universität wien

MASTERARBEIT | MASTER'S THESIS

Titel | Title

„A Syntaxonomic Approach to the Dry Grasslands of the Weinviertel – Focusing on the Bryophytes“

verfasst von | submitted by

Lisa Maria Ursula Wallerstein BSc

angestrebter akademischer Grad | in partial fulfilment of the requirements for the degree of

Master of Science (MSc)

Wien | Vienna, 2026

Studienkennzahl lt. Studienblatt | Degree programme code as it appears on the student record sheet:	UA 066 832
Studienrichtung lt. Studienblatt | Degree programme as it appears on the student record sheet:	Masterstudium Botany
Betreut von | Supervisor:	Mag. Dr. Harald Zechmeister Privatdoz.

A Syntaxonomic Approach to the Dry Grasslands of the Weinviertel – *Focusing on the Bryophytes*

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1. Introduction

The vegetation of the dry grasslands in the Weinviertel area of Lower Austria has not been thoroughly sampled since the 1980s (Holzner et al., 1986a). This was the case in 2013 (Willner et al., 2013) and has not much changed since. This thesis aims to give an overview of the dry grassland remnants and their syntaxonomy with a focus on the bryophytes growing in the sample plots.

1.1 Background

Syntaxonomy, or phytosociology, was developed by J. Braun-Blanquet and R. Tüxen in the first half of the 20th century (Braun-Blanquet, 1964). Based on earlier traditions of phytogeography, this branch of biology classifies plant communities, their hierarchical order and distribution by using character species (Tremp, 2005). Plant communities, as found in vivo, consist of specific plant species that grow together on the landscape with varying constancy. They can be grouped into syntaxa by denominating diagnostic (character and differential) species. With the help of ecological methods, phytosociology investigates the dependence of plant communities on local site conditions. These conditions are physical factors (Klink & Glawion, 2008) such as elevation, slope, and substrate.

Understanding Europe's plant cover, as seen in the proceedings of the CORINE (Coordination of Information on the Environment) landcover project, and its conservation status is also necessary to update the facts for Annex I of the Habitats Directive (Sundseth, 2020). This discipline has a direct practical use and application in environmental protection. Collected into phytosociological databases, these relevés are a very valuable source of information. Combined with GIS data, syntaxonomy is a powerful tool for environmental conservation (Dengler et al., 2008).

To assess co-occurrences of species on the scale of a vegetation stand, we used a standardized sampling procedure called a relevé. A relevé should include all plant species occurring on soil, which includes not only vascular plants but also bryophytes and lichens. All species are assigned a quantitative value, either abundance or cover or a combination of both (Dengler et al., 2008).

1.2 Dry grasslands in general

Dry grasslands exist mostly based on two factors that can prohibit the formation of woodlands. The first is a combination of abiotic factors - the climatic and substrate conditions. The second is animals (including humans and domesticated animals) which prevent steppes from being overgrown by trees and shrubs. This can occur through grazing, trampling, or other activities that keep the landscape open. Shallow soils are mostly covered by grasses that form bunches (Eijsink et al., 1978), while deeper soils in dry grassland areas are certainly fertile substrates for graminiod crops such as cereal as well.

Dry grasslands on calcareous soils, although containing scarce vegetation, are often very species rich (Löbel et al., 2006). The meso-xeric grassland species on calcareous soils mostly belong to the order *Brachypodietalia pinnati*, which comprises all European meso-xeric grasslands (Becker et al., 2012). Hillsides with a southern exposure receive more radiation from the sun than those with slopes towards the north. Therefore, the temperature of the soil is generally higher. And all the more so when the plant coverage is low or has gaps, as is often the case with dry grassland plant communities. This is because the effect of radiation on soil with scarce plant cover, as found in dry grasslands, is similar to that of uncovered soil (Klink & Glawion, 2008). This results in more xerophytic vegetation on the southern slopes.

1.3 Dry grasslands in the study area

The grasslands of the Pannonian basin in Austria have been of interest to botanists as far back as the 19th century, including Kerner von Marilaun in 1863 (Willner et al., 2013). This is to some extent based on their geographical location, since the Pannonicum is the westernmost part of the great Eurasian steppes (Pokorný et al., 2015), and the xerotherm plant associations reach back to their eastern-continental descent (Niklfeld, 1964). The substrates of the dry grasslands in our study area mostly consist of tertiary sediments. After the last ice age, forest-steppes dominated this part of the Pannonicum, but were kept at least partly free of trees by megaherbivores, and by humans and their herds of livestock thereafter (Pokorný et al., 2015).
This last factor kept the landscape open until grazing became economically unfeasible for farmers in the 19th century. One example of these changes in the Weinviertel area is a so-called "Milchhaus". These buildings were formerly used for collecting and storing the morning milk yield from a village's cattle. Grazing a village herd and not mowing the pastures seems to have been common practice, as has been mentioned for one of our study sites explicitedly, the Höllenstein (Niklfeld, 1964), sample plot 42. Grazing herds is nowadays merely a form of environmental protection and conservation strategy to restore the habitat of steppe-affine plants in the Pannonicum. Most of the time, sheep are used. One prominent exception is a large herd of cattle in the Austrian part of the Pannonicum, the longhorn Steppenrinder in the Neusiedlersee/Seewinkel Nationalpark (*Beweidung | Nationalparkneusiedlersee*, n.d.).

This change in land use has affected all large grasslands that were present in the Pannonian area of Austria until the Second World War. The increasing influence of intensive agriculture and the decline of grazing herds has dramatically reduced dry grasslands in the Pannonian lowlands (Zulka et al., 2014a). In the thirty five years since the "Dry Grassland Catalogue of Austria" (Holzner et al., 1986a) was published, some plots have become unretrieveable. Gravel and sand quarries must be added to the list of potential threats for semi-natural grasslands as well.

The grasslands of the Weinviertel are influenced by the climate, which is mostly subcontinental with transitional zones to the Alpine Belt in the west, and in the east to more arid areas of the general Pannonian region (Niklfeld, 1964). The Bohemian Massif to the northwest forms a natural border to our study area, with different vegetation communities dwelling on more siliceous substrates. There are sand dunes and saline soils in the Weinviertel as well, which were not included in our sample plots. This thesis' study area also has rocky outcrops that stretch from Stockerau to Mikulov. These are mostly calcareous, forming an archipelago-like chain called the Waschberg-Klippenzone, a Natura 2000 area. The jurassic limestone of the Falkenstein mountains, sample plot 42 is one of them, belongs to this stands of calcareous, if even withered, bedrock (Niklfeld, 1964). The other elevations and hills of the Weinviertel are mostly tertiary hills with thick loess cover (Willner et al., 2013) – an ideal substrate for dry grasslands, but also for vineyards and cereal agriculture.

The rocky grasslands of the Weinviertel also differ between the southerly and northerly exposed stands. On calcareous substrates, the north-facing slopes are dominated by *Sesleria caerulea*, while the south-facing slopes are dominated by *Festuca* or *Stipa* species. The latter have also a more open herb layer (Willner et al., 2013) which affects the moss layer as well.

In the past, some studies have mentioned a lack of relevés from the Weinviertel. This part of Austria is habitat to species of the Pannonian floral region, outlining their northernmost range. The Weinviertel is also the westernmost part of the Pontic-Pannonian floral region. Thus, second only to the Alps, the Pannonian lowlands are the largest non-alpine biogeographical region in Austria, (Willner et al., 2013) and therefore we need to know which vegetation communities are found here,

and which may need protection. This identification is also required for the declaration of Natura 2000 habitat types, as ordered by the European Union starting in 2007 (Sundseth, 2020).

Apparently, patches on gravel substrates with only short swards have the highest amount of species richness in dry grassland specialists. The distance to other dry grasslands in the vicinity also has an impact on species richness: the larger the distance, the less chance of high species richness (Zulka et al., 2014a). Since the same authors mention that historical patch size is so important to sustaining biodiversity in dry grassland habitats, we would like to add that the present patch size is the future historical patch size.

Thus, while all grassland species profit from preserving habitat, for example through set-asides and field margins, actual dry grassland species need more favourable conditions. These can be restored and assured by environmental protection measures. Such recommended measures are grazing or mowing to reduce biomass, keeping swards short, clearing away shrubbery while increasing heterogenity, and also the restoration of patch-size (Zulka et al., 2014b).

1.4 Bryophytes in syntaxonomy

(Frahm, 2001) points out that bryophytes occur as parts of vascular plant communities, as independent syntaxa that consist only of bryophytes, or as strata – layers of vegetation in vascular plant communities. They can also be classified as synusiae specific for a lifeform or growth form of bryophytes, for example epiphytic communities in forests.

Some authors stated that bryophytes and lichens are indispensable for the syntaxonomic classification of vegetation, also mentioning dry vegetation that is lichen-rich (Berg & Dengler, 2005). The same authors also stated that mosses play an important role as characteristic species of plant communities on the margins between forests and dry grasslands as well, for example in the *Trifolio-Geranietea sanguinei*.

1.5 Bryophytes in dry grasslands

Mosses are poikilohydric photosynthetic organisms (Goffinet & Shaw, 2009), they can use even the smallest amounts of humidity, be it directly from the air, like fog, or morning dew (Klink & Glawion, 2008).
Their assimilative and reproductive processes are only active when the plant is humidified (Frahm, 2001). The cytoplasm of bryophytes sticks to the cell wall rather than congregating in the middle of the cells while bound to the cell wall by Hechtian strands, as in vascular plant cells. Therefore, they can dry out very well and be revived again. Their desiccation tolerance allows them to suspend their metabolic processes during times when their surroundings are too dry for water and nutrient uptake, which happens mostly over the whole surface of the rootless plants (Goffinet & Shaw, 2009).

Bryophyte leaves in general do not have a cuticula, even if in some cases a thin cuticle is present (Goffinet & Shaw, 2009), this fact enables them to absorb water through all of their surface cells. Some mosses, for example *Pterygoneurum* species, have lamellae on the upper or lower side of their leaflets for more effective water assimilation, distribution, and storage. As an adaptation to sun-exposed stands, other species have developed succulent leaflets or hyaline tips, often elongated, at the end of their leaflets. These structures supposedly help to reflect radiation, and can also be an elongation of the middle rib (Frahm, 2001).

Hyaline tips, as found on the leaves of *Syntrichia ruralis*, also cater to the need for water uptake by presenting a condensation nucleus for the morning dew. Some families (*Encalyptaceae*, *Pottiaceae* – e.g. *Tortula* / *Syntrichia*) show a differentiation in the cellular structure of their leaflets. The upper cells are small, full of chlorophyll, and do most of the assimilation, while the lower cells closer to the stemlet are larger in size, are hyaline, and store water. A similar function is performed by alar cells – enlarged cellular structures with more lumen than their neighbouring cells. They can be found in the *Amblystegiaceae* and are an important characteristic for identification. At the bottom of the leaflets, clasping the stemlets, these alar cells take up capillary water that runs along the stemlet and guide it to the leaflet (Frahm, 2001). Many bryophytes grow in cushions, which also facilitates water uptake and storage.
Mosses in their dry state can endure higher temperatures than when moist. American studies from the 1950s found astonishing temperature survival limits of 30 minutes at 100°C for *Pleurochaete squarrosa*. Xerophytic mosses such as *Tortula ruralis* can endure long drought periods and can be recultivated from herbarium samples after several years (Frahm, 2001). Acrocarpous mosses are able to colonize new spaces via spores, most importantly by wind propagation (Jeschke, 2012). Since these species can be very small in size, mere millimetres in height, they prefer open patches to grow on. Pleurocarpous species are usually perennial and can grow to thick covers in the understorey of tall herbs and grasses. Bryophyte spores have similar distribution strategies to vascular plant diaspores. Some spores can germinate even after a substantial period of dormancy (for example as a sample in an herbarium) as findings of a study by Malta from 1922 showed: *Encalypta vulagris* spores germinated after 9 years of dormancy, and *Ceratodon purpureus* spores after sixteen years (Frahm, 2001).

Many dry grassland bryophyte species have developed methods of vegetative dispersal. This is because bryophytes' sexual reproduction is crucially dependant on water. Without it, the spermatozoids cannot move from the antheridium to the archegonium. Vegetative propagules facilitate dispersal not only in xerotherm conditions, but also if a species is dioicous and a stand (and in some cases, see *Syntrichia pagorum*, a continent) is lacking of female or male individuals (Vanderpoorten & Goffinet, 2010). In general, all fragments of a moss plantlet could function as a vegetative diaspore, but there are some specialized organs. These can be situated anywhere on the moss, from staunched or reduced branchlets – bulbils and flagellae – to leaflets that sit loosely or have a predetermined breaking point (Frahm, 2001). Some of these are important determinants for differentiating between certain species. For example, the size of rhizoid gemmae, or tubers, in some *Bryum* species. Rhizoidal tuber also occur in other lineages of acrocarpous mosses, for example Pottiaceae, but have not been found in pleurocarpous species (Goffinet & Shaw, 2009). Asexual reproduction has been recognized as an important driver for a bryophyte population's persistence and dispersal and a species' resilience against extinction (Fanfarillo et al., 2024).

(Frahm, 2001) mentions that xerothermic relict species have their main distribution ranges in the Mediterranean region but have disjunct areas in Central Europe that they colonised during the postglacial warmer periods (6000 – 7800 BP). These mosses were able to remain in these areas because the stands couldn't be overgrown by forest ("Steppenheiden-Theorie" of Gradmann 1901). It is unclear whether this is also true for bryophytes, since this concept was developed for flowering plants. However, all gametophytes of *Abietinella abietina*, *Rhytidium rugosum,* and *Pleurochaete squarrosa* on xerothermic relict stands in Central Europe are sterile. This could point out an actual relict occurrence from times that were more favourable for these mosses, which are therefore currently not able to reproduce sexually (on these stands).

1.6 Study aims

To revise the Dry Grassland Catalogue of Austria (Holzner et al., 1986b), relevés of 59 patches of dry-grasslands were carried out in the Weinviertel. This was also done to refine and confirm the syntaxonomic classification of these Pannonian grasslands. Because there were two graduate students working on this matter, and due to this author's interest in bryophytes, the post- processing of the data was split into two parts. While the analysis of the vascular plants is being carried out by the other author, this thesis focuses on the bryophytes in the sampled dry grasslands.
More specifically, the following questions are addressed in this study:
(1) Which bryophyte species occur in the dry grasslands of the Weinviertel?
(2) What is the diagnostic value of these species in terms of phytosociological units?
(3) Is the phytosociological optimum reported for the species in the literature consistent, or are there major contradictions?
(4) Do bryophytes alone allow a meaningful classification of the dry grasslands of the study area?

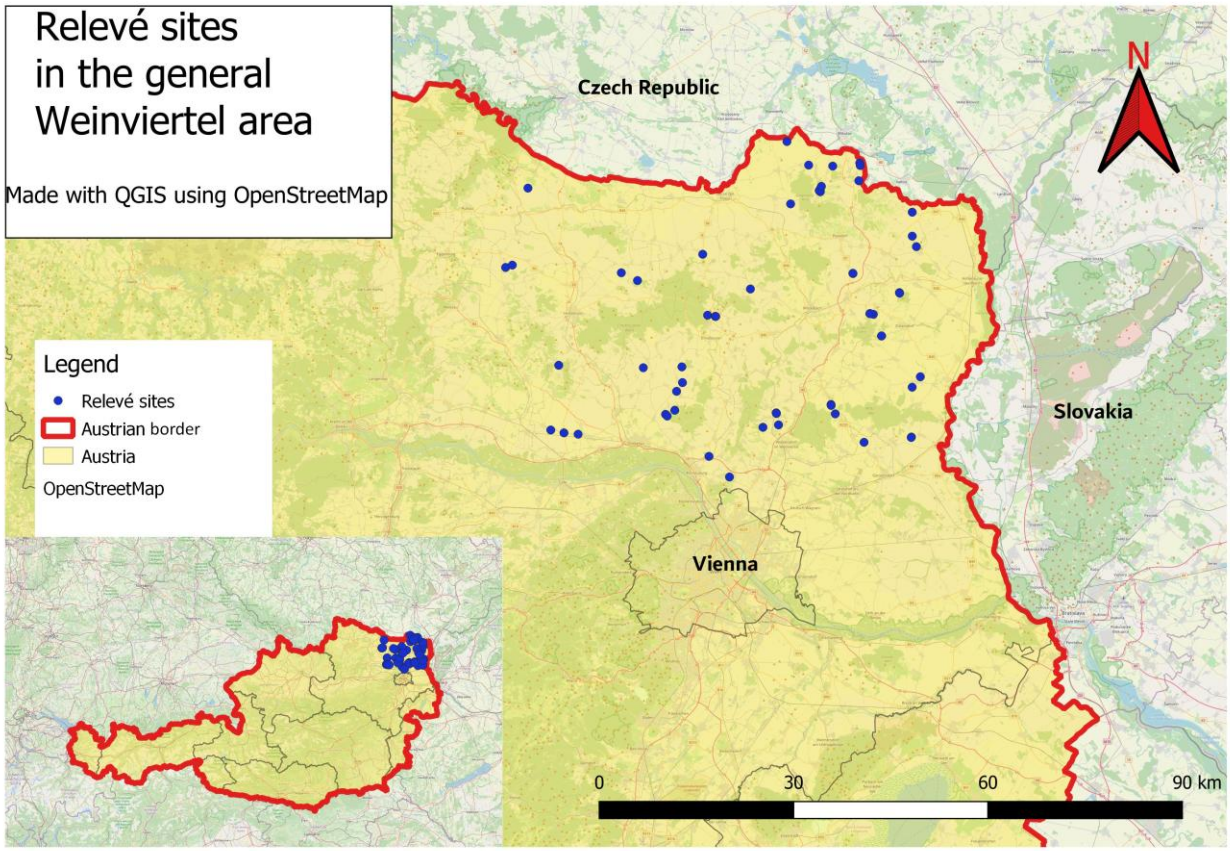

Figure 1

Map of the study area, situated in the Weinviertel, north-eastern Lower Austria. The sample plots are depicted in blue dots.

2. Study area

The thesis' sample plots (Figure 1) were located the Weinviertel. The study area coveres sites that are situated in the landscape lying between the slopes of the Bohemian massif to the west, the Czech Republic border to the north, the Morava river to the east, the loess slopes of the Wagram to the southwest, and the Danube and the slopes of the Bisamberg to the South. The acidic sandy grasslands along the Morava river, the inland dunes of the Marchfeld, and most of the calcareous cliff stands – called Waschbergzone (Figure 3) - in the middle of the Weinviertel, as these areas have already been covered by other studies, were excluded.

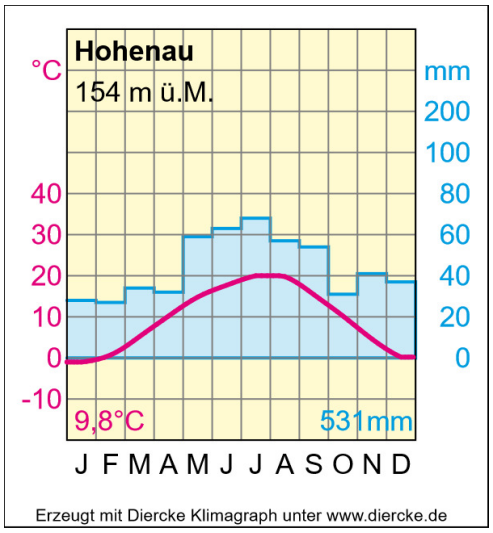

Figure 3

Climate diagram of Hohenau an der March, data derived from the ZAMG and converted into the diagram by Diercke Klimagraph, spanning the years from 1981

The climate of the Weinviertel (Figure 2) is mostly sub-continental to continental, dry summer climate with low precipitation, as is typical of the Pannonian region (Schlüsslmayr, 1999). The mean annual rainfall at the Austrian-Moravian border, the northern limit of our study area, is about 500 mm (Willner et al., 2013). The mean annual temperature in Mistelbach is 11.4°C (ZAMG, 2021).

The oldest elements of the Weinviertel geology (Figure 3) are the Bohemian Massif and the Molasse bedrocks, in the west and southwest of our study area. From the south, the next younger layers are the deep sea mud deposits of Flysch, strata that stretch to Bisamberg.

A cretaceous inland sea, the Paratethys, once covered the Vienna Basin. The chalk cliffs of the Waschberg zone and the Staatzer Klippe (Kollmann, 2009), then underwater reefs but now above sea level, were built by maritime organisms. Remnants of these organisms, around 16.5 million years old, were found at our stands close to the Austernbank of Tresdorf (sample plot 5) and also at our sample plots near Wolkersdorf (sample plots 54/55).

This part of the Paratethys was cut off from other maritime bodies of water. Eventually it turned into a freshwater sea, accumulated sediments, and silted up. During the Pleistocene, the river Danube moved south from its original position near Mistelbach, and came to rest flowing through the Wiener Pforte and Vienna. With this shifted riverbed came the fluvial sediments that the Danube gathered and transported as gravel and sands. Some stem from the Alps, glacial rubble washed out during warm times, while some still remain from the coast of the Paratethys. The youngest sediments in the area are the loess covers that were transported by wind. Loess contains 10 to 20% limestone, which makes for a very stable substrate (Kollmann, 2009). Holloways are therefore a good substrate for vascular plants and bryophytes that colonize open patches. This substrate also has a good storage capacity for water, warmth, and minerals (Kollmann, 2009).

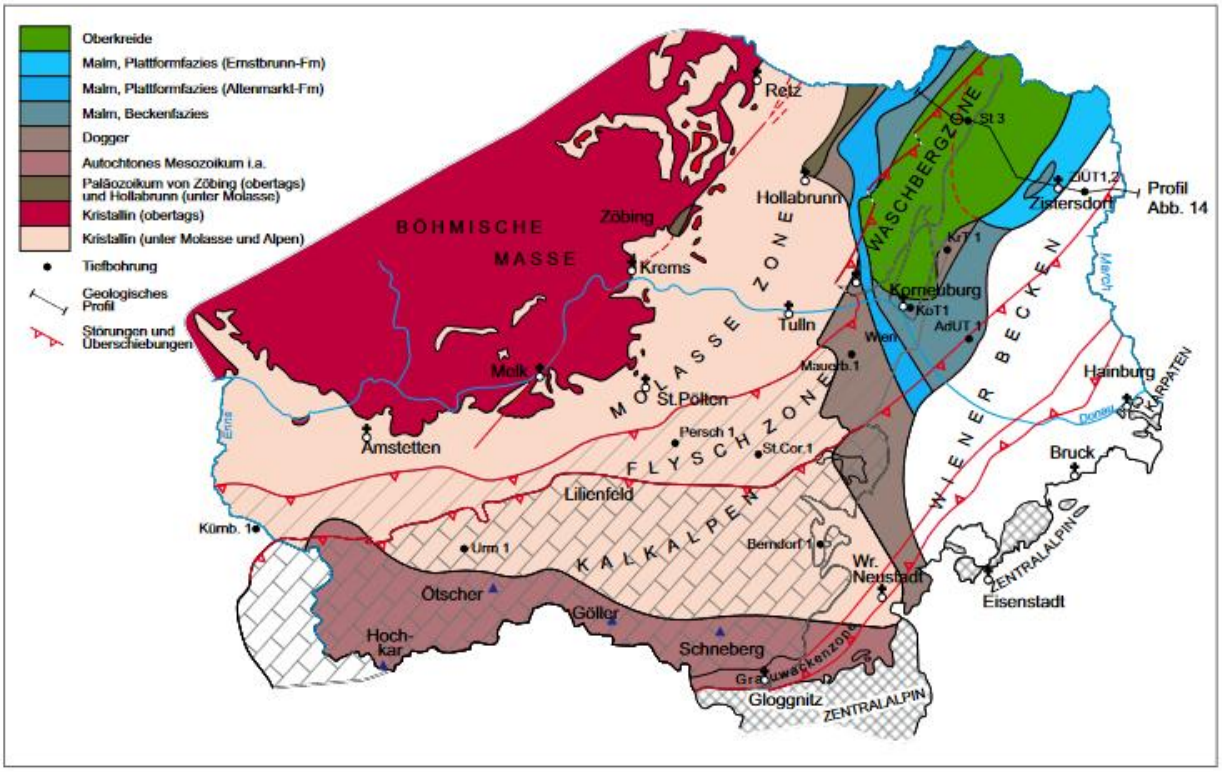

Figure 4

Overview of the founding substrate layers of the basin between the rivers Enns (West) and Thaya (East) (Wessely et al., 2006).

Although the substrate and Holocene climate of the Pannonian basin promotes forest growth, it was probably never completely covered by forest (Willner et al., 2021). Palaeolithic settlements also occurred along the Waschbergzone but were otherwise mostly limited to the river basins. Between 6,000 and 4,000 BC, Neolithic settlements were found over all of the Weinviertel, making use of the fertile loess soils (Lauermann et al., 2017). The human population was not yet so dense as to put settlement pressure onto the area, at least before the onset of agriculture – the first mowing might have took place with the development of the grass scythe around 2600 BP (Pokorný et al., 2015).

3. Methods

3.1. Field sampling

Relevés were carried out on 59 sample plots in the Weinviertel. This encompassed moss-samples to be determined and assigned to their respective relevés.

With the base of the Dry Grassland catalogue of Austria (Holzner et al., 1986b) and the precise sites known via shape files, sites that looked promising on satellite images, were chosen at random as sample plots. Locations that had been altered, diminished or were otherwise not feasible (too far away from the other sites, turned into a game preserve, or visibly damaged as seen on googlemaps satellite view…), were excluded.

The first sampling of the relevés was carried out in the late summer of 2016, to cover the late-summer (August/September) and early autumn aspect of the vegetation. The spring aspect was sampled in March/April of 2017, and field work was completed in May to June of the same year.

Vegetation was sampled on plots of 25m^2. This is larger than suggested by some authors (Dengler et al., 2008), (Löbel et al., 2006) but a commonly used plot size in dry grasslands (Willner et al., 2004).

Using the Braun-Blanquet method (Braun-Blanquet, 1964) all plants, vascular plant species and bryophytes, were filed into a list, with cover values added. We estimated abundance as cover values using a modified Braun-Blanquet scale (Table 1) .

Symbol	Cover values (%)
R	– 0,2%
+	(0.2) – 1 %
1	(1) – 5%
2a	(5) – 10%
2b	(10) – 25%
3	(25) – 50%
4	(50) – 75%
5	(75) – 100%

Table 1 Braun-Blanquet cover-values and their respective symbols that were used in our relevés.

Whenever possible, patches with homogenous conditions and vegetation, were preferred (Klink & Glawion, 2008). The slope of each sample plot was estimated in the field. So was the aspect, with the help of a compass. The altitude was measured as well – albeit with a GPS-device, so the values are not very reliable – and GPS points set.

3.2. Determination of bryophytes and data set preparation

A lot of bryophyte species that dwell in dry grasslands are not possible to determine in the field. Therefore, specimens of most species in the sample plots were collected during relevés and determined afterwards. Because acrocarpous moss species of dry grasslands are often very small, a dissecting microscope and a microscope were used for determination. This was also due to some character states – cell size, gemmae, spores – that can only be safely distinguished with the use of a stage micrometer and a measuring eye piece.

Bryophyte specimens were collected in small paper bags. The bags were marked with the plot name or number and the date of collection to represent one relevé. For each bryophyte, an entry was made into the species list of the plot and cover values were estimated. If the species was unknown, a short description of the bryophyte habitus was put into the list to assure that the cover estimated in the field was assigned to the correct species name.

After determination of the species, the relevés were entered into a TURBOVEG database (Hennekens & Schaminée, 2001). Species lists from multiple sampling of the same plot were merged and the highest cover value was taken for each species.

The identification of bryophyte species followed the Moosflora (Frahm & Frey, 2004). The first two volumes of Moosflora Baden-Württembergs (Ahrens et al., 2000) were also employed for identification. Species names were adapted to the nomenclature of the Checklist of Austrian Bryophytes, provided by the Division of Conservation Biology, Vegetation Ecology and Landscape Ecology from the University of Vienna (Köckinger et al., 2020). If the name in this list differs from the generally accepted name, the common synonym that was found in the literature is stated below.

3.4. Literature review of species diagnostic values

Information about the diagnostic value of the moss species was compiled from eight publications. There are certain differences between the studies, for example some authors stated that they only provide diagnostic species for syntaxa in the rank of a class, since there was not enough data on some syntaxa of lower rank (Mucina et al., 2016a). We excluded classes when their ecological conditions or distribution, as described in that paper, did not match with our study area, even if we found a match with the mosses from our data.

The oldest study that we used was by (Marstaller, 1993). It is dealing with a specific study area, in the southern part of Hungary, concentrating specifically on bryophyte communities. Not as synusiae, but as syntaxa in their own right. How they came to determine their character species etc. is not stated. The author provided detailed information about the composition of their findings on association-level. However, I only used the information about species' diagnostic value from alliance level and higher. The rank-specific diagnostic values are explicitly stated in their species lists.

The second oldest study that we used as a source for diagnostic species' data was by (Willner et al., 2004). The study area of this paper is located in the East of Austria and specifically focused on dry grassland patches. In contrast to our study, however, the relevés were located south of the Danube, in Lower Austria and northern Burgenland.
Like in our study, rocky grasslands were not included. The paper includes information on diagnostic species of four syntaxa: the *Cirsio-Brachypodion*, the *Festucion valesiacae*, the *Seslerio-Festucion pallentis* and the *Festuco-Brometea*.

The overview by (Schubert, 2009) is focused on bryophyte communities specifically and restricted to the area of Sachsen-Anhalt in Germany. It also puts emphasis on the fact that bryo-sociological research had already been done in the area, and the authors aim to encourage further studies on the subject.
However, it is not explicitly stated how the diagnostic value of the species had been determined. The work lists character species for all classes, orders and alliances of bryophyte communities.

The study by (Chytrý et al., 2010) presents a classification of the Vegetation of the Czech Republic. The diagnostic species listed for alliances and classes were determined by statistical methods calculating fidelity values. A big difference to the other studies is that the authors didn't include the syntaxonomic rank of "order". Moreover, syntaxa of bryophyte communities are not included in this work.

The study by (Dengler et al., 2012) presents data from dry grasslands of Transylvania. The regional diagnostic value of each species was estimated with statistical methods. Since each order included only one alliance with few associations, the species listed as diagnostic for an association in this study are considered as diagnostic species of the order in the analysis.

Another important study, considering the methods used, was carried out by (Kuzemko et al., 2014). The study area of this paper was located in the Ukraine, and its aim was to assemble data that could be used to compare the dry grasslands' species composition there to that of dry grasslands' syntaxonomy in all of Europe. Vascular plant and bryophyte species were included, as well as lichens. The diagnostic value of species was estimated with statistical methods using the same methods as in Dengler et al. (2012). However, in contrast to the latter study, supra-regional character species of classes and orders were identified on the basis of expert knowledge.

The study with the most resources for the data analysis was by (Mucina et al., 2016b). The authors of this study gathered phytosociological data from all over Europe in an attempt to classify the vegetation of Europe, unify nomenclature and consolidate the syntaxonomic hierarchy. This was

done to create a fundament for further research and to assess already existing data. The authors provided lists of diagnostic species for all classes of vascular plants, bryophytes and lichens, as well as algae. We used all but the latter for our analysis.
The authors used only "diagnostic" values and did not differentiate between character species and differential species. However, if a species was mentioned to be diagnostic for one single syntaxon only, we remarked, later in the text, that it can well be considered to be a character species. The study mainly used sources that had been accompanied with synoptic tables – but, as a main difference, did not carry out statistical research on behalf of the diagnostic species themselves.

The most recent paper that was included was the study by (Willner et al., 2017) from 2017. The study area of this research paper was quite large, it accumulated syntaxonomic information from Hungary, Eastern Austria, Moravia (south-Eastern Czech Republic), Slovakia, Romania, Slovenia, Vojvodina (North Serbia), Northern Croatia, Ukraine (except Crimea), southern Poland and the Bryansk region in Western Russia. Data was sourced from databases, and diagnostic values were calculated using statistical methods.
For our purpose, this study only yielded information on alliance-level, and only for three orders, namely the *Festucetalia valesiacae*, the *Stipo-Festucetalia pallentis* and the *Brometalia erecti*. All syntaxa in the paper were vascular-plant based, but diagnostic values of bryophytes were calculated a-posteriori.

The following information was extracted from the papers: Character species of syntaxa above association level were preferred, but all diagnostic species of alliances, orders and classes were registered. This information was collected in an excel-table. When one of the sampled bryophytes was mentioned as a character species for only associations or subassociations, they were brought into the list as characteristic for a higher level (alliance minimum) to reach a common ground with all the papers used. The names of the collected syntaxa were also checked for synonyms and corrected accordingly. Transgressive character species were rejected. Then all the syntaxa, with at least one bryophyte species being listed as characteristic, were collected in a separated table. This table was then checked for synonyms using the EuroVeg-Checklist (Mucina et al., 2016a).

The list of all the syntaxa found in the eight publications, was then assembled according to the order that they are listed in (Mucina et al., 2016a). The information extracted from the eight phytosociological studies was compiled in a table depicting the diagnostic status each moss held within the syntaxon (C: character species; D: differential or unspecified diagnostic species). Character species of alliances were also counted as character species of the order and class.

3.5. Data analysis

To classify the collected data, the TWINSPAN algorithm (Hill, 1979) was used. The graphs which represent the sampling sites were grouped into four. The method stated by the authors (Willner et al., 2013) was also used in this thesis. The following cut levels were used: 0%, 2%, 5% and 2,5%. The minimum group size was five, the maximum level of divisions was four. All data calculations, processing and table management were done via the JUICE 7.0 program (Tichý, 2002).

The TWINSPAN algorithm always places the division in the centre of the strongest gradient (Hill, 1979), which is dependent on the dataset (Willner et al., 2013). To homogenise syntaxa that had been falsely separated by the program, it can be necessary to rearrange clusters by hand, fortunately this was not the case in this thesis.

4. Results

Seventy-four syntaxa from literature research could be connected to the one hundred moss species that had been listed in the field. That number of moss species includes six taxa that were only listed as "sp." because the determination in some cases could not be more specific than the genus level, mostly due to the lack of sporophytes. However, this also included some species that were listed at aggregate level only. Most of these, and the species that had only been determined to the genus level, were removed. Except for the *Bryum capillare agg.,* which had as such, been registered in the literature as diagnostic. Some moss species had been listed but ruled out by the supervisor because of their divergent occurrence. Hence, only 76 species remained that were used for the final synthesis-table. From this table, a text-file was created to pull together the information about the syntaxa per species. Hence, with transformation in a text-managing program, a two-column table was formed.

Of the syntaxa, some had to be removed as well, for example the *Seslerion rigidae*. Whenever a species was listed with the *Koelerio-Corynophoretea* we had to exclude it, because (Mucina et al., 2016a) circumscribe that class differently (i.e., excluding the class *Sedo-Scleranthetea*). Some of the syntaxa showed a geographic distribution that was not convergent with our study area, they also were excluded. Same is true for some of the epiphytic syntaxa, and so only 45 syntaxa remained valid in our table.

In the appendix, a list of all the syntaxa for which moss species were found from the relevés to be listed as diagnostic, is shown. For the results listing all syntaxa per moss species, see results section 4.1.
Then the information of species and syntaxa was combined with the relevés. The result of this synthesis was a cross table that plots the syntaxa – via the information of "diagnostic moss species present" – to the relevés. For this information, please see Table 2. It depicts the amount of diagnostic species of each syntaxon, in the rows and in hierarchical order (*C* = class, *O* = order, *A* = alliance), being displayed per relevé in the columns.

The colour code changes from light yellow to dark green indicating an increasing number of diagnostic species. This helps the reader to see instantaneously which of the 45 syntaxa in the combined table have the most diagnostic species in our relevés: The *Festuco-Brometea* and the *Psoretea decipientis*. The reader can also look up the number of the relevé with the highest amount of diagnostic species found: 52 and 58 with thirteen diagnostic species. The relevé numbers correspond to the graphs in the result section, and to Table 6 in the appendix.

4.1. Diagnostic value of the moss species

In this section, the moss species are listed with the syntaxa they were mentioned as diagnostic for and by whom of the authors. The depictions of the sampling sites in graphs are shown in the appendix. The results for each bryophyte species are followed directly by a short discussion-part. There is also a syntaxa-list at the beginning of each moss-description. Its hierarchy is top-down and has the
following scheme: *-etea* *class* (reference)
-etalia *order* (reference)
-ion a*lliance* (reference).

For a list of all the syntaxa that are mentioned in our results, including descriptions of the syntaxa as given by (Mucina et al., 2016a), please refer back to the appendix. The list there also shows the hierarchy of the syntaxa.

Short descriptions of the respective bryophytes include information regarding (or limited to) the conditions in our study area.
Encalypta streptocarpa is the moss species with the most diagnostic nominations from our literature with eleven syntaxa, followed by *Ceratodon purpureus* with nine. Eight syntaxa nominations were found for *Abietinella abietina*, *Fissidens exilis* and *Tortella tortuosa*.

The plotted table we added as Table 2 resulted in the following mosses being noted as diagnostic species for the 45 syntaxa.

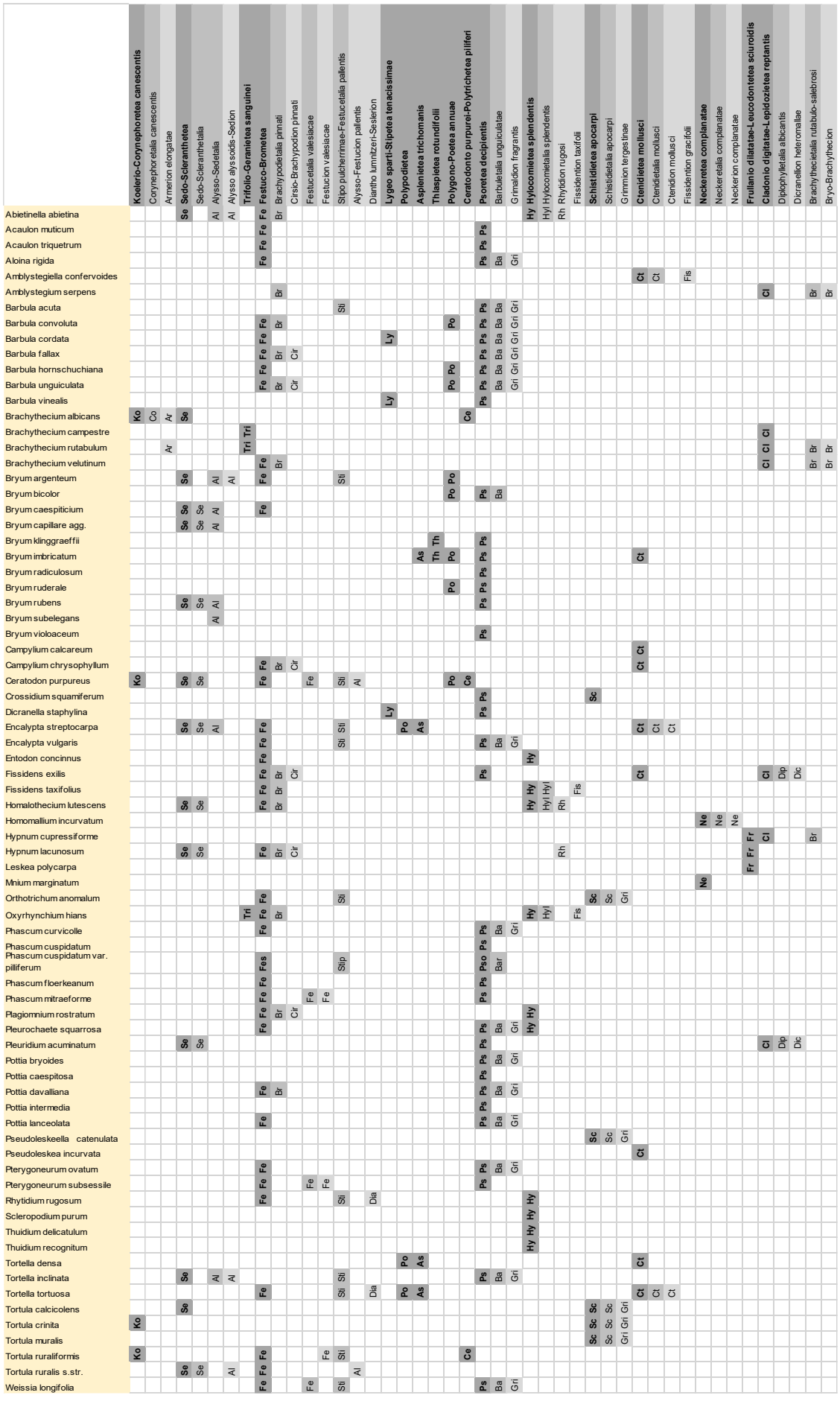

Table 2 Cross table showing the species found in the sampling plots and the syntaxa for which they are diagnostic according to the reviewed literature.

Abietinella abietina

This is a perennial species of the *Thuidiaceae* that can be found on limestone and silicieous substrates alike. It is a regular single-pennante bryophyte that does well in dry grasslands and can build felt-like covers that regulate the germination of angiosperms. On habitats that have a lot of rainfall, it is quickly overgrown by other plants. This xerothermic species is mentioned by (Schlüsslmayr, 2005) as a character species for the *Abietinellion*, which is a synonym for the *Rhytidion*.

Syntaxa:

Sedo-Scleranthetea: diagnostic species (Marstaller, 1993) and (Mucina et al., 2016a)
Festuco-Brometea: character species (Willner et al., 2004) and diagnostic species: (Mucina et al., 2016a) and (Chytrý et al., 2010)
Brachypodietalia pinnati: diagnostic species (Dengler et al., 2012) and (Chytrý et al., 2010)
Hylocomietea splendentis: diagnostic species (Mucina et al., 2016a)
Rhytidion rugosi: character species (Schubert, 2009) and (Marstaller, 1993) – as *Abietinellion*

Abietinella abietina was mentioned as a diagnostic species for the class of *Sedo-Scleranthetea* and for the class' subdivisions, the order of *Alysso-Sedetalia,* and the *Alysso alyssoidis-Sedion* supported by a different author (Kuzemko et al., 2014). All of these syntaxa dwell on calcareous substrates (Mucina et al., 2016a). The species was also mentioned to be diagnostic for a different class of higher plant species, the *Festuco-Brometea* and for its subdivision, the order of *Brachypodietalia pinnati*. Furthermore, it was stated to be diagnostic for the *Hylocomietea splendentis*, directly by (Mucina et al., 2016a) as well as indirectly by (Schubert, 2009) and (Marstaller, 1993). This information came from the species being mentioned indirectly for the *Hylocomietalia splendentis* with a direct mention for the *Rhytidion rugosi* (Marstaller, 1993) and (Schubert, 2009). However, those authors used a synonym for the alliance, the *Abietinellion abietinae*, which (Marstaller, 1993) put into the order of the *Sedo-Scleranthetalia* and the class of *Sedo-Scleranthetea*. (Mucina et al., 2016a) puts into the class of *Hylocomietea splenditis*.

So, one could conclude, that this species is present in a couple of syntaxa belonging to different classes, which is not only due to its broad amplitude, but also due to syntaxonomic differences between the studies.

Acaulon muticum

This genus of mosses forms small, bud-shaped gametophytes (Frahm, 2001). It is mentioned as a character species of the *Phascion cuspidati*, growing on loamy, baserich soils in (Schlüsslmayr, 2005). It is a dioecious species (Berg et al., 2025a).

Syntaxa:

Festuco-Brometea: diagnostic species (Mucina et al., 2016a)
Psoretea decipientis: diagnostic species (Mucina et al., 2016a)

This species was mentioned to be diagnostic for the *Festuco-Brometea*, dry grasslands on mostly base-rich soils. *A. muticum* was also mentioned to be diagnostic for the *Psoretea decipientis*, a class of syntaxa which are also found on calcareous soils (Mucina et al., 2016a).

Acaulon triquetrum

This dioecious species is mentioned as fruiting regularly, it dwells on base-rich, dry soils, dry grasslands and loess walls (Berg et al., 2025a).

Syntaxa:

Festuco-Brometea: diagnostic species (Mucina et al., 2016a)
Psoretea decipientis: diagnostic species (Mucina et al., 2016a)

Aloina rigida

Aloina species have unusually thick, fleshy leaflets with a succulent appearance – hence the genus' name. The leaflets are built with filaments on the rib as well as involute margins. The margins cover the filaments to protect the water that is stored there from evaporation (Frahm, 2001). A cross-section of an *Aloina*- leaflet looks like a basket with chlorophyll-filled cell-stacks.
These dioecious (Berg et al., 2025a) mosses build herds of single individuals that form very hard crusts on mostly loess substrate. They build their sporophytes very quickly, probably to make use of open stands.
Aloina rigida, growing on open, base rich loamy soils, is mentioned as a threatened species in Austria (red list 3) (Schlüsslmayr, 2005).

Syntaxa:

Festuco-Brometea: diagnostic species (Mucina et al., 2016a)
Psoretea decipientis: diagnostic species (Mucina et al., 2016a)
Barbuletalia unguiculatae: character species (Marstaller, 1993)
Grimaldion fragrantis: character species (Schubert, 2009)

A. rigida was mentioned as a diagnostic species for two classes, the *Festuco-Brometea* and the *Psoretea decipientis* (Mucina et al., 2016a). Both dwell mostly on base-rich soils. (Marstaller, 1993) suggests the order of *Barbuletalia unguiculatae*, which belong to the class of *Psoretea decipientis*. (Schubert, 2009) mentions it as a diagnostic species for yet another subdivision of the same class, the alliance of the *Grimaldion fragrantis.* These two syntaxa are characterized by dry and loamy soils (Mucina et al., 2016a). All authors support the same class of non-vascular plant syntaxa that this species was mentioned as diagnostic for. One of the authors, (Mucina et al., 2016a), has also provided information for a vascular-plant community.

Amblystegium confervoides *(Amblystegiella confervoides)*

In last year's publication, Mossflora von Österreich, this autoecious species is listed as ***Serpoleskea confervoides*** (Berg et al., 2025b).
This species is mentioned to be a character species of the *Bryo-Brachythecion* by (Schlüsslmayr, 2005).
Syntaxa:

Ctenidietea mollusci: diagnostic species (Mucina et al., 2016a)
Ctenidietalia mollusci: diagnostic species (Mucina et al., 2016a)
Fissidention gracifolii: character species (Marstaller, 1993)

All of the authors support the same class of syntaxa that this species was mentioned as diagnostic for, the *Ctenidietea mollusci*, which dwells on calcareous soils (Mucina et al., 2016a). The species was

also put within the order of *Ctenidietalia mollusci* and the alliance of *Fissidention gracilifolii* of the same class (Marstaller, 1993). In this paper, the alliance is called "*Fissidention pusilli"* – which is a synonym for the *F. gracilifolii* (Mucina et al., 2016a). The latter is put within the *Ctenidietalia mollusci* in (Mucina et al., 2016a) and not the *Neckeretalia complanatae* as in (Marstaller, 1993).

Amblystegium serpens

This autoecious (Berg et al., 2025b) species has been mentioned as a perennial shuttle species, and was apparently also found in an intensively farmed vineyard (Zechmeister, 1999).

Syntaxa:

Brachypodietalia pinnati: diagnostic species (Willner et al., 2004)
Cladonio digitatae-Lepidozietea reptantis: diagnostic species (Mucina et al., 2016a)
Brachythecietalia rutabulo-salebrosi: diagnostic species (Marstaller, 1993)
Bryo-Brachythecion: diagnostic species (Marstaller, 1993)

Amblystegium serpens was mentioned by two of the authors, who put it in communities that dwell on calcareous, base-rich soil and organic matter: (Willner et al., 2004) and (Marstaller, 1993). (Mucina et al., 2016a) also mentions communities on decaying matter, but also on acidic soils. This is not a problem since the decay of organic matter naturally produces humic acid. So it was accepted that the appearance on calcareous soils is "the bigger picture" and the acidic soils in the (only) lichen-and-bryophyte community deals with the small-scale microhabitat (that those species maybe create themselves). The *A. serpens* is a rather thin-structured moss compared to the species that gave its name to the syntaxa mentioned by Marstaller, the *Brachythecium.*

All of the authors support the same class of non-vascular plant syntaxa this species was mentioned as diagnostic for. One of the authors, (Willner et al., 2004) has also provided information for the species' diagnostic value in a vascular-plant community, the *Brachypodietalia pinnati*.

Barbula convoluta

This is a ruderal moss species, quite common, of the genus *Barbula* (Frahm, 2001). It is species of more open dry grasslands (Schlüsslmayr, 2005). This species has been listed as ***Steblotrichum convolutum*** in the recently published Moosflora von Österreich (Berg et al., 2025a).

Syntaxa:

Polygono-Poetea annuae: diagnostic species (Mucina et al., 2016a)
Psoretea decipientis: diagnostic species (Mucina et al., 2016a)
Barbuletalia unguiculatae: character species (Marstaller, 1993)
Grimaldion fragrantis: character species (Schubert, 2009) and (Marstaller, 1993)

B. convoluta is mentioned to be diagnostic for three different classes. Two of them are based on vascular plants. But only one of them, the *Festuco-Brometea* can be considered with justifiable satisfaction, because no trampled habitats were included in the sample plots. This information is somewhat specified by the same authors, who mention the species for the *Brachypodietalia pinnati*, which is one of the three orders in the class. This order stands for the semi-dry grasslands, which fits quite well for most of our sites' vegetation. The third class that is mentioned is based on lichen and

bryophyte communities. Three different authors mention three different categories of said class. The class itself is mentioned by the authors that never go below class-level in the "Vegetation of Europe" (Mucina et al., 2016a). With the other two sources, two levels of subdivision are mentioned: the order of *Barbuletalia unguiculatae* and the alliance of *Grimaldion fragrantis*. What they have in common is the pioneer character of the vegetation, and the dry loamy soils as substrate. The latter is a fact, that was also mentioned in the determination literature (Ahrens et al., 2000).

Barbula unguiculata

This is a ruderal moss species of the diverse genus *Barbula* (Frahm, 2001), it has been listed as a colonist species (Zechmeister, 1999) and is dioecious (Berg et al., 2025a). It prefers calcareous substrates and is a character species of the *Barbuletalia unguiculatae* (Schlüsslmayr, 2005).

Syntaxa:

Polygono-Poetea annua: diagnostic species (Mucina et al., 2016a)
Psoretea decipientis: diagnostic species (Mucina et al., 2016a)
Barbuletalia unguiculatae: character species (Marstaller, 1993)
Grimaldion fragrantis: character species (Marstaller, 1993)

This species' diagnostic value is similar to that of *Barbula convoluta*, and presents more finetuning – or support – on behalf of the subdivisions of *Festuco Brometea* with additional information by (Dengler et al., 2012).

Brachythecium albicans

This species grows on acidic substrates only and prefers dry habitats. Its stemlets are threadlike and glossy with accumbent foliage. It had its highest constancy value (30%) in the cluster of acidic sandy soils, in the study of syntaxonomic revisions of the Pannonian dry grasslands in Austria. Of all mosses mentioned in this study, only *Abietinella abientina* had a higher constancy value (32%) in that cluster (Willner et al., 2013). For context, we want to point out that it was stated that 75% constancy means that a species was present in 3 out of 4 relevés (Berg & Dengler, 2005). So overall, 30% is not a very high value.

Syntaxa:

Koelerio-Corynephoretea canescentis: diagnostic species (Mucina et al., 2016a) and (Kuzemko et al., 2014)
Corynephoretalia canescentis:
Armerion elongatae: diagnostic species (Chytrý et al., 2010)
Sedo-Scleranthetea: diagnostic species (Kuzemko et al., 2014)
Ceratodonto purpurei-Polytrichetea piliferi: diagnostic species (Mucina et al., 2016a) and character species: (Schubert, 2009)

This species was mentioned as diagnostic for three different classes and some of their respective subdivisions. The *Koelerio-Corynephoretea canescentis* (Mucina et al., 2016a) and (Kuzemko et al., 2014) and *Corynephoretalia canescentis* (Schubert, 2009) and (Kuzemko et al., 2014) are typical for siliceous substrates and are grassland communities (Mucina et al., 2016a). The latter is also true for the alliance of *Armerion elongatae* (Chytrý et al., 2010). All have in common, that the substrate they dwell on has deteriorated to sandy consistency. The slight acidity of the substrate is a feature that the latter classes share, for which *B. albicans* was also mentioned to be diagnostic for. The *Sedo-Scleranthetea* (Kuzemko et al., 2014) are a class of more rocky substrates with shallow, siliceous soils

(Mucina et al., 2016a), whilst the *Ceratodonto purpurei-Polytrichetea piliferi* (Mucina et al., 2016a) and (Schubert, 2009) dwell on more gravelly soils (Mucina et al., 2016a). It is deemed as a character species for two different classes of vascular plant species by two different authors, with slightly more support for the *Koelerio-Corynephoretea canescentis*.

Brachythecium campestre

Syntaxa:

Trifolio-Geranietea: diagnostic species (Mucina et al., 2016a)
Cladonio digitatae-Lepidozietea reptantis: diagnostic species (Mucina et al., 2016a)

This species was diagnostic for the classes of *Trifolio-Geranietea sanguinei* and of *Cladonio digitatae-Lepidozietea reptantis*, the latter are bryophyte and lichen communities on decaying organic matter and acidic soils (Mucina et al., 2016a). Lawn-thatch certainly qualifies as decaying organic matter. We indeed found moss-stemlets growing on, almost clinging to, dried remnants of herbs and grasses. Those, as a rule, were threadlike pleurocarpous mosses, maybe "Kümmerformen", with very small leaflets.

Brachythecium rutabulum

This moss is a nitrophilous species (Frahm, 2001). It is able to exploit nutrients of plant litter (Goffinet & Shaw, 2009) some of which had been noted in this thesis' relevés as "grass felt".

Syntaxa:

Armerion elongatae: diagnostic species (Chytrý et al., 2010)
Trifolio-Geranietea sanguinei: diagnostic species (Mucina et al., 2016a)
Cladonio digitatae-Lepidozietea reptantis: diagnostic species (Marstaller, 1993) and (Mucina et al., 2016a)
Brachythecietalia rutabulo-salebrosi: character species (Schubert, 2009) and diagnostic species (Marstaller, 1993)
Bryo-Brachythecion: diagnostic species (Marstaller, 1993)

This species was mentioned to be diagnostic for the *Armerion elongatae* (Chytrý et al., 2010), which are an alliance of meso-xerophytic swards on slightly acidic to alkaline sandy soils that belongs to the *Koelerio-Corynephoretea canescentis* (Mucina et al., 2016a). However, *Brachythecium rutabulum* was mentioned by a different author to be diagnostic for a different class of quite different conditions, the *Trifolio-Geranietea sanguinei* (Mucina et al., 2016a). This could be a case of fringe-plant communities, and nitrophilous moss may play a role in both syntaxa.

Brachytheciastrum velutinum *(Brachythecium velutinum)*

This autoecious (Berg et al., 2025b)moss species has been found in the Pliocene fossil flora of Europe, stemming from five to two million years ago, the data point provided in (Frahm, 2001) is from Russia (Duab Abkhazia).

Syntaxa:

Festuco-Brometea: (Mucina et al., 2016a)
Brachythecietalia rutabulo-salebrosi: diagnostic species (Marstaller, 1993)
Bryo-Brachythecion: diagnostic species (Marstaller, 1993)

This species was mentioned to be diagnostic for two classes. The first, the *Festuco-Brometea* (Mucina et al., 2016a), are syntaxa of dry grasslands on mostly base-rich soils (Mucina et al., 2016a). *Brachytheciastrum velutinum* was directly mentioned to be diagnostic for a subdivision of said class, the order of *Brachypodietalia pinnati* (Dengler et al., 2012). We then concluded that it would also be supporting the diagnostic information on class-level and increased the yield of information for the relevé-graphs by elevating the diagnostic value for the class as well. The *Brachypodietalia pinnati* are an order of meso-xerophytic grasslands on deep calcareous soils in Western and Central Europe (Mucina et al., 2016a).

The second class are the *Cladonio digitatae-Lepidozietea reptantis* which we only found indirect information for. This syntaxon consists of bryophyte and lichen communities on decaying organic matter and acidic soils (Mucina et al., 2016a). *B. velutinum* was directly mentioned to be diagnostic for the order of the *Brachythecietalia rutabulo-salebrosi* (Marstaller, 1993) and the alliance of *Bryo-Brachythecion* (Marstaller, 1993). Both are communities of hemerophilous weft- and mat-forming pleurocarpous mosses on nutrient-rich rotting wood at any stage of decay and on root flares in habitats with base-rich soil (Mucina et al., 2016a).

Bryum amblyodon *(Bryum imbricatum)*

This species has been listed as ***Bryum archangelicum*** in the recently published Moosflora von Österreich (Berg et al., 2025a).

Syntaxa:

Asplenietea trichomanis: diagnostic species (Mucina et al., 2016a)
Thlaspietea rotundifolii: diagnostic species (Mucina et al., 2016a)
Polygono-Poetea annuae: diagnostic species (Mucina et al., 2016a)
Psoretea decipientis: diagnostic species (Mucina et al., 2016a)
Ctenidietea mollusci: diagnostic species (Mucina et al., 2016a)

This species was mentioned to be diagnostic for five different classes of syntaxa, by the same author (Mucina et al., 2016a). They differ in their habitats but are mostly plant communities of calcareous substrates, with a preference of rock or scree. It was therefore decided not to consider it as a character species.

Bryum argenteum

This dioecious (Berg et al., 2025a) species forms small silvery stemlets that are quite common in cities. It is a nitrophilous species that can also supplant less competitive mosses. The tips of the leaflets of *Bryum argenteum* are elongated and hyaline. This gives the gametophytes a silvery colour that serves to reflect the sunlight (Frahm, 2001) and is an adaptation to xerothermic stands.

Syntaxa:

Alysso alyssoidis-Sedion: diagnostic species (Kuzemko et al., 2014)
Festuco-Brometea:
Stipo pulcherrimae-Festucetalia pallentis: diagnostic species (Dengler et al., 2012)
Polygono-Poetea annuae: diagnostic species (Mucina et al., 2016a)

B. argenteum was mentioned to be diagnostic for three different classes by three different sources, the *Sedo-Scleranthetea* (Kuzemko et al., 2014) indirectly, the *Festuco-Brometea* (Dengler et al., 2012) and the *Polygono-Poetea annuae* (Mucina et al., 2016a) directly. Thus, we can assume that it is a species with a broad ecological amplitude. No trampled habitats – such as the *Polygono-Poetea*

annuae, but sometimes, parts of stony outcrops were sampled during data collection, such as the syntaxa mentioned by (Kuzemko et al., 2014) and (Dengler et al., 2012). These are the order of *Alysso-Sedetalia* (Kuzemko et al., 2014) indirectly and the alliance of *Alysso alyssoidis-Sedion* (Kuzemko et al., 2014), as well as the alliance of *Stipo pulcherrimae-Festucetalia pallentis* (Dengler et al., 2012), which belongs to the *Festuco-Brometea* (Dengler et al., 2012).

Bryum bicolor

Mosses belonging to this complex of species form bulbils with which they propagate and by which they can be determinated. The bulbils are situated in the axils of their leaflets (Frahm, 2001). This species has been described by other authors to be a colonist, also forming populations locally via resident rhizoid tubers in the soil (Goffinet & Shaw, 2009). This dioecious species, and also its synonym *B. gemmiferum*, have been listed as ***Bryum dichotomum*** in the recently published Moosflora von Österreich (Berg et al., 2025a).
Syntaxa:

Polygono-Poetea annuae: diagnostic species (Mucina et al., 2016a)
Psoretea decipientis: diagnostic species (Mucina et al., 2016a)
Barbuletalia unguiculatae: character species (Marstaller, 1993)

B. bicolor was mentioned to be diagnostic for two different classes by (Mucina et al., 2016a). One of these classes, the *Psoretea decipientis*, was also supported by (Marstaller, 1993) by mentioning it with a subdivision of said class. This subdivision is the order of the *Barbuletalia unguiculatae*. This might have more diagnostic value than the *Polygono-Poetea annuae*, because no trampled habitats were sampled. The other two syntaxa are apt additions to our sampling scheme with the dry and subneutral to calcareous soils (Mucina et al., 2016a).

Bryum caespiticium

This moss species can be found in more open meadows and dry grasslands, but also on fallows, heaps of gravel and waysides (Schlüsslmayr, 2005). It is a dioecious species that becomes synoicous over time, which means it produces male inflorescences mainly, and only single archegonia are added over time (Goffinet & Shaw, 2009).

Syntaxa:

Koelerio-Corynephoretea canescentis: diagnostic species (Kuzemko et al., 2014)
Sedo-Scleranthetea: diagnostic species (Kuzemko et al., 2014)
Festuco-Brometea: character species (Willner et al., 2004)

This species was mentioned to be diagnostic for the *Koelerio-Corynephoretea canescentis* (Kuzemko et al., 2014), dry grasslands on sandy soils and on rocky outcrops (Mucina et al., 2016a).

The species was also mentioned as diagnostic for the *Sedo-Scleranthetea* (Kuzemko et al., 2014). *Bryum caespiticium* was contradictorily mentioned to be diagnostic for two subdivisions of the latter class, the order of *Sedo-Scleranthetalia* (Kuzemko et al., 2014) and the order of *Alysso-Sedetalia* (Kuzemko et al., 2014).

Lastly, this species was also described to be diagnostic for the *Festuco-Brometea* (Willner et al., 2004).

Bryum capillare agg.

This dioecious (Berg et al., 2025a) species can be found between calcareous rocks and forms whitish hairs on its long tips. It is a slightly acidophilous species and can also be found on loamy soils and gravel (Schlüsslmayr, 2005).

Syntaxa:

Sedo-Scleranthetea: character species (Kuzemko et al., 2014)

Sedo-Scleranthetalia: character species (Kuzemko et al., 2014)

The only group of syntaxa for which the *B. capillare* aggregate was mentioned as diagnostic belongs to the *Sedo-Scleranthetea* (Kuzemko et al., 2014). The diagnostic value was specified down to the alliance level, however for two syntaxa on the same level, which constituted a contradiction. Calcareous shallow soils (Mucina et al., 2016a) were certainly part of our sampled dry grassland patches. While we had explicitly ruled out to sample acidic sands beforehand, base-rich sandy patches infrequently occurred. These had mostly weathered from deteriorating base-rich rocky substrates and/or scree.

Bryum klinggraeffii

This dioecious (Berg et al., 2025a) moss species is part of the *Bryum atrovirens* (- *erythrocarpum*) complex and is distinguishable by its crimson rhizoid gemmae. It can be found on ruderal sandy and loamy stands and is mentioned to be a character species of the *Barbuletalia unguiculatae* by (Schlüsslmayr, 2005).

Syntaxa:

Thlaspietea rotundifolii: diagnostic species (Mucina et al., 2016a)

Psoretea decipientis: diagnostic species (Mucina et al., 2016a)

Bryum moravicum (also found syn. *Bryum pallens*, but with *B. moravicum* also syn. *B. flacc.*)

*(Bryum subelegans) (*for *Bryum stirtonii* – all findings changed to *B. subelegans* in TURBOVEG instead.) This dioecious species has been mentioned to be of rather broad distribution (Berg et al., 2025a).

Syntaxa:

Alysso-Sedetalia: character species (Kuzemko et al., 2014)

This bryophyte species was mentioned to be diagnostic for the *Alysso-Sedetalia* (Kuzemko et al., 2014), which are an order of thermophilous stonecrop vegetation on weathered calcareous rocks of temperate Europe (Mucina et al., 2016a).

Bryum radiculosum (*Bryum subapicatulum* – all changed to *B. radiculosum* instead.)

This dioecious (Berg et al., 2025a) and thermophilic moss species also belongs to the *Bryum atrovirens* (*-erythrocarpum-*) complex and is mentioned to be threatened in Austria (Schlüsslmayr, 2005).

Syntaxa:

Psoretea decipientis: diagnostic species (Mucina et al., 2016a)

This bryophyte species was mentioned to be diagnostic for the *Psoretea decipientis*, a class of syntaxa which grow on calcareous soils (Mucina et al., 2016a). It had not been explicitly mentioned as such, but since we found only this single vegetation unit that the moss was mentioned for, we considered *B. radiculosum* to be a character species. After all, a species that is mentioned to be differentiating a syntaxon from all others, thus singling it out, is called a character species (Faber-Langendoen et al., 2014).

Bryum rubens

This dioecious (Berg et al., 2025a) moss species dwells on loamy soils of fields, scarps, and cover of calcareous rocks. It also colonizes open patches in dry grasslands, relying on maintaining population by subterranean tubers (Vanderpoorten & Goffinet, 2010). *Bryum rubens* is the most common and abundant species of the *Bryum atrovirens* (-*erythrocarpum*-)group and mentioned as a character species of the *Barbuletalia unguiculatae* (Schlüsslmayr, 2005).

Syntaxa:

Sedo-Scleranthetalia: diagnostic species (Kuzemko et al., 2014)
Psoretea decipientis: diagnostic species (Mucina et al., 2016a)

The species *Bryum rubens* had been recorded to be diagnostic for the class of *Sedo-Scleranthetea* by directly being mentioned to be diagnostic for the order of *Sedo-Scleranthetalia* (Kuzemko et al., 2014). By the same author, it had also been included in another subdivision of the same class, the order of *Alysso-Sedetalia* (Kuzemko et al., 2014), which constituted a contradiction. *B. rubens* was also mentioned to be diagnostic for the *Psoretea decipientis* (Mucina et al., 2016a).

Bryum ruderale

This thermophilic moss is mentioned to be a character species for the *Phascion cuspidati*. It is also part of the of the *Bryum atrovirens* (-*erythrocarpum*-)group (Schlüsslmayr, 2005).

Syntaxa:

Polygono-Poetea annuae: diagnostic species (Mucina et al., 2016a)
Psoretea decipientis: diagnostic species (Mucina et al., 2016a)

Bryum violaceum

Syntaxa:

Festuco-Brometea: diagnostic species (Mucina et al., 2016a)

This dioecious (Berg et al., 2025a) species was mentioned to be diagnostic for the *Festuco-Brometea*, dry grasslands on base-rich soils (Mucina et al., 2016a). There were only two other *Bryum* species in our data that were mentioned to be diagnostic for this class, *B. caespiticium* and *B. argenteum*. They sometimes occurred together in our relevés. This species was mentioned for only this one singular syntaxon, so we can assume it is a character species (Faber-Langendoen et al., 2014).

Campylium calcareum

In last year's publication, Mossflora von Österreich, this autoecious species is listed as ***Campylophyllopsis calcarea*** (Berg et al., 2025b).
This calcicole moss species is found on limestone rocky substrates and soils (Schlüsslmayr, 2005).
Syntaxa:

Ctenidietea mollusci: diagnostic species (Mucina et al., 2016a)

This species was found to be diagnostic for *Ctenidietea mollusci*, bryophyte communities on shaded, moist to temporarily dry baserich rocks and occasionally on calcareous soil surfaces (Mucina et al., 2016a) which certainly occurred in our plots. Since this moss was mentioned for only this one singular syntaxon, we can as well assume it is a character species, after (Faber-Langendoen et al., 2014).

Campylium chrysophyllum

This dioecious (Berg et al., 2025b) bryophyte species also prefers limestone and is distinguished species of calcareous dry grasslands with open patches. *Campylium chrysophyllum* is mentioned to be a character species of the *Ctenidium mollusci* (Schlüsslmayr, 2005).

Syntaxa:

Cirsio-Brachypodion pinnati: diagnostic species (Willner et al., 2004) and (Dengler et al., 2012)
Ctenidietea mollusci: diagnostic species (Mucina et al., 2016a)

This species was mentioned to be diagnostic for two classes, directly for the *Ctenidietea mollusci* (Mucina et al., 2016a), and indirectly for the *Festuco-Brometea* (Dengler et al., 2012) (Willner et al., 2004). This was concluded based on the fact that it had been directly mentioned for the *Brachypodietalia pinnati* by (Dengler et al., 2012) and indirectly by (Willner et al., 2004). The next subdivision of the class and order is the alliance of *Cirsio-Brachypodion pinnati* (Willner et al., 2004) and (Dengler et al., 2012).

Ceratodon purpureus

Ceratodon purpureus is one of the most common acrocarpous bryophytes with a near cosmopolitan distribution (Frahm, 2001). This bryophyte species is a real ubiquist. It typically grows on acidic soils, but, with open habitats preferred, it also does well on weathered sandy substrates and dry nutrient-poor grasslands. It has a conspicuous red seta and sub-quadrangular cells.
It is a dioecious species (Berg et al., 2025a).

Syntaxa:

Koelerio-Corynephoretea canescentis: diagnostic species (Mucina et al., 2016a)
Sedo-Scleranthetea: diagnostic species (Mucina et al., 2016a)
Sedo-Scleranthetalia: character species (Kuzemko et al., 2014)
Festucetalia valesiacae: diagnostic species (Willner et al., 2017)
Stipo pulcherrimae-Festucetalia pallentis: diagnostic species (Chytrý et al., 2010)
Alysso-Festucion pallentis: diagnostic species (Chytrý et al., 2010)
Polygono-Poetea annuae: diagnostic species (Mucina et al., 2016a).
Ceratodonto purpurei-Polytrichetea piliferi: diagnostic species (Mucina et al., 2016a)

This species was mentioned to be diagnostic for the *Koelerio-Corynephoretea canescentis* (Mucina et al., 2016a), the *Sedo-Scleranthetea* (Mucina et al., 2016a) indirectly supported by (Kuzemko et al., 2014) and the *Sedo-Scleranthetalia* (Kuzemko et al., 2014). *Ceratodon purpureus* was indirectly mentioned to be diagnostic for the *Festuco-Brometea*, which we concluded based on the direct mention for the *Festucetalia valesiacae* by the same author. However, the species was also mentioned as diagnostic for a different order of the same class, by a different author, *Stipo pulcherrimae-Festucetalia pallentis* (Chytrý et al., 2010), creating a sort of contradiction. This author also gives more specific information by putting the species with the for the *Alysso-Festucion pallentis* (Chytrý et al., 2010). Since *Ceratodon purpureus* is a rather ubiquitous species, it seems plausible that this moss is diagnostic for more than one order in a class of syntaxa. Despite thus creating a contradiction, this depicts the situation better than if we would exclude one of the orders altogether. Because of that same fact, however, its diagnostic value for dry grassland syntaxa might be questionable.

The species was also found to be diagnostic for the *Polygono-Poetea annuae*, (Mucina et al., 2016a). The same author also mentions it to be diagnostic for the *Ceratodonto purpurei-Polytrichetea piliferi*, (Mucina et al., 2016a). This is supported by an additional author, who mentions *Ceratodon purpureus* to be a character species (Schlüsslmayr, 2005).

Crossidium squamiferum

The leaflet of this moss species shows xerothermic adaptions to store water and aid with assimilation. Its margins are rolled up, it has a hyaline tip, and there are filaments on the rib. Water can residue in the rolled-up leaflet margins and bring it to the assimilation-filaments (Frahm, 2001). It is an autoecious species (Berg et al., 2025a).

Syntaxa:

Psoretea decipientis: diagnostic species (Mucina et al., 2016a)
Schistidietea apocarpi: diagnostic species (Mucina et al., 2016a)

Synthesis: This species was mentioned as diagnostic for two classes that dwell on calcareous substrates, the *Psoretea decipientis* and the *Schistidietea apocarpi* (Mucina et al., 2016a).

Dicranella staphylina

This moss species is described to be a nitrophilous pioneer of open loamy stands (fields, heaps of soil) (Schlüsslmayr, 2005). It is a dioecious species, but sporophytes are rarely found (Berg et al., 2025a).

Syntaxa:

Lygeo sparti-Stipetea tenacissimae: diagnostic species (Mucina et al., 2016a)
Psoretea decipientis: diagnostic species (Mucina et al., 2016a)

Didymodon acutus *(Barbula acuta)*

This submediterranean species is a thermophilic moss that prefers dry grasslands on calcareous soils (Schlüsslmayr, 2005). The same author also mentions that this species is threatened in Austria. Other authors state, that *D. acutus* is a typical species of dry, loamy soils, and often found in badland habitats and pediments (Fanfarillo et al., 2024). It is a dioecious species (Berg et al., 2025a).

Syntaxa:

Stipo pulcherrimae-Festucetalia pallentis: diagnostic species (Dengler et al., 2012)
Psoretea decipientis: diagnostic species (Mucina et al., 2016a)
Barbuletalia unguiculatae: character species (Marstaller, 1993)
Grimaldion fragrantis: character species (Marstaller, 1993)

This moss species was mentioned to be diagnostic for the *Stipo pulcherrimae-Festucetalia pallentis* by (Dengler et al., 2012). *Didymodon acutus* was also mentioned to be diagnostic for the *Psoretea decipientis* (Mucina et al., 2016a) and two of its subdivisions.

Didymodon cordatus *(Barbula cordata)*

This moss species is dioecious, but its sporophyte is unknown (Berg et al., 2025a).

Syntaxa:

Festuco-Brometea: character species (Willner et al., 2004)
Lygeo sparti-Stipetea tenacissimae: diagnostic species (Mucina et al., 2016a)
Psoretea decipientis: diagnostic species (Mucina et al., 2016a)
Grimaldion fragrantis: character species (Schubert, 2009)

This species was mentioned to be diagnostic for three classes, the *Festuco-Brometea* (Willner et al., 2004), the *Lygeo sparti-Stipetea tenacissimae* (Mucina et al., 2016a) and the *Psoretea decipientis* (Mucina et al., 2016a). All of these dwell on base-rich to calcareous soils. *Didymodon cordatus* was implied to be diagnostic for the order of *Barbuletalia unguiculatae* (Schubert, 2009) because it was directly mentioned for the *Grimaldion fragrantis* (Schubert, 2009). Both of the latter syntaxa occur on dry and loamy soils, in pioneer bryophyte vegetation (Mucina et al., 2016a). This fits quite well with this small, acrocarpous moss species that is propagated by gemmae that sit between the upper leaflets (Frahm & Frey, 2004) which can in this way colonize denuded patches in dry grasslands. It was mentioned as a classic Loess-characterspecies by the thesis' supervisor.

Didymodon fallax *(Barbula fallax)*

This moss species is a species of base-rich stands (Schlüsslmayr, 2005). It is a dioecious species (Berg et al., 2025a).

Syntaxa:

Festuco-Brometea: diagnostic species (Dengler et al., 2012)
Brachypodietalia pinnati: diagnostic species (Dengler et al., 2012)
Cirsio-Brachypodion pinnati: diagnostic species (Dengler et al., 2012)
Psoretea decipientis: diagnostic species (Mucina et al., 2016a)
Barbuletalia unguiculatae: character species (Marstaller, 1993)
Grimaldion fragrantis: character species (Marstaller, 1993)

This species was mentioned to be diagnostic for two classes, the *Festuco-Brometea* (Dengler et al., 2012) and the *Psoretea decipientis* (Mucina et al., 2016a). Didymodon fallax was also mentioned to be of diagnostic value for two of the first class' subdivisions, the *Brachypodietalia pinnati* (Dengler et al., 2012) and the *Cirsio-Brachypodion pinnati* (Dengler et al., 2012).

The second class also had two subdivisions for which *D. fallax* was mentioned as diagnostic for. (Marstaller, 1993) mentioned the *Barbuletalia unguiculatae*, which is also supported by another author, who names it to be a character species for this order (Schlüsslmayr, 2005).

Didymodon vinealis *(Barbula vinealis)*

This species was referred to as endangered in the species list of a study on Pannonian loess cliffs in Austria (Zechmeister & Kropik, 2025). It is a dioecious species (Berg et al., 2025a).

Syntaxa:

Lygeo sparti-Stipetea tenacissimae: diagnostic species (Mucina et al., 2016a)
Psoretea decipientis: diagnostic species (Mucina et al., 2016a)

D. vinealis was mentioned to be diagnostic for two different syntaxa by (Mucina et al., 2016a). Both syntaxa can be found on calcareous substrates.

Encalypta streptocarpa

This is a dioecious species (Berg et al., 2025a), however, this moss is hardly ever in bloom. As an indicator species for limestone, it often shows lime efflorescence on its broad spatulate leaves. Its leaves also show typical hyaline basal cells, which like help to store water (Goffinet & Shaw, 2009). It also has conspicuously red filamentous gemmae and does well in dry grassland habitats and on scree.

Syntaxa:

Alysso-Sedetalia: character species (Kuzemko et al., 2014)
Stipo pulcherrimae-Festucetalia pallentis (Willner et al., 2017)
Polypodietea: diagnostic species (Mucina et al., 2016a)
Asplenietea trichomanis: diagnostic species (Mucina et al., 2016a)
Ctenidietea mollusci: diagnostic species (Mucina et al., 2016a) and (Marstaller, 1993)
Ctenidietalia mollusci: character species (Marstaller, 1993)
Ctenidion mollusci: character species (Marstaller, 1993) and (Schubert, 2009)

This moss species was found to be diagnostic for many syntaxa. Most of them are communities of vegetation on shallow soils and rocky substrates that are base-rich (Mucina et al., 2016a). The first class can only be assumed, it's the *Sedo-Scleranthetea* (Kuzemko et al., 2014) with its subdivision, the *Sedo-Scleranthetalia* (Kuzemko et al., 2014), the information for both of which we assumed because the species was directly mentioned to be a character species for the *Alysso-Sedetalia* (Kuzemko et al., 2014).

Encalypta streptocarpa can also only be indirectly, but justifiably, named in diagnostic contexts with the next big dry-grasslands class the *Festuco-Brometea*. Directly, it was mentioned for one of that class' subdivisions, the *Stipo pulcherrimae-Festucetalia pallentis* (Willner et al., 2017). The species was mentioned to be diagnostic for two classes of fern rich communities mixed with bryophytes, the *Polypodietea* and the *Asplenietea trichomanis* (Mucina et al., 2016a). Last follow the suit of the *Ctenidietea mollusci* (Mucina et al., 2016a) and (Marstaller, 1993) which the order of the *Ctenidietalia mollusci* (Marstaller, 1993) and the alliance of *Ctenidion mollusci* (Marstaller, 1993) belong to.

Encalypta vulgaris

Focusing on Austria only, this submediterranean bryophyte species has its main distribution in the Pannonian region of the country (Schlüsslmayr, 2005). It can be found in dry grasslands on limestone substrates. It is easily spotted, doing its name credit, due to its characteristically large calyptra, which completely covers the erect capsule (Goffinet & Shaw, 2009). *E. vulgaris* builds sporophytes very regularly, it is an autoecious species (Berg et al., 2025a). In contrast to its aforementioned sister species that usually propagates vegetatively. Both are calciphile (Frahm, 2001).

Syntaxa:

Stipo pulcherrimae-Festucetalia pallentis: character species (Willner et al., 2017)
Psoretea decipientis: diagnostic species (Mucina et al., 2016a)
Barbuletalia unguiculatae: character species (Marstaller, 1993)
Grimaldion fragrantis: character species (Marstaller, 1993)

This species was indirectly mentioned to be diagnostic for the *Festuco-Brometea* (Willner et al., 2004) and (Willner et al., 2017). *Encalypta vulgaris* was directly described to be diagnostic for the *Stipo pulcherrimae-Festucetalia pallentis* (Willner et al., 2017) and indirectly by (Willner et al., 2004). It was also mentioned to be diagnostic for the *Bromo pannonici -Festucion csikhegyensis*, under the synonym of *Seslerio-festucion pallentis* by (Willner et al., 2004). Whilst not referring to it that way in the graphs, however, we used the information at class-level by both (Willner et al., 2004) and (Willner et al., 2017). This alliance was mentioned to be a re-unified syntaxon on dry rocky, calcareous grasslands that can occur on – somewhat impoverished – rocky outcrops in the Weinviertel (Willner et al., 2013).
Furthermore, it was mentioned as diagnostic for the *Psoretea decipientis* (Mucina et al., 2016a) and its subdivision, the order of the *Barbuletalia unguiculatae* (Marstaller, 1993), as well as the next lower subdivision, the alliance of *Grimaldion fragrantis* (Marstaller, 1993). This is also supported by another author, who mentions *Encalypta vulgaris* as a character species for the alliance (Schlüsslmayr, 2005).

Entodon concinnus

This moss is commonly found in dry grasslands and does well on calcareous and siliceous soils. Its tips are rather pointed.
It is the most common of the four *Entodon* species in Europe and is a regular species in dry grasslands on calcareous soils (Frahm, 2001). Together with *Homalothecium lutescens*, *Rhytidium rugosum* and *Abietinella abietina*, it is a frequent species in dry grasslands of calcareous substrates (Schlüsslmayr, 2005). (Jeschke, 2012) supports this, stating that *Abietinella abietina* and *Entodon concinnuus* are omnipresent and often accumulated in dry grasslands. Both species are dioecious (Berg et al., 2025b)
Syntaxa:

Festuco-Brometea: character species (Willner et al., 2004)
Hylocomietea splendentis: diagnostic species (Mucina et al., 2016a)

Whilst (Willner et al., 2004) mentions *E. concinnus* as diagnostic for the class of *Festuco-Brometea*, (Mucina et al., 2016a) puts this species with the *Hylocomietea splenditis*. Hence there was no more differentiation to be had as to what subdivision of the *Festuco-Brometea* this species stands for. The latter is a syntaxon which includes wefts of large competitive mosses on soils, at the end of bryophyte succession (Mucina et al., 2016a). We too found communities of large, weft-forming

bryophytes at our sites. That is true for places around more rocky outcrops within the sites, and also above scree and below herbs that do not form as thick a cover as the grass-species. *Entodon concinnus* is a rather large moss species, pleurocarpous and forms strong stemlets. It can surely compete with the taller vascular plants.

Fissidens exilis

The species of *Fissidens* are small mosses which dwell on soil, however, the genus also contains mosses that live on rocks and in running waters (Frahm, 2001). This particular representative of the genus prefers base-rich, but not calcareous soils (Schlüsslmayr, 2005). The same author also stated that *Fissidens exilis* might be partial to Flysch substrates. The Moosflora von Österreich lists it as a pioneer species which can also be found in hollow ways (Berg et al., 2025a).
Syntaxa:

Cirsio-Brachypodion pinnati: diagnostic species (Willner et al., 2004)
Psoretea decipientis: diagnostic species (Mucina et al., 2016a)
Ctenidietea mollusci: diagnostic species (Mucina et al., 2016a)
Cladonio digitatae-Lepidozietea reptantis: character species (Marstaller, 1993)
Diplophylletalia albicantis: character species (Marstaller, 1993)
Dicranellion heteromallae: character species (Marstaller, 1993)

This moss species was indirectly mentioned to be diagnostic for the class of *Festuco-Brometea* and its subdivision, the *Brachypodietalia pinnati*, because it had been mentioned as diagnostic for the *Cirsio-Brachypodion pinnati* (Willner et al., 2004). *Fissidens exilis* was mentioned for three other classes as well, the *Psoretea decipientis*, the *Ctenidietea mollusci* both by (Mucina et al., 2016a), and the *Cladonio digitatae-Lepidozietea reptantis* (Marstaller, 1993). The latter also yielded information down to the alliance of the *Dicranellion heteromallae* (Marstaller, 1993). This author also stated that the species can be found on steep loess soils.

Fissidens taxifolius

This moss species prefers habitats that consist of base-rich, calcareous soils, but tolerates slightly acidic conditions (Schlüsslmayr, 2005).
Syntaxa:

Festuco-Brometea: diagnostic species (Dengler et al., 2012)
Brachypodietalia pinnati: diagnostic species (Dengler et al., 2012) and (Willner et al., 2017)
Hylocomietea splendentis: character species (Marstaller, 1993)
Hylocomietalia splendentis: character species (Marstaller, 1993)
Fissidention taxifolii: character species (Schubert, 2009)

This moss species was mentioned to be diagnostic for two classes of syntaxa, the *Festuco-Brometea* (Dengler et al., 2012) and the *Hylocomietea splenditis* (Marstaller, 1993). The first one also was supported indirectly by information that stemmed from *Fissidens taxifolius* directly being mentioned to be diagnostic for a subdivision of the class, the *Brachypodietalia pinnati* (Dengler et al., 2012) and (Willner et al., 2017). This species was also mentioned to be diagnostic for the subdivisions of the second class, the order of the *Hylocomietalia splenditis* (Marstaller, 1993) and the alliance of the *Fissidention taxifolii* (Schubert, 2009).

Homalothecium lutescens

This typical semi-dry, *Mesobromion*, grassland species is easily recognisable in the field due to its slender, ribbed leaflets with strong longitudinal folds that make up the accumbent foliage of its worm-like, pleurocarpous stemlets.
This calcicole species was mentioned to be a character species for the *Abietinellion*, which is a synonym for the *Rhytidion rugosi* (Schlüsslmayr, 2005).
Homalothecium lutescens is mentioned to have a high constancy (52%) in semi-dry grasslands of the Weinviertel, with a high amount of xerophilous species, which are dominated by *Bromus erectus* and/ or *Brachypodium pinnatum* (Willner et al., 2013)

Syntaxa:

Sedo-Scleranthetea: character species (Marstaller, 1993)
Sedo-Scleranthetalia: character species (Marstaller, 1993)
Festuco-Brometea: character species (Willner et al., 2004)
Brachypodietalia pinnati: diagnostic species (Chytrý et al., 2010) and (Dengler et al., 2012)
Hylocomietea splendentis: diagnostic species (Mucina et al., 2016a)
Rhytidion rugosi: character species (Marstaller, 1993) and (Schubert, 2009)

This species was found to be diagnostic for three classes of syntaxa, the first being the *Sedo-Scleranthetea* (Marstaller, 1993) with its subdivision, the *Sedo-Scleranthetalia* (Marstaller, 1993). The second class that *Homalothecium lutescens* was mentioned to be diagnostic for were the *Festuco-Brometea* – mentioned directly by (Willner et al., 2004) and indirectly by (Chytrý et al., 2010) and (Dengler et al., 2012). The diagnostic status indirectly implied for the class had been concluded from the information at a lower level, the order of the *Brachypodietalia pinnati* (Chytrý et al., 2010) and (Dengler et al., 2012). The third class are the *Hylocomietea splendentis*, directly mentioned by (Mucina et al., 2016a) and indirectly by (Marstaller, 1993) and (Schubert, 2009). *H. lutescens* was implied to be diagnostic for the order of *Hylocomietalia splenditis* because it was directly mentioned for the alliance of *Rhytidion rugosi* by (Marstaller, 1993) and (Schubert, 2009).

It is probably better to go along with a diagnostic value for the *Festuco-Brometea*, since the information about the *Sedo-Scleranthetea* stems only from the (Marstaller, 1993) information, which follows a different hierarchical system.

Homomallium incurvatum

This moss species is autoecious (Berg et al., 2025b)
Syntaxa:

Neckeretea complanatae: character species (Mucina et al., 2016a) and (Marstaller, 1993)
Neckeretalia complanatae: character species (Marstaller, 1993) and (Schubert, 2009)
Neckerion complanatae: character species (Marstaller, 1993)

This species, *H. incurvatum*, was mentioned to be diagnostic for one class only, the *Neckeretea complanatae* (Mucina et al., 2016a) and (Marstaller, 1993). The latter author also mentions this species in context with the subdivisions of the class, order and alliance. He is supported when it comes to the order, the *Neckeretalia complanatae*, by (Schubert, 2009). Since it is so specifically mentioned down to alliance-level, it seems to be a sound diagnostic species. Even if mentioned with hygrophilous species – because this syntaxa appear on stable soil as well.

Hypnum cupressiforme var. cupressiforme

Typical ubiquist that has a very broad amplitude of habitats. Being the most common moss of the Austrian flora, it also grows well in dry grassland areas. Its irregularly branched stemlets, with their rib-less, sickle-shaped and pointed leaflets, grow in felt-like covers. Their sporophytes have a diplolepid peristome, meaning two rings of teeth. Determination of species works mostly via the alar cells. This species is mentioned to be acidophilous, even though it is also an ubiquist (Schlüsslmayr, 2005).

Syntaxa:

Frullanio dilatatae-Leucodontetea sciuroidis: diagnostic species (Mucina et al., 2016a)
Brachythecietalia rutabulo-salebrosi: character species (Schubert, 2009)

This species was not mentioned to be specifically diagnostic for any vascular plant communities in our literature. It might be that it was not considered in this way because of its broad amplitude. Or rather one of its varieties was considered to have a better diagnostic value: We found more information with the variety of *H. cupressiforme* var. *lacunosum* (see there).

(Mucina et al., 2016a) and (Schubert, 2009) put *H. cupressiforme* into two different classes, the *Frullanio dilatatae-Leucodontetea sciuroidis* and the *Cladonio digitatae-Lepidozietea reptantis*. With the latter, the moss is also diagnostic for the subdivision, the order of *Brachythecietalia rutabulo-salebrosi*. The class-level description inlcudes acidic to humic soils, whilst the alliance level points more in a direction of base-rich substrates (Mucina et al., 2016a).

One author mentions one class of syntaxa, one the other. Schubert's mention appears to be more refined, Mucina's doesn't feature any refinement. Yet, both do not seem to have a meaningful implication for the role of this species in dry grasslands. No wonder, for this is a most common and widespread species. How ever welcome it may be in dry grasslands, it is certainly not confined to them, may they be of one type or the other.

Hypnum cupressiforme var. lacunosum

A variety of the species above, this pleurocarpous bryophyte grows perennial, and in large, high swards. It is typical for semi-arid and dry grasslands. It is called the "most frequent dry grassland moss in many parts of Europe" by (Dengler et al., 2012), and mentioned to be a moss of calcareous dry grasslands by (Frahm, 2001). This is supported by another author, who also mentions that this xerophytic moss is a character species for the *Abietinellion*, which is a synonym of the *Rhytidion* (Schlüsslmayr, 2005).

Syntaxa:

Sedo-Scleranthetea: character species (Marstaller, 1993)
Sedo-Scleranthetalia: character species (Marstaller, 1993)
Festuco-Brometea: character species (Willner et al., 2004)
Cirsio-Brachypodion pinnati: diagnostic species (Dengler et al., 2012)

Rhytidion rugosi: character species (Marstaller, 1993)
Frullanio dilatatae-Leucodontetea sciuroidis: diagnostic species (Mucina et al., 2016a)

This species was mentioned to be diagnostic for the *Sedo-Scleranthetea* (Marstaller, 1993) and its subdivision, the order of *Sedo-Scleranthetalia* (Marstaller, 1993). *Hypnum cupressiforme* var. *lacunosum* was also mentioned as diagnostic for the *Festuco-Brometea* (Willner et al., 2004) and,

indirectly for its subdivision, the order of *Brachypodietalia pinnati* (Dengler et al., 2012). This information was concluded from the species being mentioned for yet another subdivision of the same class, the alliance of *Cirsio-Brachypodion pinnati* (Dengler et al., 2012). Hence, we can not really use it as a character species for both of these vascular plant classes.

Hypnum cupressiforme var. *lacunosum* was mentioned to be diagnostic for a syntaxon called *Abietinellion* by (Marstaller, 1993), which was put into the class of *Sedo-Scleranthethea* by said author. (Mucina et al., 2016a), however, lists this syntaxon as a synonym for the *Rhytidion rugosi,* which is placed in a different class, the *Hylocomietea splendentis*. Hence, in this case, the species' diagnostic value was taken from the class level. Lastly, the species was also mentioned to be diagnostic for the *Frullanio dilatatae-Leucodontetea sciuroidis* (Mucina et al., 2016a).

The authors have more to say on behalf of the diagnostic value of this subspecies (or variety?) of *Hypnum cupressiforme* than of the *H. cupressiforme* s.str. Yet again, we have the case of (Marstaller, 1993) putting the species in a syntaxon with a different hierarchy than (Mucina et al., 2016a).

Leskea polycarpa

Leskeaceae are mosses that usually prefer limestone substrates. The thesis' supervisor mentioned strong concerns according to the fact that this species is an epiphyte, see also the Moosflora von Österreich (Berg et al., 2025b). Thus, it might be a misidentification. Since it had already been added to the calculations at this point, it remains in the species list.

Syntaxa:

Frullanio dilatatae-Leucodontetea sciuroidis: character species (Mucina et al., 2016a) and (Marstaller, 1993)

Orthotrichetalia: character species (Mucina et al., 2016a) and (Marstaller, 1993)

Leskeion polycarpae: character species (Marstaller, 1993) and (Schubert, 2009)

The species *L. polycarpa* was directly mentioned to be diagnostic for the *Frullanio dilatatae-Leucodontetea sciuroidis* by (Mucina et al., 2016a) and (Marstaller, 1993). This is also supported by (Schubert, 2009), because that author mentioned the species as a character species at the alliance level, the *Leskeion polycarpae*, which was also mentioned by (Marstaller, 1993). Hence the registration as diagnostic for the order of *Orthotrichetalia* (Mucina et al., 2016a) and (Marstaller, 1993), directly, and indirectly implied by (Schubert, 2009).

Microbryum curvicollum *(Phascum curvicolle)*

This moss with a downward curved seta is an ephemeral, ground-dwelling species (Vanderpoorten & Goffinet, 2010). This is an autoecious species, that can rarely be synoecious (Berg et al., 2025a).

Syntaxa:

Festuco-Brometea: character species (Willner et al., 2004)

Psoretea decipientis: diagnostic species (Mucina et al., 2016a)

Barbuletalia unguiculatae: character species (Marstaller, 1993)

Grimaldion fragrantis: character species (Marstaller, 1993)

M. curvicollum was mentioned to be diagnostic for two different classes, the *Festuco-Brometea* (Willner et al., 2004) and the *Psoretea decipientis* (Mucina et al., 2016a), both dwell on base-rich soils. For the latter it was also indirectly implied by (Marstaller, 1993) by mentioning it to be diagnostic for the order of *Barbuletalia unguiculatae*, and the alliance of *Grimaldion fragrantis*. So, one can assume that *M. curvicolle* is also a diagnostic species for the higher syntaxon.

Microbryum davallianum *(Pottia davalliana)*

This is a submediterranean bryophyte species (Schlüsslmayr, 2005), which is autoecious (Berg et al., 2025a).

Syntaxa:

Festuco-Brometea: character species (Kuzemko et al., 2014)
Brachypodietalia pinnati: character species (Kuzemko et al., 2014)
Psoretea decipientis: and diagnostic species: (Mucina et al., 2016a)
Barbuletalia unguiculatae: character species (Marstaller, 1993)
Grimaldion fragrantis: character species (Marstaller, 1993)

This moss species was mentioned to be diagnostic for the *Festuco-Brometea* (Kuzemko et al., 2014) by way of *Linum hirsutum-Galium verum* comm., a class of dry grassland and steppe vegetation of mostly base- and colloidrich soils (Mucina et al., 2016a). This species was also listed to be diagnostic for that order's subdivision, the *Brachypodietalia pinnati* (Kuzemko et al., 2014), by it being mentioned as a character species of the *Linum hirsutum-Galium verum comm*.

Microbryum davallianum was mentioned to be diagnostic for another class of syntaxa, the *Psoretea decipientis* (Mucina et al., 2016a). The *Barbuletalia unguiculatae* (Marstaller, 1993) and the *Grimaldion fragrantis* (Marstaller, 1993) – both syntaxa of pioneer bryophyte vegetation on dry loamy soil in grasslands (Mucina et al., 2016a), were also mentioned in the context of this moss being a character species, thus supporting the non-vascular plant class.

Microbryum floerkeanum *(Phascum floerkeanum*)

This is an autoecious species (Berg et al., 2025a).

Syntaxa:

Festuco-Brometea: character species (Willner et al., 2004)
Psoretea decipientis: diagnostic species (Mucina et al., 2016a)

Whilst (Willner et al., 2004) lists it as diagnostic for the *Festuco-Brometea*, *Microbryum floerkeanum* is not mentioned in the book about the vegetation of Europe (Mucina et al., 2016a) in this context. It is not listed to be diagnostic for any of the syntaxa with the main matrix built by vascular plants. This could also be because this is a rather small bryophyte species. Hence, it might have been overlooked, or, if not equipped with sporophytes – not identified. (Mucina et al., 2016a) lists it with the *Psoretea decipientis*, a class (nonetheless) of syntaxa that consists of lichen and bryophyte vegetation. What the two classes, the first being semi-dry and dry grasslands, have in common, is the presence of mostly calcareous soils. This is supported by the literature that was used for determination of the species (Frahm & Frey, 2004). There, also loess-affinity is mentioned which can certainly be supported by this thesis' findings.

Although this moss seems to be pretty straightforward in its preferences or affinities to certain plant communities, it might not help with any finetuning of the syntaxa-sorting process. Also because of its small habitus. But since it is growing in herds, it might well be making a making a difference by fixating the loess, colonizing it a bit so other diaspores can find hold and more moisture. And as for calcareous soil, the species-at-site list does not have a distinct calcareous site with *M. floerkeanum* found there (apparently, mainly loess-sites).

Mnium marginatum

This calcicole moss species can be found from the lowlands up to the Alps (Großer Priel) (Schlüsslmayr, 2005). In this thesis' data sampling, it was found on the Waschberg in the upper sample plot.

Syntaxa:

Neckeretea complanatae: diagnostic species (Mucina et al., 2016a)

This moss species was found to be diagnostic for one class of syntaxa only, the *Neckeretea complanatae*, (Mucina et al., 2016a). As this moss was mentioned for only this one singular syntaxon, we can as well assume it is a character species, after (Faber-Langendoen et al., 2014).

Orthotrichum anomalum

This autoecious (Berg et al., 2025b) bryophyte species dwells on sunny stands (Schlüsslmayr, 2005). It grows often epilithic and has a sporophyte that sticks out more than most of the genus' species. *Orthotrichum anomalum* is common for secondary stands.

Syntaxa:

Stipo pulcherrimae-Festucetalia pallentis: diagnostic species (Willner et al., 2017)
Schistidietea apocarpi: character species (Mucina et al., 2016a) and (Marstaller, 1993)
Schistidietalia apocarpi: character species (Marstaller, 1993)
Grimmion tergestinae: character species (Marstaller, 1993) and (Schubert, 2009)

This species was directly mentioned to be diagnostic for the order of *Stipo pulcherrimae-Festucetalia pallentis* (Willner et al., 2017). This implies it is indirectly diagnostic for the *Festuco-Brometea*. *Orthotrichum anomalum* was mentioned as diagnostic for the class of *Schistidietea apocarpi*, directly by (Mucina et al., 2016a) and (Marstaller, 1993) and indirectly by (Schubert, 2009). It was also mentioned to be diagnostic for two subdivisions of the class.

Oxyrrhynchium hians

This moss species prefers nutrient-rich soils but is otherwise found on all kinds of substrates. It is occurring, in varieties, from the lowlands up to the Alps (2020m for example, on Mount Pyhrgas) (Schlüsslmayr, 2005).

Syntaxa:

Trifolio-Geranietea sanguinei: diagnostic species (Mucina et al., 2016a)
Festuco-Brometea: diagnostic species (Dengler et al., 2012) and (Willner et al., 2017)

Brachypodietalia pinnati: diagnostic species (Dengler et al., 2012) and (Willner et al., 2017) and (Willner et al., 2004)

Hylocomietea splendentis: character species (Mucina et al., 2016a) and (Marstaller, 1993)

Hylocomietalia splendentis: character species (Marstaller, 1993)

Fissidention taxifolii: character species (Schubert, 2009)

This species was mentioned to be diagnostic for three classes, the first being the *Trifolio-Geranietea sanguinei* (Mucina et al., 2016a). The second, and better supported, being the class of the *Festuco-Brometea*, directly by (Dengler et al., 2012) and (Willner et al., 2017), and indirectly by the same author in an earlier study. There (Willner et al., 2004), the species was mentioned to be diagnostic for the subdivision of *Brachypodietalia pinnati*, this was supported by (Dengler et al., 2012) and also (Willner et al., 2017).

The third class that *Oxyrrhinchium hians* was mentioned to be diagnostic for are the *Hylocomietea splendentis*, directly by (Mucina et al., 2016a) and (Marstaller, 1993), and indirectly by (Schubert, 2009). This resulted in the listing for the *Hylocomietalia splendentis* (Marstaller, 1993), directly and (Schubert, 2009) indirectly. The latter information came from the species being mentioned for the *Fissidention taxifolii* (Schubert, 2009).

Phascum cuspidatum var. cuspidatum

The species of the genus *Phascum* that are mentioned here, have been listed under the genus name *Tortula* in the recently published Moosflora von Österreich (Berg et al., 2025a). *Phascum cuspidatum* is now a synonym for the species ***Tortula acaulon***.

This basiphilous, terricolous bryophyte was mentioned to be a character species of the *Phascion cuspidati* (Schlüsslmayr, 2005). *Phascum* species form small, bud-like gametophytes (Frahm, 2001). The sporophytes of *P. cuspidatum* produce few but large spores, that are apparently adapted to remaining dormant in the soil for at least a year (Vanderpoorten & Goffinet, 2010). (This species also produces aposporic gametophytes – without sexual reproduction, directly from gametophytic tissue. This has been described first by Eva Springer in 1935, a female bryologist. (Goffinet & Shaw, 2009).)

Syntaxa:

Psoretea decipientis: diagnostic (Mucina et al., 2016a)

This bryophyte species was mentioned to be diagnostic for the *Psoretea decipientis*, a class of syntaxa which are found on calcareous soils (Mucina et al., 2016a). Since this moss was mentioned for only this one singular syntaxon, we can as well assume it is a character species, after (Faber-Langendoen et al., 2014).

(Phascum mitraeforme, the thesis' supervisor mentioned this species to be a synonym of the variety of ***Phascum cuspidatum var. piliferum***. It is mentioned here in brackets, and only due to the factor that it was mentioned in the literature – see below – as *P. mitraeforme*.***)***

Syntaxa:

Festucion valesiacae: character species (Willner et al., 2004)

Psoretea decipientis: diagnostic species (Mucina et al., 2016a)

This species was implied to be a character species for the class of *Festuco-Brometea* and its subdivision, the order of *Festucetalia valesiacae*. This information was derived from *Phascum*

mitraeforme being directly mentioned to be a character species of the *Festucion valesiacae* (Willner et al., 2004). It was also mentioned as diagnostic for the *Psoretea decipientis*, which are syntaxa of bryophyte and lichen vegetation on subneutral and calcareous soils (Mucina et al., 2016a).

Phascum cuspidatum var. piliferum

This species is listed as ***Tortula acaulon var. pilifera*** in the Moosflora von Österreich (Berg et al., 2025a).
This thermophilous, submediterranean variety of *Phascum cuspidatum* prefers calcareous grasslands and sunny stands of the *Sedo-Scleanthetalia* ("Felsfluren"). It is mentioned to be a character species of the *Grimaldion fragrantis* (Schlüsslmayr, 2005).

Syntaxa:

Stipo pulcherrimae-Festucetalia pallentis: diagnostic species (Dengler et al., 2012)
Psoretea decipientis: character species (Mucina et al., 2016a)
Barbuletalia unguiculatae: character species (Marstaller, 1993)

This species was implied to be diagnostic for the *Festuco-Brometea* because it was directly mentioned for that class' subdivision, the *Stipo pulcherrimae-Festucetalia pallentis* (Dengler et al., 2012). *Phascum cuspidatum* var. *piliferum* was mentioned for another class, the *Psoretea decipientis,* directly by (Mucina et al., 2016a) as well as indirectly supported. The information for the latter came from directly being mentioned as a character species for the order of *Barbuletalia unguiculatae* (Marstaller, 1993).

Plagiomnium rostratum

This calcicole moss species can be found in semi-dry grasslands, rocky substrates covered with soil and even alpine stands (Schlüsslmayr, 2005). It is a synoecious species (Berg et al., 2025a).
Syntaxa:

Festuco-Brometea: character species (Dengler et al., 2012)
Brachypodietalia pinnati: character species (Dengler et al., 2012; Kuzemko et al., 2014)
Cirsio-Brachypodion pinnati: diagnostic species (Dengler et al., 2012)
Hylocomietea splendentis: diagnostic species (Mucina et al., 2016a)

This species was mentioned to be diagnostic for two classes, the first one being the *Festuco-Brometea*, directly mentioned by (Dengler et al., 2012) and indirectly implied by (Kuzemko et al., 2014). *Plagiomnium rostratum* was directly mentioned to be diagnostic for the the *Brachypodietalia pinnati* (Kuzemko et al., 2014) and (Dengler et al., 2012) and the alliance of the *Cirsio-Brachypodion pinnati* (Dengler et al., 2012). We can therefore conclude that it is a well-supported character species of the *Festuco*-Brometea. It was also mentioned to be diagnostic for the non-vascular plant class of *Hylocomietea splendentis* (Mucina et al., 2016a).

Pleuridium acuminatum

Syntaxa:

Sedo-Scleranthetalia: diagnostic species (Kuzemko et al., 2014)
Psoretea decipientis: diagnostic species (Mucina et al., 2016a)
Dicranellion heteromallae: character species (Schubert, 2009)

This species was found to be diagnostic for several classes, the first being the *Sedo-Scleranthetea* indirectly mentioned by (Kuzemko et al., 2014). This information came from the moss being directly mentioned for the *Sedo-Scleranthetalia* (Kuzemko et al., 2014). *Pleuridium acuminatum* was also mentioned to be diagnostic for the *Psoretea decipientis* (Mucina et al., 2016a) and the *Cladonio digitatae-Lepidozietea reptantis* (Schubert, 2009). The latter was only an indirect statement. We also concluded that the species had been implied to be diagnostic for the order of *Diplophylletalia albicantis* (Schubert, 2009) because it had been directly mentioned for the alliance of *Dicranellion heteromallae* (Schubert, 2009).

Pleurochaete squarrosa

This asexually propagated species grows in cushions. Contrary to similar looking species, *Pleurochaete*'s cushions soon fall apart into single stemlets when removed from the soil. This moss is a Mediterranean species , and characteristic for dry stands (Frahm, 2001). It has been listed as ***Tortella squarrosa*** in the recently published Moosflora von Österreich (Berg et al., 2025a), where it also mentioned as dioecious, but with sporophytes lacking, in Austria.

Syntaxa:

Festuco-Brometea: character species (Willner et al., 2004) and (Mucina et al., 2016a)
Psoretea decipientis: (Mucina et al., 2016a)
Barbuletalia unguiculatae: character species (Marstaller, 1993)
Grimaldion fragrantis: character species (Marstaller, 1993)
Hylocomietea splendentis: diagnostic species (Mucina et al., 2016a)

This species was mentioned to be diagnostic for the class of the *Festuco-Brometea* (Willner et al., 2004) and (Mucina et al., 2016a). *Pleurochaete squarrosa* was also mentioned as diagnostic for the class of *Psoretea decipientis*, directly by (Mucina et al., 2016a) and indirectly by (Marstaller, 1993). The latter stems from the moss being mentioned to be a character species for two subdivisions of this class. Lastly, this species was mentioned to be diagnostic for the *Hylocomietea splendentis* (Mucina et al., 2016a).

Pottia bryoides

This moss species has a submediterranean distribution area (Schlüsslmayr, 2005). The bud-shaped foliage of *Pottia*-species has conspicuous glasshairs. The seta is usually rather short. This species has been listed as the autoecious species ***Tortula protobryoides*** in the recently published Moosflora von Österreich (Berg et al., 2025a).

The leaflets are papillose, like those of many other terricolous *Pottiaceae*. This feature is an adaptation to xerothermic stands because it facilitates humidification and water storage. Water droplets would simply remain in their spheric shape on a smooth surface, or even roll off. Whereas on a papillose surface, water gets sucked into the capillary gaps and is distributed all over the leaflet's surface. The papillae also serve as protection from evaporation (Frahm, 2001).

Syntaxa:

Psoretea decipientis: diagnostic species: (Mucina et al., 2016a)
Grimaldion fragrantis: character species (Schubert, 2009)

This species was mentioned to be diagnostic for the *Psoretea decipientis*, indirectly so by (Schubert, 2009) and directly by (Mucina et al., 2016a). *Pottia bryoides* was also mentioned as diagnostic for subdivisions of the class, indirectly for the alliance of the *Barbuletalia unguiculatae* because of a direct record for the order of the *Grimaldion fragrantis* (Schubert, 2009).

Pottia caespitosa was only found in the literature used for the data synthesis, by its synonym of ***Trichostomum triumphans***, which itself has now been listed as the autoecious species ***Pottiopsis caespitosa*** in the recently published Moosflora von Österreich (Berg et al., 2025a).

Syntaxa:

Psoretea decipientis: diagnostic species (Mucina et al., 2016a)

Since this bryophyte species was only found to be diagnostic for the *Psoretea decipientis*, (Mucina et al., 2016a), it was assumed for the data synthesis as a character species, as described by Faber-Langendoen et al., (2014).

Pottia intermedia

This moss species is mentioned to be a character species of the *Phascion cuspidati* (Schlüsslmayr, 2005). It is now listed under the name ***Tortula caucasica ,*** another autoecious species, in the recently published Moosflora von Österreich (Berg et al., 2025a).

Syntaxa:

Psoretea decipientis: diagnostic species (Mucina et al., 2016a)

This bryophyte species was mentioned to be diagnostic for the *Psoretea decipientis*, (Mucina et al., 2016a). It was only mentioned for this one singular syntaxon, so we can consider it as a character species, after (Faber-Langendoen et al., 2014).

Pottia lanceolata

This calcicole moss species is a pioneer of patchy dry grasslands and mentioned to be a character species of the *Grimaldion fragrantis* (Schlüsslmayr, 2005). This supports the information that was found with another author (Marstaller, 1993). This species is listed as the autoecious species ***Tortula lindbergii*** in the Moosflora von Österreich (Berg et al., 2025a).

Syntaxa:

Festuco-Brometea: character species (Willner et al., 2004)

Psoretea decipientis: character species (Marstaller, 1993) and (Mucina et al., 2016a)

Barbuletalia unguiculatae: character species (Marstaller, 1993)

Grimaldion fragrantis: character species (Marstaller, 1993)

This species was mentioned to be a character species of the *Festuco-Brometea* (Willner et al., 2004), and also for another class, the *Psoretea decipientis* (Marstaller, 1993) and (Mucina et al., 2016a). *Pottia lanceolata* was also mentioned to be diagnostic for the subdivisions of the latter class by (Marstaller, 1993).

Pseudocrossidium hornschuchianum *(Barbula hornschuchiana)*

The genus *Pseudocrossidium* has leaflet margins that are revolute. This creates not only mechanical protection, but also aid with water storage and assimilation (Frahm, 2001). This species has a submediterranean-suboceanean distribution area, and apparently prefers sandy, calcareous soils. *Pseudocrossidium hornschuchianum* is mentioned to be a character species of the *Grimaldion fragrantis* (Schlüsslmayr, 2005). This supports our other findings:

Syntaxa:

Festuco-Brometea: character species (Willner et al., 2004)
Polygono-Poetea annuae: diagnostic species (Mucina et al., 2016a)
Psoretea decipientis: character species (Mucina et al., 2016a)
Barbuletalia unguiculatae: character species (Marstaller, 1993)
Grimaldion fragrantis: character species (Marstaller, 1993)

This species was mentioned to be diagnostic for three classes, the *Festuco-Brometea* (Willner et al., 2004), the *Polygono-Poetea annuae* (Mucina et al., 2016a) and *Psoretea decipientis* (Mucina et al., 2016a). *Pseudocrossidium hornschuchianum* was also mentioned as diagnostic for the subdivisions of the latter class by (Marstaller, 1993).

Pseudoleskea incurvata

In last year's publication, Mossflora von Österreich, this dioecious species is listed as ***Lescuraea incurvata*** (Berg et al., 2025b). Another typical bryophyte of calcareous substrates. It has very few branchlets that are slightly bent at the tips.
Syntaxa:

Ctenidietea mollusci: diagnostic species (Mucina et al., 2016a)

This species was found to be diagnostic for the *Ctenidietea mollusci*, (Mucina et al., 2016a). Since this moss was mentioned for only this one singular syntaxon, we can as well assume it is a character species, after all (Faber-Langendoen et al., 2014).

Pseudoleskeella catenulata

This dioecious (Berg et al., 2025b) bryophyte has very thin stemlets that look stringlike, their leaflets almost indistinguishable. It typically grows on calcareous substrate and can also be found in the Pannonian area.

Syntaxa:

Schistidietea apocarpi: character species (Mucina et al., 2016a) and (Marstaller, 1993)
Schistidietalia apocarpi: character species (Marstaller, 1993)
Grimmion tergestinae: character species (Marstaller, 1993) and (Schubert, 2009)

The authors of all the three studies in which we found this species mentioned, agree on its diagnostic value as a character species. Namely, as a character species for the order of *Grimmion tergestinae* (Marstaller, 1993; Schubert, 2009), and the higher syntaxa that it this order belongs to.

Pseudoscleropodium purum *(Scleropodium purum)*

(Berg & Dengler, 2005) stated that this moss species is a character species of the *Trifolio-Geranietea sanguinei*. However, it has also been listed together with *Rhytidiadelphus squarrosus* as a common grassland moss species (Goffinet & Shaw, 2009). Other authors mention this large pleurocarpous moss as one of the true competitive species amongst bryophytes, able to reach nearly 100% coverage in mown grasslands (Vanderpoorten et al., 2004). It is a dioecious species (Berg et al., 2025a).

Syntaxa:

Hylocomietea splendentis: diagnostic species (Mucina et al., 2016a)

This moss species was found to be diagnostic for the *Hylocomietea splendentis* (Mucina et al., 2016a). Since this moss was mentioned for only this one singular syntaxon, we can as well assume it is a character species, after (Faber-Langendoen et al., 2014).

Pterygoneurum ovatum

This monoecious species (Berg et al., 2025a) has been listed as an ephemere species, also found in an intensively farmed vineyard (Zechmeister, 1999).

Syntaxa:

Festuco-Brometea: character species (Willner et al., 2004)
Psoretea decipientis: character species (Marstaller, 1993) and (Mucina et al., 2016a)
Barbuletalia unguiculatae: character species (Marstaller, 1993)
Grimaldion fragrantis: character species (Marstaller, 1993)

This species was mentioned to be diagnostic for two classes, the *Festuco-Brometea* (Willner et al., 2004) and *Psoretea decipientis* (Marstaller, 1993; Mucina et al., 2016b). By the first author, the diagnostic value of *Pterygoneurum ovatum* as a character species was supported down to the alliance level.

Pterygoneurum subsessile

This monoecious (Berg et al., 2025a) species has long glass hairs. They reduce UV-radiation and act as condensation nucleus for dew. On their surface, the leaflets have an oval of lamellae, which store water between the cells that are the leaflet's assimilation-organs as well. *Pterygoneurum subsessile* is a Mediterranean moss species (Frahm, 2001). This species was referred to as endangered in the species list of a study on Pannonian loess cliffs in Austria (Zechmeister & Kropik, 2025).

Syntaxa:

Festucion valesiacae: character species (Willner et al., 2004)
Psoretea decipientis: diagnostic species (Mucina et al., 2016a)

This species was indirectly mentioned to be diagnostic for the *Festuco-Brometea* (Willner et al., 2004), and two of its subdivisions. These are the *Festucetalia valesiacae* (Willner et al., 2004) and the *Festucion valesiacae*, for which *Pterygoneurum subsessile* was directly mentioned by (Willner et al., 2004). The latter is an alliance of syntaxa that dwells on calcareous soils (Mucina et al., 2016a), much like the *Psoretea decipientis* for which the species was also mentioned as diagnostic for.

Figure 6 This leaflet of *Pterygoneurum subsessile*, magnified x10, was photographed by the author at the CIUS-lab: "Microscopy, for the MBO6 master course, was performed at the Core Facility Cell Imaging and Ultrastructure Research, University of Vienna - member of the Vienna Life-Science Instruments (VLSI)." Note the long, spiked glass hair that elongates the midrib, and the oval structure of lamellae on the surface.

Rhytidium rugosum

More often found on siliceous substrates, but also on limestone, this moss prefers sunny stands and apparently has little or no competition. Its leaflets are sickle-shaped and undulated. The glossy stemlets have a yellowish green colour and are wormlike.

The leaflets of *Rhytidium rugosum* have an appearance that is described to resemble cat paws, which is aiding the moss' water uptake. In Europe, this is a moss of xerothermic limestone stands, but its distribution stretches well into the Arctics (Frahm, 2001). This xerophytic moss species is mentioned to be a character species of the *Abietinellion*, which is a synonym of the *Rhytidion* by (Schlüsslmayr, 2005). This author also stated that it prefers calcareous stands, being a common species of dry and semi-dry grasslands.

Syntaxa:

Festuco-Brometea: character species (Willner et al., 2004) and (Mucina et al., 2016a)
Stipo pulcherrimae-Festucetalia pallentis: diagnostic species (Willner et al., 2017) and (Dengler et al., 2012)
Diantho lumnitzeri-Seslerion: diagnostic species (Chytrý et al., 2010)
Hylocomietea splendentis: diagnostic species (Mucina et al., 2016a)

This species was mentioned to be diagnostic for the *Festuco-Brometea* (Willner et al., 2004) and (Mucina et al., 2016a) and for two of its subdivisions by as much as three authors. Its position as a character species for the *Festuco-Brometea* is therefore well supported.
Lastly, this species was also mentioned to be diagnostic for a non-vascular plant community, the *Hylocomietea splendentis* (Mucina et al., 2016a).

Syntrichia calcicola *(Tortula calcicolens/ Tortula calcicola/ Tortula densa* – under this synonym, the species was mentioned to be newly found in Austria (Schlüsslmayr, 1999) but has been well documented since. It is a dioecious species (Berg et al., 2025a)**.**

Syntaxa:

Sedo-Scleranthetea: diagnostic species (Mucina et al., 2016a)
Schistidietea apocarpi: character species (Mucina et al., 2016a)
Grimmion tergestinae: character species (Marstaller, 1993)

This species was mentioned to be diagnostic for the classes of *Sedo-Scleranthetea* (Mucina et al., 2016a) and *Schistidietea apocarpi*, the latter one directly by (Mucina et al., 2016a) and indirectly by (Marstaller, 1993). *Syntrichia calcicola* was also indirectly mentioned as diagnostic for the *Schistidietalia apocarpi* by (Marstaller, 1993), which we concluded because of the species being directly mentioned for the *Grimmion tergestinae* (Marstaller, 1993) by the same author. Since it was mentioned for only one vascular plant community, we could consider it a characteristic species for said group.

Syntrichia montana *(Tortula crinita)*

In last year's publication, Mossflora von Österreich, this dioecious species is listed as ***Syntrichia montana*** (Berg et al., 2025a)**.**

Syntaxa:

Koelerio-Corynephoretea canescentis: diagnostic species (Mucina et al., 2016a) and character species (Kuzemko et al., 2014)
Schistidietea apocarpi: diagnostic species (Mucina et al., 2016a)
Grimmion tergestinae: character species (Marstaller, 1993)

This species was mentioned to be diagnostic for the class of the *Koelerio-Corynephoretea canescentis* (Mucina et al., 2016a) and (Kuzemko et al., 2014). *Syntrichia montana* was also mentioned to be diagnostic for the *Schistidietea apocarpi*, directly by (Mucina et al., 2016a) and indirectly by (Marstaller, 1993) as well as for the subdivision of *Schistidietalia apocarpi* indirectly by (Marstaller, 1993). The diagnostic value was concluded from the species being mentioned directly by (Marstaller, 1993) for the alliance of the *Grimmion tergestinae*.

Syntrichia ruraliformis *(Tortula ruraliformis)*

Syntaxa:

Koelerio-Corynephoretea canescentis: diagnostic species (Mucina et al., 2016a)
Festuco-Brometea : character species (Willner et al., 2004)
Festucion valesiacae: character species (Willner et al., 2004)
Stipo pulcherrimae-Festucetalia pallentis: diagnostic species (Dengler et al., 2012) and (Willner et al., 2017)
Ceratodonto purpurei-Polytrichetea piliferi: diagnostic species (Mucina et al., 2016a)

Syntrichia ruraliformis was mentioned to be diagnostic for three different classes of syntaxa. The first one are the *Koelerio-Corynephoretea canescentis,* only mentioned by (Mucina et al., 2016a). The

second class are the *Festuco-Brometea,* indirectly mentioned by (Willner et al., 2017), directly mentioned by (Willner et al., 2004) and also supported by (Dengler et al., 2012). It was also mentioned as diagnostic for the non-vascular plant community of the *Ceratodonto purpurei-Polytrichetea piliferi* (Mucina et al., 2016a).

Syntrichia ruralis *(Tortula ruralis s. str.)*

This dioecious (Berg et al., 2025a) moss is commonly found on secondary stands and is a terricolous species of ruralised dry grasslands. *Tortula* ruralis is a nitrophilous moss species, that also colonizes open patches in dry grasslands (Schlüsslmayr, 2005). It has been mentioned to be a calcicole steppe-grassland species of dry, sun-exposed soil, tolerating 20 – 50% humidity and daily circles of drying and rewetting. Indeed *S. ruralis* has been used for many experimental studies on desiccation tolerance – the ability to fully recover when rehydrated after dehydration to equilibrium with low water content in the surrounding atmosphere. Findings have shown, that prior to 24 h dry, gametophytes regain positive net photosynthesis after 30 minutes. Dry stored specimens regained normal metabolism after three years. (Goffinet & Shaw, 2009). This species cannot be found in sandy dry grassland, where it is substituted by *S. ruraliformis*.

Syntaxa:

Sedo-Scleranthetea: diagnostic species (Mucina et al., 2016a)
Sedo-Scleranthetalia: character species (Kuzemko et al., 2014)
Alysso alyssoidis-Sedion: character species (Kuzemko et al., 2014) and diagnostic species (Chytrý et al., 2010)
Festuco-Brometea: character species (Willner et al., 2004)
Alysso-Festucion pallentis: diagnostic species (Chytrý et al., 2010)

Syntrichia ruralis was directly mentioned by (Mucina et al., 2016a) and indirectly by (Kuzemko et al., 2014) to be diagnostic for the class of *Sedo-Scleranthetea* and two of its subdivisions. These are the alliance of *Sedo-Scleranthetalia* (Kuzemko et al., 2014) and the order of *Alysso alyssoidis-Sedion* (Kuzemko et al., 2014) and (Chytrý et al., 2010). All of those characterize syntaxa on a more rocky substrate (Mucina et al., 2016a).

This species is mentioned to have a high constancy value (39%) in the cluster of impowerished rocky grasslands on calcareous soils, including pioneer stages or transition stages to *Festuca valesiaca*-grasslands, in the Weinviertel and southern Moravia. Its constancy values were higher only in the cluster of rocky calcareous grasslands (42%) and dry grasslands on alluvial gravel soils (46%) (Willner et al., 2013). After all, the moss was also mentioned to be diagnostic for the *Festuco-Brometea* (Willner et al., 2004). This syntaxon contains also the *Alysso-Festucion pallentis* (Chytrý et al., 2010) for which *S. ruralis* was mentioned to be diagnostic for as well, which gives this class a bit of support. All in all, it is debatable which class it could be seen as characteristic for and might be better used as diagnostic species only.

Thuidium delicatulum

This moss species can be found in semi-dry grasslands, also in sandy dry grasslands, but can be found on many different substrates (mossy calcareous rocks, decaying wood e.g.) and seems to prefer more moist, less limestone-rich substrates (Schlüsslmayr, 2005).
Syntaxa:

Hylocomietea splendentis: diagnostic species (Mucina et al., 2016a)

This moss was mentioned for only this one singular syntaxon, so we might consider it as a character species, based on the study of (Faber-Langendoen et al., 2014).

Thuidium recognitum

This bryophyte species is calcicole (Schlüsslmayr, 2005). It has stemlets that are two-times pennante. That means that there is one main stemlet, and every branchlet has two pennate sidebranches.

Syntaxa:

Hylocomietea splendentis: diagnostic species (Mucina et al., 2016a)

T. recognitum was found to be diagnostic for the *Hylocomietea splendentis*, syntaxa which include wefts of large competitive mosses on soils, at the end of bryophyte succession (Mucina et al., 2016a). Since this moss was mentioned for only this one singular syntaxon, we can as well assume it is a character species, after (Faber-Langendoen et al., 2014).

Tortella densa

Most species of the *Tortella* genus are calciphilous. Their leaflets are coiled when dry (Frahm, 2001). This species is mentioned as a dioecious species (Berg et al., 2025a).
Syntaxa:

Polypodietea: diagnostic species (Mucina et al., 2016a)
Asplenietea trichomanis: diagnostic species (Mucina et al., 2016a)
Ctenidietea mollusci: diagnostic species (Mucina et al., 2016a)

Tortella densa was mentioned to be diagnostic for three different classes by (Mucina et al., 2016a), the *Polypodietea,* the *Asplenietea trichomanis* and the *Ctenidietea mollusci.* They mostly dwell on rocky substrates.

Tortella inclinata

A typical species of mesic dry grasslands, this moss prefers limestone substrates and can grow into quite dominant patches ("bestandsbildend"). Its stemlets are yellow and very crinkly. They do not fall apart like those from *Pleurochaete squarrosa* when the cushion is plucked from the substrate.

Tortella inclinata is a calcicole, thermophilic species that prefers sandy, calcareous dry grasslands with shallow soils (Schlüsslmayr, 2005). It is mentioned as a dioecious species (Berg et al., 2025a).

Syntaxa:

Sedo-Scleranthetea: diagnostic species (Mucina et al., 2016a)
Alysso alyssoidis-Sedion: diagnostic species (Chytrý et al., 2010)
Stipo pulcherrimae-Festucetalia pallentis: character species with (Willner et al., 2004) and (Willner et al., 2017)
Psoretea decipientis: character species (Mucina et al., 2016a)
Barbuletalia unguiculatae: character species (Marstaller, 1993) and (Schubert, 2009)
Grimaldion fragrantis: character species (Marstaller, 1993) and (Schubert, 2009)

This moss species was mentioned to be diagnostic for two different classes, the *Sedo-Scleranthetea* (Mucina et al., 2016a) and indirectly supported by (Chytrý et al., 2010) and the *Psoretea decipientis* (Mucina et al., 2016a) and indirectly supported by (Marstaller, 1993) and (Schubert, 2009). They differ in substrate preference: The first is characterized by dwelling on more siliceous soils, the latter is found on calcareous soils (Mucina et al., 2016a). The *Alysso-Sedetalia* are an order that belongs to the *Sedo-Scleranthetea*. For this order, we had only the information of *Tortella inclinata* being mentioned as diagnostic for its subdivision, the alliance of *Alysso alyssoidis-Sedion* (Chytrý et al., 2010). Thus, we assumed that it will also be diagnostic for said order. All of these syntaxa dwell on more rocky substrates or shallow soils. But there is a difference within the class itself, it is described by (Mucina et al., 2016a) to dwell on more siliceous rocky substrates, while the mentioned subdivisions dwell on siliceous and calcareous substrates.

The second class that *Tortella inclinata* was mentioned to be diagnostic for, also yielded information about two of its subdivisions. The *Barbuletalia unguiculatae* (Marstaller, 1993) and (Schubert, 2009) and the the *Grimaldion fragrantis* (Marstaller, 1993) and (Schubert, 2009). Both of those dwell on loamy soils.

Tortella tortuosa

This calcicole moss (Goffinet & Shaw, 2009) is an indicator species for limestone substrates, and its gametophyte is strongly contorted – when dry. Its seta is rather long, and the stemlets can grow up to 10 cm tall. *Tortella tortuosa* is an acrocarpous moss. It which can be quite dominant and is able to compete with pleurocarpous mosses (Jeschke, 2012).

Syntaxa:

- *Festuco-Brometea*: diagnostic species (Willner et al., 2017) and (Chytrý et al., 2010)
  - *Stipo pulcherrimae-Festucetalia pallentis*: diagnostic species (Dengler et al., 2012) and (Willner et al., 2017)
    - *Diantho lumnitzeri-Seslerion*: diagnostic species (Chytrý et al., 2010) and (Dengler et al., 2012)
- *Polypodietea*: diagnostic species (Mucina et al., 2016a)
- *Asplenietea trichomanis*: diagnostic species (Mucina et al., 2016a)
- *Ctenidietea mollusci*: character species (Mucina et al., 2016a) and (Marstaller, 1993)
  - *Ctenidietalia mollusci*: character species (Marstaller, 1993)
    - *Ctenidion mollusci*: character species (Marstaller, 1993) and (Schubert, 2009)

Synthesis: This moss species was mentioned to be diagnostic for four different classes, the *Festuco-Brometea* (Willner et al., 2017) and (Chytrý et al., 2010) and (Dengler et al., 2012) indirectly, the *Polypodietea* and the *Asplenietea trichomanis* (Mucina et al., 2016a), as well as the *Ctenidietea mollusci* (Mucina et al., 2016a) and (Marstaller, 1993). The *Ctenidietalia mollusci* were also included by the same authors. Both this synaxon and the *Ctenidion mollusci* (Marstaller, 1993) and (Schubert, 2009) are plant communities that – like the class – dwell on calcareous substrates. The information by the latter author supports the diagnostic value in the higher orders as well.

The *Festuco-Brometea* are a class of base-rich dry grasslands. These contain the *Stipo pulcherrimae-Festucetalia pallentis* for which the *Tortella tortuosa* was also mentioned as diagnostic, directly by (Dengler et al., 2012) and (Willner et al., 2017) and indirectly by (Chytrý et al., 2010). The species was mentioned to be diagnostic for the *Diantho lumnitzeri-Seslerion* by (Chytrý et al., 2010) and (Dengler et al., 2012), which is a subdivision of said order and class.

Tortella tortuosa, as we explained in detail above, was mentioned to be of diagnostic value for different syntaxa. A common feature seems to be the preference of calcareous substrates. The species was mentioned for only one class of flowering plant communities, the *Festuco-Brometea*. This is well supported by different authors. The information reaches down to the alliance level, the *Diantho lumnitzeri-Seslerion*. The other syntaxa which are more fern-dominated, might not be as important for our study area. But the last cryptogam-syntaxon on the species' list, the *Ctenidietea mollusci*, are well supported and down to the alliance level as well. This species was listed as a dry grassland species, belonging to the *Festuco-Brometea*, *Festucetalia valesiacea*, *Seslerio-Festucion pallentis* from a relevé at Hohe Wand (Niklfeld, 1964), over calcareous bedrock.

Tortula muralis var. muralis

This xerophytic moss species is mentioned to be a character species of the *Grimmietalia anodontis* (Schlüsslmayr, 2005). *Tortula muralis var. muralis* is a bryophyte of more rocky substrates. This species that can endure up to 14 years in dry state without losing its ability to live (Strasburger & Sitte, 2002). It is listed as an autoecious species (Berg et al., 2025a).

Syntaxa:

Schistidietea apocarpi: character species (Mucina et al., 2016a)
Grimmion tergestinae: character species (Marstaller, 1993)

This species was mentioned to be diagnostic for one class only, the *Schistidietea apocarpi* (Mucina et al., 2016a) and indirectly (Marstaller, 1993). By the latter author, *Tortula muralis* var. *muralis* was also mentioned to be diagnostic for the alliance within the same class, the *Grimmion tergestinae* (Marstaller, 1993). Thus, it was concluded it must be a character species of the higher subdivision too, the the *Schistidietalia apocarpi*. All three of these are syntaxa that dwell on limestone substrates.

Weissia longifolia

This autecious (Berg et al., 2025a) moss species reduces the surface of its leaflets that is vulnerable to evaporation by rolling the margins inwards (Frahm, 2001). It is a light-loving pioneer species that grows in patchy, poor grasslands, semi-dry grasslands and base-rich loamy soils (Schlüsslmayr, 2005).
Syntaxa:

Festuco-Brometea: character species (Willner et al., 2004)
Festucetalia valesiacae: diagnostic species (Dengler et al., 2012)
Stipo pulcherrimae-Festucetalia pallentis: diagnostic species (Dengler et al., 2012)
Psoretea decipientis: diagnostic species (Mucina et al., 2016a)
Barbuletalia unguiculatae: character species (Marstaller, 1993)
Grimaldion fragrantis: character species (Marstaller, 1993) and character species (Schubert, 2009)

The last moss species of our list was mentioned to be diagnostic for the class of *Festuco-Brometea* (Willner et al., 2004) and for the class of *Psoretea decipientis* (Mucina et al., 2016a). Belonging to the first class are the following subdivisions, the *Festucetalia valesiacae* (Dengler et al., 2012) and the *Stipo pulcherrimae-Festucetalia pallentis* (Dengler et al., 2012). Since this author mentions *W. longifolia* to be diagnostic for both orders, it was considered safe to assume it should be diagnostic for the class as well. However, there is not much distinction to be had as to which order the species is characteristic for.

All of these syntaxa are found on rocky substrates with deep to shallow soils in a more base-rich or calcareous setting (Mucina et al., 2016a). This is also true for the second class. But its subdivisions, the order of *Barbuletalia unguiculatae* (Marstaller, 1993) and the alliance of *Grimaldion fragrantis* (Marstaller, 1993) and (Schubert, 2009) dwell on rather more loamy soils. Since *Weissia longifolia* was mentioned to be diagnostic for two different classes of syntaxa, one of the vascular-plant-communities and one of the cryptogam-communities (which include ferns, mind!), by different groups of authors, it was considered to be no problem in accepting its diagnostic value for both.

Hierarchy	Syntaxon	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
C	Koelerio-Corynephoretea canescentis									1				1						2								1			
O	Corynephoretalia canescentis									1										1											
A	Armerion elongatae	1			1	1	1			2						1	1			1	1					1				1	1
C	Sedo-Scleranthetea		4	2	2	3	3	4	3	2	1	2	2	6	2	2	2	2	2	6	1	2	4	2	1	2	1	4	3	2	
O	Sedo-Scleranthetalia		2	1	1	2	2	3	2		1	1	1	3	1	2	1	1	1	3	1	1	2	2	1	1	1	3	2	1	
O	Alysso-Sedetalia		4	1	2	2	2	2	1	1	1	1	1	3	1	2	1	2	1	3		1	4	1	1	1		3	1	1	
A	Alysso alyssoidis-Sedion		2	1	1	1	1	2	1	1		1	2	3	1		1	1	1	3		1	2			1		1	2	1	
C	Trifolio-Geranietea sanguinei	1			1	2	2			1		1			1	1	2	1			2	1		1	1	2	1	1		1	1
C	Festuco-Brometea	1	12	9	8	9	7	6	4	1	1	7	6	10	7	5	4	4	4	8	5	9	11	1	5	6	4	7	5	5	
O	Brachypodietalia pinnati	1	4	3	2	4	8	1	4	2	2	7	3	5	4	3	2	1	4	4	4	6	5	2	3	5	5	3	4	5	1
A	Cirsio-Brachypodion pinnati		2	1	1	1	3		1		1	2	1	1							1		1		1	1	1	1		2	
O	Festucetalia valesiacae		1	1	1	1		1					1		1		1	1	1			1	1			1		2			
A	Festucion valesiacae		1	1	1			1						1						1			1								
O	Stipo pulcherrimae-Festucetalia pallentis	1	1	1	2	3		1	1				3	3	2		2	2	1	3	1	1	1			1		3			
A	Alysso-Festucion pallentis							1					1	1						1								1	1		
A	Diantho lumnitzeri-Seslerion								1				1								1										
C	Lygeo sparti-Stipetea tenacissimae		1	2		1								2									1					1		1	
C	Polypodietea																														
C	Asplenietea trichomanis					1																	1								
C	Thlaspietea rotundifolii				1	1		1									1						1								
C	Polygono-Poetea annuae		3	2	3	3	1	2				3		3	2	1	1	2	1	2		1	3		1			1	1		
C	Ceratodonto purpurei-Polytrichetea piliferi									1				1						2								1			
C	Psoretea decipientis	1	11	11	12	9	2	7		1	1	5	1	9	5	6	2	5	3	4		6	12	1	3	4		8	1	2	
O	Barbuletalia unguiculatae	1	7	6	7	6	2	2				4	1	5	3	3	1	3	2	2		5	7		1	3		3	1	1	
A	Grimaldion fragrantis		7	5	6	6	2	2				4	1	5	3	3	1	2	2	1		5	7		1	3		3	1	1	
C	Hylocomietea splendentis		1	1	1	2	5	1	3	2	2	3	3	2	3	1	2	1	2	2	6	3	2	1	2	3	6	3	3	3	
O	Hylocomietalia splendentis		1	1		2	4	1	2	1		3	1	2	3	1	2	1	2	2	2	3	2	1	1	3	3	2	3	3	
A	Rhytidion rugosi		1	1		1	2	1	3	1		2	1	2	1	1	1		2	2	1	2	2	1		2	1	2	2	2	
A	Fissidention taxifolii					1	2					1			2		1	1			1	1			1	1	2	1	1	1	
C	Schistidietea apocarpi			1									3	1																	
O	Schistidietalia apocarpi												3	1																	
A	Grimmion tergestinae												3	1																	
C	Ctenidietea mollusci					2	1							1						1	1		1			2	1			1	
O	Ctenidietalia mollusci																			1	1					1					
A	Ctenidion mollusci																														
A	Fissidention gracifolii																			1	1					1					
C	Neckeretea complanatae										1			1																	
O	Neckeretalia complanatae													1																	
A	Neckerion complanatae													1																	
C	Frullanio dilatatae-Leucodontetea sciuroidis	1							2				1													1	1	2	1		
C	Cladonio digitatae-Lepidozietea reptantis	3		1	1	1	2		2	2	1	1	2	1		2	1		1	1	2	1	1	2		3	2	1	1	1	2
O	Diplophylletalia albicantis																														
A	Dicranellion heteromallae																														
O	Brachythecietalia rutabulo-salebrosi	3		1	1	1	2		2	2	1	1	2	1		2	1		1	1	2	1	1	1		3	2	1	1	1	2
A	Bryo-Brachythecion	2		1	1	1	2		1	2	1	1	1	1		2	1		1	1	2	1	1	1		2	1			1	2

Hierarchy	Syntaxon	31	32	33	34	35	36	37	38	39	40	41	42	43	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60
C	Koelerio-Corynephoretea canescentis									1			1															2	1	
O	Corynephoretalia canescentis																													
A	Armerion elongatae	1	1		1	1			1							1			1				1							
C	Sedo-Scleranthetea	2	4	3	1	3	3	3	2	5	2	3	6	6	7	1	3	2	2	2	2	5	1	2	2	2		7	2	1
O	Sedo-Scleranthetalia	1	3	2	1	2	2	1	2	3	1	1	4	4	5		2	2	2	1	1	4	1		1	2		5	1	
O	Alysso-Sedetalia	1	1	2		2	1	2	1	3	1	2	2	4	4	1	1	1	1	1	1	4		2	1			4	1	2
A	Alysso alyssoidis-Sedion	1	2	1		1	2	2		3	1	2	3	3	3	1	2	1		1	1	1		2	1	1		3	2	1
C	Trifolio-Geranietea sanguinei	1	1		1	2			1							1			2	1	1	1	2				1			
C	Festuco-Brometea	3	7	7	4	5	4	9	4	8	3	3	6	6	12	3	8	3	4	4	7	13	3	8	6	3	2	13	4	3
O	Brachypodietalia pinnati	2	4	4	4	5	4	3	2	3	2	2	3	2	6	2	2	3	4	4	5	7	4	1	6	1	3	5	2	
A	Cirsio-Brachypodion pinnati			1	1								1		1	1		1	1			2			1		1	3		
O	Festucetalia valesiacae		1	1		1		2	1	1			1		1		2		1	1	2	1		2	1	1		2	1	2
A	Festucion valesiacae		1	1				1		1							1				1			1		1		1	1	2
O	Stipo pulcherrimae-Festucetalia pallentis			1		1		2	2	4		1	2	2	4	1	2		1	1	1	2		2	1			6	2	1
A	Alysso-Festucion pallentis		1				1			1			2	1	1		1	1								1		2	1	
A	Diantho lumnitzeri-Seslerion									1						1												1		
C	Lygeo sparti-Stipetea tenacissimae							1		1												1						1		
C	Polypodietea									2				2	1							1						2		1
C	Asplenietea trichomanis									2				2	1		1					2						3		1
C	Thlaspietea rotundifolii																1					1						1		
C	Polygono-Poetea annuae		1	2	1			2		2		1	2	1	2	1	5				1	2		2	1			4	1	1
C	Ceratodonto purpurei-Polytrichetea piliferi												1															2	1	
C	Psoretea decipientis		5	6	4	2		8	4	6			1	4	5	2	7		2	1	4	8	1	7	3	3		10	2	3
O	Barbuletalia unguiculatae		3	4	3	1		5	3	3				2	5	1	5		1	1	2	5		5	2			5	1	
A	Grimaldion fragrantis		3	4	3	1		5	2	3				2	5	1	4		1	1	2	5		4	2			5	1	
C	Hylocomietea splendentis	3	2	2	1	5	4	3	1	2	3	2	2	2	3	2	1	1	2	3	3	5	3	2	3	1	1	1	1	
O	Hylocomietalia splendentis	2	2	1	1	4	3	2	1	2	2	2	2	2	2	1	1	1	2	3	3	4	2	1	3	1	1	1	1	
A	Rhytidion rugosi	2	2	1	1	2	2	2	1	2	2	2	3	2	3	1	1	1	1	2	2	2	1	1	2	1		2	1	
A	Fissidention taxifolii					2	1												1	1	1	2	1		1		1			
C	Schistidietea apocarpi							1		1																				
O	Schistidietalia apocarpi							1		1																				
A	Grimmion tergestinae							1		1																				
C	Ctenidietea mollusci				1	1				2				2	1		1	1	1			4	2		3		1	5		1
O	Ctenidietalia mollusci									1				1	1							1	1					2		
A	Ctenidion mollusci									1				1	1							1						2		
A	Fissidention gracifolii																						1							
C	Neckeretea complanatae				1																									
O	Neckeretalia complanatae				1																									
A	Neckerion complanatae				1																									
C	Frullanio dilatatae-Leucodontetea sciuroidis	1	1	1	1	1	1		1	1			2	1	1	1		1					1		1	1		2	1	
C	Cladonio digitatae-Lepidozietea reptantis	2	4	2	3	3	2		3	1			1	1	1	2		2	2	1	1		4		2	1	1	1	2	
O	Diplophylletalia albicantis		1																					1						
A	Dicranellion heteromallae		1																					1						
O	Brachythecietalia rutabulo-salebrosi	2	3	2	3	3	2		3	1			1	1	1	2		2	2	1	1		4		1	1	1	1	2	
A	Bryo-Brachythecion	1	2	1	2	2	1		2						1	1		1	2	1	1		3		1		1		1	

Table 3

Colour-coded table showing the synthesis of literature data with our data from the relevés. To each syntaxon we plotted the number of diagnostic species found at each of the sampling sites. Green is the colour of higher numbers of species found, yellow stands for lower numbers up to three. The two dominating classes are the Festuco-Brometea and the Psoretea decipientis.

		%	phi	%	phi	%	phi	%	phi
number of relevés:		9		17		31		2	
TWINSPAN cluster level		1		2		3		4	
Tortula ruralis var. ruralis	9	100	83	18	---	13	---	.	---
Bryum radiculosum	9	44	53	6	---	3	---	.	---
Encalypta vulgaris	9	33	52	.	---	0	---	.	---
Tortula ruraliformis	9	33	48	.	---	3	---	.	---
Encalypta streptocarpa	9	33	46	6	---	.	---	.	---
Hypnum lacunosum	9	33	43	6	---	3	---	.	---
Pottia bryoides	9	22	42	.	---	.	---	.	---
Tortella tortuosa	9	22	42	.	---	.	---	.	---
Pottia lanceolata	9	11	---	71	66	10	---	.	---
Pterygoneurum ovatum	9	11	---	65	63	6	---	.	---
Pterygoneurum subsessile	9	11	---	59	61	3	---	.	---
Bryum bicolor	9	.	---	29	49	.	---	.	---
Aloina rigida	9	.	---	24	43	.	---	.	---
Didymodon fallax	9	.	---	35	39	16	---	.	---
Phascum curvicolle	9	11	---	29	37	.	---	.	---
Bryum subelegans	9	11	---	24	31	.	---	.	---
Bryum violaceum	9	11	---	24	31	.	---	.	---
Bryum imbricatum	9	11	---	24	31	.	---	.	---
Didymodon cordatus	9	11	---	24	31	.	---	.	---
Brachythecium rutabulum	9	.	---	24	---	48	46	.	---
Amblystegium serpens	9	44	---	29	---	77	31	50	---
Plagiomnium rostratum	9	.	---	6	---	10	---	100	91
Mnium marginatum	9	.	---	.	---	.	---	50	65
Bryum argenteum	9	67	35	76	47	6	---	.	---
Barbula convoluta	9	56	---	65	19	23	---	50	---
Phascum cuspidatum	9	22	---	59	25	19	---	50	---
Orthotrichum anomalum	9	.	---	.	---	3	---	.	---
Scleropodium purum	9	.	---	12	---	19	---	50	---
Leskea polycarpa	9	.	---	.	---	3	---	.	---
Thuidium recognitum	9	.	---	.	---	3	---	.	---
Brachythecium velutinum	9	.	---	.	---	3	---	.	---
Bryum capillare group	9	.	---	.	---	3	---	.	---
Thuidium delicatulum	9	.	---	6	---	3	---	.	---
Brachythecium campestre	9	.	---	.	---	3	---	.	---
Lescuraea incurvata	9	.	---	.	---	3	---	.	---
Weissia longifolia	9	22	---	47	---	39	---	.	---
Campylium calcareum	9	11	---	12	---	19	---	.	---
Pottia davalliana	9	11	---	.	---	3	---	.	---
Phascum cuspidatum var. piliferum	9	11	---	.	---	6	---	.	---
Bryum ruderale	9	11	---	.	---	3	---	.	---
Abietinella abietina	9	78	---	41	---	65	---	.	---
Bryum caespiticium	9	22	---	24	---	.	---	50	---

Campylium chrysophyllum	9	33	---	6	---	13	---	.	---		
Platydictya confervoides	9	11	---	.	---	10	---	.	---		
Hypnum cupressiforme	9	67	---	18	---	45	---	.	---		
Barbula unguiculata	9	11	---	6	---	10	---	.	---		
Fissidens taxifolius	9	.	---	12	---	23	---	.	---		
Crossidium squamiferum	9	.	---	6	---	.	---	.	---		
Entodon concinnus	9	.	---	.	---	10	---	.	---		
Dicranella staphylina	9	11	---	.	---	.	---	.	---		
Didymodon acutus	9	11	---	18	---	.	---	.	---		
Ceratodon purpureus	9	22	---	6	---	.	---	.	---		
Tortella densa	9	22	---	6	---	.	---	.	---		
Phascum floerkeanum	9	11	---	.	---	.	---	.	---		
Pleuridium acuminatum	9	.	---	6	---	.	---	.	---		
Tortella inclinata	9	11	---	.	---	.	---	.	---		
Tortula intermedia	9	11	---	.	---	.	---	.	---		
Brachythecium albicans	9	11	---	.	---	3	---	.	---		
Pleurochaete squarrosa	9	11	---	12	---	.	---	.	---		
Pseudocrossidium hornschuchianum	9	.	---	12	---	3	---	.	---		
Didymodon vinealis	9	22	---	24	---	3	---	.	---		
Pottia intermedia	9	11	---	12	---	.	---	.	---		
Acaulon muticum	9	.	---	.	---	6	---	.	---		
Rhytidium rugosum	9	.	---	.	---	13	---	.	---		
Pseudoleskea catenulata	9	.	---	.	---	3	---	.	---		
Homalothecium lutescens	9	89	---	65	---	77	---	.	---		
Homomallium incurvatum	9	11	---	.	---	3	---	.	---		
Tortula muralis	9	.	---	6	---	6	---	.	---		
Eurhynchium hians	9	.	---	29	---	42	---	50	---		
Bryum rubens	9	44	---	47	---	13	---	50	---		
Bryum atrovirens agg.	9	11	---	6	---	3	---	.	---		
Tortula calcicolens	9	11	---	.	---	.	---	.	---		
Pottia caespitosa	9	.	---	12	---	.	---	.	---		
Phascum cuspidatum var. mitraeforme	9	11	---	12	---	.	---	.	---		
Bryum klinggraeffii	9	.	---	12	---	3	---	.	---		

Table 4 Combined synoptic table with percentage values (left) and fidelity index, Phi coefficient, (right) in 4 columns, Fisher's exact test > 3

4.2. Comparison of TWINSPAN-grouped sampling sites

In this section, the diagnostic species of the four clusters of the TWINSPAN classification are presented. The species are sorted by descending fidelity (phi value) in each cluster. One species, Bryum argenteum, was diagnostic for two clusters. Trying to interpret these clusters, we looked up which syntaxa our mosses from the TWINSPAN-table are mentioned to be diagnostic for. Most of the mosses are diagnostic for more than one plant community. The first cluster (Table 4) has the

following syntaxa in common: the majority of the mosses are mentioned as diagnostic for the *Sedo-Scleranthetea* and the *Festuco Brometea* as well as some non-vascular plant syntaxa. The second cluster represents a combination of *Festuco Brometea* and *Psoretea decipientis*, some species differ, but the main pattern is clear. It is also the largest of the four clusters. The last two clusters are rather heterogenic. The third cluster seems to be standing for non-vascular plant groups, because the H*ylocomietea splenditis* and the *Neckeretea complanatae* do not appear as diagnosed in any other cluster.

This approach failed to provide a clear understanding of the effect those species can have. After all, more than one syntaxon might be present on site, even if the *Festuco Brometea* are dominant. But it seems that is as much as the TWINSPAN (Hill, 1979) can do for us. A regrouping by hand might have increased the clarity of syntaxonomic preferences by adding previously unsorted diagnostic species to one of the clusters that best fits the pattern of occurrence.

Each diagram stands for one sample plot location. It shows the number of diagnostic moss species that were found on that site. The species are listed under the syntaxon for which they were found to be diagnostic for in the literature. For better readability, the y-axis, listing all the syntaxa, has been reduced. The information on it has been moved to the data-description of each bar. Thus the bar graph shows exactly how many species had been found diagnostic for what syntaxon at each relevé site. This gives us the information what syntaxa could be present on the site, and which of them is represented the most.

The letter in front of the syntaxon stands for its hierarchy level: C – class, O – order, A – alliance, the latter being the lowest level used in our research. Albeit that not all the diagrams would need an x-axis that stretches up to nine – that being more than the highest amount of diagnostic species in most sites – the graphs were kept in this setting for better comparability. Only sites that had a higher number of diagnostic species were given a graph with an adjusted width.

The bar graphs were then grouped together according to a TWINSPAN analysis with four division levels. This analysis had been made with the data of the moss layer from all the relevés which resulted in the following four groups.

For a more practical appearance of the results section, the respective graphs have been moved to the supplements. The most represented syntaxa present at our sampling sites are the *Festuco-Brometea*, followed by the *Psoretea decipientis* (see Table 3).

First group

Sites 13, 19, 39, 42, 43, 44, 47, 55, 57 nine sample plots were sorted into this first cluster.

On site 13, we see that this stand was found to contain a lot of diagnostic mosses of the *Festuco Brometea*. Ten species of our relevés were considered “diagnostic” in the literature, followed up closely by nine species of another class, the *Psoretea decipientis*. Site 19 shows a clear domination of species which are diagnostic for the class of *Festuco Brometea* and also *Sedo-Scleranthetea*. Also, this is the only site that has the *Fissidention gracilifolii*. Site 39 shows a domination of *Festuco Brometea* and *Psoretea decipientis*, followed closely by the *Sedo-Scleranthetea*. Site 42 and 43 show that there were equally as many diagnostic species for *Festuco Brometea* present on this site as for the *Sedo-Scleranthetea*. A different situation presented itself on site 44. Twelve moss species were listed in the literature as diagnostic for *Festuco-Brometea*. That is twice as many as were listed for *Brachypodietalia pinnati*. This graph of site 47 shows a pattern that is distinctly different from the others of the group, except for site 55 which has also very few diagnostic species per syntaxon. Albeit

on site 47, we see an equal amount of species found diagnostic for *Festuco-Brometea* and *Brachypodietalia pinnati*. Site 55 shows a domination of *Psoretea decipientis* and *Festuco-Brometea* species. The only other two syntaxa that have more than one diagnostic species are the *Sedo-Scleranthetea* and the *Sedo-Scleranthetalia*. Site 57 with its substrate of fine gravel and sand – remnants from beyond the ice age – shows a variety of syntaxa. Two groups of syntaxa are most strongly represented: *Psoretea decipientis* and *Festuco-Brometea* with the highest number of diagnostic species, in our data, for the latter. Only site number 53 has also got thirteen diagnostic species for *Festuco-Brometea*.

Second group

Sites 2, 3, 4, 5, 7, 14, 15, 17, 22, 27, 32, 33, 37, 46, 51, 53, 59 seventeen sampling locations were sorted into this cluster.

Site 2 and 3 show a domination of species diagnostic for *Festuco-Brometea* and *Psoretea decipientis*. Site 4 shows that the *Psoretea decipientis* are stronger represented than the *Festuco Brometea*, but both are the strongest groups. There is another strongly represented group within the non-vascular plant syntaxa, it is again the group of the *Brabuletalia unguiculatae*. On site 5 we see an equal amount of species found diagnostic for *Festuco-Brometea* and *Psoretea decipientis*. On site 7, 15 and 17 we see a lower number of species found diagnostic for *Festuco-Brometea* than for *Psoretea decipientis*, the latter being more strongly represented. The *Sedo-Scleranthetea* have the third most diagnostic mosses on this site, the same pattern also shows on site 27. Site 14 shows a higher amount of species found diagnostic for *Festuco-Brometea* than for *Psoretea decipientis*. Sunken paths with their steep walls are a good substrate for moss-crusts, because they offer a lot of open surface space. A lot of loess-colonizing species that form herds can be found there. This relevé-site, however, was not as steep and long as the hollow way of site 22 and thus not as rich in diagnostic species. It is a habitat of *Gentiana cruciata* though. The syntaxon with the third most diagnostic moss species are the *Brachypodietalia pinnati*. On site 22 we again see a slightly stronger representation of the *Psoretea decipientis*. The *Festuco-Brometea* follow up close behind, and it's the highest number of moss species diagnostic for the *Psoretea decipientis* within the second grouping. *Barbuletalia unguiculatae* and *Grimaldion fragrantis* are the third strongest groups.

Site 32, the species registered as diagnostic for *Festuco-Brometea* outnumbered all other species. *Psoretea decipientis*' species are still strongly present, but not much stronger than those of *Sedo-Scleranthetea*. The latter are equal to the *Brachypodietalia pinnate* and the *Cladonio digitatae-Lepidozietea reptantis*. This is the first graph to show the *Dicranellion heteromallae*. Species that are diagnostic for *Festuco-Brometea* are once again dominating a relevé-site, number 33, as can be seen in, closely followed by *Psoretea decipientis*. The third place is shared between the *Barbuletalia unguiculatae* and the *Grimaldion fragrantis*. The same situation presented itself on site 37.

On site 46, Blauer Berg, again a domination of species diagnostic for *Festuco-Brometea* is visible, closely followed by *Psoretea decipientis*. The third most represented group are the *Barbuletalia unguiculatae*. This site is home to the *Kraschenninikovia ceratoides*, a relic from the ice ages. After all, cold draught is also a form of draught stress. It would be interesting to see whether there would also be ice-age relic mosses around, but in the sample process, they were not particularly searched for.

On site 51, a clear domination of species diagnostic for *Festuco-Brometea* is visibly expressed. The *Psoretea decipientis* are the second largest group, and the *Brachypodietalia pinnati* have the third most amount of diagnostic mosses on this site. Site 53 shows a similar distribution, but the third

most prominent syntaxon are the *Barbuletalia unguiculatae*. Site 59 has again an equal amount of species diagnostic for *Festuco-Brometea* as well as *Psoretea decipientis*. The overall amount of diagnostic species was quite low, which might be due to the fact of a lot of overgrowth and shadow from the surrounding trees. Albeit, this part of the location was the lesser shaded altogether. Also, the rocky substrate accounts for the remaining amount of more dry-grassland inclined species. Since it is one of the calcareous outcrop hilltops in the Falkenstein area, it was probably not woody at all, at least in former times. The spring aspect was full of lovely early bloomers.

Third group

Sites 1, 6, 8, 9, 11, 12, 16, 18, 20, 21, 23, 25, 26, 28, 29, 30, 31, 34, 35, 36, 38, 40, 41, 45, 48, 49, 50, 52, 54, 56, 58 thirty-one locations were put into this cluster.

On site 1, two syntaxa aare depicted as those with the most diagnostic species which have not been exceptionally expressed before: *Cladonio digitatae- Lepidozietea reptantis* and *Brachythecietalia rutabulo-salebrosi*. There is only one more syntaxon that has more than one diagnostic species on this site, the *Bryo-Brachythecion*. This is one of the few cases in our results where syntaxa of the non-vascular group surpass those of the vascular plants.
On site 6 the number of species diagnostic for *Brachypodietalia pinnati* exceeds the number of species diagnostic for *Festuco- Brometea*. This is the first time in this course of results. The third most diagnostic mosses were found for the *Hylocomietea splenditis*.

On site 8, *Festuco-Brometea* and *Brachypodietalia pinnate* are equally represented. Two classes share the third place, the *Sedo-Scleranthetea* and the *Hylocomietea splenditis*. The first time that there is no syntaxon actually surpassing the others in terms of diagnostic species is the situation on site 9. On site 11, an old quarry, the *Festuco-Brometea* and the *Brachypodietalia pinnati* are equally represented and have more diagnostic species than the other syntaxa. The *Psoretea decipientis* are on third place. The *Festuco-Brometea* are the most represented syntaxon on site 12, 16, 28 and 25. On site 26, we see that on the upper part of the relevé location, there are altogether less syntaxa than on site 25. Also, the *Hylocomietea splenditis* are dominating this site. They are closely followed by the *Brachypodietalia pinnati*. Next in line are the *Festuco-Brometea*.

On site 18, the *Festuco-Brometea* and the *Brachypodietalia pinnati* are equally represented and have more diagnostic species than the other syntaxa. The *Hylocomietea splenditis* are dominating site 20. They are closely followed by the *Festuco-Brometea*. The *Brachypodietalia pinnate* have the third most amount of diagnostic species here. On site 21, the *Festuco-Brometea* are once again dominating the scene. The *Psoretea decipientis* are now equally strong as the *Brachypodietalia pinnati*, so there is some visible difference to the site down the hillside, see site 20. The *Barbuletalia unguiculatae* and *the Grimaldion fragrantis* share the third place.

There is no syntaxon on site 23 that has the most diagnostic species. All represented syntaxa are very low in diagnostic species. That might be because on the south-exposed side, there were little bryophytes present. Also, at one point it had been mown before the relevé took place.
On site 29, Zeiserlberg This is the habitat of a very special plant, the glacial relict species *Crambe tartaria*, the *Festuco-Brometea* and the *Brachypodietalia pinnati* are equally represented and have more diagnostic species than the other syntaxa. The *Hylocomietea splenditis* and the *Hylocomietalia splenditis* share the third place. Relevé-site number 30 has the fewest amount of syntaxa of all the sites. It was very much overgrown with bushes. It's most exciting plant to-be-found was the *Aristolochia clematites.* There is a similarity to the distribution of syntaxa in former sites, but on site 31, the *Festuco-Brometea*, together with the *Hylocomietea splenditis* are stronger represented.

The *Festuco-Brometea*, *Brachypotdietalia pinnati* and the *Psoretea decipientis* have the most diagnostic moss species on site 34. On site 35, the *Festuco-Brometea*, *Brachypotdietalia pinnati* and the *Hylocomietea splenditis* have the most diagnostic moss species on this site. The second most diagnostic species belong to the *Hylocomietalia splenditis*. We see a similar situation as in the previous relevé site on site 36. The *Festuco-Brometea*, *Brachypotdietalia pinnati* and the *Hylocomietea splenditis* again have the most diagnostic moss species. The *Hylocomietalia splenditis* and the *Sedo-Scleranthetea* are on second place with one species less than the leading syntaxa. The *Festuco-Brometea* and the *Psoretea decipientis* have the most diagnostic moss species on site 38. The *Barbuletalia unguiculatae*, the *Cladonio digitate-Lepidozietea reptantis* and the *Brachythecietalia rutabulo-salebrosi* share the second place. The *Festuco-Brometea* and the *Hylocomietea splenditis* have the most diagnostic moss species, but overall, the number of different syntaxa designated to site 40 is quite low. The *Sedo-Scleranthetea* and the *Festuco-Brometea* are the main syntaxa on site 41. There were not many different syntaxa present altogether, but more than on the former site. The *Festuco-Brometea* are the most represented syntaxon on site 45. Overall, the amount of diagnostic moss species per syntaxon was low. In comparison to the previous sites with "low participation", there are quite a lot of syntaxa present – or represented, and all the way through the alliance level.

The *Festuco-Brometea* and the *Brachypodietalia pinnati* are the syntaxa with the most diagnostic species on site 48, 49, 50, 54 and 58. On site 52, the *Brachypodietalia pinnati* are the most strongly supported flowering-plant community. The *Cladonio digitatae-Lepidozietea reptantis* and the *Brachythecietalia rutabulo-salebrosi* are the most strongly supported non-vascular plant community. The *Festuco-Brometea*, the *Hylocomietea splenditis* and the *Bryo-Brachythecion* share the second place. We see, that the *Brachypodietalia pinnati* have the most diagnostic species on site 56. All other plant communities follow behind the *Festuco-Brometea*, which come in second. Overall, numbers of diagnostic moss species are low, and there was not much variety in syntaxa altogether.

Fourth group

Sites 10, 24 only two sampling sites remained for this cluster.

Note, that this relevé site is in a different grouping than the one on the same location, Waschberg. The *Brachypodietalia pinnati* and the *Hylocomietea splenditis* have the most diagnostic moss species here, on site 10. On site 24, at the Hausberg at Gaiselsberg, north-exposed slope, the *Festuco-Brometea* are the syntaxon with the most diagnostic moss species. The *Brachypodietalia pinnate* and the *Psoretea decipientis* share the second place, and there is only one more syntaxon that has one more diagnostic species than the rest, the *Hylocomietea splenditis*.

5. Discussion

5.1. About the results and arising questions

Our results can be summed up with the fact that the most represented syntaxa at our sampling sites in the Weinviertel are the *Festuco-Brometea*. Next in line are the *Psoretea decipientis* (see Table 4). In a study about species richness (Zulka et al., 2014b), the authors stated that they used dry grassland patches of the *Festuco-Brometea* to assess both bio-diversity enhancing and diminishing factors. Their study area, albeit belonging to the Pannonikum, was mainly located south of the Danube and Vienna. The study aiming to revise the vegetation communities of the Pannonian basin in Austria (Willner et al., 2013) also mentions that the two main syntaxon groups are those belonging to the *Festuco-Brometea* and the *Molinio-Arrhenatheretea*. Of the latter, they did not appear in this

thesis' findings, since they are vegetation stands on more deep, fertile soils used for example as pastures (Mucina et al., 2016b).

Species such as *Abietinella abietina* have shown that, albeit being mentioned as diagnostic by many of our authors, the broad amplitude of the moss splits the diagnostic value up into more than one vascular-plant class of syntaxa. We see this in the synoptic Table 3, even though its fidelity values are good, the species is not sorted into any of the main clusters. On the other hand, the moss species with the highest fidelity value, *Syntrichia ruralis*, is also sorted into two main classes by the different authors. While it is seen as a strong diagnostic species for the *Sedo-Scleranthetea* (Mucina et al., 2016a) and even character species for the *Sedo-Scleranthetalia* (Kuzemko et al., 2014), others hold it as a character species for the *Festuco-Brometea* (Willner et al., 2004) by statistical methods (high constancy value (39%) in the cluster including *Festuca valesiaca*- grasslands in the Weinviertel and southern Moravia).
The results surely also depend on the fact that no rocky dry grasslands were included in the sample plots. Our designated diagnostic species might have been sorted into different clusters then.
The results also show that the grassland species of a more semi-dry character are stronger represented than those of the grass steppes. However, this might be also due to a generalizing factor of the moss-data we heavily relied on. There certainly were some specialist mosses too, especially over loess substrates.

Sometimes it was difficult to interpret the site-graphs. Because it seems that the most represented syntaxon should be the one present on that site. Yet, the situation was not always clear. Questions arose such as the following: If a class is supported by further "high ranking" syntaxa, say, the third place is within the class that has already been second place, is that not more important than the first ranked? Because it's more specifying then? Hence declaring this is not the one with the most but the most refined syntaxon? Is it then even necessary to note the 3rd places just to have some more information? However, a study on xerotherm vegetation of eastern Lower Austria lists two relevés of a Diernberg close to Falkenstein (Niklfeld, 1964), sorting the herblayer into *Festuco-Brometea*, *Festucetalia valesiacae*, and the results of graph 30 (see Appendix) for sample plot 59, Dürrenberg, as it were, reciprocate this. Site 42 has also been mentioned as a common pasture, stating that the dry grasslands here are anthropogenic, located between the castle ruin of Falkenstein and the Diernberg/ Dürrenberg (Niklfeld, 1964).

All in all, the situation of splitting the vascular- and non-vascular plant sections is supported due to us using this system, and it seems practical enough. Admitting the fact that only a certain amount of mosses had been found there – some, pleurocarpous and therefore must've been settling there for quite *some* time, it is possible to say that they must have been influenced by the amount and species (varying life strategies *and* therefore forms!) of flowering plants. And maybe vice versa - so this also influenced our results, naturally. The limited amounts of mosses define what we can assume as a resulting syntaxon – or syntaxa! The question therefore is not "can we describe plant associations and communities by looking at the mosses?" but *how* well can we do that? Do we want to put the mosses in the pot with the flowering plants? Or should we rather look at them each on their own – shiftwise (moss-cohorts apart from the layer of flowering plants).

Well, how do we define the amount of mosses that have to be diagnostic for a syntaxon to be accepted as "present" – or is it best to be put in relation to "how many species are present per syntaxon?". Are the rest of them, represented by one diagnostic species only, just statistical noise? And – mosses are more small scale- distributed, especially in dry grasslands – there might be open "islands" in deep grassland that stay moist for long, where wafts are thick, and there might be open

patches on shallow soil – or thick but water-binding, surface-dry substrates that are home to petite herds of – likewise long dwelling – or perennial aprocarpous mosses.
Furthermore, the finetuneing in science is great for diving into a better understanding of the matter itself. But to really see the bigger picture of dry grassland landscapes, one might have to zoom out of the non-vascular plant world.
A study on badland grasslands in Tuscany used bryophyte, lichen and vascular plant data, to discern patterns of cross-taxon congruence, receiving a weak signal. The authors state that some predictive power of vascular plant syntaxa towards bryophyte species had been previously shown congruent signals, however, that seemed to depend on the ecosystem in question (Fanfarillo et al., 2024).

A study focused on dry grasslands in Öland, Sweden, sampling data on vascular plant, lichen and bryophyte species richness stated that species richness was best predicted by soil pH (Löbel et al., 2006). The authors were able to list a syntaxonomical classification of their sample plots as belonging to the *Festuco-Brometea* (semi-dry basiphilous grasslands), *Sedo-Scleranthetea* (weathered rock and outcrop communities)and *Koelerio-Corynephoretea* (dry grasslands on sand soils), stating 15 units were found altogether, but the did not list those in the paper directly.

The suggestion of treating the two edaphic, basiphilous sudivisions of the semidry grasslands as one syntaxon was observed. One occurs in drier conditions, and *Bromus erectus* appears in both syntaxa with high constancy values. But all other diagnostic species point in the direction of *Cirsio brachypodion*. Thus, we considered the re-unified *Cirsio-Brachypodion* and the *Bromion erecti* as one alliance of *Cirsio brachypodion*. Those two joined, as mentioned in literature, have a better representation by five diagnostic species (Willner et al., 2013). Of the mosses in our relevés, *Brachythecium albicans* had the highest cover value (52%) in the aforementioned study's cluster that stands for *Cirsio brachypodion*. It is also a cryptogam species that has the highest cover value of all cryptogams in that cluster (Willner et al., 2013).

5.2. About the general situation and data collection in the field

Sometimes, it was impossible to find the same actual site in the field where the original dry-grasslands catalogue had located certain interesting stands. Also, it's been onto 30 years since then, so there was bound to be some difference concerning building and agriculture. Some of these plots are indeed managed by local groups engaging in nature protection activities – management of bushes etc. often because they are tourist-attractions. So that was a factor of data-limitation as well as the factor time, which is of course also the amount of money that could be afforded. The first because the moss-flowering time and flourishing would've provided better bryophyte data. The main growth period for bryophytes in temperate climates tends to be autumn, due to sufficient water supply (Goffinet & Shaw, 2009). The latter because it would've provided for a better take on the flowering plants that we hadn't seen in full bloom (orchids for that matter) and on one plot the grasses bevor mowing. That would've meant covering nature's most active time – but it also is a most active time at university. The only extra tour we made was in May to see *Crambe tartaria* in full bloom. That took a whole day from Vienna and back with only about two hours at the actual site.

The diagnostic value of bryophytes for syntaxonomic purposes is dependent on the system of syntaxa that is used. In this thesis, where the focus was placed on dry grasslands, more refined sampling is needed to have a better overview of the bryophytes present in the area. It might well be, that limited experience with dry grassland moss species has biased the results. The main study focus to begin with, were the vascular plant species. When the workload was divided, this thesis' aim was

to determine the bryophyte species and use the information for a syntaxonomic sorting-approach. Hence, the use of literature-research to create a synthesis of data from fieldwork and literature.

5.3. Concluding thoughts

For a regular botanist, this approach might not be so useful, because it incapsulates the dry grasslands into two separated worlds, the one of the mostly vertically uprising (and macroscopically easier to determine) higher plant species and the crypotgams that horizontally arrange themselves. It might be better to use a system that includes the more common bryophyte species with the vascular plants. Most botanists who are trained in the field know their fair share of moss species. But unless those belong to the taller growing mosses, for example *Rhythidium rugosum*, cryptogams not necessarily meet the eye, for example an *Aloina* species.

For a computer program, it doesn't matter whether it is an expert in the one or the other plant group who files in the data. The more information it can have to process into save, sturdy results, the better. Hence, I recommend comparing the results of this thesis' data (that rests mostly on bryophyte data) to the outcome of the vascular-based sorting of the same study field's relevés. It should be similar if the same syntaxonomic hierarchy (we recommend (Mucina et al., 2016a)) is used.

This has also been discussed by (Berg et al., 2020), authors of a paper that looks into the facilities of dividing plant communities into syntaxa and synusiae. Synusiae are also mentioned to express a certain appearance of stands that share main components of vegetation, such as large pleurocarpous mosses. For example , *Hypnum cupressiforme* var. *lacunosum*, *Homalothecium lutescens*, and *Abietinella abietina* were mentioned to build synusiae in densely grown dry grasslands (Schlüsslmayr, 1999).
It might be more important to state that albeit synusiae can be a helpful system of sorting vegetation, it again creates a splitting of data into human-made hierarchies which might not be representative of natural occurrences. Adding more boxes to sort vegetation into will not help to create a better overview. Which is even more true when relying only on statistical methods, even if contradictions lead to more interesting questions. But would it make any sense to divide syntaxa into vascular- and non-vascular syntaxa, while the rest of the world uses the higher-plant dominated system?

Bryophyte species richness has been found to decrease when management of calcareous grasslands ceases. Mowing, one way to keep vegetation from developing into a dense herb and shrub canopy, has a positive effect on some rare plant species, such as orchids, however, to keep up a diverse layer of bryophyte species in dry grasslands, grazing is the better management plan (Vanderpoorten & Goffinet, 2010). Maintaining an intermediate disturbance is key, since overly grazing plots can put too much pressure on the bryophyte layer as well. The fact that in many European countries, a substantial amount of red list species has been found in dry grasslands, strongly speaks for the preservation of the diversity of these landscapes (Goffinet & Shaw, 2009). Especially since other authors mention robust evidence of expansion of bryophytes from warmer regions due to climate change, and a decline in species from nutrient poor habitats (Pakeman et al., 2022).

6. German abstract:

Die Vegetationsgesellschaften der Weinviertler Trockenrasen sind für die Wissenschaft aufgrund mehrerer Aspekte von Interesse. Einerseits stellen sie die westlichsten Habitate mehrerer pannonischer Steppenpflanzen dar. Andererseits sind sie somit ein wichtiger Beitrag zur allgemeinen Biodiversität Österreichs, im Staatsgebiet sonst selten und damit ein schützenswertes Gut. Um die Einteilung der Weinviertler Trockenrasen genauer darstellen zu können, wurden an 59 Standorten, ausgewählt aus dem Österreichischen Trockenrasenkatalog Vegetationserhebungen gemacht. Dies geschah mit besonderer Berücksichtigung der Moose, denn die bei den Relevés aufgenommenen Moosarten wurden für eine syntaxonomische Gliederung im Literaturvergleich herangezogen. Eine Art, die im Kontext einer Vegetationsgesellschaft als diagnostisch genannt wurde, konnte für alle darüberstehenden Syntaxa (Ordnung und Klasse) als ebenfalls diagnostisch gelistet werden. Diese Daten wurden mit den Standorten so verknüpft, dass aus einer daraus resultierenden Kreuztabelle Diagramme für jeden Standort gezeichnet wurden. Sie zeigen die dort aufgefundenen Moosartenzahlen pro Vegetationsgesellschaft, sodass sich ablesen lässt, welche Gesellschaft am jeweiligen Standort dominiert. So lässt sich sagen, dass *Festuco-Brometea* und *Psoretea decipientis* die dominierenden Vegetationsgesellschaften der von uns untersuchten Flächen im Weinviertel sind. Sie spielen auch in den von TWINSPAN erstellten Clustern die Hauptrolle, wenn man betrachtet, welche Syntaxa am stärksten durch diagnostische Arten vertreten sind.

7. References

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8. Acknowledgements

Big thanks go to to Wolfgang Willner for his advice and help during the data analysis and syntaxonomic sorting and Harald Zechmeister for his help and correction during the identification process of the bryophytes. Many thanks also to the CIUS core facility for providing me with valuable input and technical devices to picture my moss samples. “Microscopy (to be specified if necessary) was performed at the Core Facility Cell Imaging and Ultrastructure Research, University of Vienna - member of the Vienna Life-Science Instruments (VLSI).”

Thanks to Eric Arn, Benjamin Schuster, Paul Achatz and Arno Wallerstein for proof reading and comments on the manuscript. Thanks to G.S.H. for driving the car: “Without a car, science is futile in the Weinviertel. “

Thanks to my loving family, caring friends and to the music of Count Basie, Duke Ellington, Novaks Kapelle, and Primordial Undermind, Torùn, Bird People, Outer Vertex, MS Mutt, Gebenedeit, Libramar and many more of the now endangered Vienna music scene and its clubs. *All these places have their moments, with lovers and friends I still can recall, some are dead, and some are living. In my life, I have loved them all*. (The Beatles)

About determinating dry grassland mosses: **"**now the feeling? losing a calyptra on the way to the petri dish, or a sporophyte jumps off the tweezers... and finding it miles away? plus, to passersby-colleagues, it probably looks like you're working with very important, fragile, yet somehow invisible stuff! Like examining dots of the letter 'i' .**"**

9. Appendix

Table 2 lists from 59 relevés , with applied TWINSPAN divisions:

TWINSPAN cluster level		1	1	1	1	1	1	1	1	1	2	2	2	2	2	2	2	2	2	2	2	2	2
Relevé number		13	19	39	42	43	45	48	56	58	2	3	4	5	7	14	15	17	22	27	32		
Table Number		13	19	39	42	43	44	47	55	57	2	3	4	5	7	14	15	17	22	27	32		
Tortula ruralis var. ruralis	9	2	+	1	4	3	1	3	2	1	.	.	.	.	+	.	.	.	.	.	1		
Bryum radiculosum	9	.	.	.	+	+	.	.	+	+	.	.	+	.	.	.	.	.	.	.	.		
Encalypta vulgaris	9	+	.	+	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.		
Tortula ruraliformis	9	1	+	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.		
Encalypta streptocarpa	9	.	.	.	.	+	+	.	.	+	.	.	.	.	.	.	.	.	.	.	.		
Hypnum lacunosum	9	.	.	.	3	.	+	.	.	1	.	.	.	.	.	.	.	.	.	r	.		
Pottia bryoides	9	+	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.		
Tortella tortuosa	9	.	.	1	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.		
Pottia lanceolata	9	+	.	.	.	.	.	.	.	.	+	2	.	+	.	.	+	+	+	+	+		
Pterygoneurum ovatum	9	.	.	.	.	+	.	.	.	.	+	+	1	.	1	+	1	.	r	.	+		
Pterygoneurum subsessile	9	.	.	.	.	.	.	.	+	.	+	+	+	.	1	.	.	.	r	.	+		
Bryum bicolor	9	.	.	.	.	.	.	.	.	.	.	+	+	.	.	.	.	1	.	.	.		
Aloina rigida	9	.	.	.	.	.	.	.	.	.	r	+	+	.	.	.	.	.	1	.	.		
Didymodon fallax	9	.	.	.	.	.	.	.	.	.	+	+	+	+	.	.	.	.	r	.	.		
Phascum curvicolle	9	.	.	.	.	.	.	.	.	+	.	.	.	+	.	.	.	.	r	.	.		
Bryum subelegans	9	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	+	.	+	+	.		
Bryum violaceum	9	.	.	.	.	.	.	.	.	+	.	.	.	+	.	+	.	.	.	r	.		
Bryum imbricatum	9	.	.	.	.	.	.	.	.	+	.	.	.	+	.	.	.	.	+	.	.		
Didymodon cordatus	9	+	.	.	.	.	.	.	.	.	+	+	.	.	.	.	.	.	+	.	.		
Brachythecium rutabulum	9	.	.	.	.	.	.	.	.	.	.	.	+	+	.	.	1	.	.	.	r		
Amblystegium serpens	9	+	+	.	.	.	1	+	.	.	.	+	.	.	.	.	+	.	+	.	+		
Plagiomnium rostratum	9	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.		
Mnium marginatum	9	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.		
Bryum argenteum	9	+	+	2	1	1	+	.	.	.	+	1	+	+	1	+	.	+	r	.	.		
Barbula convoluta	9	r	+	+	.	.	2	.	.	+	+	.	+	+	.	1	+	.	+	.	+		
Phascum cuspidatum	9	+	.	.	.	.	.	.	+	.	+	+	.	.	+	+	1	+	r	+	.		
Orthotrichum anomalum	9	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.		
Scleropodium purum	9	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	4	.		

Leskea polycarpa	9	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Thuidium recognitum	9	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Brachythecium velutinum	9	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Bryum capillare group	9	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
huidium delicatulum	9	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Brachythecium campestre	9	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Lescuraea incurvata	9	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Weissia longifolia	9	.	.	.	.	.	+	.	.	+	.	.	.	+	.	+	.	+	.	+	.
Campylium calcareum	9	.	.	.	.	.	.	.	.	+	.	.	.	+	.	.	.	.	.	.	.
Pottia davalliana	9	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Phascum cuspidatum var. piliferum	9	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Bryum ruderale	9	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Abietinella abietina	9	1	+	1	1	2	+	.	.	1	+	.	.	.	.	.	.	.	1	2	1
Bryum caespiticium	9	.	.	.	.	.	2	.	.	+	+	.	.	+	.	.	.	.	.	+	.
Campylium chrysophyllum	9	r	.	.	.	.	.	+	.	+	.	.	.	.	.	.	.	.	.	.	.
Platydictya confervoides	9	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Hypnum cupressiforme	9	.	.	1	1	2	.	+	+	1	.	.	.	.	.	.	.	.	.	2	2
Barbula unguiculata	9	.	.	.	.	.	.	.	.	+	+	.	.	.	.	.	.	.	.	.	.
Fissidens taxifolius	9	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.
Crossidium squamiferum	9	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.
Entodon concinnus	9	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Dicranella staphylina	9	r	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Didymodon acutus	9	.	.	+	.	.	.	.	.	.	.	.	+	+	.	.	.	.	.	r	.
Ceratodon purpureus	9	.	.	.	+	.	.	.	.	1	.	.	.	.	.	.	.	.	.	+	.
Tortella densa	9	.	.	1	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Phascum floerkeanum	9	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Pleuridium acuminatum	9	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+
Tortella inclinata	9	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.
Tortula intermedia	9	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Brachythecium albicans	9	.	2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Pleurochaete squarrosa	9	.	.	.	.	.	2	.	.	.	.	.	+	.	.	.	.	.	.	.	.
Pseudocrossidium hornschuchianum	9	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.
Didymodon vinealis	9	.	.	2	.	.	.	.	.	+	.	2	.	+	.	.	.	.	.	+	.
Pottia intermedia	9	.	.	.	.	.	.	.	.	+	.	.	.	.	+	.	.	.	.	+	.
Acaulon muticum	9	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Rhytidium rugosum	9	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Pseudoleskea catenulata	9	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Homalothecium lutescens	9	+	+	1	+	1	+	1	r	.	.	1	.	1	2	2	+	.	1	.	1
Homomallium incurvatum	9	r	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Tortula muralis	9	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Eurhynchium hians	9	.	.	.	.	.	.	.	.	.	.	.	.	1	.	3	.	2	.	r	.
Bryum rubens	9	+	+	2	.	+	.	.	.	.	1	.	+	.	1	.	1	+	+	.	.
Bryum atrovirens agg.	9	2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.
Tortula calcicolens	9	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Pottia caespitosa	9	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	+	.
Phascum cuspidatum var. mitraeforme	9	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Bryum klinggraeffii	9	.	.	.	.	.	.	.	.	.	.	.	+	.	+	.	.	.	.	.	.

Table from 59 relevés , with applied TWINSPAN divisions

TWINSPAN cluster level	2	2	2	2	2	2	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
Relevé number	33	37	47	52	54	60	1	6	8	9	11	12	16	18	20	21	23	25	26	28	29
Table Number	33	37	46	51	53	59	1	6	8	9	11	12	16	18	20	21	23	25	26	28	29
Tortula ruralis var. ruralis	.	.	2	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	r	.
Bryum radiculosum	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.
Encalypta vulgaris	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Tortula ruraliformis	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Encalypta streptocarpa	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Hypnum lacunosum	.	.	.	.	.	.	.	.	3	.	.	.	.	.	.	.	.	.	.	.	.
Pottia bryoides	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.

Tortella tortuosa	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Pottia lanceolata	+	1	.	+	+	.	.	.	.	.	.	.	.	.	.	1	.	+	.	.	.
Pterygoneurum ovatum	.	r	+	.	+	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.
Pterygoneurum subsessile	.	+	+	.	+	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Bryum bicolor	.	.	+	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Aloina rigida	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Didymodon fallax	+	.	.	.	.	.	.	+	.	.	+	.	.	.	.	.	.	+	.	.	+
Phascum curvicolle	+	.	.	+	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Bryum subelegans	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Bryum violaceum	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Bryum imbricatum	.	.	r	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Didymodon cordatus	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Brachythecium rutabulum	.	.	.	.	.	.	+	1	.	1	.	.	1	.	3	.	.	+	.	.	2
Amblystegium serpens	+	.	.	.	.	.	1	+	r	3	+	+	.	+	r	1	r	1	+	.	.
Plagiomnium rostratum	.	.	.	+	.	.	.	+	.	.	.	3	.	.	1	.	.	.	.	.	.
Mnium marginatum	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Bryum argenteum	+	+	+	.	+	1	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.
Barbula convoluta	+	+	+	1	.	.	.	.	.	.	+	.	.	+	.	+	.	.	.	r	.
Phascum cuspidatum	.	1	.	.	.	+	.	.	.	+	.	.	.	+	.	.	.	+	.	.	.
Orthotrichum anomalum	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.
Scleropodium purum	+	.	.	.	.	.	.	.	.	2	.	.	.	.	3	.	.	.	+	.	.
Leskea polycarpa	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Thuidium recognitum	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	3	.	.
Brachythecium velutinum	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Bryum capillare group	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.
Thuidium delicatulum	.	.	.	.	r	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.
Brachythecium campestre	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	r	.	.	.	.
Lescuraea incurvata	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Weissia longifolia	.	1	+	+	+	.	.	.	.	.	.	+	+	+	.	+	.	+	.	.	.
Campylium calcareum	.	.	.	1	.	.	.	+	.	.	.	.	.	.	.	.	.	3	.	.	.
Pottia davalliana	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	r	.	.	.	.	.
Phascum cuspidatum var. piliferum	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Bryum ruderale	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Abietinella abietina	.	1	.	3	+	.	.	2	2	2	3	3	.	2	.	2	.	1	.	1	2
Bryum caespiticium	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Campylium chrysophyllum	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	r	.	+
Platydictya confervoides	.	.	.	.	.	.	.	.	.	.	.	.	.	.	2	.	.	+	.	.	.
Hypnum cupressiforme	3	.	.	.	.	.	1	.	2	.	.	2	.	.	.	.	.	2	+	r	.
Barbula unguiculata	.	.	.	.	.	.	.	+	.	.	+	.	.	.	.	.	.	.	.	.	.
Fissidens taxifolius	.	.	.	+	.	.	.	+	.	.	.	.	.	.	.	.	.	.	r	r	1
Crossidium squamiferum	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Entodon concinnus	.	.	.	.	.	.	.	.	.	.	.	.	.	.	3	.	.	.	.	.	.
Dicranella staphylina	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Didymodon acutus	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Ceratodon purpureus	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Tortella densa	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Phascum floerkeanum	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Pleuridium acuminatum	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Tortella inclinata	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Tortula intermedia	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Brachythecium albicans	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.
Pleurochaete squarrosa	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Pseudocrossidium hornschuchianum	.	.	2	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.
Didymodon vinealis	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+
Pottia intermedia	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Acaulon muticum	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.
Rhytidium rugosum	.	.	.	.	.	.	.	.	3	.	.	+	.	.	1	.	.	.	.	.	.
Pseudoleskea catenulata	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.
Homalothecium lutescens	2	2	1	1	.	.	.	4	3	.	1	.	1	2	1	2	+	2	3	2	2
Homomallium incurvatum	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Tortula muralis	.	+	.	.	.	.	.	.	.	.	+	+	.	.	.	.	.	.	.	.	.
Eurhynchium hians	.	.	.	+	.	.	.	2	.	.	2	.	3	.	2	+	.	2	3	.	.

Bryum rubens	+	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	
Bryum atrovirens agg.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	
Tortula calcicolens	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	
Pottia caespitosa	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	
Phascum cuspidatum var. mitraeforme	+	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	
Bryum klinggraeffii	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	

Table from 59 relevés , with applied TWINSPAN divisions																				
TWINSPAN cluster level	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	4	4	
Relevé number	30	31	34	35	36	38	40	41	46	49	50	51	53	55	57	59	10	24		
Table Number	30	31	34	35	36	38	40	41	45	48	49	50	52	54	56	58	10	24		
Tortula ruralis var. ruralis	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	+	.	.		
Bryum radiculosum	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.		
Encalypta vulgaris	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.		
Tortula ruraliformis	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.		
Encalypta streptocarpa	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.		
Hypnum lacunosum	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.		
Pottia bryoides	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.		
Tortella tortuosa	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.		
Pottia lanceolata	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.		
Pterygoneurum ovatum	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.		
Pterygoneurum subsessile	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.		
Bryum bicolor	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.		
Aloina rigida	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.		
Didymodon fallax	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.		
Phascum curvicolle	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.		
Bryum subelegans	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.		
Bryum violaceum	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.		
Bryum imbricatum	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.		
Didymodon cordatus	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.		
Brachythecium rutabulum	2	1	+	+	.	2	.	.	2	1	.	.	2	.	.	.	.	.		
Amblystegium serpens	2	.	+	+	1	1	.	.	.	2	+	+	2	1	+	+	1	.		
Plagiomnium rostratum	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	3	4		
Mnium marginatum	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.		
Bryum argenteum	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.		
Barbula convoluta	.	.	+	.	.	.	.	.	.	.	.	+	.	1	.	.	.	+		
Phascum cuspidatum	.	.	1	.	.	.	.	.	+	.	.	.	1	.	.	.	.	+		
Orthotrichum anomalum	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.		
Scleropodium purum	.	.	.	+	2	.	.	.	.	.	.	.	1	.	.	.	1	.		
Leskea polycarpa	.	.	.	.	.	.	.	.	.	.	.	.	.	2	.	.	.	.		
Thuidium recognitum	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.		
Brachythecium velutinum	.	.	.	.	.	.	.	.	.	.	.	.	2	.	.	.	.	.		
Bryum capillare group	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.		
Thuidium delicatulum	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.		
Brachythecium campestre	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.		
Lescuraea incurvata	.	.	.	.	.	.	.	.	.	.	.	.	.	r	.	.	.	.		
Weissia longifolia	.	.	.	+	.	+	.	.	.	+	+	+	.	1	.	+	.	.		
Campylium calcareum	.	.	+	+	.	.	.	.	.	.	.	.	+	1	.	.	.	.		
Pottia davalliana	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.		
Phascum cuspidatum var. piliferum	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.		
Bryum ruderale	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.		
Abietinella abietina	.	1	.	2	4	.	2	3	2	.	1	2	.	2	.	1	.	.		
Bryum caespiticium	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+		
Campylium chrysophyllum	.	.	.	.	.	.	.	.	.	+	.	.	.	.	+	.	.	.		
Platydictya confervoides	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.		
Hypnum cupressiforme	.	4	2	1	3	+	.	.	5	.	.	.	2	.	.	3	.	.		
Barbula unguiculata	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.		
Fissidens taxifolius	.	.	.	+	+	.	.	.	.	.	.	.	.	1	.	.	.	.		
Crossidium squamiferum	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.		

Entodon concinnus	.	1	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Dicranella staphylina	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Didymodon acutus	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Ceratodon purpureus	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Tortella densa	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Phascum floerkeanum	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Pleuridium acuminatum	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Tortella inclinata	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Tortula intermedia	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Brachythecium albicans	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Pleurochaete squarrosa	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Pseudocrossidium hornschuchianum	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Didymodon vinealis	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Pottia intermedia	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Acaulon muticum	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.
Rhytidium rugosum	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.
Pseudoleskea catenulata	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Homalothecium lutescens	.	2	2	1	1	2	3	4	.	2	2	+	2	2	.	.	.	.			
Homomallium incurvatum	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Tortula muralis	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Eurhynchium hians	.	.	.	+	.	.	.	.	.	3	+	+	1	.	2	.	.	1			
Bryum rubens	.	.	.	+	.	+	.	.	.	r	.	.	.	.	.	.	+	.			
Bryum atrovirens agg.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.			
Tortula calcicolens	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.			
Pottia caespitosa	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.			
Phascum cuspidatum var. mitraeforme	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.			
Bryum klinggraeffii	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.			

Table 3 List of the relevé locations numbered according to TURBOVEG (note that one location has been cancelled and the graph-numbers have moved up accordingly) as well as the numbers of the graphs from the Twinspan-grouped sampling sites, the dry-grasslands catalogue and the description of the locations as used in the field. The number that was given to the locations in the dry-grasslands catalogue is a code. The first two digits refer to a part of Austria, as is found on a sheet of the map in scale 1:50 000. The last two are a serial number that counts the amount of relevé sites within that part.

Turbo-Veg	Graph (Twin-span)	Dry grasslands catalogue	Locations
1	1	4012	kl. Leeberg, nördl. Niederfellabrunn
2	2	4016	Wagram. W Hausleiten
3	3	3913	Südhang Leeberg in Gaisruck – actually Pettendorf
4	4	3912	Wagram westl. Eggendorf/Gaisruck
5	5	4116	Fossilienwelt Tresdorf, Am Teiritz
6	6	4119	Kronatwettberg, Mittig in Fläche
7	7	4013	Leeberg SONiederfellabrunn
8	8	4014	Michelberg S-Hang
9	9	4015a	Waschberg Unterhang
10	10	4015b	Waschberg Gipfel
11	11	4011	Steinbruch Bruderndorf, Singer, zw. Bruderndorf und Maisbierbaum
12	12	2412	„Steinbruch“ W Oberleis, Steinberger Heide bei Ernstbrunn
13	13	2413a	Oberleiserberg Klippe
14	14	4206	Hohlweg SW Götzendorf

15	15	4203	Böschung NW Großschweinbarth; zwischen Bad Pirawarth und Großschweinbarth
16	16	4209b	Wiener Äcker Brache oben am Riegel zw. Prottes und Ollersdorf; Abhang Richtung Windräder
17	17	4209a	Wiener Äcker W-Hang Riegel zw. Prottes und Ollersdorf
18	18	4211	Wäldchenrand NW Ernestinenhof, Feldrain am Waldrand bei Pumpe zw. Matzen und Prottes
19	19	4210	Brache Wartberg SO Raggendorf, bei Hochstand
20	20	4202a	S Bad Pirawarth, bei Bahn unten
21	21	4202b	S Bad Pirawarth, bei Bahn oben
22	22	4205	„Spitz“ Hohlweg N Götzendorf; bei Götzelsdorf nördlich
23	23	4216a	Hausberg Gaiselberg, S exponiert
24	24	4216b	Hausberg Gaiselberg, N exponiert, "ggenüber"
25	25	2512a	S Maustrenk W unten
26	26	2512b	S Maustrenk W oben
27	27	2513	S Maustrenk Ost
28	28	1001	ND Heidberg an d Grenze, Trockenrasen Heidberg
29	29	1003	Zeiserlberg NSG; zwischen Pottenhofen und Ollersdorf
30	30	2402	ND Galgenberg bei Zlabern
31	31	2511a	ehem terrassierter Hügel S Erdberg oben; 1,2 km SSO Erdberg
32	32	2511b	ehem terrassierter Hügel S Erdberg Hang
33	33	2509e	3,5 km S Katzelsdorf, N Altlichtenwarth „Rehschädeln“; v. Ölpumpe nach Westen
34	34	2510	N Altlichtenwarth, Hang mit Blick zum Windpark
35	35	2515a	„Steinberg“ neben Straße 1; Heide beim Windpark, an d. Str. v. Neusiedl a.d. Zaya nach Maustrenk
36	36	2515b	„Steinberg“ neben Straße 2
37	37	2506	Klippe Steinebrunn; oberhalb Felskante im Osten
38	38	2508	Katzelsdorf Böschung bei Straße neben See (Fischteich)
39	39	2504	Falkenstein Felskuppe im Wildgatter, Kuppe zwischen Dürrenberg und Sender
40	40	1104a	O Glasermühle 1; 0,3km, NO Drasenhofen
41	41	1104b	O Glasermühle 2, neben Feldweg
42	42	2502	Falkenstein Höllenstein O-Hang, unterhalb Gipfel
43	43	2503	Falkenstein Kreuzberg; Hang überm Steinbruch
45	44	1101	Schweinbarther Berg
46	45	2409	Galgenberg N Michelstetten
47	46	2406	Blauer Berg
48	47	2213	Am Gupferten
49	48	2305	Bockstallberg Unterhang
50	49	2304	Dernberg
51	50	2238	NSG Mühlberg
52	51	2239	Goldberg O Braunsdorf; Hügel mit weißem Kreuz
53	52	3909	Kalte Stube, Böschung neben Apfelplantage, Kürbisfeld
54	53	4001	Leeberg Großmugl
55	54	4106a	Haulesbergen bei Schleinbach/Wolkersdorf, W-Hang
56	55	4106b	Haulesbergen bei Schleinbach/Wolkersdorf, S-Hang, Sand, rechts von 4106a, sandiger
57	56	4108	Wartberg Ulrichskirchen, Nähe Kreuz, unterhalb Kuppe
58	57	4107	Soldatenkreuz
59	58	2413b	Oberleiserberg Plateau

60	59	2501	Falkenstein ND Dürrenberg
		2404	Falkenstein in d. Ruine