Tuexenia 40: 409–427. Göttingen 2020.
doi: 10.14471/2020.40.017, available online at www.zobodat.at

Species-rich grasslands of the Apuseni Mts (Romania): role of traditional farming and local ecological knowledge

Artenreiches Grasland im Apuseni-Gebirge (Rumänien): Rolle der traditionellen Landnutzung und ökologischen Kenntnisse der Landnutzer

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Abstract

Traditional low-intensity farming died out in almost all European countries but is well maintained in the Romanian Carpathians. The main aim of our interdisciplinary study was to document traditional farming systems and local ecological knowledge in the colline and sub-montane zone of the Apuseni Mts and to relate this information to recent grassland plant diversity. We performed a detailed botanical and ethnological research at two sites within the Dobrești (site Dobrești) and Bratca (site Ponoară) communes. Six nested-plot series of increasing size (0.0001 m², 0.001 m², 0.01 m², 0.1 m², 1 m², 10 m², 100 m²) were sampled at each site to record presence and cover of vascular plants, bryophytes and lichens. Information on the farming practices applied within each sampling plot and local ecological knowledge related to grassland biodiversity were obtained from the farmers during outdoor interviews. In both sites plant diversity was very high at both site and plot level. The average species richness in 10 m² plots was 50 (Dobrești) and 59 (Ponoară) vascular plant and 8 (in both sites) bryophyte species. Species richness of vascular plants increased with intensity and heterogeneity of recent management and was the highest in fallows recently used as meadows. Almost all meadows were part of a crop-meadow rotation and currently managed by a combination of cutting (once or twice per year) and grazing (5 different grazing systems). Permanent pastures were poorer in species than fallows and grazed meadows. Our records document how a combination of multiple traditional farming practices (including mowing, grazing, manuring and ploughing), which were applied in rotation, may support high plant diversity in a heterogeneous landscape with high complexity and sustainable low-intensity farming. Our results provide an illustration of (1) multidimensionality of traditional farming, (2) close links between animal husbandry and grassland management and (3) deep local ecological knowledge and experience preserved in rural Carpathian regions.

Keywords: Carpathian Mountains, low-intensity farming, nested-plot series, plant diversity, rural culture, species richness, traditional ecological knowledge

Erweiterte deutsche Zusammenfassung am Ende des Artikels

Manuscript received 31 March 2020, accepted 16 July 2020
Co-ordinating Editor: Thomas Becker

1. Introduction

Traditional low-intensity agriculture contributed to the development of extraordinary diversity of rural landscapes and semi-natural habitats in Europe (BIGNAL & MCCRACKEN 2000, ANGOLETTI & ROTHERHAM 2015, BÜRGI et al. 2015, BONARI et al. 2017). Unfortunately, there are not many regions left where one can observe and study this process up to now; in most European countries traditional rural cultures and related local ecological knowledge died out many decades ago. The Romanian Carpathians are among the few regions with well-maintained traditional farming. In some villages a substantial proportion of inhabitants is still engaged in agriculture and local households survive on a semi-subsistence basis. In such regions, grasslands represent a fundamental value and animal breeding together with haymaking occupy most of the local people's time (DAHLSTRÖM et al. 2013, BABAI & MOLNÁR 2014, IVAȘCU et al. 2016, KUN et al. 2019).

Traditional agriculture includes various types of land utilisation by private farms, which typically occurs within small grassland parcels usually belonging to a single family, each having their own customs and traditions, so that the landscape is very diverse. But neither the size of parcels nor the level of labour mechanisation is decisive for traditional farming. The most important feature is that traditions and rural culture play an important role in the local farming approaches. In this aspect, traditional grassland management differs from the modern high-intensity grassland management as well as from low-intensity conservation grassland management. The main difference from the conservation approach is that local farmers never focus on biodiversity aspects, but rather on temporal stability in fodder quantity and quality, which is the main prerequisite for a long-term ecological sustainability. High biodiversity of traditionally managed grasslands is thus only a side effect (not the main goal) of traditional farming.

There is much knowledge about the recent decline of grassland diversity and its reasons all over Europe. Land-use changes are considered to be among the most important factors (HABEL et al. 2013, DENGLER et al. 2014, TÖRÖK et al. 2018). It is frequently reported in the scientific literature that traditionally managed landscapes have high conservation value (FISCHER et al. 2012). However, very little is known about the particular historical land-use practices that promoted the accumulation of grassland diversity in the rural landscape. Moreover, knowledge is missing about how traditional grassland management can help us to conserve the maintained high nature value grasslands and to restore the already impoverished ones. Although the high biodiversity value of Central and Eastern European farmland has long been reported, research on agricultural biodiversity from this part of Europe is underrepresented in the international literature (SUTCLIFFE et al. 2015). The main motivation of this study was to gather new knowledge on this topic by using a novel interdisciplinary approach connecting botany and ecology with history and ethnology.

Due to the rarity of authentic traditional farming in Europe, studies focusing on traditional grassland management are rare, too. The numerous recent studies on grassland species composition and diversity related to grassland management are usually focused on areas with extinct traditional rural cultures or those managed by alternative conservational grassland management (SUTCLIFFE et al. 2015). To fill this gap, we performed a detailed interdisciplinary study in the Romanian Apuseni Mts. We investigated two sites within the Dobrești and Bratca communes with the following aims: (1) to describe the predominantly used farming system, (2) to gather the local ecological knowledge related to various

grassland management practices, (3) to evaluate the plant diversity of the studied grassland parcels in relation to the land-use and (4) to discuss specific effects of traditional management practices on plant diversity at several spatial scales.

2. Materials and methods

2.1 Study sites

The site **Dobreşti** within the Dobreşti commune (Bihor County, N 46° 52′ 47″, E 22° 20′ 22″) is located in the south-western part of the Piatra Craiului Mts (Apuseni Mts), 48 km southeast from Oradea, in the valley of the Holod river, a tributary to the Crişul Negru river. The elevation of the Dobreşti centre is 161 m a.s.l. and the investigated grasslands were located at elevations between 200 and 330 m a.s.l. The climate is temperate continental, with most rainfall occurring at the end of May and the beginning of June. The mean annual temperature is 10.5 °C and the total annual precipitation is 608 mm (at 168 m a.s.l., https://it.climate-data.org/europa/romania/bihor/dobresti-333074/). Our study area (Fig. 1) covers parts of the following villages within the Dobreşti commune: Dobreşti, Hidişel, Luncasprie and Topa de Sus. In 2011 the population of the commune was 5119 inhabitants according to the town hall data (se also http://www.recensamantromania.ro/wp-content/uploads/2012/08/TS4.pdf), consisting mainly of Romanians (87% in 2002 and 85% in 2011) and Roma (13% in 2002 and 15% in 2011). Currently (since the 1980s), the population size is gradually decreasing, showing a maximal decline between 2007 and 2011, when the number of inhabitants dropped by 10%, from 5651 to 5119 (Supplement E1). In 2019 the population of the commune was 5400 according to the town hall officials. In 2002 the largest village, Dobreşti, had 1991 inhabitants, Hidişel 776, Luncasprie 959 and Topa de Sus 760. The village Dobreşti was first historically mentioned in 1508, but human remains dating from the Bronze Age have been found in the Izbucul Topliţei cave (Luncasprie) (https://www.primdobresti.ro/comuna/relieful-si-vegetatia_p179.html#).

The site **Ponoară** (Bihor county, N 46° 53′ 8″, E 22° 39′ 27″) is part of the Bratca commune situated 80 km east from Oradea in the Vad-Borod Depression, between the Plopiş Mts in the North-east and the Piatra Craiului Mts in the South (Apuseni Mts). The altitude of Ponoară represents the maximum of the Bratca commune; the village centre is at 650 m a.s.l., and the investigated grasslands were located at elevations between 677 and 764 m a.s.l. The climate is characterised by cold and snowy winters. The mean annual temperature is 7.9 °C, and the total annual precipitation is 721 mm (at 671 m a.s.l., https://it.climate-data.org/europa/romania/bihor/ponoara-332961/). Monthly precipitation reaches its maximum in June and its minimum in March. Like the whole Bratca commune (Supplement E1), the population of the Ponoară village has been gradually decreasing, from over 1225 in 1900 to 744 in 2002 and 662 in 2011). The first historical record of Ponoară dates back to 1435, when it was mentioned as „possessio Walachalis", meaning the majority of the population was Romanian (https://www.primaria-bratca.ro/vechi/pagina/prezentare-generala.html). Ethnically, the structure of the population in the commune has not changed over time, and in 2011, 93% of the 5158 inhabitants of the Bratca commune were Romanians, 5% Roma, 0.6% Hungarians, 0.06 Slovaks and the remaining undeclared (http://www.recensamantromania.ro/rezultate-2/). During the 1st World War the Zam-Ciucea-Sighet frontline between the Romanian and the Hungarian army was encompassing the Bratca commune. Also during the 2nd World War, following the events in August 1940, the commune was split between Romania and Hungary, with only the village Damiş left on the Romanian side of the border (https://www.primaria-bratca.ro/vechi/pagina/istoricul-localitatii.html). These historical events are reflected also in the commune's demography (Supplement E1).

2.2 Sampling design and data collection

The field research was carried out in June 2019. Each study site, Dobreşti and Ponoară, was delimited as a circle of 25 km² in an extensively managed rural landscape (Fig. 1). To maximise the variability in vegetation composition on our plots, we stratified each site by slope inclination (flat, moderate,

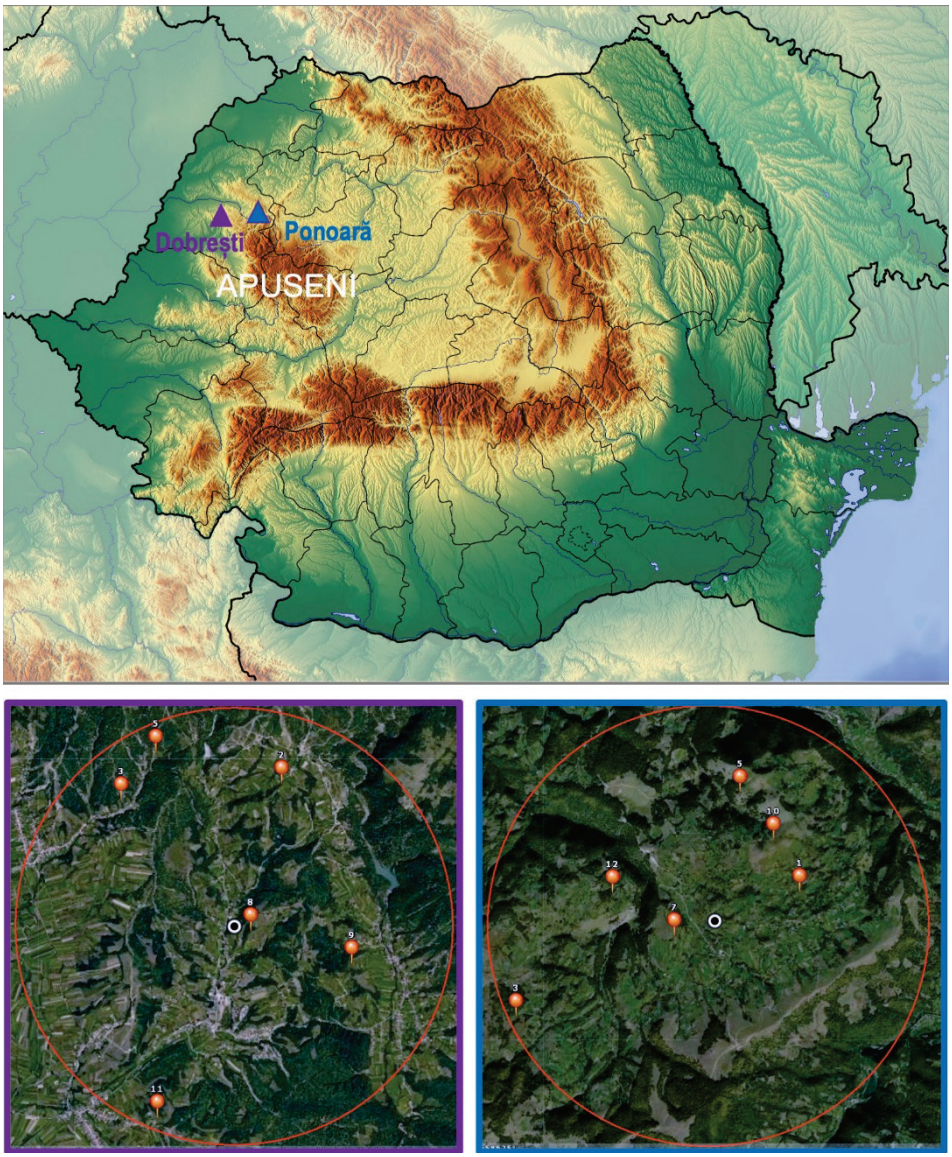


Fig. 1. Location of the the two study sites in the Apuseni Carpathians, Romania, (above) and location of nested-plot series in the Dobrești (bottom left) and Ponoară (bottom right) sites. Basic map source: https://commons.wikimedia.org/wiki/File:Romania_location_map_Topographic.png.

Abb. 1. Lage der beiden Untersuchungsgebiete im Apuseni-Gebirge in den rumänischen Karpaten (oben). Lage der Serien ineinander geschachtelter Aufnahmeflächen in Dobrești (unten links) und Ponoară (unten rechts). Die Kartenquelle ist in der englischen Abbildungsunterschrift angegeben.

steep) and slope exposition (W-N-E vs. E-S-W). In each combination of inclination and exposition, we randomly placed a series of 7 nested plots (Fig. 2) of increasing size (0.0001 m^2, 0.001 m^2, 0.01 m^2, 0.1 m^2, 1 m^2, 10 m^2 and 100 m^2) in a homogeneous vegetation patch. Thus we obtained 6 nested-plot series for each site: two in a flat area, one on a moderate W-N-E slope, one on a steep W-N-E slope,

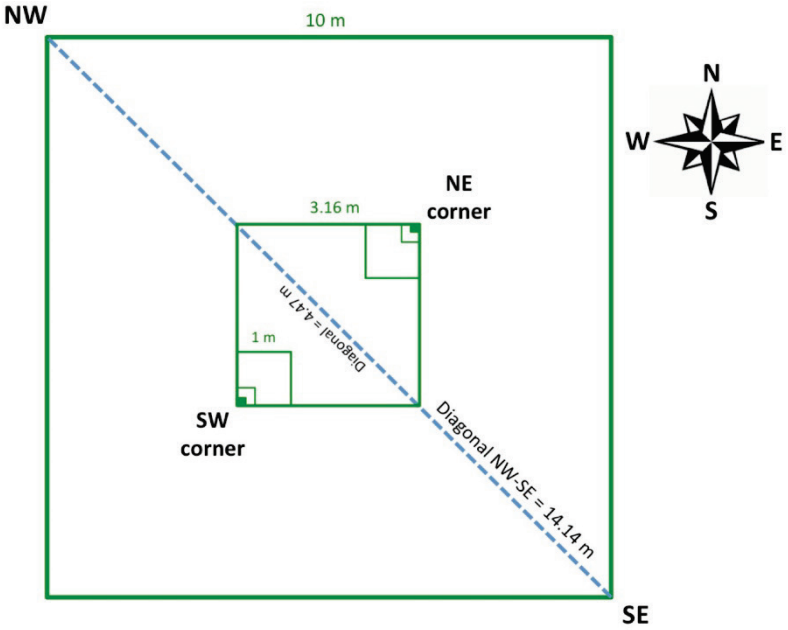


Fig. 2. Arrangement of the nested-plot series covering 7 spatial scales: 0.0001 m², 0.001 m², 0.01 m², 0.1 m², 1 m², 10 m² and 100 m². The first three scales are merged in the smallest green quadrat.

Abb. 2. Aufbau einer Serie ineinander geschachtelter Aufnahmeflächen mit den sieben räumlichen Skalen: 0,0001 m²; 0,001 m²; 0,01 m²; 0,1 m², 1 m², 10 m² und 100 m². Die beiden kleinen grüngefüllten Quadrate umfassen die ersten drei Skalen.

one on a moderate E-S-W slope and one on a steep E-S-W slope. In each nested-plot series we recorded all species of vascular plants, bryophytes and lichens. Cover values were estimated with high accuracy (especially in lower values) for all species in the 10-m² quadrats. For this plot size also the detailed environmental data were obtained (Supplement E2). Topography was characterised by elevation (m a.s.l.), inclination (°), microrelief (small-scale variability of microtopography expressed as a deviation from a smooth plane in cm) and soil depth (measured at five random points with a steel rod of 1 cm diameter). A mixed soil sample of the uppermost 10 cm of the mineral soil was taken from five random locations, air-dried and analysed for the following soil parameters: pH (KCl), carbon (C, used to calculate the soil humus content), phosphorus (P), potassium (K), calcium (Ca), magnesium (Mg) and total nitrogen (N, used to calculate the C/N ratio to assess the accessible nutrition status of the soil). Information on the management practices applied in each sampling plot was obtained from the farmers during outdoor interviews. Our questions focused on agricultural practices used recently (since 2010) and during the two historical periods 1950–1990 (the period of centrally planned economy in Romania) and 1990–2010 (the period of market economy in Romania). Based on the information from plot owners and/or their neighbours, we were able to evaluate the following variables (Supplement E2): mowing (long-term effect of mowing calculated as sum of mowing events per year throughout the three time periods), grazing (long-term effect of grazing calculated as sum of grazing presences per year throughout the three time periods), manuring (long-term effect of manuring calculated as sum of manure applications per year throughout the three time periods), ploughing (long-term effect of ploughing calculated as sum of ploughing events per year throughout the three time periods), year of the last ploughing, grazing system (A – autumn grazing, AS – spring and autumn grazing, F – fencing and whole-season grazing in enclosures, C – common pasture with whole-season free grazing, H – whole-season herding with a shepherd, N – no grazing), grazing animal (cow, sheep, goat, pig, goose). The variable “impact

of recent management" was calculated as sum of management elements applied annually since 2010, including mowing, grazing, manuring, ploughing and cleaning. It measures the impact of exclusively traditional management practices and reflects both their heterogeneity and frequency.

Local ecological knowledge and experience of interviewed persons was recorded, transcribed, translated and summarised. We interviewed five men and one woman in the Dobrești site (name, gender and age): Constantin D., m, 69; Vasile D., m, 69; Ionel B., m, 36; Ionel B., m, 46; Nicu B., m, 57; S.C. m, 51 and Viorica M., f, 67. At the Ponoară site, five men and three women were interviewed: Viorel B., m, 57; Dorina B., f, 52; Viorel S., m, 39; Florica, f, 60; Mihaela B., f, 29; shepherd, m, 78; Călin Ț., m, n/a and Alexandru S., m, 59. The town halls in Dobrești and Bratca (for the Ponoară site) were visited to get precise recent and historical numbers of inhabitants and animals in each study site.

2.3 Data processing and analyses

Detrended Correspondence Analysis (DCA) was used to evaluate the variation in plant species composition of the 10-m² plots. Plants determined to genus level only were omitted unless they were the only representatives of the genus. *Centaurea erdneri* was merged with *C. phrygia* s. str. within the *C. phrygia* agg. *Hypnum cupressiforme* var. *lacunosum* was merged with *H. cupressiforme*. Species cover values were log-transformed. The measured management, topographical and soil variables were used as supplementary data in the DCA with the aim to interpret the ordination axes.

Species richness of vascular plants and bryophytes as well as number of all species present were calculated for each of the plot sizes. The total number of species recorded in each study site was used as a measure of the site species pool; it was calculated separately for vascular plants and bryophytes. Lichens were omitted from the analyses due to their rare occurrence in the studied grasslands.

Nomenclature of vascular plants follows the database Euro+Med Plantbase (EURO+MED 2006-). Nomenclature of bryophytes follows HILL et al. (2006).

3. Results

3.1 Farming practices and local ecological knowledge

The population size of the studied communes Dobrești and Bratca has recently become very similar, reaching around 5000 people (Supplement E1), but it is obvious that higher-elevation and more remote settlements of the Bratca commune have been on a steadily decreasing trend for the last 80 years, while the population in the Dobrești commune is much more stable. The situation is the opposite if we compare the changes in farming practices (Supplement S1): Traditional farming approaches were better maintained in Ponoară, where more inhabitants are still engaged in agriculture and animal husbandry has not declined so profoundly during the last decades (see also Supplements E3 and E4 for details). In both communes grassland habitats including permanent pastures, fallows and grazed meadows are important parts of the rural landscapes (Fig. 3, 6a–e), and most of the recent meadows have previously been used as cropland at least for some years.

3.2 Grassland types and grassland plant diversity in Dobrești and Ponoară

Permanent (usually communal) pastures and older fallows recently used as hay meadows were the most common grassland types in the studied villages. Apart from two abandoned meadows transformed to orchards (Dobrești 8, 9), each sampling plot was used also for grazing, either exclusively or at least during some period of the year. Differences in grazing systems, combinations of grazing animals and different crop-fallow rotation systems hindered the delimitation of clear grassland categories. Regarding specific recent and historical land-use patterns, each plot represented a category of its own.

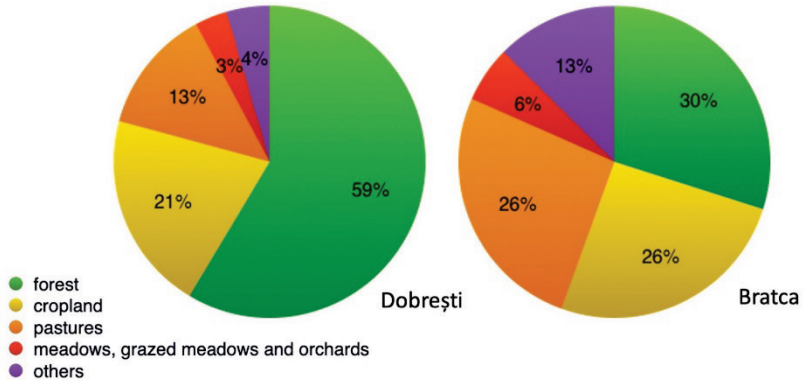


Fig. 3. Land use in the communes of Dobrești and Bratca (includes the Ponoară village) in 1990. The total commune area is 13,400 ha in Dobrești and 13,648 ha in Bratca. Sources: National Statistical Institute of Romania, town hall Dobrești, town hall Bratca.

Abb. 3. Landnutzung in den Gemeinden Dobrești und Bratca (einschließlich Ponoară) im Jahr 1990. Die Gesamtfläche von Dobrești beträgt 13.400 ha und von Bratca 13.648 ha. Quellen: Nationales Statistisches Institut Rumänien, Rathäuser von Dobrești und Bratca.

Phytosociologically, the sampling plots in Dobrești represent the following alliances (Supplement E2): *Arrhenatherion elatioris* Luquet 1926 (three plots), *Cynosurion cristati* Tx. 1947 (two plots) and *Deschampsion cespitosae* Horvatić 1930 (one plot). The sampling plots in Ponoară represent two phytosociological alliances: *Cirsio-Brachypodion pinnati* Hadač et Klika in Klika et Hadač 1944 (five plots) and *Violion caninae* Schwickerath 1944 (one plot). The species of vascular plants, bryophytes and lichens recorded in each of the sampling plots are listed in Supplement E5 and E6.

According to the floristic composition, the Dobrești plots are distributed mainly along the first DCA axis, while the Ponoară plots are spread mainly along the second DCA axis (Fig. 4). The first ordination axis is best correlated with the impact of recent management and is also related to different grazing systems. It is obvious that the Ponoară plots, although located at higher elevation, are managed more intensively than the plots in Dobrești, where the animal numbers are very low and many grasslands have recently been abandoned.

Species richness of vascular plants increased with impact of recent management and was generally the highest in fallows recently used as meadows (Fig. 5). In Ponoară the species-richest plot (Ponoară 12) was recently cut twice a year (in June and August), manured every other year, grazed in spring by sheep (until 15 May) and again in autumn by sheep and cows (from September to November) and cleaned in spring from litter and shrubs. It was ploughed 15 years ago to grow cereals (wheat and rye). The second-richest plot (Ponoară 7) was a restored meadow used also as a corn field and cow pasture in the past. Recently it was cut twice a year (in July and August), grazed in autumn by cows, regularly manured and cleaned in spring. In Dobrești the plots richest in vascular plants (Dobrești 8 and Dobrești 9) were fallows used as corn fields 10–15 years ago, later used as hay meadows and recently transformed to walnut orchards.

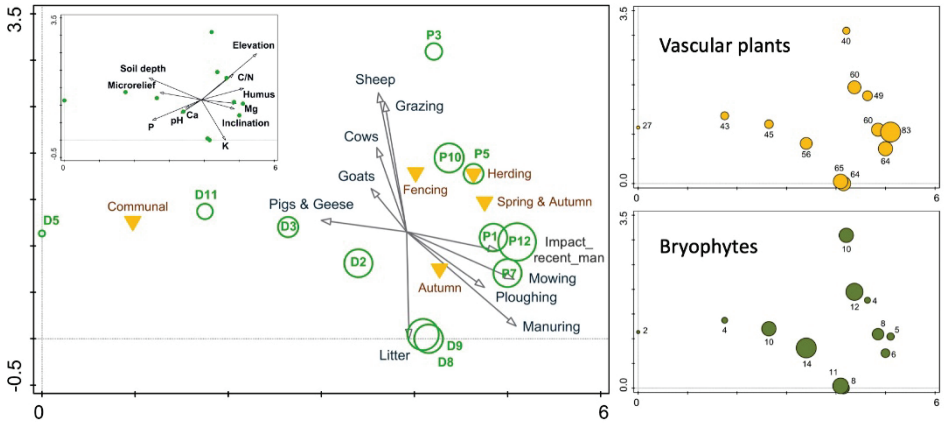


Fig. 4. DCA based on plant species composition in the 10-m² plots. The position of the sampling plots is shown with post-hoc correlated management variables (central graph, sample plot symbols according to the total number of plant species), topographical and soil variables (upper left corner), vascular plant species richness (upper right corner) and bryophyte species richness (lower right corner). Plots from Dobrești: D2, D3, D5, D8, D9 and D11; plots from Ponoară: P1, P3, P5, P7, P10 and P12. Total variation: 3.755, gradient length: 5.1, eigenvalues: 1st axis 0.709, 2nd axis 0.377.

Abb. 4. DCA-Graphen der Pflanzenartenzusammensetzung der 10 m²-Aufnahmeflächen. Der große Graph und der kleine Graph oben links zeigen die Position der Aufnahmen auf Basis der Gesamtarten-zusammensetzung an. Die Vektoren im großen Graphen zeigen die Korrelationen der Nutzungs-variablen und im kleinen Graphen oben links die Korrelationen der topograpfischen und Boden-variablen mit den DCA-Achsen an. Die beiden DCA-Graphen rechts zeigen die Positionen der Gefäß-pflanzen- und Moosaufnahmen mit den genauen Artenzahlen (je größer ein Symbol desto höher die Artenzahl). Aufnahmeflächen von Dobrești: D2, D3, D5, D8, D9, D11 und Ponoară: P1, P3, P5, P7, P10, P12. Gesamtvariation: 3,755, Gradientenlänge: 5,1, Eigenwert Achse 1: 0,709 und Achse 2: 0,377.

Bryophyte species richness was highest in plots with medium impact of recent management. The bryophyte-richest plot (Dobrești 2) was a 3rd-year fallow of a wheat and legume field, recently mown twice a year (June and August), grazed in autumn (September–December) by cows and fertilised by animal dung and N-chemical fertiliser. The second-richest plot (Dobrești 9) was an older fallow used as a hay meadow and recently transformed into a walnut orchard. In Ponoară the plot richest in bryophytes (Ponoară 10) was a remote meadow cut once a year (August), grazed in spring and autumn by sheep and cows, regularly manured and cleaned from litter, shrubs and stones. About 30 years ago it was ploughed and used to grow cereals. The second-richest plot (Ponoară 3) used to be a fallow for 15 years until it was turned into a meadow. For the last 4 or 5 years it has been used as a pasture for cows (from May to early October) and sheep (in April and in late October). The correlation of vascular plant and bryophyte species richness was highest at smaller plot sizes between 0.001 and 0.1 m² (Supplement E7) and quite low in 10-m² and 100-m² plots.

The increase in total species number with increasing plot size is shown in Figure 5. It is evident that permanent pastures that are managed by grazing only (plots Dobrești 3, 5, 11; Ponoară 2, 5) have the lowest species numbers across all the scales. On the other hand, in the species-richest plots of both study sites (Dobrești 8, 9; Ponoară 1, 12), an increase of species numbers occurs mainly at larger plot sizes. For photographs of the plots, see Supplement E8 and E9. Total number of species recorded in the nested-plot series (which is a surrogate of

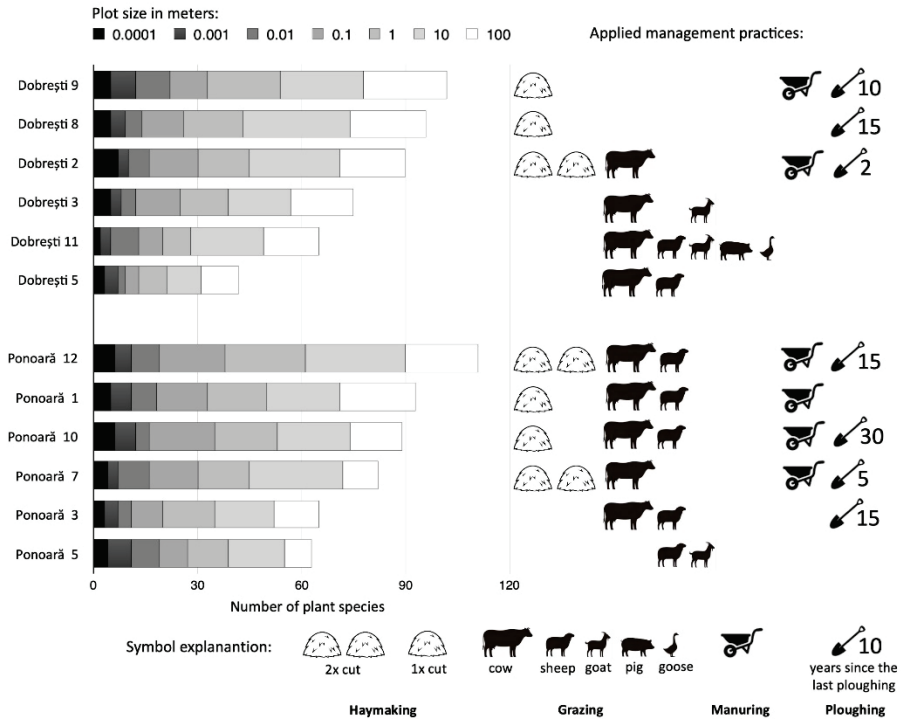


Fig. 5. Increase in total species number in twelve nested-plot series across seven spatial scales (from 0.0001 m^2 to 100 m^2) and its relation to the applied management practices. The series are ordered by site (Dobreşti and Ponoară) and within the sites by decreasing species richness. It is obvious that in both sites and at all plot sizes fallows and grazed meadows are richer in species than permanent pastures and that even manuring and ploughing do not have detrimental effects on plant diversity if they are used together and followed by a regular mowing or grazing regime.

Abb. 5. Gestapelte Zunahme der Gesamtartenzahl mit der Flächengröße (von 0,0001 m^2 bis 100 m^2) in den 12 Serien ineinander geschachtelter Aufnahmeflächen in Beziehung zur Landnutzungsform. Die Serien der Aufnahmeflächen sind nach Gemeinden (oben Dobreşti und unten Ponoară) geordnet und darin nach abnehmendem Artenreichtum. In beiden Gemeinden waren Brachen und beweidete Wiesen auch auf unterschiedlichen räumlichen Skalen artenreicher als Weiden. Gelegentliches Umbrechen und mäßige Düngung führten nicht zu einer Artenverarmung, da beide Maßnahmen zusammen durchgeführt wurden und nach dem Ende der Ackernutzung zügig mit der Beweidung oder Mahdnutzung begonnen wurde.

local grassland species pool) was 197 vascular plants, 25 bryophytes and 0 lichens in Dobreşti (Supplement E5) and 170 vascular plants, 36 bryophytes and 1 lichen in Ponoară (Supplement E6).

4. Discussion

The Carpathian Mountains are home to highly diverse semi-natural habitats and rural landscapes (PAGE et al. 2011, BABAI & MOLNÁR 2014, LOSS et al. 2015, KUN et al. 2019), which represent a valuable biocultural heritage worth preserving for future generations. Romania contains one half (exactly 50%) of the Carpathian territory, and in some regions the

traditional rural culture is still well preserved. These areas are still characterised by traditional farming methods usually only slightly modified by recent adaptations so that visiting these regions is like time-travelling through several decades or even centuries of agricultural history.

The main aim of our interdisciplinary study was to document local farming systems and ecological knowledge/experience in two communes of the Apuseni Carpathians in Romania and to relate this information to current grassland plant diversity of the studied sites. The sites were selected without any previous knowledge about the local agriculture and/or biodiversity (none of the authors visited the study sites previous to the fieldwork). The selection was based on a GIS-derived stratification considering mainly the elevation, CORINE grassland habitat area and presence of actively managed grassland according to satellite landscape images. The novelty of our interdisciplinary approach is to link detailed parcel management data with a plant diversity inventory.

Although many recent studies emphasise the extraordinary value of extensively managed agricultural landscapes for biodiversity conservation (e.g. KLEIJN et al. 2009, PAGE et al. 2011, LOSS et al. 2014, 2015), only a few of them describe how this high nature value (HNV) has been achieved (a good example is the study by KUN et al. 2019). Although the traditional farming practices summarised in our study are adapted to the particular sites and cannot be generally applied without careful consideration, they serve as illustration of (1) multidimensionality of traditional farming, (2) close links between animal husbandry and grassland management and (3) deep local ecological knowledge and experience preserved in rural Carpathian regions.

Based on our previous experience from Central and Eastern Europe as well as comparisons with data available in the literature (e.g. RUSDEA et al. 2005, BABAI & MOLNÁR 2014, KUN et al. 2019), the plant diversity was very high in our study sites and the local ecological knowledge still well preserved. All of the approached and interviewed local inhabitants provided valuable contribution to our synthesis (Supplement S1, E3–E4) thanks to deep ecological knowledge and experience with local farming methods.

Similar to the other rural regions in Romania (RUSDEA et al. 2005, PAGE et al. 2011, DAHLSTRÖM et al. 2013, IVAŞCU et al. 2016), the number of animals shows a steadily decreasing trend in our study sites, and correspondingly, the area of actively managed grasslands is decreasing as well. Moreover, life-style changes accompanied by agricultural modernisation approach the traditional rural communities, resulting in abandonment of traditional farming methods. From this point of view, gathering local ecological knowledge with respect to land use is an urgent and highly valuable activity.

Similar to other regions of the Apuseni Mts (BRINKMANN & REIF 2007), the open land of Dobreşti and Ponoară is dominated by different types of mown and grazed grassland. In each historical period the level of meadow management reflected the level of stable cattle breeding and farming intensity in the respective region (PODOLÁK 2008). From the economic point of view, the main attention was usually paid to the practice of manuring as a guarantee for high hay quality. The presented examples demonstrate that in a heterogeneous traditional landscape with sustainable agriculture, even ploughing and manuring may be part of a diversity-supporting farming system. Ploughing is generally considered as having long-lasting effects on species and functional diversity of agricultural ecosystems (LE PROVOST et al. 2020). The conversion of permanent grasslands into annual crops may have particularly strong effects on low-mobility organisms and species with narrow feeding niches. However, maintaining permanent grasslands in the surrounding landscape (LE PROVOST et al. 2020) or

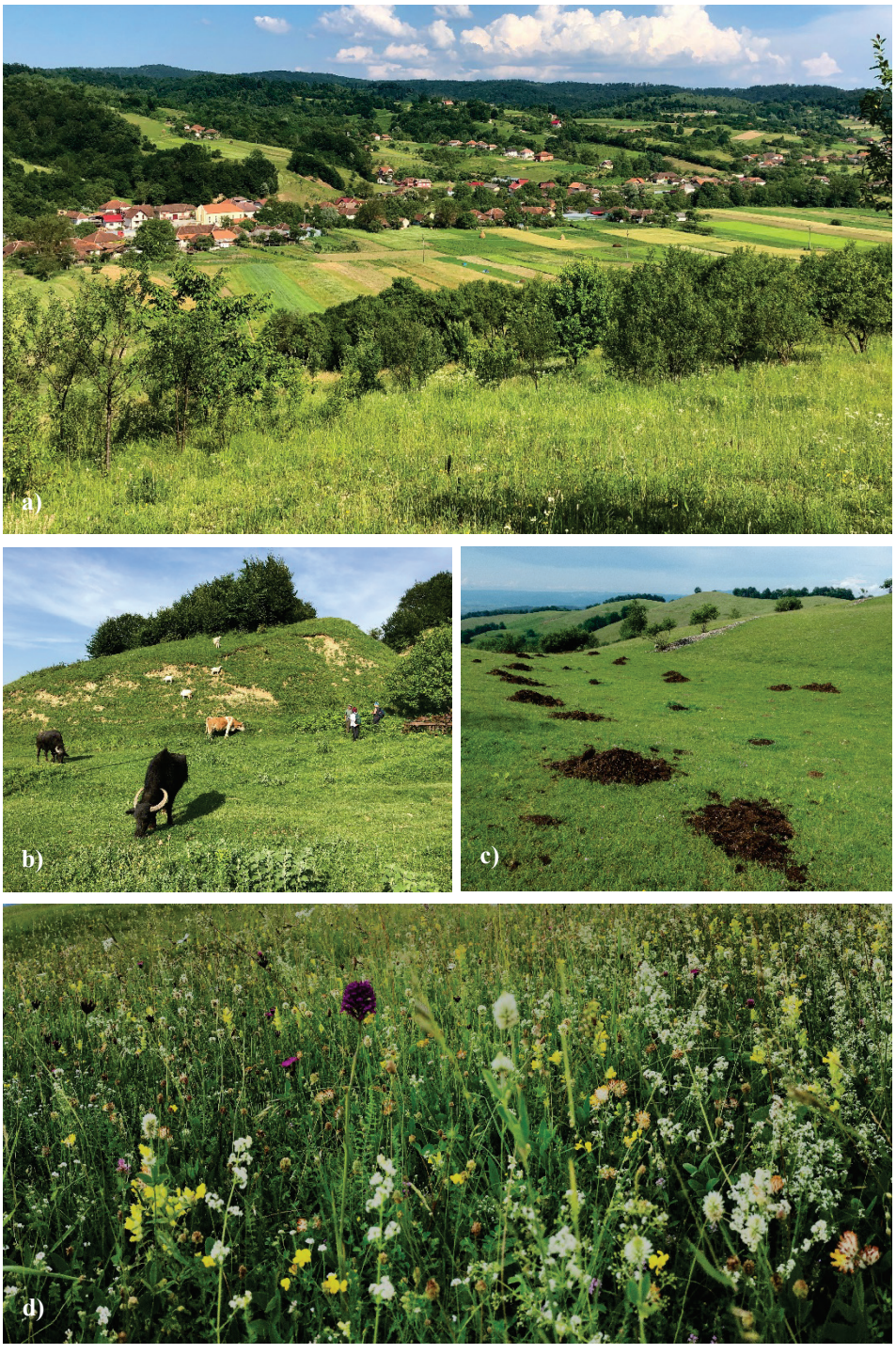
increasing edge density and landscape complexity (TSCHARNTKE et al. 2012) may mitigate this loss, probably by providing stable, heterogeneous and resource-rich habitats many species can persist in and migrate between.

In our study sites ploughing is frequently used as a last resort method to restore the value of a land that is no longer good for grass/hay production. It helps to level the ant and mole hills and to aerate and enrich the soil. The problem is not the ploughing itself, but rather how the parcel is used after it has been ploughed. If accompanied by manuring (using animal dung containing viable seeds of target grassland species) and subsequent regular cutting or grazing, the positive effects outweigh the negative, and ploughing can become a means of successful land improvement. Ploughing can be an efficient restoration measure in abandoned or degraded grasslands formerly used in a crop-grassland rotation. In this special case it can increase plant diversity over the course of several years.

The fast regeneration of a productive meadow taking only four or five years since the last ploughing was reported also for *Centaurea pseudophrygia-Polygono-Trisetion* grasslands from the montane belt of a nearby region of the Apuseni Mts around Gheţari (REIF et al. 2005) and can be attributed to the close vicinity of permanent grasslands surrounding the small cropland parcels. Another important factor is an immediate switch to mowing already in the first year fallows. Especially in fallows cut twice per season, the strong selection favours species resprouting close to the ground with rosettes or runners. The role of the seed bank is probably subordinate (REIF et al. 2005). As the fallow vegetation contains many weeds, this first-year hay is dried and stored separately so that the *Cirsium* and *Rumex* seeds do not get into the manure and then again into the field (RUŞDEA et al. 2005). It is clear that not only a sufficient quantity of seminatural habitats in the landscape but also their specific quality should be viewed as important conditions for biodiversity conservation in agricultural landscapes (LE PROVOST et al. 2020).

In the studied area, a specific crop rotation may be an important factor contributing to fast grassland regeneration on abandoned arable land. The inclusion of alfalfa or clover following the main cultivated crop prior to leaving the land fallow is purposeful. The legumes effectively suppress weeds and enrich the soil with nitrogen. At the same time they keep the parcel surface covered and prevent soil erosion. The establishment of grassland species in this rotation system is obviously very successful.

Another important factor contributing to fast grassland regeneration on arable or degraded land is a regular application of animal dung to the fallows. A combination of ploughing and manuring with subsequent regular mowing was successfully used as a restoration measure to improve grassland quality after degradation in Ponoară (plot Ponoară 7, Fig. 6). The value of animal dung is well recognised by local farmers in both our study sites, and most farmers prefer manure to chemical fertiliser. Dung of animals fed on high quality hay from species-rich grasslands is a precious source of diaspores and inevitably contributes to the enrichment of the local grassland flora. Hay is usually obtained and combined from various meadow types, and thus the dung contains seeds of plants with various habitat requirements, which emphasises the role of dung in the process of grassland regeneration. In many regions of the Apuseni Mts, manuring of fallows and meadows is widespread. For instance, at higher elevations in Gheţari, the majority (more than 80%) of the produced animal dung is used for meadows, mainly for those cut twice a year, and only oligotrophic meadows are manured through grazing cattle (RUSDEA et al. 2005, p. 163). The productive meadows near


a)
b)
c)
d)

the houses are manured annually (usually in April with 15–190, on average 91 dt/ha), and the other eutrophic meadows are usually manured every other year (or at larger intervals, with 3–55, on average 18 dt/ha).

An interesting feature of local agriculture in Ponoară is the cultivation of common kidney vetch (*Anthyllis vulneraria*). This legume species is not commonly used to improve hay in the Carpathians or elsewhere, although it is a constant element of the grassland flora in both Central and Eastern Europe. The only mentioning of its intentional cultivation comes from an old work of the priest and botanists Jozef Ľudovít Holuby (HOLUBY 1906) describing new habits of farmers in the Bošácka dolina Valley (Biele Karpaty Mts, Slovakia) at the turn of the 19th century: "*Bôľhoj* (*Anthyllis vulneraria*) is sown with oats or barley and during the next year, no matter if the cereals succeed or not, the field will provide a lot of fodder. After mowing, the parcel is ploughed once or twice, and then is sown with rye, which will give a better harvest than in the valley." Unlike *A. vulneraria*, common bird's-foot trefoil (*Lotus corniculatus*) is frequently used as forage by people in both sites, Dobrești and Ponoară.

Most of the parcels sampled during our study were extraordinarily rich in species, both of vascular plants and bryophytes. The average species richness of vascular plants in 10-m² and 100-m² plots was 50 and 67 for Dobrești and 59 and 72 for Ponoară. The average

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Fig. 6. a) Landscape in Lunca Sprie, Dobrești commune. Most hay meadows were ploughed and cultivated in the past using the common rotation between 1. corn, 2. wheat plus alfalfa or clover and 3. grazed meadow. Due to a decreasing number of animals, some old fallows were transformed to orchards or became abandoned. **b)** Interview with Constantin D. in the communal pasture of Hidișel, Dobrești commune. Only a few animals are left in the village and most farmers keep their cattle in stables. About 10 cows and buffaloes and some goats graze this pasture. **c)** Even the remote grazed meadows in Ponoară are fertilised by farmyard manure, which is brought to the place in winter, deposited in heaps and manually spread. **d)** Remote meadows in Ponoară are usually cut once a year (August), grazed in spring and autumn by sheep and cows, regularly manured and cleaned from litter, shrubs and stones in spring. They are very rich in orchids – along with *Anacamptis pyramidalis* visible in the picture we found *Gymnadenia conopsea*, *Anacamptis coriophora*, *Orchis ustulata* and *Platanthera bifolia* (Photos: M. Janišová, June 2019).

Abb. 6. a) Landschaft in Lunca Sprie in der Gemeinde Dobrești. Die meisten Heuwiesenflächen wurden hier früher nach dem Pflügen zuerst mit Mais und dann mit Weizen in Mischung mit Alfalfa oder Klee bestellt, bevor sie anschließend wieder als Heuwiese genutzt wurden. Wegen der abnehmenden Anzahl der Nutztiere wurden einige ältere Brachen in Obstwiesen umgewandelt oder sie fielen brach. **b)** Interview mit Constantin D. auf der Almendweide von Hidișel in der Gemeinde Dobrești. Hier gibt es im Dorf nur noch wenige Tiere und die meisten Einwohner halten ihr Vieh im Stall. Die gezeigte Weidefläche wird von ca. 10 Kühen und Büffeln und einigen Ziegen beweidet. **c)** In Ponoară werden auch die abgelegenen Wiesen gedüngt. Der im Winter zu den Wiesen transportierte Stallmist wird dort in Haufen gelagert und schließlich von Hand verteilt. **d)** In Ponoară werden die abgelegenen Wiesen üblicherweise einmal pro Jahr im August gemäht und im Herbst und darauffolgenden Frühjahr mit Schafen und Kühen beweidet. Die Wiesen werden regelmäßig gedüngt und im Frühjahr von Streu, Büschen und Steinen gesäubert. Sie sind reich an Orchideen; neben dem abgebildeten *Anacamptis pyramidalis* fanden wir hier die Arten *Gymnadenia conopsea*, *Anacamptis coriophora*, *Orchis ustulata* und *Platanthera bifolia*. (Fotos: M. Janišová, Juni 2019).

bryophyte species richness was 8 per 10 m² in both sites and 10 and 9 species per 100 m² in Dobreşti and Ponoară, respectively. The richest plot in Ponoară (with 83 vascular plant and 5 bryophyte species in the 10-m² plot and 101 vascular plant and 8 bryophyte species in the 100-m² plot) represents the highest species richness recorded with this sampling approach in Romania during the last three years of our research, which includes another 8 sites in the Romanian Carpathians (Janišová et al., unpublished results). Similarly managed, but slightly species-poorer vegetation has been recorded in Romanian Bucovina (Moldovița), Maramureș (Ieud, Surdești), Harghita (Valea Rece) and the Căliman Mts (Poiana Stampei). In traditionally managed grasslands of the nearby site Gheţari (Apuseni Mts), a much lower species richness of vascular plants was reported (BRINKMANN & REIF 2007): an average of 28–48 species in 25 m² for various grassland types and 29 species for fallow stages between arable field and meadow. This difference may be explained mainly by the high elevation of the Gheţari site (above 1000 m a.s.l.), but the design of nested-plot series used in our study could also be a reason why we recorded higher richness values as especially the smallest plot sizes motivate a researcher to identify each single shoot.

An extreme small-scale richness in vascular plants is known from several regions in the Carpathians; however, the "record" grasslands are not always managed traditionally. In the Czech and Slovak Carpathians (CHYTRÝ et al. 2015), many of the richest semi-dry and mesic meadows have recently been managed by state or non-governmental nature conservation organisations (e.g. meadows of the White Carpathians and Slovenský raj Mts). High species richness is also typical for the Transylvanian Basin in Romania and the eastern periphery of the Ukrainian Carpathians (DENGLER et al. 2012, ROLEČEK et al. 2019), where the species-rich vegetation is probably related to a long continuity of open landscape and the existence of an ancient pool of species of Eurasian forest-steppe and hemiboreal forests (ROLEČEK et al. 2014).

Species-rich orchid meadows, like the remote meadows in Ponoară, have recently become critically endangered throughout Europe. The extreme vulnerability of species-rich mountain hay meadows is caused mainly by the gradual decline of animal husbandry, lack of manure and lack of interest in hay as the best-quality animal fodder. Remote meadows are the first to be abandoned when the number of cattle starts to decrease due to ageing of the village population. Meadows also lose importance for local economies because there are alternative fodder resources available such as corn or legumes (obtained frequently from more fertile lowland areas). The manure produced by the remaining livestock is insufficient for the farm needs and used preferably for fields. In the past, the importance of meadows for the local economy was demonstrated by the fact that in some regions (upper Hron valley, Slovakia) meadows were manured preferentially compared to cropland (PODOLÁK 1961, p. 564). In Ponoară the species-rich montane meadows have been preserved in a very ancient form, still supported by the ancient farming practices. The changes in livestock numbers are rather recent, and consequences regarding biodiversity are not visible yet. There is still a chance to maintain these habitats of European importance for the future by adopting appropriate measures at both local and national level.

There are plenty of articles evaluating the role of recent Common Agricultural Policy (CAP) or agro-environmental subsidy systems in conservation of HNV grasslands (FISCHER et al. 2012, IANCU & STROE 2016). Some of the farmers we interviewed did not receive the payments or used them only partially. However, if the economical system is set so that the farmers do not get a fair price for their agricultural products, the agro-environmental payments are often an important source of income and therefore have a decisive influence on

the current land abandonment. Following the post-socialist transition, Romanian mountain regions face serious challenges such as underemployment and rural population decline, which put traditional farming at risk. To date, the EU rural development policy is strongly focused on economic development, with biodiversity conservation being of little concern (MIKULCAK et al. 2013).

The future maintenance of the Apuseni species-rich grasslands is much dependent on the future agricultural policy in the European Union and on whether the politicians will follow the suggestions of the scientists (PE'ER et al. 2020). Unfortunately, initiating change through policy is a slow process. Although the nature conservation importance of low-intensity farming systems has been recognised for several decades (BIGNAL & MCCRACKEN 1996), there has not been much change, and fast biodiversity decline is reported in numerous recent papers. There is therefore a pressing need to look for other opportunities to maintain surviving systems and, where possible, to reinstate those recently lost. The continuation of low-intensity farming practices should be made viable for local land managers in places where it still exists (SUTCLIFFE et al. 2015).

Erweiterte Deutsche Zusammenfassung

Einleitung – Während in den meisten europäischen Ländern die traditionelle extensive Landnutzung mindestens am Aussterben ist, wird sie in den rumänischen Karpaten vielerorts mit Selbstverständlichkeit noch praktiziert (REIF et al. 2005, PAGE et al. 2011, DAHLSTRÖM et al. 2013, BABAI & MOLNÁR 2014, IVAŞCU et al. 2016). Ein Produkt der traditionellen extensiven Landnutzung in den rumänischen Karpaten ist ausgedehntes artenreiches Grasland (BABAI & MOLNÁR 2014, LOSS et al. 2015, KUN et al. 2019). Wir untersuchten Zusammenhänge zwischen der Artenzusammensetzung sowie dem Artenreichtum des traditionellen extensiven Graslands und der Landnutzungsform im Apuseni-Gebirge, einem Teilgebiet der rumänischen Karpaten. Einerseits wird im Apuseni-Gebirge die traditionelle Landnutzung noch in ganz verschiedener Form praktiziert, und andererseits wurde der Einfluss unterschiedlicher traditioneller Landnutzungssysteme auf die Artenzusammensetzung und den Artenreichtum des extensiven Graslands bisher kaum untersucht. Dazu wurden Vegetationsaufnahmen angefertigt und Interviews mit den Landnutzern zu ihren Landnutzungsmethoden durchgeführt. Kenntnisse der Zusammenhänge zwischen den Methoden der traditionellen Landnutzung und dem Artenreichtum des Graslands sind notwendig, um das artenreiche Grasland zu erhalten und verarmte Graslandbestände zu renaturieren; beides gilt sowohl für unser Untersuchungsgebiet als auch für andere Gebiete in Europa. Die konkreten Ziele unserer interdisziplinären Studie waren (1) eine Bestandsaufnahme des Artenreichtums des Graslands mit ihrer genauen Nutzungsform, (2) eine Bestandsaufnahme der ökologischen Kenntnisse der lokalen Landnutzer hinsichtlich der Graslandnutzung auf der Basis von Interviews, (3) eine Analyse von Zusammenhängen zwischen Artenreichtum und Nutzungsform sowie (4) eine Einschätzung der Auswirkung der räumlichen Skala auf den Zusammenhang zwischen der Nutzungsform und dem Artenreichtum.

Methoden – Die Untersuchungen wurde in zwei Gemeinden am Nordwestrand des Apuseni-Gebirges in Rumänien durchgeführt. In der Gemeinde Dobreşti lagen die Untersuchungsflächen in der collinen Stufe und in der Gemeinde Bratca (hier das Gebiet Ponoară) in der submontanen Stufe. In jedem Gebiet wurde in sechs Serien ineinander geschachtelter Aufnahmeflächen zunehmender Größe (0,0001 m^2; 0,001 m^2; 0,01 m^2; 0,1 m^2; 1 m^2; 10 m^2; 100 m^2; s. Abb. 2) die Präsenz der Gefäßpflanzen, Moose und Flechten aufgenommen. Auf den 10 m^2-Flächen wurde zudem die Deckung der Arten geschätzt sowie Umweltdaten zur Topographie (Meereshöhe, Hanginklination, Mikrorelief, Bodengründigkeit) und Pedologie (pH-Wert, Bodengehalte an Humus, Phosphor, Kalium, Kalzium, Magnesium, Stickstoff sowie das C/N-Verhältnis des Oberbodens) bestimmt. Die Informationen zur Landnutzung und zu den ökologischen Kenntnissen der Landnutzer wurden durch Interviews mit den Landnutzern vor Ort gewonnen. Die Landnutzung wurde nach drei Perioden unterschieden: 1950–1990,

1990–2010 und 2010–2019. Die Langzeitwirkung von Mähen, Weiden, Düngen und Pflügen wurde dann als Summe ihrer Präsenzen/Frequenzen über die drei Perioden berechnet. An Weidesystemen wurden Herbstweide, Frühjahrs- und Herbstweide in Kombination, eingezäunte Ganzjahresweide, freie Ganzjahresweide sowie Hutweide unterschieden, und an Weidetieren Kühe, Schafe, Ziegen, Schweine sowie Gänse. Die Summen der seit 2010 jährlich angewendeten Managementelemente Mähen, Weiden, Düngen, Pflügen sowie Säubern der Flächen von Gehölzen, Streu und Steinen, wurden berechnet, um die Auswirkungen des aktuellen Managements auszudrücken. *Detrended Correspondence Analysis* (DCA) mit logarithmisch transformierten Artendeckungswerten wurde verwendet, um die Variation der Pflanzenartenzusammensetzung der 10 m²-Flächen zu untersuchen. Um die DCA-Gradienten zu interpretieren wurden die Variablen der Landnutzung, des Bodens und der Topographie mit den DCA-Achsen korreliert.

Ergebnisse – In Dobrești gehörten die Graslandgesellschaften zu den Verbänden *Arrhenatherion elatioris*, *Cynosurion cristati* und *Deschampsion cespitosae* und in Ponoară zum *Cirsio-Brachypodion pinnati* und *Violion caninae*. Beide Gemeinden repräsentieren naturschutzfachlich wertvolle Gebiete, in denen die kleinbäuerlichen Strukturen zumindest teilweise noch existieren. In Ponoară war die Praxis der traditionellen Landwirtschaft insgesamt besser erhalten. Hier waren in der traditionellen Landwirtschaft auch noch mehr Einwohner beschäftigt und die Tierhaltung hatte während der letzten Jahrzehnte noch nicht so stark abgenommen. Der Artenreichtum war in beiden Gebieten sowohl im gesamten Gebiet als auch auf den Aufnahmeflächen hoch. Der durchschnittliche Artenreichtum pro 10 m² lag in Dobrești bei 50 und in Ponoară bei 59 Gefäßpflanzenarten. In beiden Gebieten kamen auf 10 m² Fläche durchschnittlich acht Moosarten vor.

Die häufigsten Nutztypen waren Dauerweiden und ältere Brachen, die aktuell als Heuwiesen genutzt wurden. Mit wenigen Ausnahmen wurde jede Aufnahmefläche entweder ausschließlich oder zumindest zeitweise im Jahr als Weide genutzt. Die meisten der untersuchten Wiesen wurden in der Vergangenheit zeitweise als Acker genutzt; die Ackernutzung lag zum Zeitpunkt der Vegetationsaufnahme meist 10–15 Jahre zurück (Abb. 5 sowie Anhang S1, E3–E4). Zum Zeitpunkt der Untersuchung wurden alle Bestände ein- bis zweimal pro Jahr gemäht und in fünf unterschiedlichen Formen beweidet. Am artenreichsten waren frühere Brachen, die aktuell als beweidete Wiesen genutzt wurden. Dauerweiden waren dagegen artenärmer als Brachen und beweidete Wiesen (Abb. 4 und 5).

Diskussion – Unsere Studie zeigt mehrere Beispiele, wie eine rotierende Abfolge von Grasland- und Ackernutzung einschließlich moderater Düngergaben in Form von Stallmist in einer traditionell-extensiv bewirtschafteten und kleinräumig strukturierten Landschaft im Graslands zu einem sehr hohen Pflanzenartenreichtum führen kann. Ausgehend von einem weitgehenden Verschwinden der Graslandarten während der Ackerphase diskutieren wir das Phänomen der offenbar schnellen Graslandregeneration nach Einstellen der Ackernutzung und Wiederaufnahme der Graslandnutzung. Unserer Meinung stellt nach der Ackerphase ein frühes und regelmäßiges Mähen oder Beweiden eine Vorrausetzung für diese schnelle Regeneration des Graslands dar, da dadurch konkurrenzkräftige Ruderalarten unterdrückt werden. Eine weitere Vorrausetzung ist ein Ausbringen von Stallmist mit vielen keimfähigen Diasporen der Graslandarten. Wichtig ist ebenfalls, dass die Ackerparzellen nicht zu groß und von artenreichem Grasland als Ausgangspunkt für eine Wiederbesiedlung umgeben sind. Diese Regeneration dürfte also v. a. in stark strukturierten Graslandsystemen mit kleinen Parzellen und ausreichend vielen artenreichen Graslandbeständen gut funktionieren, nicht aber in den intensiv-industriell genutzten Landschaften mit ihren großen Parzellen und ihrem höchstens artenarmen Intensivgrasland. Eine rotierende Abfolge von Grasland- und Ackernutzung kann also unter den genannten Umständen ein nachhaltiges Nutzungssystem für artenreiches Grasland bilden. Insgesamt illustrieren unsere Ergebnisse, dass i) die traditionelle Graslandnutzung in ihren Nutzformen vielschichtig sein und durchaus zeitweise Ackernutzung beinhalten kann, ii) enge Beziehungen zwischen Viehwirtschaft und Graslandmanagement bestehen und iii) in ländlichen Regionen wie den Karpaten das ökologische Wissen und die ökologische Erfahrung der lokalen Landnutzer bei alldem eine wichtige Rolle spielen.

Acknowledgement

We are grateful to our respondents, who shared their own experience and valuable local-specific farming details and to Tomáš Hlásny for deriving precise climate data for our study plots. We acknowledge the E-OBS dataset from the EU-FP6 project UERRA (https://www.uerra.eu) and the Copernicus Climate Change Service and the data providers in the ECA&D project (https://eca.knmi.nl). We thank Albert Reif and an anonymous reviewer for valuable improvements of our manuscript, Aiko Huckauf for the linguistic check, and Thomas Becker for handling the manuscript and translation to German. Financial support was provided by the Slovak Academy of Sciences, grant VEGA 2/0095/19 and NGS grant.

Author contribution

MJ contributed the idea, methodology, field sampling, data processing/analyses and paper writing, AB and AI interviewed the farmers, AB transcribed and translated the interviews, IŠ participated in field sampling, and PŠ determined the bryophytes. All authors read and commented on the manuscript.

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Supplements

Supplement S1. Summary on historical and recent farming in Dobrești and Ponoară.

Beilage S1. Übersicht der historischen und aktuellen Landnutzung in Dobrești und Ponoară.

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

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

Supplement E1. Population of the Dobrești and Bratca communes since 1880.

Anhang E1. Entwicklung der Einwohnerzahl in den Gemeinden Dobrești und Bratca seit 1880.

Supplement E2. Basic data on the sampled nested-plot series including topographic, edaphic and management variables.

Anhang E2. Grunddaten der Serien der ineinander geschachtelten Aufnahmeflächen mit topographischen, edaphischen und Nutzungsvariablen.

Supplement E3. Farming practices and local ecological knowledge in Dobrești.

Anhang E3. Nutzungspraxis und lokales ökologisches Wissen in der Gemeinde Dobrești.

Supplement E4. Farming practices and local ecological knowledge in Ponoară.

Anhang E4. Nutzungspraxis und lokales ökologisches Wissen in der Gemeinde Ponoară.

Supplement E5. Species data from the nested-plot series in Dobrești.

Anhang E5. Artdaten der ineinander geschachtelten Aufnahmeflächen in Dobrești.

Supplement E6. Species data from the nested-plot series in Ponoară.

Anhang E6. Artdaten der ineinander geschachtelten Aufnahmeflächen in Ponoară.

Supplement E7. Variation in the Pearson correlation coefficient between vascular plant and bryophyte species richness with increasing sampling plot size.

Anhang E7. Variation des Pearson-Koeffizienten der Korrelation zwischen Gefäßpflanzen- und Moosartenreichtum mit zunehmender Größe der Aufnahmeflächen.

Supplement E8. Nested-plot series in the Dobreşti site.

Anhang E8. Serien der ineinander geschachtelten Aufnahmeflächen in Dobreşti.

Supplement E9. Nested-plot series in the Ponoară site.

Anhang E9. Serien der ineinander geschachtelten Aufnahmeflächen in Ponoară.

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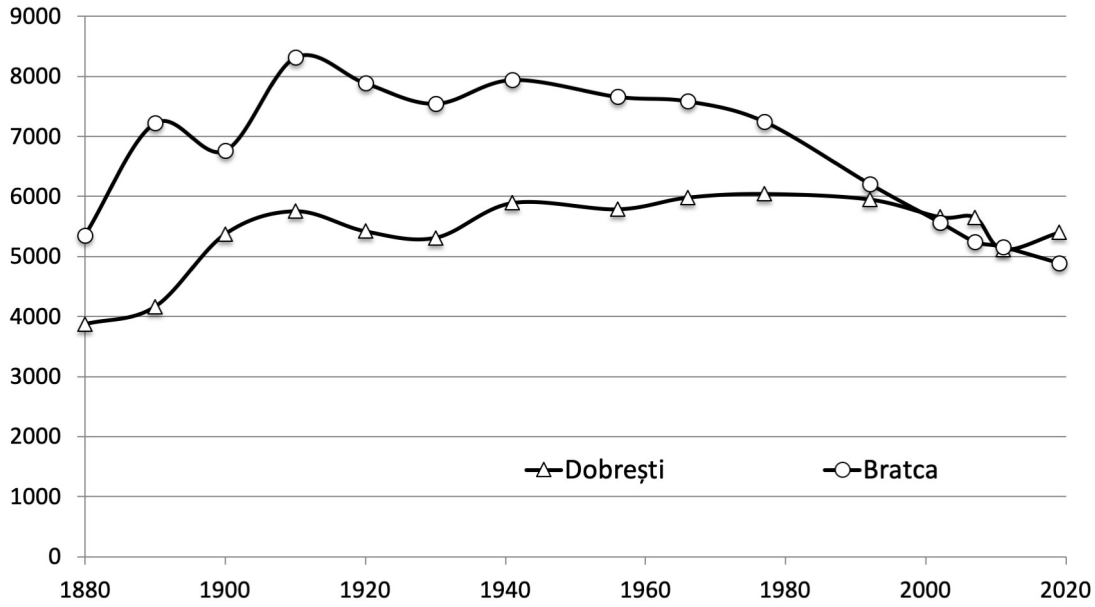
Supplement S1. Summary on historical and recent farming in Dobrești and Ponoară. More details including the farmers' statements are included in Online resources E4 and E5

Beilage S1. Übersicht der historischen und aktuellen Landnutzung in Dobrești und Ponoară. Weitere Details der Interviews mit den Landwirten finden sich in den elektronischen Anhängen E4 und E5.

Farming details	**Dobrești**	**Ponoară**
Proportion of grasslands (excluding fallows) in the commune in 1990	Dobrești commune: 17%	Bratca commune: 32%
Collectivism	Yes, before 1989 half of the commune was collectivised, but most settlements studied were not under collectivism	No
Crops and crop rotation (recently used)	Crops: corn, wheat, potatoes Fodder crops: clover, alfalfa 1st year: corn 2nd year: wheat + alfalfa or clover 3rd and several following years: mowing and grazing	Crops: corn, potatoes, wheat, rye, oats, beans, cabbage, vegetables Fodder crops: mainly clover and *Lotus corniculatus*, sometimes also alfalfa and *Anthyllis vulneraria*
Animal husbandry	Mainly focused on meat	Mainly focused on milk
Ownership of pastures	Town hall + landowner association	Town hall + landowner associations + private ownership
Pastures/Grazing		
a) Period	From 15 April – 5 May until 1 November	From the beginning of May until snow falls in late October/beginning of November (cows)
b) Grazing system	No shepherds, animals roam freely on pastures and also elsewhere after the crop is harvested. Stable husbandry becomes more frequent due to the lack of working force.	No shepherds for cows, electric fences used; the cows sleep in barns on the pastures, people go to milk them twice a day. Sheep kept in flocks with shepherds in close mountain pastures. A unique system of sheep mountain grazing and wintering, which was used in the past, has recently been abandoned.
c) Number of animals	Decrease mainly since 2000 Recent numbers in the Dobrești commune (2018): 300–600 sheep, 1000 cows, 30 water buffaloes, 50 horses, 100–200 geese	Decrease mainly since 2012 Recent numbers in the Ponoară village (2018): 2580 sheep, 750 cows and 80 horses
d) Animal breeds	Romanian Bălțata (cow), Lipițan (horse)	Romanian Bălțata (cow), Țurcana (sheep)
Meadows/Mowing		
a) Origin	Very few permanent hay meadows, most recent meadows originate from fallows	Many recent meadows originate from fallows
b) Mowing period	1st cut in June (after 15 June), 2nd cut in August or September	June–September, including the aftermath
c) Mowing frequency	Twice a year for inner meadows, once a year for remote ones	Twice a year for inner meadows, once a year for remote ones
d) Mechanisation of mowing	Mowing machines, tractors, mechanical rakes, balloting machines. Hand mowing is becoming rare.	Mowing machines, tractors, balloting machines. Hand mowing is becoming rare.
e) Hay storage	Hay is stored mainly in bales (easier to transport and store at home), traditional haystacks are becoming rare. Hay in excess is burned, rarely stored for more years.	Hay is stored mainly in bales (easier to transport and store at home). Very few families still make haystacks.
f) Hay quality	Cultivated hay (alfalfa and clover) and *otava* (second-cut hay) are considered to be the best fodder for animals. Mowing time affects hay quality: The grasses should have seeds visible; the legumes should start to flower. Hay obtained from hand mowing is of better quality than mechanically mown hay (broken stems and contained dust).	Cultivated hay (alfalfa and clover or alfalfa with oats) and *otava* (second-cut hay) are considered to be the best fodder for animals. *Otava* can also be stored longer (up to 7 years) without loss of quality.
g) Hayseed (plant seeds obtained from hay)	Used for grassland regeneration in the past. Recently used as fodder for poultry and as cure (infusions) for respiratory diseases.	Hayseeds are fed to the cows.
Grassland maintenance and restoration		
a) Grassland improvement	If enough manure, meadows are manured annually by ripe animal dung (1 year old) spread in spring. Spring and autumn grazing are used to manure fallows. Synthetic fertiliser is used only for cropland.	Manuring mainly on fallows, sheep corralling in May on fields and fallows. Mature dung is distributed to parcels in autumn and spread in the following spring.
b) Cleaning from shrubs and trees	Almost no cleaning during the last 20 years.	Spring cleaning of meadows from shrubs, trees and unwanted vegetation (*Rumex* spp.), but also from rocks (which are abundant in karst relief). Levelling anthills is common on meadows.
c) Cleaning from bracken (*Pteridium aquilinum*)	Bracken (*ferriga*) has recently been spreading on abandoned land. It the past it was used as bedding for pigs. To get rid of it, application of a herbicide after cutting leaves or ploughing is recommended. Burning is not recommended as it supports the spread of bracken and shrubs. Bracken and rushes (*Juncus* spp.) can be grazed by horses and goats in small quantities.	Cutting leaves repeatedly for 2–3 years.
d) Cleaning from mattgrass (*Nardus stricta*)	It can only be mowed when it is wet (early in the morning)	Ploughing. When impossible due to rocks, manuring is used.
e) Cleaning from mosses	Through grazing with sheep.	No solution
Recent trends	Decreasing area of the arable land and its transformation to meadows and orchards. Abandonment of communal pastures resulting in an increase of forested area.	Abandonment of remote areas. Decreasing number of sheep, sheep flocks and sheep keepers.
Economic support	Subsidies for land claimed by a majority of farmers. Farmers keeping buffaloes receive subsidies for each animal.	Subsidies for land claimed by a majority of farmers.
Economic barriers	No organised milk collection system; intermediaries to buy the animals for meat. Uncertainty.	No organised milk collection system; intermediaries to buy the animals for meat. Uncertainty.

Supplement E1. Population of the Dobrești and Bratca communes since 1880.

Anhang E1. Entwicklung der Einwohnerzahl in den Gemeinden Dobrești und Bratca seit 1880.



Supplement E2. Basic data on the sampled nested-plot series including topographic, edaphic and management variables. Phytosociological affiliations are: Arrh – *Arrhenatherion elatioris* , Cir-Br – *Cirsio-Brachypodion pinnati* , Cyn – *Cynosurion cristati* , Desch – *Deschampsion cespitosae* , Viol – *Violion caninae* . Management variables were calculated as sum of events per year throughout the three time periods 1950–1990, 1990–2010 and 2010–2019. Grazing systems are: A – autumn grazing, AS – spring and autumn grazing, C – common pasture with whole-season free grazing, F – fencing and whole-season grazing in enclosures, H – whole-season herding with a shepherd, N – no grazing.

Anhang E2. Grunddaten der Serien der ineinander geschachtelten Aufnahmeflächen mit topographischen, edaphischen und Nutzungsvariablen. Abkürzungen der pflanzensoziologischen Einheiten: Arrh – *Arrhenatherion elatioris* , Cir-Br – *Cirsio-Brachypodion pinnati* , Cyn – *Cynosurion cristati* , Desch – *Deschampsion cespitosae* , Viol – *Violion caninae* . Die Managementvariablen wurden berechnet als Summe der Ereignisse pro Jahr über die drei Zeiträume 1950-1990, 1990-2010 and 2010-2019. Beweidungstyp: A – Herbstweide, AS – Frühjahrs- und Herbstweide, C – Allmende mit ganzjähriger freier Beweidung, F – Eingezäunte Dauerweide, H – Ganzjährige Huteweide, N – keine Beweidung.

		Dobrești 2	Dobrești 3	Dobrești 5	Dobrești 8	Dobrești 9	Dobrești 11	Ponoară 1	Ponoară 3	Ponoară 5	Ponoară 7	Ponoară 10	Ponoară 12
Latitude	[°]	46.871889	46.870083	46.8755	46.854944	46.851139	46.833361	46.892222	46.877472	46.903917	46.887	46.898361	46.892083
Longitude	[°]	22.290972	22.263972	22.269778	22.28575	22.302778	22.270028	22.669083	22.620278	22.658833	22.647528	22.664528	22.636889
Phytosociological affiliation*		Arrh	Cyn	Desch	Arrh	Arrh	Cyn	Cir-Br	Viol	Cir-Br	Cir-Br	Cir-Br	Cir-Br
Climate variables													
Mean annual temperature (1990-2019)	[°C]	10.4	10.4	10.4	10.4	9.5	10.4	7.8	7.8	9.1	7.8	7.8	7.8
Mean annual precipitation (1990-2019)	mm	525	525	525	525	563	525	631	631	588	631	631	631
Topographic and soil variables													
Elevation	m a.s.l.	331	208	203	222	251	222	677	731	667	704	764	688
Aspect of the slope	[°]	45	269	118	249	77	46	222	65	210	100	24	79
Inclination	[°]	5	20	3	10	17	10	7	5	25	18	15	18
Microrelief	cm	5	5	9	4	10	10	4	10	5	4	3	3
Soil depth	cm	13.4	24.2	47.4	22.4	26	32.4	17.4	38.4	11	14.2	22.8	19.8
pH KCl)		4.36	4.34	6.54	5.15	4.72	5.77	4.76	4.64	5.53	6.33	4.35	4.99
Humus	g/kg	32.76	36.89	37.76	42.41	40.86	67.75	113.96	50.34	72.06	80.86	64.31	91.2
Soil P	mg/kg	6.03	6.06	5.54	5.97	5.59	6.02	4.63	5.39	4.22	3.97	4.38	4.69
Soil K	mg/kg	252.02	107.92	103.7	171.7	181.85	181.85	178.49	116.16	146.93	277.41	120.19	171.7
Soil Ca	g/kg	1.25	1.25	11.47	2.66	3.29	6.63	10.31	0.18	8.1	5.58	2.66	3.91
Soil Mg	mg/kg	227.93	249.06	328.29	324.66	262.07	433.15	272.38	77.72	1157.02	1445.57	589.17	1021.06
Soil C/N		9.00	10.70	8.36	9.80	10.92	9.29	11.91	10.81	13.62	9.42	10.97	9.25
Management variables													
Litter	%	0	0	8	80	20	0	0	0	3	3	0	0
Mowing		6	0	0	2.2	2.5	0	3	2	0	6	3	6
Grazing		3	3	3	0	0	3	2	3	3	3	3	3
Manuring		3	0	0	2	3	0	3	0	0	3	3	3
Ploughing		3	0	0	2	2	0	0	2	0	3	1	2
Years since the last ploughing		2	–	–	15	10	–	–	15	–	5	30	15
Impact of recent management		4	2	2	0.2	3.5	2	4	2	2	6	4	5
Grazing system		A	F	C	N	N	C	F	F	H	A	AS	AS
Cow grazing	0/1	1	1	1	0	0	1	1	1	0	1	1	1
Sheep grazing	0/1	0	1	1	0	0	1	1	1	1	0	1	1
Goat grazing	0/1	0	0	0	0	0	1	0	0	1	0	0	0
Grazing by other animals (pigs, geese)	0/1	0	0	0	0	0	1	0	0	0	0	0	0
Other data													
Sampling date		13.6.19	15.6.19	14.6.19	14.6.19	13.6.19	12.6.19	18.6.19	16.6.19	17.6.19	15.6.19	17.6.19	16.6.19
Cover of herb layer	%	95	90	98	95	98	99	95	75	92	98	95	97
Cover of cryptogam layer	%	25	12	5	17	40	15	15	50	50	25	60	50
Cover of dead wood	%	0	0.5	2	0	0	0	0	0	1	0	0	0
Cover of stones and rocks (> 63 mm)	%	1	0	0	0	0	0	0.1	0	0.1	0	0	0
Cover of gravel (2–63 mm)	%	0	1	0	0	0	0	0.5	0	0	5	0	0
Cover of fine soil (< 2 mm)	%	99	99	100	100	100	100	99.4	100	99.9	95	100	100
Maximum height of herb layer	cm	102	32	68	101	105	15	55	61	40	99	89	84
Mean height of herb layer	cm	29.8	9.6	32.6	38.4	33.8	8	16.2	5	8	26.8	51.4	36
Cover of bare soil	%	5	4	0	0	2	1	5	10	1	0.5	2	2
Cover of dung	%	3	0.5	0	0	0	0.001	0.3	1.5	0.5	0	0	0
Cover of anthills	%	1	0.3	0	0	2	0	0	2	0	0.5	0	1
Cover of molehills	%	1	0	0	0	0	0	0.1	3	0	0	0	0

Supplement E3. Farming practices and local ecological knowledge in Dobrești.

Anhang E3. Nutzungspraxis und lokales ökologisches Wissen in der Gemeinde Dobrești.

Farming practices and local ecological knowledge in Dobrești

Of the total area of the Dobrești commune (13400 ha), 21% is arable land (2764 ha), 13% pastures (1739 ha), 2% meadows and grazed meadows (246 ha), 2% orchards (200 ha), and the remaining area is covered by forests (59%), water bodies, roads and buildings (4%, 601 ha; Fig. 3). Most of the pastures (1600-1700 ha) are owned by the town hall and the landowners association. The number of all types of cattle decreased, especially after 2000. Recently, in the Dobrești commune there are about 1000 heads of cattle (mainly *Romanian Bălțată*, in 1990 there were 2500 heads of cattle), 30 water buffaloes (10-15 years ago there were 200 buffaloes), about 50 horses (*Lipițan* breed), 3000-4000 pigs, and 100-200 geese. Since 2017 there is a flock of 300-600 sheep in Hidișel managed by a sheep keepers association and grazed on the communal pastures.

Thirty years ago, in each house there were horses, oxen, buffaloes. Recently, only 5 families have buffaloes (S.C.).

Only the plain lowlands of the commune were collectivized, encompassing half of the commune. The land use in Dobrești, Copoșeni and Luncasprie was never affected by collective farming.

Hidișel has been under collectivization laws during communism. People were stripped of their land and forced to work in factories and in state farms. They were left with only 16 acres/household, around the house (C.D.).

Many inhabitants of the commune are engaged in agriculture, recently there are 2086 positions in the Agricultural Register (town hall info). Most of the inhabitants are retired. Most young people (working class) are either working in the cities nearby (Oradea, Beiuș) or abroad. An average household owns about 1-2 ha of land, most of which is used to grow crops in a rotation system. The following crop rotation scheme has been used most frequently in the past: 1st year corn, 2nd year wheat, 3rd year alfalfa or clover (cut 3-4 times/year), 4th year haymaking on a fallow (cut twice a year). Recently, many farmers skip the corn and alternate only wheat, clover & alfalfa, and hay meadow. Some farmers alternate more crops, e.g. corn, wheat, grass with clover and alfalfa, potatoes. The stage of haymaking usually lasts several years. Ploughing is applied each 5th to 7th year and is considered as the best way of grassland improvement and restoration. Most of the recent meadows were ploughed in the past and the permanent hay meadows are almost missing in the commune (the few small parcels that have never been ploughed are restricted to steep and hardly managed spots). Crop rotation applied in the commune is used also for the establishment of meadows from the forest. Meadows are usually established closer to forests than the cropland due to wild boars, which frequently destroy crops.

We alternate crops each year by first sowing corn, then wheat and when the wheat has a certain height a bit alfalfa and clover are sown already in the second year, so that they can be mown in the third year (N.B.).

Clover and alfalfa help the grass to return and they both improve the hay quality. They persist in the fallow for 4-5 (on rich soils even for 7) years after sowing (I.B.).

Corn benefits from the freshly ploughed soil because all the remaining roots in the soil ferment and act like a manure. Corn is also not so sensitive to the soil boulders with the plant remnants (C.D.).

To restore a degraded grassland with a decreased productivity it is necessary to plough it, plant corn for one year, then wheat, then alfalfa, and then keep on mowing it for several years. Annual manuring would also be required. This process usually has to be repeated after 5-6-7 years on every fallow (C.D.).

Sheep grazing and ploughing can improve the grass, it is especially efficient in moss removal (V.D., I.B.).

After cutting the forest, corn is grown for 1-2 years, then wheat, sown with clover, and after harvesting the wheat clover is harvested for the next 1-2 years, then the meadow is established (S.C.).

There are a lot of wild boars here, they can come over 50 at once. People stay during the night near cultivated lands to defend them against wild boars. They also use fabric with pheromones to chase away wild boars (S.C.).

The soil in the commune is generally considered to be very poor. In the past, manure (animal dung) was used to increase productivity of fields and hay meadows. Recently, it is used mainly for crops, since animals are few and the produced manure quantity is restricted. One-year old manure is spread on fields in spring. Synthetic fertilizer -nitrogen complex applied in summer - is used for crops, especially corn.

Nitrogen fertilizer should be applied during a period with dry weather, in a rainy weather it can burn the plants (C.D.).

Nitrogen is not used for grassland because the stems and stalks of plants get too thick and hard and the animals don’t like such a hay (C.D.).

Synthetic fertilizer isn’t maybe healthy for the soil, but it gives very good productivity (I.B.).

Most of the agricultural products are used as animal fodder. Corn is used mostly as feed for the pigs.

Alfalfa can bloat the cows, it is dangerous in autumn, when there is lot of dew, and the animals move everywhere after the harvest. The clover is not dangerous (C.D.).

Meadows in the village are cut twice. Mowing starts around June 15th and the second cut for aftermath (*otava*) is done in August or September. *Otava* is valued more than the first-cut-hay also because it contains much clover. In some villages, by *otava* they mean alfalfa and/or clover hay. Alfalfa is cut 3-4 times a year. Many people consider alfalfa hay as the best and most nutritious. Grass is mown by hand, motor mowers or tractors and the hay is stored in bales or traditional haystacks. Traditional haystack making is getting less frequent since many people bought balloting machines. There are not many people to help them with the field work, so mechanization is a necessity.

The grass is ready for mowing when the seeds are produced (N.B.).

Alfalfa is ready for mowing when it gives its head, before it blooms. The clover as well. Grass is ready for mowing when the seeds start to be visible. When the grass gets older, it is no longer good (C.D.).

Otava is better than hay, because it is not like a straw and smaller. Good hay is that with clover, bird's-foot trefoil (*Lotus corniculatus*), sudan grass (*Sorghum* × *drummondii*), there should be more grass in it. The hay is better if it is prepared manually, and the one stored in haystacks. Tractor breaks the hay and balloting machine also breaks the hay. The one in the bales is dustier, it breaks. It also contains the litter (N.B.).

The hay is best when cut by scythe. Both the tractor mower and the balloting machine rip the grass and put a lot of dust in the hay (C.D.).

Many villagers have mowing machines and tractors, they rake hay using the tractor, have balloting machines, etc., but there are still older people who can't afford to pay the tractor to come and mow, so they do it by hand. People not owning the balloting machine store hay in haystacks (N.B., S.C.).

Animal husbandry focuses on meat rather than on milk production. Grazing of cows starts between April 15th and May 5th and usually ends on November 1st. Communal or private pastures are used for grazing cattle. The pigs are left free in the forest or stay around the ponds. Sheep are grazed on communal pastures and in the forest. Free grazing of all kinds of animals is applied especially after crops are harvested. There are not enough people available to watch over cattle, so they stay without shepherds in spite that there may get lost. In Copoșeni they never lost animals, but it has happened that the pigs returned home with the wild boar friends. Wolves and bears living in the region are also a potential threat. Many farmers abandoned traditional grazing and switched to stable husbandry because of the lack of working force. Traditionally, children would go graze the animals in the morning and return with them home at nightfall.

Milk production is not a big factor here, people mostly breed and sell the young cattle even though the price is very low for them (around 2600 lei=approximately 240 Eur for 2 younglings) (N.B.).

In autumn the cows can graze everywhere except hay meadows for making *otava*. They can stay on the pasture until December (N.B.).

The cows and the pigs of the village roam free all day and they come back home at night by themselves. (N.B.)

The arable land after harvesting corn is free for grazing, but according to the owner. All the animals are left alone on the pasture, they come home alone (S.C.).

Now there are more sheep in the village than before (S.C.).

Many farmers keep animals in stables and feed them with hay and alfalfa ballots all the year. This approach lessens milk productivity and the animals can get overgrown hooves from stable living (C.D.).

Recent changes in land-use include mainly decreasing area of the arable land and its transformation to meadows and orchards. Abandonment of communal pastures is also common since the number of animals/households has decreased, resulting in increase of forested area. The old communal pastures are now fragmented, with parcels legally registered as forest and under National Forestry Agency management. Most farmers take the APIA payments for land, an important economic aspect that supports the local population and encourages them to keep working their land. Those breeding buffaloes receive subsidies for each animal, too.

There is not much abandoned land in the commune. Even if people don't use their land for themselves, they let other people which have animals (usually neighbours) use their land (C.D.).

Today the land is more abandoned, because there are many older families. There are many abandoned enclaves. In the areas that are no longer used, the land is spontaneously overgrown by ash, oak, cherry (S.C.).

The common pasture in Hidișel is recently grazed by only few animals: about 10 cows and buffaloes and some goats. After 1989, when there were many more animals in the village, only pigs from all the village and geese grazed the lower part of the communal pasture. In the last 3 years, this place is grazed by a flock of sheep, and mixed grazing is practiced in autumn. There are about 15 horses left in the village, many people don't really use them for work, they are kept for beauty (C.D.).

Without subsidies, no agriculture is done now (S.C.).

Grassland abandonment results in spread of unwanted trees, shrubs and forbs, sometimes also mosses. The structure of a stand changes and its productivity is reduced. The most problematic is spread of poisonous bracken (*Pteridium aquilinum*), locally called *feriga*. People still remember traditional approaches to improve and restore degraded grasslands. Burning is generally considered as an inaproapriate restoration measure.

Bracken was not problematic in the past because there were many animals that grazed around, and it was not strong enough to sprout so abundantly (C.D.).

Feriga [ferns] used to be mown and the leaves were used as bedding for pigs. For pigs it is not poisonous, pigs even like the rhizomes, but the cows are sensitive to the spores (I.B., V.D.).

What could help to suppress bracken: Cutting the leaves, gathering them, and burning them on the second day, application of a herbicide at the bottom part of the fern, and ploughing the land (N.B.).

Ploughing and application of a herbicide can be helpful, but the success is not sure, as the fern (*feriga)* has very deep rhizomes (I.B., V.D.).

Burning land supports the spread of bracken and also spiny shrubs grow larger and expand more. Bracken and rushes (*Juncus* sp.) can be grazed by horses, and goats also eat them in small quantities (C.D.).

During the abandonment the mosses spread in the grass. Since 2017 the sheep reduced mosses. Burning is not a good method to clean pastures as it also supports the fern (*feriga*) in the next year (S. C.).

Recently, most people do not do anything against the fern (*feriga*) (S.C.).

People in Dobrești commune do not use the hayseed („*stroh*“, plant seeds obtained from hay) to restore disturbed grasslands. They use it to feed the chicken and whatever is left ends up in the manure. They also prepare tea from hayseed to cure respiratory diseases.

There are some who were spreading *stroh*, but it is not done lately (S.C.).

Supplement E4. Farming practices and local ecological knowledge in Ponoară.

Anhang E4. Nutzungspraxis und lokales ökologisches Wissen in der Gemeinde Ponoară.

Ponoară – farming system and local ecological knowledge

Of the total area of the Bratca commune (13648 ha), 26% is arable land (3498 ha), 26% pastures (3562 ha), 6% meadows, grazed meadows and orchards (792 ha), and the remaining area is covered by forests (30%, 4080 ha), roads, buildings, and unspecified areas (13%, 1716 ha; Fig. 3b). The agricultural development in Ponoară is affected by the karst relief and calcareous geological bedrock. „Ponor" in the village name means a natural surface opening in a karst limestone landscape. Such openings are very common in Ponoară. Most inhabitants are engaged in local agriculture but there are also many people working in the nearby towns or abroad. The local farmers focus on milk rather than meat production. In 2018 there were 2580 sheep, 750 cows and 80 horses in the Ponoară village. The decrease in animal numbers is visible also in this region, however, it has rather recent character and most changes occurred since the last 5-7 years. In the past, during the communist regime, people kept more sheep and less cows than today. The most widespread in the village are cow breed *Romanian Bălțata* and sheep breed *Țurcana*. Within the Bratca commune, only Beznea had a cooperative, the other villages such as Bratca, Damiș, Ponoară, Lorău and Valea Crișului never had a collective farming. Villagers from Ponoară exchanged pork meat for construction materials with the state during that time.

Most grassland area is used as grazed meadows (626 ha). Pasture area consists of 157 ha of communal pastures and private pastures owned by the villagers (these are mainly used for cow grazing, for which they use electric fences). Pasture area has decreased since the last 20 years and the communal pastures are heavily forested. Some pastures have been used by people from Beznea, who recently graze two sheep flocks in Ponoară. Some people send their sheep to the mountain pasture called Sălniș. In the past, sheep returning from high altitude pastures in autumn stayed outside the farms during the winter. The very old wooden winter stables for sheep, and the shelters for families living with them outside the farms, are still maintained in Ponoară. However, this way of sheep wintering is not used any more.

Most people still keep animals and very few land parcels are abandoned, most of them being at high altitudes. There is no organized milk collection system, the local association of animal breeders is a rather formal institution, but not providing protection of domestic products. Animal products, calf and lamb meat as well as dairy products, are sold in animal market of the two nearby towns, Huedin and Bratca. The landowners association of the village owns 285 ha of land and provides them for usage to the farmers.

The sheep gather through May. They are kept in corrals on a field, to fertilize it (M.B.).

Cow grazing starts in May and ends with the first snow (usually in October or November) (Florica).

People in the village have sheep and goats that they usually keep in a sheepfold - *stâna* - in the close mountains. There used to be about 7 sheepfolds in Ponoară with about 2000 sheep. Now there are only 2 sheepfolds left with about 500 sheep and goats (V.B.).

There are very few sheep keepers in the area, and they don't have many animals. In the past, almost every family in the village had sheep (Shepherd).

There is a communal pasture for cows cleaned by the landowners association (V.B.).

If you register your animals for grazing on the land of the association you are allowed to graze them on their land for free, they receive the subsidies for the grazed land and in return for this favour you receive 2 m3 of firewood.

Wool is used only for crocheting (V.S.).

The village will look worse in the next 20 years since young people are not interested in keeping animals and farming, not even with subsidies. Also there is no market to sell the animals for a fair price like it was before and very often, *samsars* (sellers, which buy animals for cheap and sell them in the western Europe as the first quality meat) collect the animals promising payment upon selling them but they never bring the money. I am is still expecting to receive 17 000 lei (approx. 3600 euros) for some animals I sold 2 years ago (Shepherd).

Even without subsidies, as long as the animals are there, people will work their land (V.S.).

Almost each family in Ponoară owns a tractor, a mowing machine and a heavy car, which is a necessary transport mean to reach sparse settlements in the rugged terrain. Many farmers have balloting machines. Most farmers used subsidies to buy the mechanisation. In the Bratca commune they have about 1200 subsidy applications.

We receive subventions from APIA for the animals and for the land. We have more land than what is registered (about 20 ha), but we cannot afford yet to register it since we have to pay taxes for the past 5 years when we would (V.B.).

We invested a lot in mechanisation, we have a tractor, tractor mowing machine, other mowing machines, ballot making machine, etc., so we will not make haystacks anymore. The last haystack we have is from 2-3 years ago (V.B.).

The fields in Ponoară are used mainly to cultivate corn and potatoes, but some people cultivate also wheat, rye, oats, beans, cabbage, and vegetables. Legumes are frequently cultivated as fodder, mainly clover and *Lotus corniculatus*, less frequently also alfalfa (because, according to the farmers, it does not like rocky soil). We recorded also a cultivation of *Anthyllis vulneraria* (Fig. 10). Fields (especially those with potatoes) are manured by animal dung or chemical fertilizers are used. The meadows are manured if sufficient dung is left after manuring the fields. The piled manure is left until autumn to ripen before it is distributed. Sometimes the manure is distributed and left to ripen directly on a meadow (Fig. 11). In spring, manure is spread and hay meadows are cleaned from shrubs, trees and rocks. Hay meadows located close to the settlements are cut twice a year, those more remote only once a year.

I have bought this land some years ago. In the past this parcel was also ploughed using horses, which means that it was a good land to buy (V.B.).

Hay making takes the whole summer, from June until September (V.S.).

We were manually mowing before and we used to mow all the land (Florica).

I sow oats with alfalfa to produce a fine hay (Florica).

Good hay is the one with alfalfa and clover (V.S.).

Hay goes bad after 2-3 years, the *otava* (aftermath) can last longer, for 6-7 years (V.B.).

Abandoned or degraded pastures are restored using the local procedures, which include leveling of anthills, cleaning from unwanted vegetation, and, finally, manure is spread. Ploughing is considered as the best way to get rid of matgrass (*Nardus stricta*). Bracken (*Pteridium aquilinum*) is supressed by cutting it repeatedly for 2-3 years.

One can get rid of the matgrass only with ploughing or manuring, and ploughing is sometimes impossible because of rocks (V.B.).

One cannot do anything against the mosses (V.S.).

The *ștevie* (local name for the tall dock - *Rumex* species without the sour taste) is weeded as cows do not like it (V.S.).

Supplement E5. Species data from the nested-plot series in Dobreşti.

Anhang E5. Artdaten der ineinander geschachtelten Aufnahmeflächen in Dobreşti.

Group	Layer	Original ID of plot	Dobresti_2_SE_0.0001	Dobresti_2_SE_0.001	Dobresti_2_SE_0.01	Dobresti_2_SE_0.1	Dobresti_2_SE_1	Dobresti_2_NW_0.0001	Dobresti_2_NW_0.001	Dobresti_2_NW_0.01	Dobresti_2_NW_0.1	Dobresti_2_NW_1	Dobresti_2_10	Dobresti_2_100	Dobresti_3_SE_0.0001	Dobresti_3_SE_0.001	Dobresti_3_SE_0.01	Dobresti_3_SE_0.1	Dobresti_3_SE_1	Dobresti_3_NW_0.0001	Dobresti_3_NW_0.001	Dobresti_3_NW_0.01	Dobresti_3_NW_0.1	Dobresti_3_NW_1	Dobresti_3_10	Dobresti_3_100	Dobresti_5_SE_0.0001	Dobresti_5_SE_0.001	Dobresti_5_SE_0.01	Dobresti_5_SE_0.1	Dobresti_5_SE_1	Dobresti_5_NW_0.0001	Dobresti_5_NW_0.001	Dobresti_5_NW_0.01	Dobresti_5_NW_0.1	Dobresti_5_NW_1	Dobresti_5_10	Dobresti_5_100	Dobresti_8_SE_0.0001	Dobresti_8_SE_0.001	Dobresti_8_SE_0.01	Dobresti_8_SE_0.1	Dobresti_8_SE_1	Dobresti_8_NW_0.0001	Dobresti_8_NW_0.001	Dobresti_8_NW_0.01	Dobresti_8_NW_0.1	Dobresti_8_NW_1	Dobresti_8_10	Dobresti_8_100	Dobresti_9_SE_0.0001	Dobresti_9_SE_0.001	Dobresti_9_SE_0.01	Dobresti_9_SE_0.1	Dobresti_9_SE_1	Dobresti_9_NW_0.0001	Dobresti_9_NW_0.001	Dobresti_9_NW_0.01	Dobresti_9_NW_0.1	Dobresti_9_NW_1	Dobresti_9_10	Dobresti_9_100	Dobresti_11_SE_0.0001	Dobresti_11_SE_0.001	Dobresti_11_SE_0.01	Dobresti_11_SE_0.1	Dobresti_11_SE_1	Dobresti_11_NW_0.0001	Dobresti_11_NW_0.001	Dobresti_11_NW_0.01	Dobresti_11_NW_0.1	Dobresti_11_NW_1	Dobresti_11_10	Dobresti_11_100
		E1 cover (%)											**95**												**90**												**98**												**95**												**98**												**99**	
		E0 cover (%)											**25**												**12**												**5**												**17**												**40**												**15**	
		Performance measure	P/A	P/A	P/A	P/A	P/A	P/A	P/A	P/A	P/A	P/A	%	P/A	P/A	P/A	P/A	P/A	P/A	P/A	P/A	P/A	P/A	P/A	%	P/A	P/A	P/A	P/A	P/A	P/A	P/A	P/A	P/A	P/A	P/A	%	P/A	P/A	P/A	P/A	P/A	P/A	P/A	P/A	P/A	P/A	P/A	%	P/A	P/A	P/A	P/A	P/A	P/A	P/A	P/A	P/A	P/A	P/A	%	P/A	P/A	P/A	P/A	P/A	P/A	P/A	P/A	P/A	P/A	P/A	%	P/A
Group	**Layer**	Area [m²]	**1E-04**	**0.001**	**0.01**	**0.1**	**1**	**1E-04**	**0.001**	**0.01**	**0.1**	**1**	**10**	**100**	**1E-04**	**0.001**	**0.01**	**0.1**	**1**	**1E-04**	**0.001**	**0.01**	**0.1**	**1**	**10**	**100**	**1E-04**	**0.001**	**0.01**	**0.1**	**1**	**1E-04**	**0.001**	**0.01**	**0.1**	**1**	**10**	**100**	**1E-04**	**0.001**	**0.01**	**0.1**	**1**	**1E-04**	**0.001**	**0.01**	**0.1**	**1**	**10**	**100**	**1E-04**	**0.001**	**0.01**	**0.1**	**1**	**1E-04**	**0.001**	**0.01**	**0.1**	**1**	**10**	**100**	**1E-04**	**0.001**	**0.01**	**0.1**	**1**	**1E-04**	**0.001**	**0.01**	**0.1**	**1**	**10**	**100**
		number of vascular plants	4	7	10	23	34	4	6	13	25	38	56	74	2	3	7	16	31	4	8	12	24	32	45	60	2	4	7	9	13	3	7	8	12	22	27	38	3	6	10	23	37	3	6	11	20	36	64	86	5	10	16	30	44	2	7	16	23	46	65	84	0	2	10	17	26	3	6	13	19	25	43	59
		number of bryophytes	1	1	1	4	11	5	5	6	6	6	14	15	2	2	2	3	5	2	2	2	6	8	10	14	0	1	1	2	2	1	1	1	1	2	2	2	1	2	2	3	6	3	3	3	3	3	8	8	0	0	3	4	7	2	6	7	7	8	11	16	1	1	1	1	1	0	1	1	1	1	4	4
		number of lichens	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		number of all species	**5**	**8**	**11**	**27**	**45**	**9**	**11**	**19**	**31**	**44**	**70**	**89**	**4**	**5**	**9**	**19**	**36**	**6**	**10**	**14**	**30**	**40**	**55**	**74**	**2**	**5**	**8**	**11**	**15**	**4**	**8**	**9**	**13**	**24**	**29**	**40**	**4**	**8**	**12**	**26**	**43**	**6**	**9**	**14**	**23**	**39**	**72**	**94**	**5**	**10**	**19**	**34**	**51**	**4**	**13**	**23**	**30**	**54**	**76**	**100**	**1**	**3**	**11**	**18**	**27**	**3**	**7**	**14**	**20**	**26**	**47**	**63**
VP	H	*Acer* sp.																																																												1												
VP	H	*Achillea collina*															1	1	1		1	1	1	1	3	1															1	1	1			1	1	1	3	1		1	1	1	1					1	1	1												
VP	H	*Achillea millefolium* agg.												1																							1	0.01	1																													1	1	1	1	1	1	1	1	17	1
VP	H	*Agrimonia eupatoria*												1					1						0.05	1																					1	1	1	1			1	1	1		1	1	1	1	2	1				1	1			1	1	1	0.5	1
VP	H	*Agrostis capillaris*					1						1	1				1	1			1	1	1	27	1													1	1	1	1	1				1	1	23	1		1	1	1	1			1	1	1	4	1												
VP	H	*Agrostis stolonifera*																									1	1	1	1	1			1	1	1	65	1																											1	1	1		1	1	1	1	10	1
VP	H	*Ajuga genevensis*											0.01	1												1																							1																								
VP	H	*Allium vineale*										1	0.1	1																																					1																								
VP	H	*Althaea officinalis*																																																																												1
VP	H	*Ambrosia artemisiifolia*																																																																											0.2	1
VP	H	*Anagallis arvensis*					1						0.001	1					1						0.001	1																																																
VP	H	*Anthoxanthum odoratum*		1	1	1	1				1	1	3	1																													1	1				1	1	4	1					1					1	1	1												
VP	H	*Anthyllis vulneraria*																																																																												1
VP	H	*Aphanes arvensis*															1	1	1	1	1	1	1	1	2	1																																									1				1	1	0.01	1
VP	H	*Arrhenatherum elatius*																																																					1						1	1												
VP	H	*Bellis perennis*																					1	1	0.3	1											1	0.01	1																													1	1			1	1	1	5	1
VP	H	*Brachypodium pinnatum*					1			1	1	1	0.5	1																																1	1	1	0.2	1																								
VP	H	*Brachypodium sylvaticum*																																													1	2	1		1	1	1	1					1	2	1												
VP	H	*Briza media*				1	1					1	5	1																																			0.01	1					1				1	1	2	1												
VP	H	*Bromus hordeaceus*												1																																			0.1	1																	1						0.1	1
VP	H	*Bupleurum falcatum*																	1						0.001	1																																																
VP	H	*Calamagrostis epigejos*																																							1	1						0.01	1								1	1	1	1												
VP	H	*Campanula cervicaria*																																															1												1												
VP	H	*Campanula patula*										1	0.1	1																																					1											1	0.001	1												
VP	H	*Carduus acanthoides*																																																																											0.02	1
VP	H	*Carduus* sp.																																																																									1	1	0.001	1
VP	H	*Carex caryophyllea*										1	1	1											0.1	1																	1		1	1	1	1	2	1					1			1	1	1	1	1												
VP	H	*Carex depressa* subsp. *transylvanica*													1	1	1	1	1					1	5	1																																																
VP	H	*Carex hirta*																											1	1	1	1	1	1	1	1	1	10	1										1	0.02	1																									1
VP	H	*Carex muricata* agg.																																																																1	1	1					0.5	1
VP	H	*Carex pallescens*												1																													1			1	1	1	1	1		1	1	1	1	1					1	1	1												
VP	H	*Carlina vulgaris*																																														1	0.1	1																								
VP	H	*Carpinus betulus*																																			0.001	1																																				
VP	H	*Centaurea phrygia* agg.				1	1	1					0.1	1																																							1	1	1	1			1	1	1	12	1												
VP	H	*Centaurea scabiosa*									1	1	6	1																																																												
VP	H	*Centaurea* sp.																																							1	1	1		1	1	1	1	11	1																								
VP	H	*Centaurea stoebe*																																																													1												
VP	H	*Centaurium erythraea*																	1						0.001	1																																																
VP	H	*Cerastium fontanum* subsp. *vulgare*				1	1						0.1	1									1	1	0.01	1																							0.03	1					1					1	0.2	1					1				1	1	2	1
VP	H	*Cerastium pumilum* subsp. *pumilum*											0.001	1				1	1	1	1	1	1	1	0.2	1																																							1	1			1	1	1	5	1
VP	H	*Cirsium arvense*												1																																																												
VP	H	*Cirsium eriophorum*																																																																												1
VP	H	*Clinopodium vulgare*												1																											1	1	1	1				1	1	0.1	1				1	1	1				1	1	0.7	1												
VP	H	*Convolvulus arvensis*				1	1	1				1	1	2	1																													1						0.01	1		1	1	1	1	1						0.1	1												
VP	H	*Cornus sanguinea*																																																													1												
VP	H	*Crataegus monogyna*																																																												0.3	1												
VP	H	*Crepis biennis*					1						0.01	1																																																	1													1
VP	H	*Crepis capillaris*																	1					1	0.3	1																																																
VP	H	*Crepis setosa*												1					1						0.1	1																																																
VP	H	*Cruciata glabra*																																															1																								
VP	H	*Cruciata laevipes*												1																													1				1	1	0.2	1																								
VP	H	*Cuscuta* sp.																																																																												1
VP	H	*Cynodon dactylon*																1	1				1	1	1.5	1			1	1	1		1	1	1	1	4	1																													1					1	3	1
VP	H	*Cynosurus cristatus*				1	1	1			1	1	1	5	1				1	1				1	1	2	1																							0.1	1																					1	1	2	1
VP	H	*Dactylis glomerata*										1	0.1	1																													1					1	0.7	1					1	1					1	0.5	1												
VP	H	*Danthonia alpina*											0.1	1																																																												
VP	H	*Danthonia decumbens*				1	1						1.5	1					1						0.2	1																	1						3	1										1	0.5	1												
VP	H	*Daucus carota*	1	1	1	1	1	1	1	1	1	1	20	1											0.2	1																							0.1	1	1	1	1	1	1				1	1	2.5	1											0.01	1
VP	H	*Dianthus armeria*																																															0.001	1											1												
VP	H	*Dorycnium pentaphyllum*																																													1	0.3	1										1	0.1	1												
VP	H	*Echium vulgare*																								1																																																
VP	H	*Eleocharis palustris*																																			0.2	1																																				
VP	H	*Elymus caninus*										1	0.1	1																																																												
VP	H	*Elytrigia repens*												1										1	1	1																							1																								
VP	H	*Epilobium parviflorum*																																					1																																				
VP	H	*Equisetum arvense*																																																					1						0.2	1												
VP	H	*Equisetum palustre*																									1	1	1	1	1					1	5	1																																				
VP	H	*Erigeron annuus*					1					1	1	1					1			1	1	1	3	1																							1				1	1			1	1	1	3	1													1
VP	H	*Eryngium campestre*																																																																		1						0.01	1
VP	H	*Euphorbia cyparissias*																								1																						1	0.001	1											1											1	1
VP	H	*Euphorbia maculata*																	1				1	1	0.05	1																																																
VP	H	*Euphorbia platyphyllos* subsp. *platyphyllos*																																																																											0.2	1
VP	H	*Festuca rubra* agg.						1	1	1	1	1	1	1						1	1	1	1	1	1	1													1	1	1	1	1	1	1	1	1	2	1		1	1	1	1			1	1	1	3	1		1	1	1	1					1	3	1
VP	H	*Filago germanica*																	1				1	1	0.3	1																																																
VP	H	*Filipendula vulgaris*												1																																															1												
VP	H	*Fragaria vesca*												1																											1	1					1	0.5	1				1	1	1					1	0.5	1												
VP	H	*Galium aparine*																																									1						0.001	1																								
VP	H	*Galium divaricatum*																	1						0.01	1																																																
VP	H	*Galium mollugo* agg.							1	1	1	1	1.5	1																																			1	1	1					1						0.5	1												
VP	H	*Galium palustre*																																					1																																				
VP	H	*Geranium columbinum*																								1																1	1						0.01	1																								
VP	H	*Geranium dissectum*																																																																												1
VP	H	*Geranium* cf. *pusillum*																																																																	1	1				1	1	2	1
VP	H	*Glechoma hederacea*																																																			1	1	1				1	1	2	1												
VP	H	*Glyceria notata*																													1						0.01	1																																				
VP	H	*Gypsophila muralis*																								1																																																
VP	H	*Holcus lanatus*					1				1	1	0.8	1																									1					1					1	2	1					1				1	1	1	1												
VP	H	*Hypericum perforatum*																																															1											0.3	1												
VP	H	*Hypochaeris radicata*	1	1	1	1	1				1	1	4	1					1			1	1	1	5	1																																																
VP	H	*Juglans regia*																																															1												1												
VP	H	*Juncus articulatus*																													1		1	1	1	1	6	1																																				
VP	H	*Juncus compressus*																																			2	1																																					1
VP	H	*Juncus effusus*																																					1																																				
VP	H	*Juncus inflexus*																																			1	1																																					1
VP	H	*Juncus tenuis*																								1									1	1	2	1																																				
VP	H	*Knautia arvensis*																																																				1	1					1	3	1												
VP	H	*Lathyrus latifolius*																																																					1			1	1	1	3	1												
VP	H	*Lathyrus tuberosus*												1																																																												
VP	H	*Leontodon hispidus* subsp. *hastilis*																1	1				1	1	2	1																													1	1	1	1	1	1	1												
VP	H	*Leontodon hispidus* subsp. *hispidus*																						1	0.2	1																																	1	0.2	1												
VP	H	*Leopoldia comosa*										1	0.2	1																																					1											1												
VP	H	*Lepidium campestre*											0.3	1																																																												
VP	H	*Leucanthemum vulgare* agg.					1				1	1	1	1																											1	1					1	0.3	1					1					1	2	1												
VP	H	*Linum catharticum*																																																									1	1	1	0.1	1												
VP	H	*Lolium perenne*																					1	1	2	1					1					1	1	1																													1	1			1	1	1	5	1
VP	H	*Lotus corniculatus*	1	1	1	1	1			1	1	1	6	1												1																					1	1	1	0.4	1					1	1					1	0.5	1									1	1	2	1
VP	H	*Luzula campestris*				1	1				1	1	0.1	1			1	1	1					1	0.5	1															1	1		1	1	1	1	0.2	1			1	1	1		1	1	1	1	2	1					1					1	0.1	1
VP	H	*Lysimachia nummularia*																											1	1	1				1	1	1	1					1	1						0.2	1											0.5	1											0.1	1
VP	H	*Lysimachia vulgaris*																																															1										1	7	1												
VP	H	*Medicago falcata*																																																																									1	0.01	1
VP	H	*Medicago lupulina*																																																																	1	1			1	1	1	2	1
VP	H	*Mentha arvensis*																								1																																												1						0.1	1
VP	H	*Mentha longifolia*																																																																												1
VP	H	*Mentha* sp.																																					1																																				
VP	H	*Myosotis arvensis*												1																																																												
VP	H	*Ononis spinosa* subsp. *hircina*																																															1																								
VP	H	*Ononis spinosa* subsp. *spinosa*																																					1																																				
VP	H	*Orchis ustulata*																																																												0.01	1												
VP	H	*Origanum vulgare*																																															1																								
VP	H	*Oxalis stricta*				1	1						0.1	1				1	1		1	1	1	1	0.2	1																	1						0.001	1											1												
VP	H	*Picris hieracioides*																																																					1	1						2	1												
VP	H	*Pilosella bauhini*											0.5	1																																															1												
VP	H	*Pilosella officinarum*											0.5	1																											1	1	1					0.1	1																								
VP	H	*Pilosella officinarum* × *lactucella*																																															0.2	1																								
VP	H	*Pimpinella saxifraga*																	1						0.01	1															1	1	1	1	1	1	1	4	1					1						0.3	1												
VP	H	*Plantago lanceolata*	1	1	1	1	1			1	1	1	5	1				1	1		1	1	1	1	3	1										1	0.2	1											0.01	1										1	0.5	1			1	1	1		1	1	1	1	15	1
VP	H	*Plantago major*																																	1	0.1	1																																			0.01	1
VP	H	*Plantago media*												1																																																1	0.2	1												
VP	H	*Poa bulbosa*																					1	1	1	0.05	1																																																
VP	H	*Poa compressa*					1				1	1	0.5	1																													1				1	1	1	1				1	1					1	0.01	1												
VP	H	*Poa pratensis* agg.					1					1	1	1			1	1	1	1				1	1	5	1												1		1	1	1	1						0.1	1								1	1	1	1	0.5	1		1	1	1	1	1	1	1	1	1	20	1
VP	H	*Poa trivialis*																													1	1	1	1	1	1	2	1																																					1
VP	H	*Poaceae* sp.																																	1	0.01	1																																				
VP	H	*Polygala comosa*																																															0.4	1					1						0.2	1												
VP	H	*Polygala vulgaris* subsp. *vulgaris*				1	1					1	0.2	1																																			0.2	1																								
VP	H	*Potentilla argentea*				1	1	1	1	1	1	1	2	1											0.2	1																							1																									1
VP	H	*Potentilla reptans*												1									1	1	0.1	1				1	1		1	1	1	1	4	1											0.1	1			1	1	1					0.3	1			1	1	1					0.01	1
VP	H	*Prunella laciniata*																							0.001	1																																									1						0.001	1
VP	H	*Prunella vulgaris*				1	1			1	1	1	0.5	1																							1	0.2	1																						1	0.5	1												
VP	H	*Prunus avium*																																																													1												
VP	H	*Prunus domestica*											0.3	1																																														0.3	1												
VP	H	*Prunus* sp.																								1																							1																								
VP	H	*Pyrus communis*																																																													1												
VP	H	*Quercus rubra*																																																													1												
VP	H	*Quercus* sp.																																															1																								
VP	H	*Ranunculus bulbosus*																	1					1	0.3	1																																																
VP	H	*Ranunculus polyanthemos*				1	1			1	1	1	0.5	1																											1	1				1	1	1	1				1	1					1	2	1					1						0.01	1
VP	H	*Ranunculus repens*																											1	1	1	1		1	1	1	1	6	1																																			0.01	1
VP	H	*Ranunculus sardous*																																					1																																				
VP	H	*Rhinanthus alectorolophus*					1				1	1	3	1																											1	1				1	1	2	1																								
VP	H	*Rosa canina* agg.												1																																			1	3	1											0.5	1												
VP	H	*Rosa rubiginosa*																								1																							1																								
VP	H	*Rubus caesius*																								1																							1																								
VP	H	*Rumex acetosa*		1	1	1	1	1	1	1	1	1	1	1																									1				1	1	1					0.2	1					1	1		1	1	1	1	0.5	1												
VP	H	*Rumex acetosella*																																															1																								
VP	H	*Rumex crispus*																								1																																																
VP	H	*Sagina subulata*																								1																																																
VP	H	*Sanguisorba minor*				1	1				1	1	1	1																														1					1	0.01	1					1	1					1	0.3	1												
VP	H	*Scabiosa ochroleuca*																																															0.3	1																								
VP	H	*Schedonorus pratensis*				1	1				1	1	2	1																									1					1						2	1					1			1	1	1	2	1												
VP	H	*Scleranthus annuus*																1	1					1	0.02	1																																																
VP	H	*Scorzoneroides autumnalis*																	1						0.2	1																																																
VP	H	*Stachys officinalis*																																																																									1	0.01	1
VP	H	*Stellaria graminea*									1	1	0.1	1												1																						1	0.001	1																								
VP	H	*Taraxacum* sect. *Erythrosperma*																1	1					1	0.5	1																																									1	1			1	1	1	1	1
VP	H	*Taraxacum* sect. *Taraxacum*				1	1			1	1	1	0.5	1																	1	1				1	1	1	1																																				
VP	H	*Thymus dacicus*												1							1	1	1	1	0.5	1																																																
VP	H	*Thymus pulegioides* subsp. *pulegioides*																																					1	1	1	1	1	1	1	1	1	1	10	1				1	1		1	1	1	1	5	1												1
VP	H	*Tragopogon pratensis* subsp. *orientalis*																																																												0.001	1												
VP	H	*Trifolium campestre*																																							1	1			1	1	1	1	1					1			1	1	1	4	1											0.1	1
VP	H	*Trifolium dubium*				1	1						1.5	1																					1	0.01	1											1	0.001	1															1	1	1					0.1	1
VP	H	*Trifolium hybridum*																																															1																								
VP	H	*Trifolium medium*																																															1	1													1												
VP	H	*Trifolium montanum*																																																													1												
VP	H	*Trifolium ochroleucon*																																																													1												
VP	H	*Trifolium pratense*										1	0.5	1																									1																																	1	1	1	2	1
VP	H	*Trifolium repens*		1	1	1	1		1	1	1	1	5	1	1	1	1	1	1	1	1	1	1	1	25	1			1	1	1	1	1	1	1	1	15	1	1	1	1	1	1						1	1					1						0.5	1			1	1	1	1	1	1	1	1	5	1
VP	H	*Trisetum flavescens*																																																												0.02	1												
VP	H	*Valerianella rimosa*										1	0.01	1																																																												
VP	H	*Verbena officinalis*																								1										1	0.01	1																																			0.4	1
VP	H	*Veronica anagalis-aquatica*																																	1	1	0.01	1																																				
VP	H	*Veronica arvensis*											0.001	1			1	1	1				1	1	0.2	1																																							1	1	1		1	1	1	1	0.5	1
VP	H	*Veronica chamaedrys*																																									1					1	0.5	1											0.01	1												
VP	H	*Veronica officinalis*											0.01	1																											1	1				1	1	3	1											1												
VP	H	*Vicia cassubica*																																																					1	1						1	1												
VP	H	*Vicia hirsuta*																																															0.1	1	1	1	1	1	1				1	1	0.5	1												
VP	H	*Vicia lathyroides*																																																																												1
VP	H	*Vicia sativa* subsp. *nigra*																																									1						0.2	1				1	1	1	1	1	1	1	1	1												
VP	H	*Vicia tetrasperma*																																																																									1	0.001	1
VP	H	*Vicia villosa* subsp. *varia*												1																											1	1					1	2	1																								
VP	H	*Viola alba*																																															1																								
VP	H	*Viola arvensis* agg.																																															1																								
VP	H	*Viola canina*																																															0.2	1	1	1	1	1	1					1	1	1												
VP	H	*Viola hirta*																																																					1	1					1	0.2	1												
VP	H	*Viola tricolor*											0.01	1																																																												
VP	H	*Vulpia myuros*					1					1	0.4	1									1	1	1	1																																																
VP	H	*Xanthium orientale* subsp. *italicum*																																																																												1
B	C	*Atrichum undulatum*											0.1	1																																																												
B	C	*Barbula unguiculata*																					1	1	0.1	1																																																
B	C	*Brachythecium campestre*																	1				1	1	1	1																													1	1	1	1	0.1	1												
B	C	*Brachythecium glareosum*								1	1	1	1	1																																			2	1																								
B	C	*Brachythecium rivulare*					1	1	1	1	1	1	5	1				1	1	1	1	1	1	1	2	1				1	1	1	1	1	1	1	3	1																		1	1	1	1	1	0.7	1	1	1	1	1	1		1	1	1	1	15	1
B	C	*Brachythecium rutabulum*					1						0.1	1																																																												
B	C	*Brachythecium salebrosum*											3	1																																																												
B	C	*Brachytheciastrum velnutinum*																																																													1												
B	C	*Bryum rubens*																																																													1												
B	C	*Calliergonella cuspidata*				1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	6	1		1	1	1	1					1	2	1	1	1	1	1	1						1	1										1	0.5	1											0.1	1
B	C	*Calliergonella lindbergii*				1	1	1	1	1	1	1	3	1	1	1	1	1	1						2	1																																																
B	C	*Campyliadelphus chrysophyllus*	1	1	1	1	1						0.01	1									1	1	0.5	1																											1	1	1		1	1	1	1	3	1											0.1	1
B	C	*Ceratodon purpureus*																								1																																																
B	C	*Cirriphyllum piliferum*																								1																	1						0.01	1			1	1	1						3	1												
B	C	*Climacium dendroides*																								1																																																
B	C	*Drepanocladus aduncus*																								1																																																
B	C	*Fissidens taxifolius*																																																												0.1	1												
B	C	*Oxyrrhynchium hians*				1	1	1	1	1	1	1	1	1									1	1	0.5	1																			1	1	1	1	1	1	1						1		1	1	1	1	2	1												
B	C	*Plagiomnium affine*					1	1	1	1	1	1	0.1	1																																							1	1			1	1	1	1	1												
B	C	*Plagiomnium undulatum*																																																													1												
B	C	*Pseudoscleropodium purum*					1						0.1	1																									1	1	1	1	1	1	1	1	1	11	1			1	1	1	1	1	1	1	1	25	1												
B	C	*Rhytidiadelphus squarrosus*																						1	0.1	1																													1						1	1												
B	C	*Thuidium assimile*					1						0.5	1																											1	1	1	1	1	1	1	4	1					1		1	1	1	1	5	1												
B	C	*Tortula* sp.					1						0.01	1										1	0.1	1																																													0.001	1
B	C	*Trichodon cylindricus*												1																													1						0.01	1											1												
B	C	*Weissia* sp.					1						0.1	1					1						0.001	1																	1						0.1	1											1												

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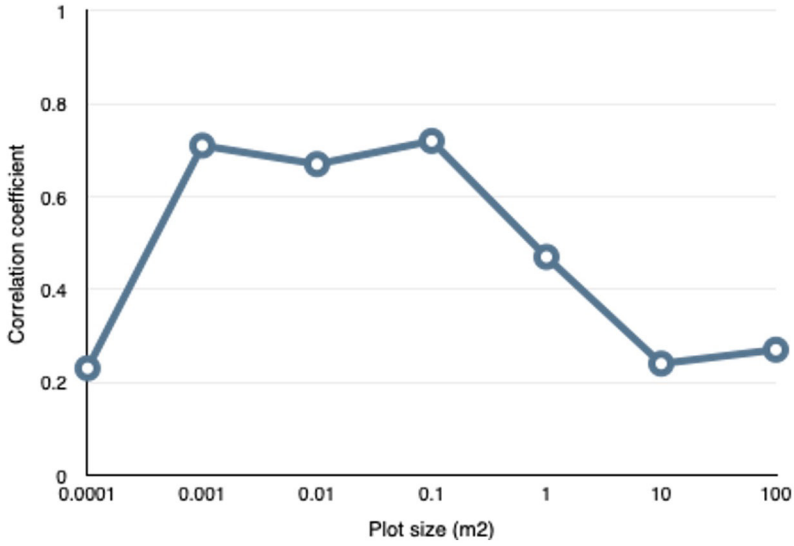
Supplement E6. Species data from the nested-plot series in Ponoară.

Anhang E6. Artdaten der ineinander geschachtelten Aufnahmeflächen in Ponoară.

Group	Layer	Original ID of plot	Ponoara_1_SE_0.0001	Ponoara_1_SE_0.001	Ponoara_1_SE_0.01	Ponoara_1_SE_0.1	Ponoara_1_SE_1	Ponoara_1_NW_0.0001	Ponoara_1_NW_0.001	Ponoara_1_NW_0.01	Ponoara_1_NW_0.1	Ponoara_1_NW_1	Ponoara_1_10	Ponoara_1_100	Ponoara_3_SE_0.0001	Ponoara_3_SE_0.001	Ponoara_3_SE_0.01	Ponoara_3_SE_0.1	Ponoara_3_SE_1	Ponoara_3_NW_0.0001	Ponoara_3_NW_0.001	Ponoara_3_NW_0.01	Ponoara_3_NW_0.1	Ponoara_3_NW_1	Ponoara_3_10	Ponoara_3_100	Ponoara_5_SE_0.0001	Ponoara_5_SE_0.001	Ponoara_5_SE_0.01	Ponoara_5_SE_0.1	Ponoara_5_SE_1	Ponoara_5_NW_0.0001	Ponoara_5_NW_0.001	Ponoara_5_NW_0.01	Ponoara_5_NW_0.1	Ponoara_5_NW_1	Ponoara_5_10	Ponoara_5_100	Ponoara_7_SE_0.0001	Ponoara_7_SE_0.001	Ponoara_7_SE_0.01	Ponoara_7_SE_0.1	Ponoara_7_SE_1	Ponoara_7_NW_0.0001	Ponoara_7_NW_0.001	Ponoara_7_NW_0.01	Ponoara_7_NW_0.1	Ponoara_7_NW_1	Ponoara_7_10	Ponoara_7_100	Ponoara_10_SE_0.0001	Ponoara_10_SE_0.001	Ponoara_10_SE_0.01	Ponoara_10_SE_0.1	Ponoara_10_SE_1	Ponoara_10_NW_0.0001	Ponoara_10_NW_0.001	Ponoara_10_NW_0.01	Ponoara_10_NW_0.1	Ponoara_10_NW_1	Ponoara_10_10	Ponoara_10_100	Ponoara_12_SE_0.0001	Ponoara_12_SE_0.001	Ponoara_12_SE_0.01	Ponoara_12_SE_0.1	Ponoara_12_SE_1	Ponoara_12_NW_0.0001	Ponoara_12_NW_0.001	Ponoara_12_NW_0.01	Ponoara_12_NW_0.1	Ponoara_12_NW_1	Ponoara_12_10	Ponoara_12_100
		E1 cover (%)											**95**												**75**												**92**												**98**												**95**												**97**	
		E0 cover (%)											**15**												**50**												**50**												**25**												**60**												**50**	
		Performance measure	P/A	P/A	P/A	P/A	P/A	P/A	P/A	P/A	P/A	P/A	%	P/A	P/A	P/A	P/A	P/A	P/A	P/A	P/A	P/A	P/A	P/A	%	P/A	P/A	P/A	P/A	P/A	P/A	P/A	P/A	P/A	P/A	P/A	%	P/A	P/A	P/A	P/A	P/A	P/A	P/A	P/A	P/A	P/A	P/A	%	P/A	P/A	P/A	P/A	P/A	P/A	P/A	P/A	P/A	P/A	P/A	%	P/A	P/A	P/A	P/A	P/A	P/A	P/A	P/A	P/A	P/A	P/A	%	P/A
		Area [m²]	**1E-04**	**0.001**	**0.01**	**0.1**	**1**	**1E-04**	**0.001**	**0.01**	**0.1**	**1**	**10**	**100**	**1E-04**	**0.001**	**0.01**	**0.1**	**1**	**1E-04**	**0.001**	**0.01**	**0.1**	**1**	**10**	**100**	**1E-04**	**0.001**	**0.01**	**0.1**	**1**	**1E-04**	**0.001**	**0.01**	**0.1**	**1**	**10**	**100**	**1E-04**	**0.001**	**0.01**	**0.1**	**1**	**1E-04**	**0.001**	**0.01**	**0.1**	**1**	**10**	**100**	**1E-04**	**0.001**	**0.01**	**0.1**	**1**	**1E-04**	**0.001**	**0.01**	**0.1**	**1**	**10**	**100**	**1E-04**	**0.001**	**0.01**	**0.1**	**1**	**1E-04**	**0.001**	**0.01**	**0.1**	**1**	**10**	**100**
		number of vascular plants	2	7	14	23	42	4	8	13	32	44	60	82	3	5	10	17	27	2	3	5	14	26	40	49	3	8	17	24	36	2	8	14	22	31	49	55	3	5	11	28	44	2	5	14	25	35	64	74	6	8	11	27	45	4	9	13	29	42	60	73	4	8	16	29	51	2	7	14	35	58	83	101
		number of bryophytes	1	2	2	3	4	2	3	5	5	6	8	8	1	3	3	4	6	0	2	2	2	8	10	14	1	3	3	4	4	1	2	2	2	4	4	6	0	0	2	2	4	3	3	3	3	4	6	6	1	4	4	8	11	0	2	2	3	5	12	14	3	3	3	5	5	3	3	4	5	5	5	8
		number of lichens	0	0	0	0	0	1	1	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		number of all species	**3**	**9**	**16**	**26**	**46**	**7**	**12**	**19**	**38**	**51**	**69**	**91**	**4**	**8**	**13**	**21**	**33**	**2**	**5**	**7**	**16**	**34**	**50**	**63**	**4**	**11**	**21**	**29**	**41**	**3**	**10**	**16**	**24**	**35**	**54**	**62**	**3**	**5**	**13**	**30**	**48**	**5**	**8**	**17**	**28**	**39**	**70**	**80**	**7**	**12**	**15**	**35**	**56**	**4**	**11**	**15**	**32**	**47**	**72**	**87**	**7**	**11**	**19**	**34**	**56**	**5**	**10**	**18**	**40**	**63**	**88**	**109**
VP	H	*Acer pseudoplatanus*											0.01	1																																																												
VP	H	*Achillea collina*		1	1	1	1						1	1																								1			1	1	1						0.5	1													1	1	1	1	1					1	2.5	1
VP	H	*Achillea millefolium* agg.															1	1	1	1	1	1	1	1	3	1																									1	1	1	1	1		1	1	1	1	3	1												
VP	H	*Agrimonia eupatoria*																					1	1	0.1	1					1						0.1	1																	1						0.2	1												
VP	H	*Agrostis capillaris*			1	1	1				1	1	5	1			1	1	1	1	1	1	1	1	25	1		1	1	1	1				1	1	5	1															1	1	1		1	1	1	1	15	1				1	1						2	1
VP	H	*Ajuga genevensis*					1						0.01	1																			1	1	1	1	0.01	1											0.01	1																	1						0.2	1
VP	H	*Anacamptis coriophora*																																																												1												
VP	H	*Anacamptis morio*																																																																								1
VP	H	*Anacamptis pyramidalis*																																																										1	0.01	1												
VP	H	*Anthoxanthum odoratum*					1						0.5	1					1						0.2	1					1						0.2	1					1						0.2	1	1	1	1	1	1				1	1	2	1					1					1	0.5	1
VP	H	*Anthyllis vulneraria*					1				1	1	2	1																											1	1	1			1	1	1	3	1												1					1						0.1	1
VP	H	*Arabis hirsuta*																																															0.01	1															1	1	1					1	0.1	1
VP	H	*Arenaria serpyllifolia*																																																																							0.001	1
VP	H	*Asperula cynanchica*					1						0.1	1																1	1					1	0.3	1										1	0.2	1																								1
VP	H	*Avenella flexuosa*																								1																																																
VP	H	*Brachypodium pinnatum*												1																																				1												1			1	1	1				1	1	4	1
VP	H	*Brachypodium sylvaticum*																																			0.2	1																																				
VP	H	*Briza media*			1	1	1			1	1	1	1	1																											1	1	1		1	1	1	1	12	1				1	1				1	1	3.5	1				1	1				1	1	0.5	1
VP	H	*Campanula cervicaria*																																													1	1	0.2	1																								
VP	H	*Campanula glomerata*																																																																				1	1	1	0.2	1
VP	H	*Campanula patula*																																																												1												1
VP	H	*Campanula persicifolia*																																																											0.01	1												
VP	H	*Campanula rapunculoides*																																																					1						0.01	1												
VP	H	*Carduus nutans*																																				1																																				
VP	H	*Carex caryophyllea*												1																	1						0.5	1	1	1	1	1	1		1	1	1	1	5	1					1					1	0.2	1			1	1	1	1	1	1	1	1	0.5	1
VP	H	*Carex depressa* subsp. *transylvanica*	1	1	1	1	1	1	1	1	1	1	5	1																	1					1	0.01	1																																			0.1	1
VP	H	*Carex filiformis*																																																																1	1				1	1	1	1
VP	H	*Carex flacca*												1																																																												
VP	H	*Carex montana*											0.5	1																																										1	1	1	1	1	1	1					1						2	1
VP	H	*Carex pallescens*																							0.1	1																	1						0.2	1				1	1						0.2	1		1	1	1	1				1	1	1	1
VP	H	*Carex pilulifera*									1	1	5	1		1	1	1	1				1	1	2	1	1	1	1	1	1	1	1	1	1	1	5	1													1	1	1	1	1						3	1												
VP	H	*Carlina acaulis*																																															0.01	1											0.4	1												
VP	H	*Carlina vulgaris*																													1					1	0.3	1																																				
VP	H	*Carum carvi*					1				1	1	0.1	1																																								1	1				1	1	1	1												
VP	H	*Centaurea erdneri*																																															0.2	1																								
VP	H	*Centaurea phrygia* agg.		1	1	1	1					1	4	1					1						1	1																												1	1	1	1	1	1	1	3	1					1					1	1	1
VP	H	*Centaurea scabiosa*				1	1				1	1	3	1																													1					1	3	1											0.2	1					1					1	3	1
VP	H	*Cerastium fontanum* subsp. *vulgare*				1	1						0.05	1										1	0.01	1						1	1	1	1	1	0.001	1																								1												
VP	H	*Cichorium intybus*																					1	1	0.1	1																																																
VP	H	*Colchicum autumnale*												1											0.1	1																																									1				1	1	2	1
VP	H	*Convolvulus arvensis*																												1	1						0.1	1				1	1					1	0.2	1																	1						0.1	1
VP	H	*Cornus sanguinea*																																																																								1
VP	H	*Crataegus monogyna*												1												1											0.7	1																																			0.2	1
VP	H	*Crepis biennis*																																																1																						1	0.2	1
VP	H	*Crepis capillaris*												1																																																												
VP	H	*Cruciata glabra*																						1	0.5	1												1																	1	1	1	1	1	1	0.5	1				1	1				1	1	0.1	1
VP	H	*Cuscuta* sp.																																														1	0.001	1																								
VP	H	*Cynodon dactylon*																													1					1	5	1																																				
VP	H	*Cynosurus cristatus*										1	0.5	1																																				1			1	1	1					1	0.3	1				1	1						0.2	1
VP	H	*Dactylis glomerata*				1	1		1	1	1	1	1	1																												1	1				1	1	3	1				1	1						0.5	1					1			1	1	1	1	1
VP	H	*Danthonia alpina*									1	1	1	1																1	1		1	1	1	1	7	1				1	1					1	5	1							1	1	1	1	3	1				1	1			1	1	1	4	1
VP	H	*Danthonia decumbens*				1	1					1	0.5	1	1	1	1	1	1			1	1	1	15	1		1	1	1	1				1	1	5	1																				1	1	1	1	1					1				1	1	0.5	1
VP	H	*Daucus carota*																																									1				1	1	1	1																								1
VP	H	*Dianthus carthusianorum*											0.05	1																													1				1	1	0.3	1																							0.1	1
VP	H	*Dorycnium pentaphyllum*																																																1																								
VP	H	*Echium vulgare*												1																																				1																								
VP	H	*Elytrigia repens*																																																																							0.2	1
VP	H	*Erigeron annuus*																																			0.05	1																						1	0.01	1					1						0.1	1
VP	H	*Eryngium campestre*																																				1																																				
VP	H	*Euphorbia cyparissias*																													1				1	1	0.5	1																																				
VP	H	*Euphorbia salicifolia*																																													1	1	1	1																								
VP	H	*Festuca ovina*																																																																	1						1	1
VP	H	*Festuca rubra* agg.									1	1	0.5	1	1	1	1	1	1				1	1	3	1															1	1	1						1	1	1	1	1	1	1	1	1	1	1	1	40	1												1
VP	H	*Festuca stricta* subsp. *sulcata*		1	1	1	1	1	1	1	1	1	15	1															1	1	1			1	1	1	10	1		1	1	1	1	1	1	1	1	1	15	1													1	1	1	1	1		1	1	1	1	19	1
VP	H	*Festuca valesiaca*																											1	1	1					1	2	1																																				
VP	H	*Filipendula vulgaris*			1	1	1					1	1	1																							0.1	1		1	1	1	1						0.2	1		1	1	1	1				1	1	5	1		1	1	1	1		1	1	1	1	12	1
VP	H	*Fragaria vesca*				1	1						0.1	1																																																												1
VP	H	*Fragaria viridis*																										1	1	1	1					1	1.5	1																																				
VP	H	*Galium mollugo* agg.																																															0.5	1																							0.1	1
VP	H	*Galium verum*					1						0.1	1																																			0.1	1					1						0.3	1					1				1	1	0.1	1
VP	H	*Gymnadenia conopsea*																																																					1						0.01	1												
VP	H	*Helianthemum nummularium* subsp. *obscurum*			1	1	1				1	1	2	1					1						0.01	1																																									1				1	1	0.2	1
VP	H	*Holcus lanatus*																1	1					1	0.1	1																																				1												
VP	H	*Hypericum maculatum*																						1	0.1	1																																				1												
VP	H	*Hypericum perforatum*																																																1																								
VP	H	*Hypochaeris maculata*											0.4	1																																														1	0.1	1										1	0.2	1
VP	H	*Hypochaeris radicata*																							2	1			1	1	1						0.5	1																	1					1	1	1										1	0.2	1
VP	H	*Jacobaea vulgaris*												1																																																												
VP	H	*Juncus conglomeratus*																								1																																																
VP	H	*Knautia arvensis*					1				1	1	0.5	1																													1			1	1	1	5	1					1					1	1	1	1	1	1	1	1				1	1	3	1
VP	H	*Lathyrus latifolius*												1																																																1												1
VP	H	*Lathyrus tuberosus*																																																									1	1	0.01	1										1	0.1	1
VP	H	*Lembotropis nigricans*																	1					1	0.2	1																																																
VP	H	*Leontodon hispidus* subsp. *hastilis*					1				1	1	1	1																	1						0.001	1				1	1		1	1	1	1	3	1				1	1					1	1	1					1			1	1	1	3	1
VP	H	*Leontodon hispidus* subsp. *hispidus*					1				1	1	0.5	1																													1						3	1				1	1				1	1	1	1			1	1	1					1	2	1
VP	H	*Leucanthemum vulgare* agg.					1					1	0.1	1											0.01	1																1	1						2	1				1	1				1	1	1	1				1	1					1	0.5	1
VP	H	*Linum catharticum*									1	1	0.01	1															1	1	1				1	1	0.2	1			1	1	1					1	0.01	1												1					1					1	0.3	1
VP	H	*Lolium perenne*																																																																							0.2	1
VP	H	*Lotus corniculatus*				1	1					1	3	1											0.1	1			1	1	1				1	1	2	1			1	1	1				1	1	2	1				1	1				1	1	1	1			1	1	1				1	1	3	1
VP	H	*Luzula campestris*									1	1	0.1	1				1	1					1	0.2	1																	1						0.2	1				1	1				1	1	1	1											0.1	1
VP	H	*Luzula multiflora*																																																										1	1	1												
VP	H	*Lysimachia punctata*																	1					1	0.1	1																																																
VP	H	*Malus domestica*																																																																							0.3	1
VP	H	*Medicago falcata*								1	1	1	0.3	1																						1	0.2	1				1	1			1	1	1	3	1																						1	0.5	1
VP	H	*Medicago lupulina*		1	1	1	1						0.3	1					1						0.01	1		1	1	1	1		1	1	1	1	0.01	1											0.1	1																						1	0.01	1
VP	H	*Melampyrum arvense*												1																																																												
VP	H	*Nardus stricta*																1	1						1	1																																																
VP	H	*Orchis ustulata*												1																																																1												
VP	H	*Orobanche* sp.																																																1																								
VP	H	*Peucedanum oreoselinum*																1	1				1	1	1	1																																			0.2	1												1
VP	H	*Phleum phleoides*												1																																																												
VP	H	*Pilosella bauhini*																1	1					1	0.01	1																1	1				1	1	0.3	1											0.2	1											0.2	1
VP	H	*Pilosella hoppeana*																																																																								1
VP	H	*Pilosella officinarum*		1	1	1	1		1	1	1	1	1	1							1	1	1	1	5	1	1	1	1	1	1		1	1	1	1	30	1					1						0.1	1					1					1	0.1	1												
VP	H	*Pilosella officinarum* × *bauhini*																																																1																								
VP	H	*Pimpinella saxifraga*										1	0.5	1																																								1	1				1	1	1.5	1			1	1	1			1	1	1	3	1
VP	H	*Plantago lanceolata*			1	1	1				1	1	2	1				1	1			1	1	1	3	1	1	1	1	1	1		1	1	1	1	3	1				1	1			1	1	1	1	1	1	1	1	1	1		1	1	1	1	3	1		1	1	1	1		1	1	1	1	1	1
VP	H	*Plantago media*										1	0.1	1																							0.2	1					1					1	0.2	1																						1	0.1	1
VP	H	*Platanthera bifolia*																																																					1						0.1	1												
VP	H	*Poa pratensis* agg.												1														1	1	1	1			1	1	1	0.1	1									1	1	3	1																								1
VP	H	*Polygala comosa*					1				1	1	0.2	1																	1				1	1	0.1	1					1						0.2	1				1	1						0.1	1				1	1				1	1	1	1
VP	H	*Polygala vulgaris* subsp. *vulgaris*																								1																												1	1			1	1	1	1	1												
VP	H	*Potentilla erecta*															1	1	1				1	1	4	1								1	1	1	0.01	1											0.1	1					1					1	0.1	1										1	0.1	1
VP	H	*Potentilla incana*				1	1			1	1	1	1	1															1	1	1			1	1	1	2	1																																				1
VP	H	*Potentilla inclinata*																																															0.1	1																								
VP	H	*Primula veris*																																																1				1	1				1	1	3	1			1	1	1				1	1	1	1
VP	H	*Prunella grandiflora*																																															0.1	1																								
VP	H	*Prunella laciniata*					1	1	1	1	1	1	0.8	1																1	1					1	0.2	1										1	0.1	1																							0.2	1
VP	H	*Prunella vulgaris*					1				1	1	0.5	1					1					1	6	1																										1	1	1	1				1	1	3	1		1	1	1	1		1	1	1	1	2	1
VP	H	*Prunella* × *intermedia*												1																																																											1
VP	H	*Prunus domestica*																																																																								1
VP	H	*Prunus* sp.												1																																																											
VP	H	*Prunus spinosa*																	1						2	1																																																
VP	H	*Pteridium aquilinum*																												1	1						4	1																																				
VP	H	*Ranunculus bulbosus*	1	1	1	1	1		1	1	1	1	0.5	1												1											0.2	1				1	1	1	1	1	1	1	1	1				1	1				1	1	0.01	1	1	1	1	1	1						0.5	1
VP	H	*Ranunculus polyanthemos*												1												1																													1						0.4	1									1	1	0.5	1
VP	H	*Rhinanthus minor*									1	1	0.1	1																												1	1						3	1												1				1	1					1	0.2	1
VP	H	*Rhinanthus rumelicus*																																																																	1						2	1
VP	H	*Rhinanthus wagneri*												1																																				1																								1
VP	H	*Rosa canina* agg.																								1																																																
VP	H	*Rosa rubiginosa*																																				1																																				
VP	H	*Rumex acetosa*																																																																								1
VP	H	*Rumex acetosella*															1	1	1				1	1	3	1									1	1	0.001	1																																				
VP	H	*Salvia verticillata*												1																									1	1	1	1	1			1	1	1	15	1																							0.3	1
VP	H	*Sanguisorba minor*					1		1	1	1	1	0.5	1															1	1	1			1	1	1	7	1				1	1			1	1	1	5	1					1				1	1	0.3	1				1	1					1	0.5	1
VP	H	*Scabiosa columbaria*					1				1	1	0.2	1																																													1	1	0.5	1												
VP	H	*Scabiosa ochroleuca*																												1	1				1	1	0.01	1					1						0.01	1																	1				1	1	0.2	1
VP	H	*Schedonorus pratensis*												1																																																												1
VP	H	*Scorzoneroides autumnalis*														1	1	1	1						0.5	1																																																
VP	H	*Securigera varia*			1	1	1					1	15	1																												1	1						3	1											0.3	1											0.5	1
VP	H	*Seseli annuum*												1																																									1						0.01	1												
VP	H	*Solidago virgaurea*																							0.1	1																																																
VP	H	*Stachys germanica*																																				1				1	1						0.1	1																								
VP	H	*Stachys officinalis*											0.1	1					1						0.2	1																							0.2	1												1			1	1	1				1	1	5	1
VP	H	*Stellaria graminea*																						1	0.001	1																													1				1	1	0.1	1					1						0.2	1
VP	H	*Taraxacum* sect. *Erythrosperma*																													1					1	0.3	1																																		1	0.1	1
VP	H	*Taraxacum* sect. *Taraxacum*																																									1						0.1	1																								
VP	H	*Teucrium chamaedrys*				1	1			1	1	1	0.2	1															1	1	1			1	1	1	2	1					1					1	1	1																								1
VP	H	*Thymus dacicus*			1	1	1						3	1					1					1	10	1			1	1	1		1	1	1	1	12	1				1	1			1	1	1	5	1			1	1	1			1	1	1	10	1					1					1	1	1
VP	H	*Thymus pulegioides* subsp. *pulegioides*					1	1	1	1	1	1	4	1																																																												
VP	H	*Tragopogon pratensis* subsp. *orientalis*											0.2	1																																		1	0.2	1																	1				1	1	0.5	1
VP	H	*Trifolium campestre*												1																																																											0.2	1
VP	H	*Trifolium dubium*																																			0.001	1																																				
VP	H	*Trifolium micranthum*																																																					1						0.001	1												
VP	H	*Trifolium montanum*					1				1	1	5	1																																			0.1	1				1	1			1	1	1	1	1				1	1		1	1	1	1	4	1
VP	H	*Trifolium ochroleucon*										1	0.2	1																																																				1	1			1	1	1	2	1
VP	H	*Trifolium pratense*												1												1																	1				1	1	1	1					1					1	0.2	1									1	1	2	1
VP	H	*Trifolium repens*					1					1	1	1	1	1	1	1	1				1	1	2	1											0.1	1	1	1	1	1	1						0.3	1	1	1	1	1	1		1	1	1	1	5	1									1	1	0.2	1
VP	H	*Trisetum flavescens*										1	0.1	1																												1	1				1	1	5	1																						1	0.1	1
VP	H	*Verbena officinalis*																																																																						1	0.1	1
VP	H	*Veronica arvensis*																																													1	1	0.001	1																								1
VP	H	*Veronica austriaca* subsp. *austriaca*				1	1						0.3	1																	1						0.001	1																																	1	1	0.1	
VP	H	*Veronica austriaca* subsp. *teucrium*																																								1	1			1	1	1	4	1																								
VP	H	*Veronica chamaedrys*																								1																1	1			1	1	1	2	1																	1			1	1	1	1	1
VP	H	*Veronica officinalis*																1	1				1	1	4	1				1	1						0.1	1																																				
VP	H	*Vicia cracca*																																																													1										1	0.1	1
VP	H	*Vicia sativa* subsp. *nigra*																																																																				1	1	0.1	1
VP	H	*Viola canina*															1	1	1					1	3	1																													1					1	0.1	1												
VP	H	*Viola hirta*																													1						0.1	1					1						0.1	1																1	1	1	1	1	1	1	0.5	1
VP	H	*Viola hirta* × *odorata* (*V.* ×*scabra*)					1			1	1	1	0.5	1																																																											
B	C	*Abietinella abietina*						1	1	1	1	1	3	1														1	1	1	1		1	1	1	1	10	1			1	1	1	1	1	1	1	1	20	1					1						0.5	1	1	1	1	1	1				1	1	15	1
B	C	*Atrichum undulatum*																						1	0.1	1																																				1												
B	C	*Brachythecium albicans*										1	1	1																														1	1	1	1	1	0.5	1																								
B	C	*Brachythecium salebrosum*											1	1																																																												
B	C	*Brachythecium* sp.																			1	1	1	1	0.01	1																																																
B	C	*Brachythecium tommasinii*				1	1						0.1	1																																																												
B	C	*Bryum* sp.																						1	0.01	1																																																
B	C	*Calliergonella cuspidata*																																																				1	1						0.1	1												
B	C	*Ceratodon purpureus*																								1																																																
B	C	*Cirriphyllum piliferum*																																																				1	1						0.1	1												
B	C	*Climacium dendroides*																																																		1	1	1	1					1	2	1												
B	C	*Dicranum polysetum*																																																		1	1	1	1						0.1	1												
B	C	*Entodon concinnus*					1			1	1	1	1	1																													1						0.01	1																1	1	1	1	1	1	1	1	1
B	C	*Fissidens dubius*																										1	1	1	1					1	0.05	1																																				
B	C	*Homalothecium lutescens*		1	1	1	1		1	1	1	1	2	1																											1	1	1					1	1	1													1	1	1	1	1	1	1	1	1	1	30	1
B	C	*Hylocomium splendens*														1	1	1	1						10	1																										1	1	1	1				1	1	10	1												
B	C	*Hypnum cupressiforme*								1	1	1	2	1																																								1	1						2	1												
B	C	*Hypnum cupressiforme* var. *lacunosum*																									1	1	1	1	1	1	1	1	1	1	10	1																																				
B	C	*Oligotrichum hercynicum*																						1	0.1	1																																																
B	C	*Oxyrrhynchium hians*																																										1	1	1	1	1	5	1																								
B	C	*Plagiomnium affine*														1	1	1	1						0.01	1																													1						0.2	1												1
B	C	*Plagiomnium cuspidatum*																																																					1						0.1	1												
B	C	*Plagiomnium undulatum*																																																										1	0.1	1												
B	C	*Pleurozium schreberi*																1	1					1	5	1																																																
B	C	*Pogonatum aloides*																								1																																																
B	C	*Pohlia annotina*																								1																																																
B	C	*Pohlia nutans*																								1																																																
B	C	*Polytrichum commune*																	1					1	0.2	1																																																
B	C	*Pseudoscleropodium purum*																																																																								1
B	C	*Rhytidiadelphus squarrosus*													1	1	1	1	1		1	1	1	1	35	1																									1	1	1	1	1		1	1	1	1	40	1				1	1			1	1	1	0.1	1
B	C	*Rhytidium rugosum*																												1	1					1	30	1																																				
B	C	*Sanionia uncinata*																																																																								1
B	C	*Thuidium assimile*	1	1	1	1	1	1	1	1	1	1	5	1					1					1	0.5	1																	1						0.1	1				1	1		1	1	1	1	5	1	1	1	1	1	1	1	1	1	1	1	5	1
B	C	*Thuidium delicatulum*																																																												1												
B	C	*Tortella tortuosa*																																				1																																				
B	C	*Weissia longifolia*																																				1																																				
L	C	*Cladonia furcata*						1	1	1	1	1	0.1	1															1	1	1						0.5	1																																				

Supplement E7. Variation in the Pearson correlation coefficient between vascular plant and bryophyte species richness with increasing sampling plot size.

Anhang E7. Variation des Pearson-Koeffizienten der Korrelation zwischen Gefäßpflanzen- und Moosartenreichtum mit zunehmender Größe der Aufnahmeflächen.



Supplement E8. Nested-plot series in the Dobrești site: a) Dobrești 2, b) Dobrești 3, c) Dobrești 5, d) Dobrești 8, e) Dobrești 9, f) Dobrești 11. Photos M. Janišová, June 2019.

Anhang E8. Serien der ineinander geschachtelten Aufnahmeflächen in Dobrești: a) Dobrești 2, b) Dobrești 3, c) Dobrești 5, d) Dobrești 8, e) Dobrești 9, f) Dobrești 11. Photos M. Janišová, Juni 2019.

a)

b)

c)

d)

e)

f)

Supplement E9. Nested-plot series in the Ponoară site: a) Ponoară 1, b) Ponoară 3, c) Ponoară 5, d) Ponoară 7, e) Ponoară 10, f) Ponoară 12. Photos M. Janišová, June 2019.

Anhang E9. Serien der ineinander geschachtelten Aufnahmeflächen in Ponoară: a) Ponoară 1, b) Ponoară 3, c) Ponoară 5, d) Ponoară 7, e) Ponoară 10, f) Ponoară 12. Photos M. Janišová, Juni 2019.

a)

b)

c)

d)

e)

f)