], KRAJINA (1933): 14 [table 26 (3, 6–8), table 27 (1, 6), table 28 (8), table 29 (3), table 31 (1, 2, 6), table 33 (3, 7, 8)], PAWŁOWSKI et al. (1928): 6 [table 9 (1, 2), table 10 (1, 3–5)], RÜBEL (1911): 1 [p. 125 (1)], ŠEFFER (1991): 9 [table 1 (2, 6, 7, 9–11, 13, 16, 17)], ŠIBÍK, unpublished: 2 [p. 65, p. 67].

Ass. 1.3.4 – Cirsio spinosissimi-Pucedanetum ostruthiae (44 relevés)

AICHINGER (1933): 1 [table 38 (2)], BRAUN-BLANQUET (1976): 24 [table 1 (1, 6–9, 11–14, 17, 18, 20–22, 24, 26, 27, 29, 31–33, 35, 37, 41)], DE FOUCAULT & DELPECH (1984): 1 [table 1 (8)], DÜRING & WIERER (1995): 4 [table 17 (22, 27, 37, 50)], KRAJINA (1933): 1 [table 26 (1)], LIPPERT (1966): 1 (relevé 85), OBERDORFER (1950): 1 [table 5 (7)], PEDROTTI (1984): 6 [table 1 (2, 6, 12–14, 15)], SMETTAN (1981): 3 [table 141 (207, 626, 792)], WIKUS (1960): 2 [table 17 (2, 8)].

Ass. 1.4.1 – Crepido conyzifoliae-Calamagrostietum villosae (71 relevés)

BERNHARDT (2000): 4 [table 2 (48–51)], JENÍK et al. (1980): 3 [p. 10 (84), p. 11 (172, 220)], Kočí, unpublished: 55 [Czech National Phytosociological Database], MICHL, unpublished: 6, ŠIBÍK, unpublished: 1 [p. 73], SOFRON & ŠTĚPÁN (1971): 2 [table 4 (38, 39)].

Ass. 1.4.2 – Digitalo ambiguae-Calamagrostietum arundinaceae (36 relevés)

CHYTRÝ (1992): 1 [table 2 (4)], HADAČ et al. (1969): 4 [p. 241 (7, 162, 163, 165)], HAUPTLORENZ, unpublished: 6 [table 1 (15, 20, 26–28), table 2 (17)], ISSLER (1936): 1 [p. 127 (1)], JENÍK et al. (1980): 1 [p. 11 (110)], Kočí, unpublished: 9 [Czech National Phytosociological Database], KORNAŠ & MEDWECKA-KORNAŠ (1967): 1 [table 16 (2)], MICHL, unpublished: 3, PHILIPPI (1989): 4 [table 7 (1, 2, 5, 8)], VIGO I BONADA (1984): 2 [table 3 (2, 5)], VOGEL (1981): 4 (relevé 18, 23, 27, 32).

Ass. 1.4.3 – Athyrietum filicis-feminae (106 relevés)

BERNHARDT (2000): 2 [table 2 (52, 53)], HADAČ (1956): 2 [table 20 (51, 56)], HÖFLER & WENDELBERGER (1960): 2 [table 3 (17, 19)], KLIMENT et al. (2004): 1 [p. 114 (1)], Kočí, unpublished: 52 [Czech National Phytosociological Database], KRAJČIOVÁ-ŠIBÍKOVÁ et al. (2005): 1 [p. 201 (1)], MICHL, unpublished: 5, PAWŁOWSKI et al. (1928): 1 [table 9 (3)], PHILIPPI (1989): 2 [table 7 (12), p. 803 (1)], SOFRON & ŠTĚPÁN (1971): 9 [table 3 (29, 32–37, 40, 41), table 4 (40, 41)], SÝKORA & ŠTURSA (1973): 28 [table 1 (1–14, 17–22), table 2 (1–8)], ZLATNÍK (1928): 1 [table 10 (41)].

Ass. 1.5.1 – Prenanthesetum purpureae (140 relevés)

BERNHARDT (2000): 2 [table 2 (54, 55)], BRAUN-BLANQUET & SUTTER (1977a): 2 (relevé 21, 22), CHYTRÝ (1992): 3 [table 2 (5, 7, 8)], CHYTRÝ & VICHEREK (1996): 1 [table 2 (3)], CHYTRÝ, unpublished: 2 [Czech National Phytosociological Database], DELPECH & DE FOUCAULT (1984): 1 [table 6 (1)], GÖTZ & RIEGEL (1989): 4 [table 5 (4, 7–9)], HADAČ et al. (1969): 1 [p. 152 (222)], HAUPTLORENZ, unpublished: 1 [table 5 (44)], HUML et al. (1979): 1 [table 2 (8)], KLIMENT et al. (2004): 1 [table 5 (1)], Kočí, unpublished: 25 [Czech National Phytosociological Database], KOPECKÝ & HEJNÝ (1971): 24 [table (1–19, 23, 27, 30–32)], KOPECKÝ (1971): 2 (relevé 15, 16), KORNAŠ & MEDWECKA-KORNAŠ (1967): 3 [table 13 (5, 7, 9)], KRAJINA (1933): 1 [table 26 (4)], MICHL, unpublished: 20, MURMANN-KRISTEN (1987): 8 [table 11 (7), table 24 (1), table 38 (4), table 39 (6, 8, 9), table 42 (23, 28)], PHILIPPI (1989): 3 [table 8 (1, 16), p. 880 (1)], SCHWABE (1987): 7 [table 14 (6, 7, 11, 12), table 16 (4, 10, 12)], SMETTAN (1981): 5 [table 75 (1, 2), table 132 (121, 124), table 136 (474)], VOGEL (1981): 16 (relevé 2, 3, 5–7, 9, 11–14, 17, 28, 30, 31, 35, 36), WÖRZ (1989): 6 [table 5 (1, 2, 5, 6, 8, 9)], ZLATNÍK (1928): 1 [table 10 (37)].

Ass. 1.5.2 – Doronico austriaci-Aruncetum vulgaris (16 relevés)

BRAUN-BLANQUET & SUTTER (1977a): 10 (relevé 1–4, 6–9, 12, 14), KORNAŠ & MEDWECKA-KORNAŠ (1967): 3 [table 13 (2, 4, 8)], LHOTE (1984): 1 [table 1 (14)], MURMANN-KRISTEN (1987): 2 [table 22 (2, 7)].

Ass. 1.5.3 – Petasito albi-Cirsietum erisithalis (5 relevés)

BRAUN-BLANQUET & SUTTER (1977b): 3 (relevé 7, 9, 11), KLIMENT et al. (2004): 1 [table 5 (7)], KORNAŠ & MEDWECKA-KORNAŠ (1967): 1 [table 16 (1)].

Ass. 1.5.4 – Luzulo luzuloidis-Thelypteridetum limbospermae (18 relevés)

MURMANN-KRISTEN (1987): 7 [table 11 (1, 4–6), table 19 (16), table 20 (3), table 38 (7)], WITTIG (2000): 11 [table 3 (2, 5–10, 12–15)].

Ass. 1.5.5 – Lunaria rediviva-[Arunco dioici-Petasition albi] community (11 relevés)

Kočí, unpublished: 1 [Czech National Phytosociological Database], MÍCHL, unpublished: 10.

Ass. 1.5.6 – Agropyro canini-Petasitetum kablikiani (28 relevés)

HADAČ et al. (1969): 3 [p. 169 (39, 48, 78)], KLIMENT & JAROLÍMEK (2002): 7 [table 2 (7, 10, 29, 88–90, 93)], KLIMENT et al. (2004): 4 [table 5 (2–5)], KOPECKÝ (1971): 9 (relevé 4, 7–14), KORNAŠ & MEDWECKA-KORNAŠ (1967): 4 [table 13 (1, 6, 10), table 14 (3)], UNAR et al. (1985): 1 [p. 47 (1)].

Ord. 2 – Epilobio lactiflori-Geranietalia sylvatici (67 relevés)

DAHL (1956): 1 [table 37 (566)], KALELA (1939): 38 [table 32 (1, 4–6), table 33 (2, 3, 7–9, 11), table 34 (1, 5), table 35 (1), table 38 (1), table 39 (1–8), table 40 (2–8), table 41 (1–5), table 42 (1–4)], MÍCHL, unpublished: 3, ODLAND (1981): 25 [table 1 (13, 16–22), table 2 (3, 6–8, 10, 12–18) table 5 (2, 12, 15, 21, 26)].