

Grassland vegetation of Hodrušská hornatina highland in Central Slovakia

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Key words: grasslands, ordination, Slovakia, species richness, syntaxonomy, Štiavnické vrchy Mts., threatened species.

Kľúčne besede: travišča, ordinácia, Slovaška, vrstna pestrosť, sintaksonómia, gorovje Štiavnické vrchy, ohrozené vrste.

Abstract

This paper is focused on the grassland communities in Hodrušská hornatina highland, Central Slovakia. We studied grasslands at 153 sites during the vegetation periods of 2013–2015 and recorded 303 species of vascular plants in the studied localities. The species richness ranged from 16 to 66 taxa per relevé. Data analysis (TWINSPAN, DCA) grouped the relevés into eight clusters. These clusters include five associations from three alliances: *Holcetum lanati* (*Deschampsion cespitosae*), *Pastinaco sativae-Arrhenatherum elatioris*, *Alchemillo-Arrhenatheretum elatioris*, *Anthoxantho odorati-Agrostietum tenuis* (all from *Arrhenatherion elatioris*) and *Onobrychido viciifoliae-Brometum erecti* (*Bromion erecti*). The other three clusters represent the transitional and successional stages of the communities listed above. A brief description of syntaxa is given. At some sites, the threatened, rare or protected taxa of Slovakia occurred as well, one from each of the categories of Critically Endangered and Vulnerable, nine species of the Nearly Threatened and six species from the category of Least Concerned.

Izvleček

V članku obravnavamo travniške združbe na hribovju Hodrušská hornatina na osrednjem Slovaškem. V obdobju 2013–2015 smo preučili travišča na 153 lokacijah in zabeležili 303 vrste rastlin. Vrstna pestrosť je bila med 16 in 66 taksonov na vegetacijski popis. Analiza podatkov (TWINSPAN, DCA) je pokazala združevanje popisov v osem klastrov. Ti šopi vključujejo pet asociacij iz treh zvez: *Holcetum lanati* (*Deschampsion cespitosae*), *Pastinaco sativae-Arrhenatherum elatioris*, *Alchemillo-Arrhenatheretum elatioris*, *Anthoxantho odorati-Agrostietum tenuis* (vsi iz zveze *Arrhenatherion elatioris*) in *Onobrychido viciifoliae-Brometum erecti* (*Bromion erecti*). Ostali trije klastri predstavljajo prehodne in sukcesijske stadije zgoraj omenjenih združb. Predstavili smo kratek opis združb. Na določenih lokacijah uspevajo tudi ogrožene, redke ali zaščitene rastlinske vrste. Ena spada v kategorijo skrajno ogrožene in ranljive vrste, devet med potencialno ogrožene vrste in šest med najmanj ogrožene vrste.

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Introduction

Since the beginning of the 20th century, when the research on European meadows started (e.g. Braun-Blanquet 1930), a large number of surveys on grasslands across Europe have been carried out. Species-rich grassland communities were described, for example, in the north of Scandinavia (Dierssen 1996), and Estonia (Kull & Zobel 1991, Kukk & Kull 1997, Sammuli et al. 2003), in Central Europe in the Alps (Mucina et al. 1993, Tasse & Tappeiner 2002), in the Czech Republic and Slovakia (Chytrý et al. 2007, Janišová et al. 2007), in Hungary (Borhidi & Sánta 1999, Botta-Dukát et al. 2005, Borhidi et al. 2012), and in the south of the Balkans (Ačić et al. 2015), in Bulgaria (Velev & Vassilev 2014) or Croatia (Stančić 2008).

Slovakia is a small country in Central Europe with rather diverse relief, climate and geology. Its geographic position determines a rich flora. The majority of the country falls into the Western Carpathian region, but the Eastern Carpathian and Pannonian regions are also present. Following the phytogeographic division suggested by Futák (1966), the bordering of the two regions (Carpathian and Pannonian) allows the intersection of the Pannonian and Carpathian vegetation components. Natural grasslands have developed here only in the ecologically extreme habitats (Hájková et al. 2001), and local grasslands are closely connected with human activities. Several hundred years of human agricultural activities resulted in the rise of very valuable habitats with secondary plant communities (Novák 2008). In comparison with other communities, the grasslands of the European temperate zone are noted for their rich flora and high diversity (Pärtel et al. 1996, Šeffler et al. 2002). Many of them are also listed as the habitats of European importance, in Annex I, of the Habitats Directive (Council Directive 92/43/EEC on the conservation of natural habitats and wild fauna and flora). In Slovakia, the grassland area significantly expanded during the 18th and 19th centuries alongside the expansion of agriculture (Ružičková & Kalivoda 2007). In 1920, more than one million hectares of grassland was registered in Slovakia. However, due the changing political situation, their area has been consistently declining in the last decades (Galvánek & Viestová 2006, Ružičková & Kalivoda 2007, Novák 2009, Ružičková et al. 2011). Unmanaged areas usually successional change towards scrub and forest vegetation (Moog et al. 2002). A large number of publications have focused on grassland research in Slovakia. Among the first were the studies by Futák (1943, 1947), Jurko (1951) and Májovský (1953). Many studies focused on classification and syntaxonomy of grasslands (Jurko 1974, Michálková, Janišová et al. 2008, Janišová et al. 2010a, b, Hegedúšová et al. 2011).

The synthesis of phytosociological data from Slovakia was completed in the fifth volume of the Vegetation of Slovakia (Hegedúšová Vantarová & Škodová 2014), devoted to grassland vegetation.

Slovak grasslands are generally quite well-known, and some case studies were published also from Central Slovakia, including the Štiavnické vrchy mountains (Ružičková 1986, Ružičková & Halada 2005, Banášová et al. 2006, Hegedúšová & Ružičková 2007). In spite of this knowledge, there is no comprehensive study from the area of Hodrušská hornatina highland (western part of Štiavnické vrchy mountains in Central Slovakia).

The aim of this study is (i) to complete the information on the syntaxa of grassland vegetation in Hodrušská hornatina highland, (ii) assess the variability of plant communities and (iii) highlight the presence of threatened species.

Study Area

The study area is situated in the western part of the Štiavnické vrchy mountains in Central Slovakia (Figure 1). The area of Hodrušská hornatina highland is more than 35,136 ha. The study area is part of the largest volcanic mountain range of the Western Carpathians (Miklós & Izakovičová 2006). The lowest point of the area is 232 m a.s.l. and the highest is 939 m a.s.l., so the vertical dissection is 707 m. The bedrock of the area is mainly formed by andesite, granite, and limestone in some parts. The prevailing soil type in the territory of Hodrušská hornatina highland is cambisol. The rendzinas are mostly associated with the limestone bedrock (Miklós & Hrnčiarová (eds.) 2002). Fluvisols are the dominant soil type along rivers and springs (Kunca et al. 2005). The studied area belongs to the moderately warm climate region with average temperatures from 6 °C to 10 °C. Summers are relatively short and dry, with average temperatures of the hottest month between 15 °C and 19 °C. On the other side, average temperatures of the coldest month are between -1 °C and -5 °C. The annual precipitation is 700–900 mm (SHMÚ 2015). The majority of the territory is covered in forests; mixed oak-hornbeam forests (*Carpinion betuli*) and beech forests (*Fagion sylvaticae*) dominate.

Methods

In our research we focused on semi-natural grasslands developed and maintained by human activity. We set the sample plots to cover most of the grasslands in the study area. They included meadows with intensive and extensive management, pastures, orchards, and even

abandoned grasslands. A total of 153 phytosociological relevés were made across the study area. The survey was carried out within three vegetation periods (2013–2015), according to the Zürich-Montpellier methodological approach (Braun-Blanquet 1964). The sample plots were squares, with the area of 25 m² each, which is recommended for grasslands (Chytrý & Otýpková 2003). The nine-element ordination scale (van der Maarel 1979) was used for the estimation of species abundance. The relevés were entered into the Turboveg database management program (Hennekens & Schaminée 2001). The numerical classification was performed by TWINSPLAN classification (Hill 1979), carried out using the software JUICE (Tichý 2002). We have used the crispness of classification to determine the optimal number of clusters (Botta-Dukát et al. 2005). Based on the highest Actual Average Crispness Value, the data were divided into eight groups. Diagnostic species for the clusters in the data set were determined by calculation of species fidelity to each cluster, using the phi coefficient in JUICE (Chytrý et al. 2002). The threshold fidelity value for diagnostic species was set to $\phi = 0.20$. Non-significant fidelity values were

excluded using Fisher's exact test ($P < 0.001$). For the interpretation of position and relations between the communities, a Detrended Correspondence Analysis (DCA) was carried out in CANOCO 4.5 for Windows package (ter Braak & Šmilauer 2002). For environmental characterization of vegetation groups, the Ellenberg indicator values for soil reaction, moisture, nutrient content, temperature, and continentality, were used (Ellenberg et al. 1992). Some environmental data (altitude, slope, aspect and applied management) were also collected in the field. The heat index was calculated according to the formula: $\text{heat index} = \cos(\text{aspect} - 225^\circ) \times \text{tg}(\text{slope})$ (Parker 1988). The management was encoded as intensively managed, extensively managed, and abandoned. These data were plotted onto the DCA ordination diagram as supplementary environmental variables. For the nomenclature of vascular plants, the list of Marhold & Hindák (1998) was used. A list of vegetation units of Slovakia (Hegedüšová Vantarová & Škodová 2014) was used for the nomenclature of grassland communities. The threatened species were assessed according to the recent Red list of ferns and flowering plants of Slovakia (Eliáš et al. 2015).

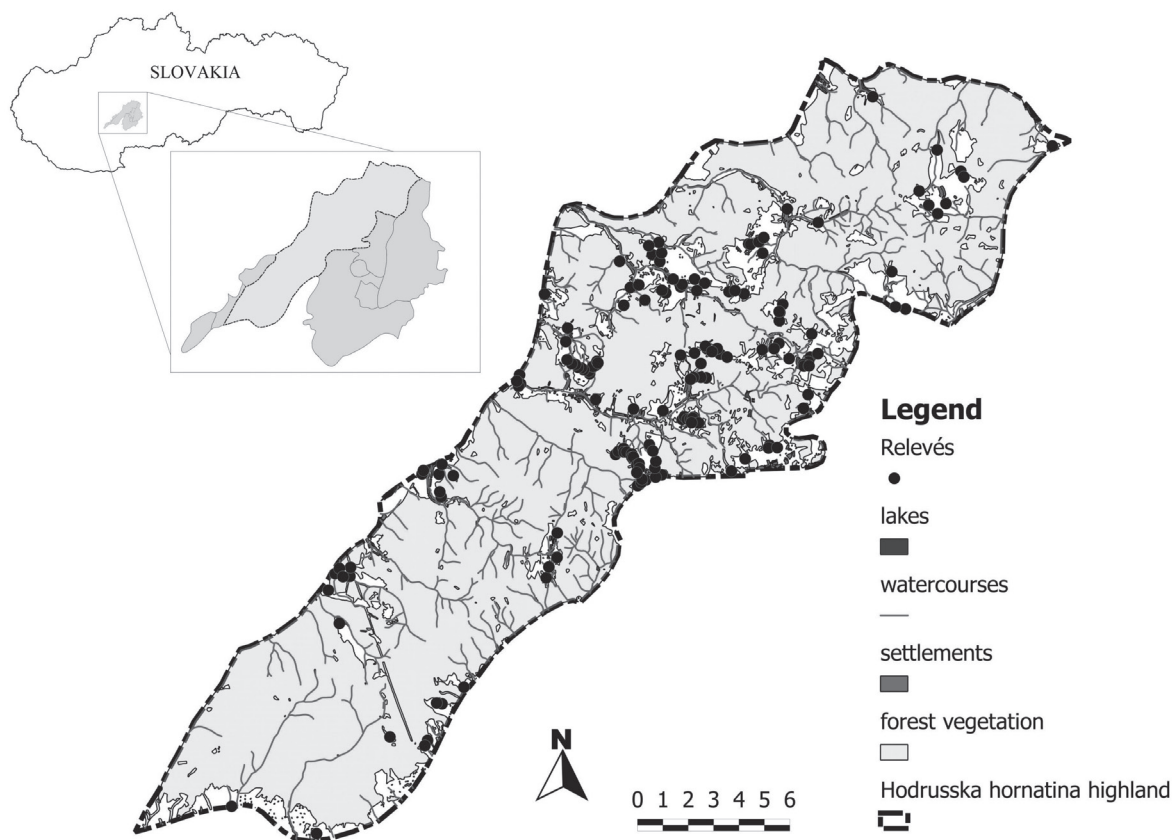


Figure 1: Location of the study area in the Slovak Republic. Black points show the location of relevé plots.
Slika 1: Lokacija preučevanega območja na Slovaškem. Črne točke predstavljajo lokacije popisnih ploskev.

Results

In total, we sampled 153 phytosociological relevés in Hodrušská hornatina highland and recorded 303 species of vascular plants. The species richness ranged from 16 to 66 taxa per relevé (on average 41.8 species). Using TWINSPLAN, we classified the relevés into eight clusters. We were able to distinguish two classes *Molinio-Arrhenatheretea* R. Tx. 1937 and *Festuco-Brometea* Br.-Bl. et R. Tx. ex Soó 1947. Nine relevés were assigned to the association *Holcetum lanati* Issler 1936, 37 relevés were classified as *Pastinaco sativae-Arrhenatheretum elatioris* Passarge 1964, 33 relevés as *Alchemillo-Arrhenatheretum elatioris* Sougnez et Limbourg 1963, 30 relevés as *Anthoxantho odorati-Agrostietum tenuis* Sillinger 1933 and five relevés as *Onobrychido viciifoliae-Brometum erecti* T.Müller 1966. The relevés that could not be assigned to associations due their transitional character were classified to the alliance level (*Arrhenatherion elatioris* Luquet 1926 and *Bromion erecti* Koch 1926). A subsequent Detrended Correspondence Analysis (DCA) has confirmed this classification (Figure 2). The total inertia in the DCA was 5.71; eigenvalues were 0.249 (axis 1) and 0.167 (axis 2). The first axis explained 4.4 % of the variance of species data, the second axis 2.9 %. The first axis was positively correlated with light (correlation coefficient 0.4200) and negatively correlated with nutrient content and moisture (correlation coefficient -0.8980 and -0.8134). This fact suggests that the main gradient in our dataset is related to light, nutrient content and moisture. The kind of applied management proved to be rather important. The abandonment was positively correlated with the first axis (0.3427), intensive type of management (-0.4392) and mown grasslands (-0.2024) were negatively correlated with it. Most of the relevés were concentrated in the central part of the DCA diagram. This fact is explained by the small differences in species composition between mesophilic associations within the alliance *Arrhenatherion elatioris* (*Anthoxantho odorati-Agrostietum tenuis*, *Alchemillo-Arrhenatheretum elatioris*, *Pastinaco sativae-Arrhenatheretum elatioris*) and all their transitional and successional phases. Relevés from intensified meadows of the association *Pastinaco sativae-Arrhenatheretum elatioris* were clearly separated in the left part of the graph, following the nutrient content gradient. Wetter association *Holcetum lanati* were also situated more in the left part of the graph. Relevés of dry grasslands from the alliance *Bromion erecti* were, on the other side, in the right part. The second axis was positively correlated with soil reaction (0.6529), temperature (0.4780) and continentality (0.3967). Some outliers might be caused by differences in species composition due to management type, succession changes, or changes in water regime at

the site. Our syntaxonomical scheme follows the concept for grassland vegetation in Slovakia (Hegedúšová Vantarová & Škodová 2014).

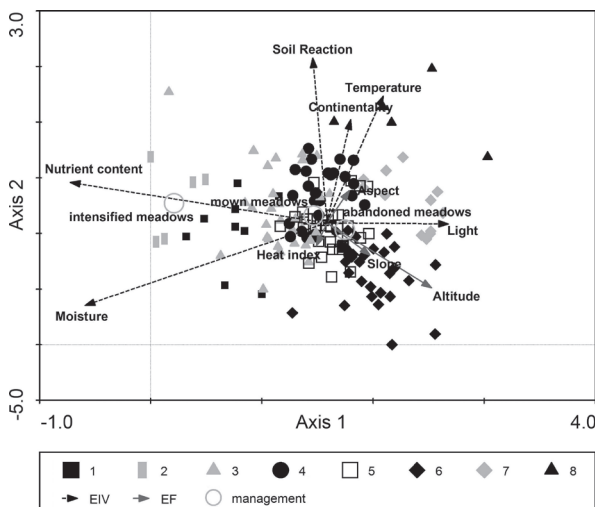


Figure 2: Detrended Correspondence analysis (DCA) ordination diagram of phytosociological relevés based on average Ellenberg indicator values and environmental factors. Syntaxa are marked as follows: 1 *Holcetum lanati*, 2 *Pastinaco sativae-Arrhenatheretum elatioris* – intensive meadows, 3 *Pastinaco sativae-Arrhenatheretum elatioris*, 4 *Alchemillo-Arrhenatheretum elatioris*, 5 *Arrhenatherion elatioris*, 6 *Anthoxantho odorati-Agrostietum tenuis*, 7 *Brometalia erecti*, 8 *Onobrychido viciifoliae-Brometum erecti*.

Slika 2: Ordinacijski diagram korespondenčne analize z odstranjenim trendom (DCA) fitocenoloških popisov in povprečnih Ellenbergovih indikatorskih vrednosti in okoljskih dejavnikov. Sintaksoni so označeni kot: 1 *Holcetum lanati*, 2 *Pastinaco sativae-Arrhenatheretum elatioris* – intenzivne meje, 3 *Pastinaco sativae-Arrhenatheretum elatioris*, 4 *Alchemillo-Arrhenatheretum elatioris*, 5 *Arrhenatherion elatioris*, 6 *Anthoxantho odorati-Agrostietum tenuis*, 7 *Brometalia erecti*, 8 *Onobrychido viciifoliae-Brometum erecti*.

The hierarchical system of syntaxa

Molinio-Arrhenatheretea R. Tx. 1937

Molinion caeruleae Koch 1926

Deschampsion cespitosae Horvatić 1930

Holcetum lanati Issler 1936

Arrhenatheretalia R. Tx. 1931

Arrhenatherion elatioris Luquet 1926

Pastinaco sativae-Arrhenatheretum elatioris Passarge 1964

Alchemillo-Arrhenatheretum elatioris Sougnez et Limbourg 1963

Anthoxantho odorati-Agrostietum tenuis Sillinger 1933

Festuco-Brometea Br.-Bl. et R. Tx. ex Soó 1947

Brometalia erecti Br.-Bl. 1936

Bromion erecti Koch 1926

Onobrychido viciifoliae-Brometum erecti T. Müller 1966

The association *Holcetum lanati* included plant communities dominated by grass species *Poa pratensis*, *Alopecurus pratensis*, *Festuca pratensis* and *Holcus lanatus*. The total coverage of the herb layer mostly reached 100 %. The association was recorded at altitudes between 238 and 387 m a.s.l. The average number of species per relevé was 35. The spring aspect was formed of herbs *Cardamine pratensis*, and the early summer aspect of herbs *Ranunculus acris* and *Lychnis flos-cuculi*. *Lysimachia nummularia* and *Plantago lanceolata* formed the undergrowth. The gradient of moisture is correlated with relevés of this association. This vegetation mostly occurs on river alluviums. Higher water supply in spring and desiccation during summer is typical for this community. Transition towards the mesophilous alliance of *Arrhenatherion elatioris* was common during spring periods with water absence. Species as *Campanula patula*, *Crepis biennis*, *Equisetum arvense*, *Leontodon hispidus*, *Leucanthemum vulgare*, *Pastinaca sativa* and *Veronica chamaedrys* were of higher constancy in these relevés.

The second and third group represent the association of *Pastinaco sativae-Arrhenatheretum elatioris*. The gradient of soil nutrient content and moisture are correlated with the association, especially the second group associated with high values. Species-poor meadows of the second group were intensively managed. In consequence of the high nutrition content, coming from fertilization, high grasses such as *Arrhenatherum elatius*, *Dactylis glomerata*, *Festuca pratensis* and *Poa pratensis* predominated. The number of species fluctuated from 26 to 37 species, 32 on average. *Knautia arvensis* and *Crepis biennis* were the species with higher constancy. The undergrowth was mainly composed of shade-tolerant species *Achillea millefolium*, *Trifolium pratense*, *Trifolium repens* and the species of *Taraxacum* sect. *Ruderalia*. Some ruderal species occurred as well (*Cirsium arvense*, *Potentilla reptans*). The grasslands of the third group had higher species richness, on average 39 species per relevé. Some of them were orchards, meadows, and extensively used or abandoned meadows. Within the third group, we distinguished two variants of the above mentioned association – one variant with *Geranium pratense* and one, more frequent variant, with *Anthriscus sylvestris*. The first variant was characterised by species such as *Centaurea elatior*, *Crepis biennis*, *Filipendula vulgaris*, *Geranium pratense*, *Taraxacum* sect. *Ruderalia*, *Trifolium repens*, and *Trisetum flavescens*. It occupied sites in cold hollows, on river banks, and on deep soils with higher nutrient and water content. On the other hand the second variant was connected with warmer, occasionally ploughed sites. The constant species were *Anthriscus sylvestris*, *Plantago lanceolata*, and *Veronica chamaedrys*. From the vulnerable species, only

Cyanus segetum was found in two meadows, but merely on the very edge of the parcel.

The communities of the fourth group were among the most species-rich communities in our territory. The average number of species was 45, hence 66 species per relevé was the highest number. These communities were classified to the association *Alchemillo-Arrhenatherion elatioris*. A high abundance of the typical species of the alliance *Arrhenatherion elatioris* is characteristic for this vegetation type. *Arrhenatherum elatius*, *Dactylis glomerata*, *Festuca pratensis*, *Festuca rubra* and *Poa pratensis* were typically present. In early spring, *Primula veris* dominated in the vegetation. During summer, the colourful aspect was formed mainly by herbs *Tragopogon orientalis*, *Salvia pratensis*, *Dianthus carthusianorum*, *Leucanthemum vulgare*, *Crepis biennis* and *Campanula patula*. In the hierarchical system of syntaxa, this association is transitional between *Pastinaco sativae-Arrhenatheretum elatioris* and *Anthoxantho odorati-Agrostietum tenuis*.

Mesophilous meadows from the fifth group were mainly located in orchards, sites along streams, and on moderate slopes with deeper soil. Due to a sufficiency of nutrients and moisture, the vegetation was tall and dense, grasses prevailed – *Arrhenatherum elatius*, *Dactylis glomerata*, *Trisetum flavescens*, *Festuca pratensis*, *Poa pratensis*. However, *Arrhenatherum elatius* dominated. The average number of species was 42. In many cases the vegetation of this group could be classified as transitional stages between the associations *Pastinaco sativae-Arrhenatheretum elatioris* and *Alchemillo-Arrhenatherion elatioris*. Some of the communities within this group were closely related to the association *Poo-Trisetetum flavescens*. Most of the sites, however, were abandoned, so the vegetation was at a higher stage of succession with the presence of shrub and tree species.

The association *Anthoxantho odorati-Agrostietum tenuis* represents rich, once-mowed meadows or extensively used pastures, with 44 species per relevé on average, which also assign them to the grassland communities with high species diversity. They mostly occurred in the near vicinity of rural settlements on slight slopes at higher altitude. Relevés of this type of vegetation were negatively correlated to nutrient content. The vegetation consists of middle high or low grasses *Festuca rubra*, *Briza media*, from graminoids *Luzula campestris* and *Luzula luzuloides*. Presence of the species of the alliance *Violion caninae* was typical for this association. Species *Viola canina*, *Luzula campestris*, *Polygala vulgaris*, *Veronica officinalis* and *Nardus stricta* had higher frequency of occurrence. Five of the recorded meadows were abandoned. Due to the lack of management at these places, the ingrowths of high grasses such as *Arrhenatherum elatius*, *Dactylis glomerata* and

Brachypodium pinnatum was very common. Threatened and protected species are often present in this association. In our case, nine of the relevés from this group contained rare species – *Aquilegia vulgaris*, *Convallaria majalis*, *Crepis praemorsa*, *Dactylorhiza fuchsii*, *Dactylorhiza sambucina*, *Gymnadenia conopsea* and *Orchis morio*.

Communities of the alliance *Bromion erecti* were relatively species-rich (on average 43 species per relevé). In comparison to the rest of the data set, this unit included the vegetation of warm and dry stands. At some of the sites, the vegetation consisted of two layers: tall grasses (*Avenella flexuosus*, *Avenula pubescens*, *Brachypodium pinnatum*, *Arrhenatherum elatius*), short caespitose grasses and graminoid species (*Carex caryophylla*, *Carex montana* and *Carex pilulifera*). Xerophilic species (*Anthyllis vulneraria*, *Potentilla alba*, *Teucrium chamaedrys*, *Potentilla rupestris*), mesophilic (*Leucanthemum vulgare*) and hygrophilic herbs (*Betonica officinalis*) were present as well. Communities of this group were close to the association *Brachypodio pinnati-Molinietum arundinaceae*. At some sites we could distinguish a variant with *Potentilla erecta* with constant species *Anthoxanthum odoratum*, *Briza media*, *Hypericum perforatum*, *Potentilla erecta*, *Thlaspi montanum*, and *Orchis morio*. At acid soil, we recorded transitions towards the association of *Campanulo rotundifoliae-Dianthetum deltoideis* (alliance *Violion caninae*) with species *Veronica officinalis*, *Viola canina*, *Potentilla erecta*, *Nardus stricta*. High grasses dominated at locations without any management. Self-seeded trees (*Acer campestre*, *Carpinus betulus*, *Crataegus monogyna*) and species of warm herb fringe communities (*Geranium sanguineum*, *Trifolium alpestre*, *Trifolium montanum* and the threatened *Lychnis coronaria*) penetrated into the vegetation. In some cases, transitional forms towards the associations of *Ranunculo bulbosi-Arrhenatheretum elatioris* and *Onobrychido viciifoliae-Brometum erecti* could be recognised.

Grassland communities represented by the strongly dominant *Bromus erectus*, situated on dry or mesic sites, were classified as the association *Onobrychido viciifoliae-Brometum erecti* from the alliance of *Bromion erecti*. Some other subdominant grasses such as *Avenula pubescens*, *Dactylis glomerata*, *Festuca rubra* occurred in higher constancy. Regularly managed sites were especially rich in flowering plants. The number of species ranged between 37 and 60 (48 species on average). Beside the typical thermophilous species *Dianthus carthusianorum*, *Pimpinella saxifraga*, *Ranunculus bulbosus*, *Salvia pratensis*, *Sanguisorba minor*, *Securigera varia*, *Teucrium chamaedrys*, some mesophilous species were also present (*Linum catharticum*, *Tragopogon orientalis*, *Veronica chamaedrys*). In two cases, we can consider the mesophilic variant of the association with *Leucanthemum vulgare*, which differs

in the presence of the species from alliance *Arrhenatherion elatioris* (e.g. *Acetosa pratensis*, *Anthoxanthum odoratum*, *Campanula patula*, *Crepis biennis*, *Leucanthemum vulgare*, *Tragopogon orientalis*, *Trifolium pratense*, *Trisetum flavescens*). In addition, orchids also frequently occurred here (*Dactylorhiza sambucina*, *Gymnadenia conopsea*).

The threatened, rare and protected taxa of Slovakia occurred at some sites as well. The most endangered species recorded at our sites were *Orobanche elatior* (Critically Endangered CR) and *Thlaspi montanum* (Vulnerable VU). We recorded six less vulnerable species belonging to the category Least Concern (LC; *Aquilegia vulgaris*, *Centaureum erythraea*, *Convallaria majalis*, *Cyanus segetum*, *Gymnadenia conopsea*, *Lychnis coronaria*) and nine species of the category Near Threatened (NT; *Anemone sylvestris*, *Crepis praemorsa*, *Lilium bulbiferum*, *Dactylorhiza fuchsii*, *Dactylorhiza majalis*, *Dactylorhiza sambucina*, *Orchis morio*, *Potentilla rupestris*, *Saxifraga granulata*). Nine of the above mentioned threatened species are protected by law in the Slovak Republic – *Gymnadenia conopsea*, *Lychnis coronaria*, *Lilium bulbiferum*, *Dactylorhiza fuchsii*, *Dactylorhiza majalis*, *Dactylorhiza sambucina*, *Orchis morio*, *Potentilla rupestris* and *Thlaspi montanum*.

Discussion and conclusions

Grasslands in the temperate zone of Europe, in comparison to other communities, are noted for their rich flora and high diversity (Pärtel et al. 1996, Šeffer et al. 2002). Among the communities with the highest species diversity are those of the Czech Republic and Slovakia, especially in the Biele Karpaty mountains, with 103 species per 24 m² (Klimeš 1997) or even 105 species per 16 m² in the National Nature Reserve of Čertoryje (Merunková et al. 2012). Chytrý et al. (2015) and Vadel (2015) claim the Slovenský raj National Park to have the species richest grassland communities. Due to the fact that the above mentioned areas are mainly situated on limestone bedrock, we expected lower species richness in Hodrušská hornatina highland because of the geological substrate that is mostly andezite. This was confirmed as we have recorded lower species richness – it ranged from 16 to 66 taxa per 25 m². However, some of our sites were situated on limestone bedrock, where the number of species reached 60 or even 66 species. Ružičková & Halada (2005) also found species-rich orchard meadows in Štiavnické vrchy mountains. But they were mainly of the other associations; *Poo-Trisetetum flavescens* with the average number of 41 species (36–50) and the association *Ranunculo bulbosi-Arrhenatheretum elatioris*, with 47 species on average (39–58). Some mesophilous mead-

ows from the alliance *Arrhenatherion elatioris* (the fifth group of our relevés) were closely related to these two associations.

Out of 153 phytosociological relevés, we determined five associations and two groups of higher syntaxa: *Molinio-Arrhenatheretea* and *Festuco-Brometea* classes. *Holcetum lanati* occurs probably in the whole of temperate Europe, but its distribution has not been very well documented yet (Stančík 2008). From Central Slovakia, Kováčová (1976) states its occurrence on the alluvium of the Krupinica river. The majority of our relevés include communities from the alliance *Arrhenatherion elatioris*. This alliance is widely distributed over whole Europe, from the north – Scandinavia (Dierssen 1996), through Central Europe to the south – the Balkans (Stančík 2008, Velev et al. 2011, Velev & Vassilev 2014). In Slovakia, these communities are very frequent in uplands and submountain regions (Janišová et al. 2007). In our research area, the association *Pastinaco sativae-Arrhenatheretum elatioris* was the most common. According to Hájková et al. (2014), it can be found almost in the whole area of Slovakia, but mainly in uplands and the inner basins of the Slovak Carpathians because the lowland localities were ploughed up or intensified. There are also some unpublished records of Ružičková from the Štiavnické vrchy mountains (Hájková et al. 2014). The association *Alchemillo-Arrhenatheretum elatioris* is mainly distributed on the volcanic or limestone bedrock of the central and western parts of Slovakia, including the Štiavnické vrchy mountains (Ružičková & Halada 2005, Banášová et al. 2006). The association *Anthoxantho odorati-Agrostietum tenuis* is not a rare community either. It occurs on shallower and more acidic soil, almost in the whole Carpathian region of Slovakia (Janišová et al. 2010b). Ružičková (1986) and Ružičková & Halada (2005) stated its occurrence in the Štiavnické vrchy mountains. The western part of Central Europe (France, Great Britain, Denmark, even the south of Sweden) is a centre of the occurrence of *Bromion erecti* (Chytrý et al., 2007). Communities of this alliance in the subcontinental climate are known from the Czech Republic (Chytrý et al. 2007), Hungary (Borhidi & Sánta 1999) and Slovakia (Hegedúšová Vantarová & Škodová 2014). According to Janišová et al. (2010b), the associations of this alliance represent the most frequent semi-dry grasslands in Central Slovakia. In the past, these communities were regularly mown. The two associations within this alliance do not differ much. This type of vegetation represents the transition stage towards the association of *Ranunculo bulbosi-Arrhenatheretum elatioris* (Škodová 2007). Ružičková & Halada (2005) stated that *Onobrychido viciifoliae-Brometum erecti* occurred also in the Štiavnické vrchy mountains.

According to the actual Red List of plant species of Slovakia (Eliáš et al. 2015) we identified 17 species listed in IUCN categories. The critically endangered *Orobancha elatior* is a taxon with not enough data on its occurrence within Slovakia (Eliáš et al. 2015). However, in older literature, it is considered as a rare taxon in the studied area, mainly in the south-east of the territory (Hlavaček 1985). At grasslands in Hodrušská hornatina highland, *Orchis morio* was the most frequent of threatened species. Salenka (2012) and Slezák et al. (2012) also reported this species from several locations in the territory (e.g. Vyhne village). The occurrence of thermophilic species *Lychnis coronaria* is stated from warmer parts of our studied area (Hlavaček 1985, Tóthová 2014). Species *Aquilegia vulgaris*, *Dactylorhiza sambucina*, *Gymnadenia conopsea* and *Saxifraga granulata* could be classified as more abundant in Hodrušská hornatina highlands (Futák et al. 1982, Bertová et al. 1985, Salenka 2012, Slezák et al. 2012).

The highest number of threatened species (15 species) was found in the association *Anthoxantho odorati-Agrostietum tenuis*. Also according to Uhliarová et al. (2014), threatened and protected species are often present in this association. We can also claim this association as the most vulnerable. Because of its occurrence on sites with higher altitude, it is most likely to be abandoned. Dry grasslands of the alliance of *Bromion erecti* have to face many threats, either. First of all, the abandonment causes successional changes in species composition as well as expansion of tall grasses and shrub. For maintaining the vegetation type in proper condition we would recommend the rotation of regular pasture and mowing.

Although the area of Hodrušská hornatina highland is mostly covered by forest vegetation, many valuable semi-natural grasslands can be found here. There are meadows, pastures and also orchard meadows, which are typical for the historical cultural landscape in Slovakia. Grasslands are very important to people for different reasons (agriculture, landscape-aesthetic value, recreation). Some of them are important in maintaining the vulnerable and threatened species. The floristic and vegetation composition is a result of a complex influence of many environment variables (Škodová et al. 2011) as well as of the site history, age, and traditional type of management practices (Pärtel et al. 1996, Hájková et al. 2011). The structure and the species composition depend on the ecological conditions, particularly the light, nutrient content and water regime. As our research showed, suitable management is an especially important factor in maintaining grassland communities. However, people are consistently losing their interest in farming. Every year, there are more and more abandoned meadows, which are gradually changing towards forests. There are still some

meadows with traditional agricultural management, but we think the situation with their long-term maintenance is not very promising. It is necessary to continue with the management activities or find alternatives to traditional farming and utilization of meadows.

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Table 1: Shortened synoptic table of studied plant communities.

Tabela 1: Skrajšana sinoptična tabela preučevanih rastlinskih združb

Group No.	1	2	3	4	5	6	7	8
No. of relevés	9	5	32	27	33	30	12	5
Association <i>Holcetum lanati</i>								
<i>Cardamine pratensis</i>	67 ^{71.2}	.	6	7	.	.	.	.
<i>Lysimachia nummularia</i>	44 ^{59.1}	.	6	.	.	.	.	.
<i>Equisetum arvense</i>	56 ^{48.6}	40	6	.	.	.	.	.
<i>Lychnis flos-cuculi</i>	67 ^{37.1}	80	28	11	3	7	.	.
Association <i>Pastinaco sativae-Arrhenatheretum elatioris</i>-intensive meadows								
<i>Symphytum officinale</i>	.	60 ^{73.1}	3	.	.	.	.	.
<i>Cirsium oleraceum</i>	.	40 ^{60.7}	.	.	.	.	.	.
<i>Rumex obtusifolius</i>	.	40 ^{60.7}	.	.	.	.	.	.
<i>Stellaria media</i>	.	40 ^{60.7}	.	.	.	.	.	.
<i>Carduus personata</i>	.	40 ^{60.7}	.	.	.	.	.	.
<i>Plantago omajor</i>	56	80 ^{52.5}	16	4	3	.	.	20
Association <i>Pastinaco sativae-Arrhenatheretum elatioris</i>								
<i>Veronica chamaedrys</i>	89	40	97 ^{21.6}	78	64	73	67	60
Association <i>Alchemillo-Arrhenatheretum elatioris</i>								
<i>Vicia hirsuta</i>	.	.	25	44 ^{35.8}	21	3	8	.
<i>Lathyrus pratensis</i>	22	40	50	63 ^{30.3}	36	7	.	.
<i>Centaurea phrygia</i>	.	.	12	37 ^{30.1}	3	7	33	.
Association <i>Alchemillo-Arrhenatheretum elatioris</i>								
<i>Primula veris</i>	11	.	9	7	39 ^{32.5}	27	.	.
<i>Salvia pratensis</i>	11	.	16	63	76 ^{26.6}	13	50	100
<i>Plantago media</i>	44	.	9	48	61 ^{24.9}	23	17	40
<i>Dianthus carthusianorum</i>	.	.	16	48	82 ^{24.0}	80	75	100
Association <i>Anthoxantho odorati-Agrostietum tenuis</i>								
<i>Hieracium cymosum</i>	.	.	3	4	15	50 ^{54.2}	.	.
<i>Potentilla erecta</i>	22	.	3	11	18	67 ^{47.3}	25	.
<i>Genista tinctoria</i>	.	.	.	.	18	40 ^{43.4}	8	.
<i>Polygala vulgaris</i>	.	.	3	7	21	70 ^{41.7}	25	60

Group No.	1	2	3	4	5	6	7	8
No. of relevés	9	5	32	27	33	30	12	5
<i>Hypochaeris radicata</i>	11	.	6	.	15	33 ^{34.5}	.	.
<i>Viola canina</i>	22	.	16	15	24	60 ^{34.2}	42	.
<i>Thymus pulegioides</i>	.	.	9	30	39	73 ^{33.2}	67	40
<i>Briza media</i>	11	.	19	33	64	83 ^{32.8}	75	40
<i>Hieracium pilosella</i>	.	.	.	15	15	53 ^{32.8}	50	20
<i>Luzula campestris</i>	56	.	59	63	67	97 ^{29.6}	83	40
<i>Veronica serpyllifolia</i>	22	.	9	7	9	33 ^{28.9}	.	.
<i>Cruciata glabra</i>	56	.	47	70	52	83 ^{27.4}	50	20
<i>Veronica officinalis</i>	.	.	.	11	3	33 ^{23.6}	33	20
Alliance Bromion erecti								
<i>Geranium sanguineum</i>	.	.	3	4	6	7	67 ^{59.5}	20
<i>Avenella flexuosa</i>	.	.	.	4	.	.	42 ^{58.8}	.
<i>Campanula persicifolia</i>	.	.	.	4	9	3	42 ^{50.3}	.
<i>Trifolium alpestre</i>	11	.	16	7	18	20	75 ^{50.3}	20
<i>Silene nutans</i> s.lat.	.	.	.	4	9	10	42 ^{46.7}	.
<i>Brachypodium pinnatum</i>	.	.	3	.	6	7	42 ^{40.9}	20
Association Onobrychido viciifoliae- Brometum erecti								
<i>Bromus erectus</i>	.	20	9	.	3	.	25	100 ^{76.4}
<i>Campanula rapunculoides</i>	.	.	.	7	.	.	.	60 ^{70.2}
<i>Linum catharticum</i>	.	.	3	4	12	10	8	80 ^{69.8}
<i>Medicago falcata</i>	.	.	3	7	.	.	.	60 ^{68.2}
<i>Securigera varia</i>	.	.	.	4	.	.	8	60 ^{67.3}
<i>Primula elatior</i>	.	.	9	15	3	3	25	80 ^{63.5}
<i>Ranunculus bulbosus</i>	11	.	19	4	12	27	42	100 ^{62.5}
<i>Medicago lupulina</i>	.	20	19	.	15	3	8	80 ^{60.5}
<i>Sanguisorba minor</i>	.	.	3	11	18	3	33	80 ^{59.6}
<i>Avenula pubescens</i>	.	.	16	30	3	3	92	100 ^{57.2}

Table 2: Relevés of the association *Holcetum lanati* Issler 1936.

No. of relevés	118	20	93	69	91	104	4	103	1
Character species									
<i>Cardamine pratensis</i>	+	+	+	.	1	+	.	+	.
<i>Ranunculus acris</i>	2	1	2	2	1	2	.	2	+
<i>Lychnis flos-cuculi</i>	+	.	1	1	1	+	.	+	.
<i>Lysimachia nummularia</i>	1	.	.	2	.	1	.	+	.
<i>Equisetum arvense</i>	.	+	+	+	.	.	.	1	+
<i>Plantago major</i>	1	+	.	.	.	1	r	.	+
<i>Plantago lanceolata</i>	+	1	1	.	+	+	+	1	1
<i>Rumex acetosa</i>	1	+	1	2	+	+	.	1	+
<i>Veronica chamaedrys</i>	1	1	.	+	+	+	+	+	+
<i>Poa pratensis</i>	2	.	1	+	.	3	+	2	+
Other species									
<i>Alopecurus pratensis</i>	2	.	2	2	2	1	.	1	1
<i>Ranunculus repens</i>	2	1	.	2	+	+	+	.	1
<i>Festuca pratensis</i> s.str.	1	+	.	1	1	1	+	.	+
<i>Trifolium repens</i>	1	+	.	1	.	2	+	+	1
<i>Achillea millefolium</i>	+	.	.	+	1	+	1	+	1
<i>Cerastium holosteoides</i>	+	+	.	+	+	1	.	+	+
<i>Taraxacum</i> sect. <i>Ruderalia</i>	1	.	r	.	+	1	+	1	+
<i>Trifolium pratense</i>	2	1	2	.	.	1	+	1	1
<i>Anthoxanthum odoratum</i>	1	.	2	2	.	+	+	+	.
<i>Campanula patula</i>	.	r	1	+	.	1	.	+	+
<i>Centaurea jacea</i>	+	+	.	.	1	.	+	1	2
<i>Carex pallescens</i>	.	2	.	2	2	+	+	.	.
<i>Cruciata glabra</i>	.	2	.	1	+	.	+	+	.
<i>Galium mollugo</i> agg.	.	.	1	+	+	.	.	1	+
<i>Luzula campestris</i>	.	+	1	.	1	+	.	+	.

Tabela 2: Popisi asociacije *Holcetum lanati* Issler 1936.

No. of relevés	118	20	93	69	91	104	4	103	1
<i>Leucanthemum vulgare</i>	.	+	+	.	+	+	.	+	.
<i>Dactylis glomerata</i>	2	.	.	.	+	.	+	1	+
<i>Carex muricata</i> agg.	.	2	.	1	.	+	+	.	.
<i>Leontodon autumnalis</i>	.	.	.	.	.	2	1	+	r
<i>Plantago media</i>	.	.	.	.	.	r	+	1	r
<i>Leontodon hispidus</i>	.	.	1	.	.	.	1	1	+
<i>Lotus corniculatus</i>	+	.	.	.	.	.	1	+	+
<i>Holcus lanatus</i>	2	2	.	.	.	.	.	.	+
<i>Myosotis arvensis</i>	.	.	.	+	+	+	.	.	.
<i>Agrostis capillaris</i>	.	.	.	+	.	.	+	.	+
<i>Poa compressa</i>	+	.	.	.	2	1	.	.	.
<i>Cynosurus cristatus</i>	.	.	.	.	1	2	+	.	.
<i>Trifolium campestre</i>	+	.	+	.	+	.	.	.	.
<i>Potentilla reptans</i>	+	.	+	.	+	.	.	.	.
<i>Agrimonia eupatoria</i>	.	.	.	.	+	.	1	.	+
<i>Vicia tetrasperma</i>	.	.	1	.	+	.	+	.	.
<i>Glechoma hederacea</i>	1	.	.	.	.	+	.	.	+
<i>Stellaria graminea</i>	+	+	.	.	.	+	.	.	.
<i>Rumex acetosella</i> s.lat.	+	+	.	.	.	+	.	.	.
<i>Prunella vulgaris</i>	.	.	.	.	.	+	+	.	+
<i>Arrhenatherum elatius</i>	.	.	1	.	.	.	+	.	+
<i>Daucus carota</i>	.	.	+	.	.	.	+	.	+
<i>Knautia arvensis</i>	.	.	r	.	.	.	+	.	1
<i>Pimpinella saxifraga</i>	.	+	.	.	.	.	+	1	.
<i>Crepis biennis</i>	.	.	.	.	.	.	+	1	1
<i>Trisetum flavescens</i>	2	.	2	.	.	.	.	2	.

Table 3: Relevés of the association *Pastinaco sativae-Arrhenatheretum elatioris* Passarge 1964 - intensively used meadows.

Tabela 3: Popisi asociacije *Pastinaco sativae-Arrhenatheretum elatioris* Passarge 1964 – intenzivno gospodarjena travišča.

No. of relevés	98	2	3	102	101
Character species					
<i>Carduus personata</i>	.	1	+	.	.
<i>Cirsium oleraceum</i>	.	1	r	.	.
<i>Plantago major</i>	1	2	2	.	+
<i>Rumex obtusifolius</i>	.	1	1	.	.
<i>Stellaria media</i>	.	.	.	+	+
<i>Symphytum officinale</i>	.	1	1	.	1
<i>Achillea millefolium</i>	1	2	2	+	1
<i>Alopecurus pratensis</i>	2	1	1	2	+
<i>Dactylis glomerata</i>	2	1	1	+	2
<i>Poa pratensis</i>	2	2	2	3	2
<i>Ranunculus acris</i>	+	+	+	1	1
<i>Taraxacum</i> sect. <i>Ruderalia</i>	1	1	1	1	+
<i>Trifolium pratense</i>	2	2	2	1	2
Other species					
<i>Ranunculus repens</i>	+	2	2	+	.
<i>Arrhenatherum elatius</i>	1	1	1	+	.
<i>Trifolium repens</i>	+	2	2	.	2

No. of relevés	98	2	3	102	101
<i>Deschampsia cespitosa</i>	1	2	2	.	2
<i>Agrimonia eupatoria</i>	.	1	1	+	1
<i>Plantago lanceolata</i>	1	2	2	.	+
<i>Lychnis flos-cuculi</i>	+	+	+	.	+
<i>Glechoma hederacea</i>	1	2	2	.	.
<i>Galium mollugo</i> agg.	.	1	1	2	.
<i>Anthriscus sylvestris</i>	.	r	r	1	.
<i>Centaurea jacea</i>	1	.	.	1	1
<i>Trisetum flavescens</i>	1	.	.	1	+
<i>Daucus carota</i>	.	1	1	.	+
<i>Veronica verna</i>	.	+	+	.	+
<i>Rumex acetosa</i>	1	.	+	.	.
<i>Veronica chamaedrys</i>	1	.	.	1	.
<i>Vicia sepium</i>	+	.	.	+	.
<i>Lathyrus pratensis</i>	.	2	2	.	.
<i>Equisetum arvense</i>	.	1	2	.	.
<i>Pimpinella saxifraga</i> s.str.	.	1	1	.	.

Table 4: Relevés of the association *Pastinaco sativae-Arrhenatheretum elatioris* Passarge 1964.

Tabela 4: Popisi asociacije *Pastinaco sativae-Arrhenatheretum elatioris* Passarge 1964.

No. of relevés	40	54	59	60	13	39	12	10	5	31	100	79	113	97	140	30	96	138	139	152	85	120	38	136	34	19	115	112	114	123	110	116		
Character species																																		
<i>Veronica chamaedrys</i>	1	+	+	+	1	1	+	+	1	1	1	+	1	1	.	2	1	+	1	1	+	1	1	+	2	1	1	+	2	+	1	2		
<i>Achillea millefolium</i>	1	+	1	+	2	.	1	1	.	1	+	+	+	1	+	2	1	1	+	+	+	+	1	.	1	+	+	+	+	+	+	+	+	
<i>Arrhenatherum elatius</i>	2	.	2	.	.	2	.	+	.	+	2	1	2	.	+	1	+	2	2	1	.	3	+	4	1	.	2	2	1	.	1	1		
<i>Alopecurus pratensis</i>	1	2	2	2	2	1	+	2	.	.	2	1	2	1	.	1	.	2	1	1	2	2	1	.	1	+	.	2	2	+	1	1		
<i>Dactylis glomerata</i>	1	+	+	2	+	2	+	+	2	+	2	+	1	2	+	+	.	1	1	.	+	2	1	2	1	.	+	2	+	1	1	1		
<i>Plantago lanceolata</i>	1	.	1	.	1	.	1	1	+	1	.	1	+	1	1	2	1	1	1	1	1	2	2	1	.	+	+	1	+	2	1	+	1	
<i>Rumex acetosa</i>	+	+	+	+	1	+	r	.	+	+	1	r	+	1	+	+	1	+	+	+	+	+	+	.	+	r	.	+	1	.	.	+		
<i>Trifolium pratense</i>	2	2	1	+	2	1	2	2	1	2	.	2	2	2	2	2	2	1	2	1	2	2	2	.	2	2	2	2	1	2	1	2	1	2
<i>Festuca pratensis</i>	+	1	.	.	.	+	.	.	+	.	.	+	.	.	.	+	.	1	3	.	.	1	1	1	2	.	1	1	+	1	.	+		
<i>Festuca rubra</i>	+	+	1	2	.	.	2	1	+	2	.	.	+	2	+	+	+	+	+	+	.	.	2	.	2	3	1	+	.	+	+	+		
<i>Fragaria viridis</i>	1	2	.	3	.	
<i>Poa pratensis</i>	2	.	.	.	+	1	+	+	+	.	1	.	1	.	+	.	.	.	.	.	1	1	+	+	1	+	1	.	+	3	2	1
<i>Rhinanthus minor</i>	1	.	1	+	1	.	.	+	r	1	.	.	.	1	+	+	+	+	+	+	.	3	.	1	
<i>Trifolium repens</i>	2	1	1	2	2	1	2	2	1	2	.	2	1	.	2	.	1	2	.	.	1	2	.	2	2	2	2	2	2	2	2	2	2	
<i>Trisetum flavescens</i>	.	+	1	1	.	.	+	.	1	1	+	1	2	+	1	2	.	2	1	.	.	2	1	.	2	+	2	2	2	2	2	2	2	
<i>Ranunculus acris</i>	+	+	+	1	.	+	.	.	+	+	1	+	2	1	+	2	2	.	1	.	1	r	+	.	2	.	.	1	2	+	.	2		
<i>Taraxacum sect. Ruderalia</i>	.	+	+	2	2	+	2	.	+	+	.	.	.	r	.	2	+	+	.	.	.	1	+	.	2	+	.	+	1	2	2	1		
<i>Lotus corniculatus</i>	+	.	+	.	.	.	2	.	.	2	1	2	1	1	1	.	.	+	.	r	1	+	1	.	2	+	2	+	2	.	.	1		
<i>Leucanthemum vulgare</i>	+	.	+	+	+	+	+	+	+	+	+	1	1	+	+	.	+	.	+	+	1	+	.	1	
<i>Campanula patula</i>	1	.	.	+	.	.	.	.	2	+	r	+	1	r	+	+	r	+	.	.	.	.	+	.	r	1	+	r	1	+	.	1
<i>Luzula campestris</i>	.	.	+	.	+	.	+	+	1	+	+	.	+	+	+	1	1	.	.	+	1	+	+	+	.	+	.	.	+	
<i>Pimpinella saxifraga</i>	+	2	+	.	.	+	1	.	+	2	+	+	+	+	.	+	1	+	.	.	+	+	
<i>Tragopogon orientalis</i>	+	r	+	2	r	+	.	.	.	.	.	+	.	.	.	.	.	+	+	.	.	1	r	+	+	1	.	+	.	+	.	.
<i>Cerastium holosteoides</i>	.	.	+	+	1	.	+	2	1	+	.	.	.	+	+	2	.	.	.	+	.	.	+	.	.	+	.	+	+	+	+	2	+	
<i>Myosotis arvensis</i>	+	.	+	+	.	+	1	+	+	+	.	1	1	.	.	.	+	+	.	1	+	.	.	.	.	.	+	+	.	r	1	.
<i>Avenula versicolor</i>	.	1	1	1	.	+	2	.	1	1	+	+	2	1	.	1	.	.	.	+	2	.	+	.	2	1	.	.	.	.	1	.
<i>Leontodon autumnalis</i>	.	.	.	2	.	.	1	+	2	1	.	1	.	.	1	1	.	+	+	+	.	.	1	.	1	1	+	.	.	1	.	1		
<i>Ranunculus repens</i>	1	2	+	+	1	.	+	.	+	2	+	.	.	1	+	2	1	.	.	1	.	.	2	2	.	.	.	.	.	.	.	r
<i>Centaurea elatior</i>	+	1	+	2	.	.	.	.	.	.	+	1	2	.	.	+	.	.	.	.	.	.	.	+	.	2	.	+	.	1	+	.
<i>Leontodon hispidus</i>	.	.	2	.	+	.	.	.	.	1	+	.	.	1	.	1	1	.	+	.	2	2	.	.	.	2	+	+	1	1	+	2
<i>Anthoxanthum odoratum</i>	.	.	.	.	.	.	+	+	+	.	+	+	1	2	2	.	2	1	.	.	2	1	1	.	.	.	1	1	+	.	.	1
<i>Lathyrus pratensis</i>	+	+	+	2	.	.	.	.	.	.	1	.	.	.	+	+	+	.	.	1	1	+	+	.	2	.	+	.	+	.	.	+
<i>Centaurea jacea</i>	r	.	.	.	.	+	.	.	+	r	1	+	1	.	+	+	2	1	+	.	2	.	.	.	2	.	.	+	.	.	.	.
<i>Cruciata glabra</i>	+	.	.	.	.	+	.	.	1	+	+	.	1	.	+	.	+	.	.	1	1	+	2	.	1	+	+	.	.	.	.	.
<i>Rumex acetosella</i>	1	+	+	+	.	+	.	.	.	+	.	.	1	.	.	.	+	.	r	+	.	.	+	+	+	
<i>Vicia sepium</i>	2	.	2	2	1	2	+	.	+	.	+	+	+	+	r	+	.	
<i>Anthriscus sylvestris</i>	+	2	2	2	.	2	.	.	r	r	.	.	.	+	.	r	1	.	.	+	.	.	+	1	
<i>Knautia arvensis</i>	.	.	+	r	.	r	.	.	.	.	.	.	+	.	+	.	.	+	+	.	2	.	2	.	1	r	1	.	.	.	.	+
<i>Galium verum</i>	.	+	.	.	+	+	+	+	.	.	1	.	.	+	+	.	1	1	+	1	.	
<i>Crepis biennis</i>	.	.	.	2	1	2	.	.	+	1	.	r	+	.	.	.	r	+	1	+	1	
<i>Veronica verna</i>	+	.	+	.	+	.	1	2	1	1	.	+	.	+	.	1	+	
<i>Fragaria vesca</i>	+	.	+	.	+	.	1	1	2	1	1	2	.	.	+	1	+	
<i>Vicia cracca</i>	2	1	.	.	+	2	+	.	+	+	+	+	1	+	.	.	.	

Table 5: Relevés of the association *Alchemillo-Arrhenatheretum elatioris* Sougnez et Limbourg 1963.
Tabela 5: Popisi asociacije *Alchemillo-Arrhenatheretum elatioris* Sougnez et Limbourg 1963.

Character species	131	111	129	18	141	131	132	134	92	86	108	58	137	77	62	37	33	82	122	122	117	121	153	124	148	133	150	
<i>Centaurea phrygia</i>	+	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·
<i>Lathyrus pratensis</i>	+	+	1	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·
<i>Vicia hirsuta</i>	·	·	·	2	+	+	+	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·
<i>Achillea millefolium</i>	+	+	+	1	+	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
<i>Arrhenatherum elatius</i>	3	2	3	·	2	2	3	+	1	·	·	·	2	2	+	+	+	+	+	+	2	3	+	2	2	1	2	
<i>Dactylis glomerata</i>	1	1	+	·	·	·	·	·	1	+	2	1	+	2	+	1	1	+	+	+	·	·	·	·	·	·	·	·
<i>Festuca rubra</i>	2	2	2	3	2	1	2	1	+	2	1	+	·	·	+	2	1	2	·	2	1	+	2	+	2	3	1	+
<i>Plantago lanceolata</i>	1	+	·	+	·	1	·	1	1	2	1	2	1	2	1	+	+	1	1	+	2	1	1	+	1	+	+	1
<i>Rumex acetosa</i>	+	·	+	1	+	·	·	·	+	1	+	+	+	+	+	+	+	+	+	+	1	·	·	·	·	·	·	·
<i>Trisetum flavescens</i>	+	1	·	+	·	1	2	2	2	+	2	+	1	1	2	1	2	+	1	2	2	2	·	2	2	2	2	1
<i>Trifolium pratense</i>	+	+	1	·	1	1	1	1	+	2	1	2	2	2	2	2	2	2	1	2	2	2	1	·	1	+	1	1
<i>Anthoxanthum odoratum</i>	2	+	2	·	·	·	·	·	+	1	·	·	2	·	·	·	·	·	2	1	+	1	2	·	·	+	3	3
<i>Avenula pubescens</i>	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·
<i>Fragaria viridis</i>	·	2	3	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·
<i>Leontodon hispidus</i>	+	1	·	·	·	·	·	·	1	1	·	2	1	2	+	2	2	·	2	·	2	·	2	1	+	+	2	
<i>Veronica chamaedrys</i>	·	+	+	1	·	·	·	·	+	2	2	1	·	·	·	·	·	·	1	+	+	1	+	1	+	1	·	·
<i>Pimpinella saxifraga</i>	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·
<i>Lotus corniculatus</i>	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·
<i>Alopecurus pratensis</i>	2	2	2	1	+	1	2	+	2	2	1	1	2	1	2	·	·	·	1	·	1	+	+	+	1	·	·	·
<i>Tragopogon orientalis</i>	·	+	+	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·
<i>Cruciata glabra</i>	·	1	·	2	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·
<i>Leucanthemum vulgare</i>	r	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·
<i>Trifolium repens</i>	·	·	·	1	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·
<i>Salvia pratensis</i>	+	1	2	·	·	·	·	·	·	1	1	·	2	1	2	·	·	·	·	·	1	2	1	1	1	·	·	·
<i>Centaurea jacea</i>	+	1	r	2	·	·	·	·	·	1	+	·	1	+	·	·	·	·	·	·	·	·	·	·	·	·	·	·
<i>Luzula campestris</i>	+	+	+	2	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·
<i>Knautia arvensis</i>	+	r	·	1	·	·	·	·	·	1	·	1	·	2	+	r	r	1	·	2	1	1	·	·	·	·	·	·
<i>Stellaria graminea</i>	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·
<i>Campnula patula</i>	·	+	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·
<i>Hypericum perforatum</i>	·	·	+	+	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·
<i>Taraxacum sect. Ruderalia</i>	·	r	·	+	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·
<i>Cerastium holosteoides</i>	·	·	+	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·
<i>Galium verum</i>	1	+	1	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·

No. of relevés	131	111	129	18	141	131	132	134	92	86	108	58	137	77	62	37	33	82	122	122	117	121	153	124	148	133	150
<i>Poa angustifolia</i>	+	1	+	.	+	.	.	.	.	.	1	+	+	.	+	.	.	.	.	.	+	+	+	+	.	.	.
<i>Festuca pratensis</i>	.	+	1	.	.	1	.	.	.	.	+	1	+	.	.	.	.	1	.	1	+	2	.	.	.	.	1
<i>Filipendula vulgaris</i>	+	+	+	+	.	+	+	1	2	.	1	2	+	+	.	.	.	.	.	+
<i>Plantago media</i>	r	+	.	.	1	.	+	+	.	.	+	.	.	.	.	1	.	2	.	2	+	.	.	+	.	.	+
<i>Ranunculus acris</i>	.	+	+	.	.	.	+	1	.	.	+	r	1	+	+	.	1	+	+	2	.	.	.	.	.	.	.
<i>Dianthus carthusianorum</i>	+	+	+	.	+	+	+	+	2	+	.	2	.	+	.	.	+	+	.	1	.
<i>Rhinanthus minor</i>	2	+	1	.	2	1	+	2	.	+	+	1	+	+	2	.	.	.	.
<i>Leontodon autumnalis</i>	.	.	.	r	.	.	.	2	.	.	2	1	1	1	2	2	.	.	.	2	.	.	.	.	+	.	1
<i>Ranunculus repens</i>	+	+	1	.	.	.	+	+	+	+	1	2	.	.	.	.	.	.	.	.	.	.
<i>Poa pratensis</i>	+	.	.	+	.	.	1	1	2	.	.	.	.	.	.	1	+	1	1	.	.	1	.	.	.	.	.
<i>Vicia sepium</i>	+	+	+	.	+	+	+	+	+	+
<i>Ranunculus polyanthemos</i>	.	+	.	1	.	.	.	.	.	.	1	.	+	.	.	.	.	.	.	1	.	1	r	+	.	.	.
<i>Myosotis arvensis</i>	.	+	+	+	+	.	+	+	+	+	+	+	.	.	.	+	+
<i>Vicia cracca</i>	.	.	+	+	+	.	2	.	.	.	.	.	.	.	+	.	.	.	.	+
<i>Euphorbia cyparissias</i>	.	.	r	.	.	+	+	+	+	.	1	.	.	+	.	.	.	1	.	.	.	1	.	.	.	+	.
<i>Rumex acetosella</i>	.	.	.	2	.	.	.	+	+	.	.	.	.	.	.	.	.	.	.	.	r	.	r	+	.	.	1
<i>Briza media</i>	+	2	+	.	.	.	.	.	.	.	+	.	.	.	.	1	.	.	.	+	1	.	.	.	.	.	.
<i>Rosa canina</i> s.lat.	r	r	.	.	.	+	.	r	r	.	+	.	r	.	1	.	.	.	r	.	.	.	.	.	.	.	.
<i>Avenula versicolor</i>	.	.	.	+	+	1	.	.	.	2	2	1	.	.	1	.	+	.	.	2	.
<i>Trifolium montianum</i>	+	1	1	+	.	.	+	1	.	.	.	.	2
<i>Daucus carota</i>	+	.	+	+	+	+	+
<i>Fragaria vesca</i>	+	.	2	.	2	1	.	1	1	.	.	.	1	.	.	.	.	2
<i>Centaurea elatior</i>	1	1	.	2	r	1	.	1	2	.	1	.	+	.	.	.	.
<i>Thymus pulegioides</i>	.	+	.	.	.	+	+	+	+	+	+	1	.
<i>Lychmis viscaria</i>	.	+
<i>Alchemilla xanthochlora</i>	.	+	.	+
<i>Galium mollugo</i>	.	+	+	.	2	.	.	.	1	.	r	.	.	.	.	.	.	+
<i>Anthriscus sylvestris</i>	.	r	.	r	.	.	.	r	.	.	1	.	.	.	.	r	.	.	.	.	.	.	.	.	.	.	.
<i>Viola arvensis</i>
<i>Vicia tetrasperma</i>	r	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
<i>Veronica verna</i>	1	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.
<i>Carex pallescens</i>	.	1	2	.	.	.	.	.	.	.	.	.	.	2	.	.	.	.	.	.	.	.	.	.	.	.	.
<i>Crataegus monogyna</i>	.	1	.	.	.	.	.	.	r	.	.	.	.	.	.	.	.	.	.	.	r	.	.	.	.	r	r
<i>Carex muricata</i>	.	.	2	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.
<i>Colchicum autumnale</i>	.	.	r	+	.	.	.	.	.	r	.	2	.	.	.	.	.	.	.	.	.	.	.	.	.	r	.
<i>Trifolium campestre</i>	.	.	.	+	1	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.

Table 6: Relevés of the alliance *Arrhenatherion elatioris* Luquet 1926.
Tabela 6: Popisi zveze *Arrhenatherion elatioris* Luquet 1926.

No. of relevés	76	70	78	80	83	75	74	36	46	81	84	55	57	41	64	28	29	32	135	42	16	87	61	35	7	14	15	17	44	6	48	43	11					
Character species																																						
<i>Dianthus carthusianorum</i>	+	.	+	+	+	+	+	+	+	.	.	1	2	+	+	+	+	+	+	+	.	+	+	+	+	+	+	+	+	+	+	+	+	.				
<i>Plantago media</i>	.	.	+	1	1	2	2	.	.	.	.	.	+	.	.	2	2	+	3	.	2	2	+	r	1	1	+	.	1	2	+	.	.	.				
<i>Primula veris</i>	+	.	.	1	.	2	.	2	.	.	.	.	.	.	.	2	2	1	.	1	1	.	.	.	.	.	.	.	.	2	.	1	.	1	.			
<i>Salvia pratensis</i>	2	.	2	+	.	2	2	2	r	2	.	.	+	.	.	1	2	1	.	1	1	.	1	1	.	1	2	r	.	1	1	r	2	.	.			
<i>Achillea millefolium</i>	.	.	+	1	+	1	.	.	.	+	+	1	.	.	1	2	1	2	1	1	2	1	1	1	+	2	1	1	1	1	1	1	1	.	2	.		
<i>Arrhenatherum elatius</i>	1	.	2	1	2	1	.	2	2	2	2	.	+	.	.	1	1	+	2	1	+	+	+	+	+	+	+	2	1	2	1	2	2	+	+	.		
<i>Dactylis glomerata</i>	+	+	+	+	+	+	+	+	+	2	2	+	1	+	1	+	+	+	+	+	+	+	+	+	+	.	1	+	.	+	1	+	+	+	.	.		
<i>Leucanthemum vulgare</i>	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	.	.	
<i>Plantago lanceolata</i>	+	+	1	1	+	.	.	1	1	1	1	+	2	+	1	+	1	+	1	+	1	+	+	2	1	1	1	1	1	1	2	2	+	+	+	.	.	
<i>Trifolium pratense</i>	1	1	1	1	1	.	+	+	.	1	1	1	1	1	1	1	1	2	1	+	+	+	1	2	1	2	+	.	2	1	1	1	1	1	1	1	1	1
<i>Bromus hordeaceus</i>	+	+	2	2	1	+	3	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
<i>Festuca pratensis</i>	+	3	+	+	1	.	.	.	+	1	2	2	.	1	1	+	+	1	.	1	.	1	2	+	.	.	.	.	.	.	.	.	.	.	.	.	.
<i>Festuca rubra</i>	.	.	.	1	2	1	1	.	.	.	.	.	3	2	3	2	2	2	2	+	.	2	2	3	3	1	2	2	2	1	+	+	+	+	3	1	1	
Other species																																						
<i>Lathyrus pratensis</i>	.	1	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
<i>Vicia hirsuta</i>	.	.	+	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
<i>Rumex acetosa</i>	+	.	+	+	r	.	+	.	+	+	1	+	.	r	.	r	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
<i>Trisetum flavescens</i>	+	.	1	.	1	.	2	.	.	1	1	2	+	1	1	+	1	1	2	1	1	+	1	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.
<i>Anthoxanthum odoratum</i>	+	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
<i>Arrhenatherum elatius</i>	1	.	2	1	2	1	.	2	2	2	2	.	+	.	.	1	1	+	2	1	+	+	+	+	+	+	+	2	1	2	1	2	1	2	2	+	+	
<i>Lotus corniculatus</i>	2	2	2	2	+	1	+	.	.	1	1	+	1	1	+	2	2	2	+	+	+	+	+	+	+	+	+	+	1	+	+	+	+	+	+	+	+	+
<i>Trifolium repens</i>	1	2	1	1	.	+	+	.	.	.	.	.	1	1	1	2	1	2	2	+	+	2	2	1	1	.	1	+	.	2	1	1	.	.	.	.	.
<i>Leontodon hispidus</i>	2	.	2	1	1	.	1	.	+	1	1	2	1	2	1	2	2	2	2	2	2	.	1	2	2	.	.	.	.	.	.	.	.	.	.	.	.
<i>Poa pratensis</i>	+	.	1	+	+	2	.	.	.	.	.	.	.	.	1	1	1	+	+	+	.	+	1	.	1	.	+	1	1	1	1	1	1	1	1	1	1	1
<i>Knautia arvensis</i>	+	.	+	+	+	2	.	.	.	.	.	.	.	.	r	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
<i>Tragopogon orientalis</i>	+	.	+	+	r	.	.	.	r	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
<i>Luzula campestris</i>	.	+	+	+	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
<i>Fragaria vesca</i>	.	.	1	.	.	.	+	+	1	2	.	.	.	.	.	2	2	2	.	1	2	2	+	+	.	2	1	2	2	1	1	1	1	1	1	1	1	1
<i>Filipendula vulgaris</i>	2	.	+	2	+	2	.	2	2	2	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
<i>Briza media</i>	1	1	1	1	1	+	+	+	1	+	.	.	.	.	.	1	1	.	1	2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
<i>Pimpinella saxifraga</i>	.	.	+	.	.	.	+	+	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
<i>Veronica chamaedrys</i>	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
<i>Alpecurus pratensis</i>	.	+	2	+	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.

No. of relevés	76	70	78	80	83	75	74	36	46	81	84	55	57	41	64	28	29	32	135	42	16	87	61	35	7	14	15	17	44	6	48	43	11				
<i>Cerastium holosteoides</i>	+	.	+	+	+	+	+	+	.	.	.	.	1	+	1	+	+	+	+	.	+	+	+	.	.	.	.	.	.	.	.	.	.	1		
<i>Avenula versicolor</i>	1	.	.	+	+	1	2	1	.	.	.	2	2	.	.	1	1	1	1	.	1	1	+	1	.	.	.	.	.	.	.	.	.	+
<i>Rhinanthus minor</i>	+	.	2	+	+	2	.	.	.	.	+	.	.	.	.	1	+	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	2	
<i>Ranunculus repens</i>	+	.	+	+	+	+	+	+	.	1	1	+	2	.	.	1	.	.	2	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.
<i>Ranunculus acris</i>	.	.	+	+	+	1	+	+	.	+	1	.	.	.	.	.	+	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
<i>Myosotis arvensis</i>	.	.	+	+	+	+	+	+	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
<i>Cruciata glabra</i>	.	+	+	1	+	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1
<i>Campanula patula</i>	.	+	+	+	+	.	.	r	r	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
<i>Vicia sepium</i>	.	+	+	+	+	.	.	2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
<i>Vicia tetrasperma</i>	.	.	.	.	.	+	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
<i>Trifolium montanum</i>	1	.	1	1	+	+	2	.	1	.	1	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	2
<i>Rumex acetosella</i>	.	+	.	.	+	.	.	.	.	.	.	+	2	+	2	+	+	+	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+
<i>Galium verum</i>	.	.	+	1	1	.	.	.	.	1	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1
<i>Veronica verna</i>	.	.	+	+	+	.	.	.	.	.	.	.	1	+	+	+	+	+	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
<i>Viola arvensis</i>	.	.	.	.	+	.	.	.	.	.	.	.	1	+	+	+	+	+	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
<i>Euphorbia cyparissias</i>	.	.	.	.	.	1	.	.	.	.	.	.	+	.	.	2	2	.	2	.	2	+	1	1	.	.	.	.	.	.	.	.	.	.	+
<i>Leontodon autumnalis</i>	1	.	.	.	+	.	.	.	.	.	.	2	1	.	1	2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
<i>Lychis viscaria</i>	.	.	.	.	.	.	.	.	.	.	.	1	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
<i>Hypericum perforatum</i>	.	+	+	1	+	.	.	.	.	.	1	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
<i>Vicia cracca</i>	2	.	+	1	.	.	+	2	.	+	1	.	.	2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+
<i>Thymus pulegioides</i>	.	+	+	+	+	+	+	+	1
<i>Taraxacum</i> sect. <i>Ruderalia</i>	.	+	+	+	.	.	.	.	.	.	1	+	1	r	2	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	2
<i>Potentilla argentea</i>	.	.	.	.	.	.	.	.	.	.	.	.	2	+	+	+	+	+	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
<i>Centaurea jacea</i>	.	.	.	+	+	2	+	.	r
<i>Centaurea elatior</i>	2	1	.	1	+	2	+	.	.	r
<i>Colchicum autumnale</i>	.	2	2	r	2	2
<i>Carex pallescens</i>	.	+	+	+	2	2	.	.	.	2
<i>Trifolium campestre</i>	.	.	2	2	+
<i>Agrimonia eupatoria</i>	.	.	r	+	2	2
<i>Centaurea scabiosa</i>	.	.	r	.	+	1	2	2
<i>Stellaria graminea</i>	+	.	.	+
<i>Crepis biennis</i>	+	.	.	+
<i>Securigera varia</i>	2
<i>Deschampsia cespitosa</i>	2
<i>Agrostis capillaris</i>	+	1	.	+	+
<i>Alchemilla xanthochlora</i>	+	1

No. of relevés	76	70	78	80	83	75	74	36	46	81	84	55	57	41	64	28	29	32	135	42	16	87	61	35	7	14	15	17	44	6	48	43	11			
<i>Carex muricata</i>	.	.	1	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
<i>Rosa canina</i>
<i>Silene vulgaris</i>
<i>Viola canina</i>
<i>Cynosurus cristatus</i>	2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
<i>Prunella vulgaris</i>	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
<i>Polygala vulgaris</i>
<i>Trifolium alpestre</i>	2	.	2	.	.	.	.	.	2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
<i>Thesium linophyllum</i>	+
<i>Potentilla erecta</i>
<i>Genista tinctoria</i>
<i>Sanguisorba minor</i>
<i>Erophila verna</i>
<i>Sanguisorba officinalis</i>
<i>Hieracium cymosum</i>
<i>Hypochaeris radicata</i>
<i>Medicago lupulina</i>
<i>Potentilla reptans</i>
<i>Galium mollugo</i> agg.
<i>Hieracium pilosella</i>
<i>Dianthus deltoides</i>
<i>Trifolium ochroleucon</i>	2	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
<i>Geranium pratense</i>	+
<i>Fragaria viridis</i>
<i>Convulbulus arvensis</i>
<i>Betonica officinalis</i>
<i>Linum catharticum</i>
<i>Daucus carota</i>
<i>Hypericum maculatum</i>
<i>Ajuga reptans</i>
<i>Potentilla aurea</i>
<i>Hieracium baubini</i>
<i>Ranunculus polyanthemos</i>
<i>Cerastium brachypetalum</i>
<i>Ranunculus bulbosus</i>

No. of relevés	73	56	47	128	27	71	51	50	21	72	24	119	22	23	45	151	25	68	66	63	65	9	99	8	53	67	109	49	95	52			
<i>Rumex acetosella</i>	2	.	.	.	.	.	+	+	+	.	.	.	.	.	2	.	2	+	+	+	1	1	.	1	.	.	.	.	.	+
<i>Centaurea elatior</i>	2	1	.	+	1	.	.	r	.	2	r	.	2	r	1	.	r	.	.	.	.	.	1	1	+	2	+	.	.	.	
<i>Ranunculus acris</i>	+	.	+	+	1	+	+	.	.	.	.	1	.	.	.	.	.	r	.	.	.	.	.	+	2	2	+	.	.	+	
<i>Rhinanthus minor</i>	+	.	.	.	.	.	+	1	.	2	.	1	+	+	2	.	.	+	+	+	+	1	.	2	.	.	.	.	+	+
<i>Avenula versicolor</i>	.	2	.	.	2	.	+	2	.	.	.	.	+	.	.	.	.	+	1	2	2	1	.	1	2	2	+	1	.	2	
<i>Dactylis glomerata</i>	+	+	+	2	1	1	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	1	1	.	1	.	.	.	.	.
<i>Stellaria graminea</i>	+	+	+	.	.	.	+	.	+	+	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+
<i>Rosa canina</i>	.	2	.	.	r	.	1	+	.	r	.	r	.	.	.	.	.	r	2	.	.	.	.	.	.	.	.	.	.	1	1
<i>Fragaria vesca</i>	+	1	2	.	1	1	2	.	.	.	.	.	2	1	.	.	.	.	.	.	.	.	2	.	2	+	.	.	2	2	.
<i>Lycchnis viscaria</i>	+	+	+	+	+	.	+	+	2	2	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
<i>Fitipendula vulgaris</i>	.	2	2	+	2	+	2	+	2	2	+	2	2	2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
<i>Alchemilla xanthochlora</i>	.	.	+	.	2	+	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	1	.	1	+	.	.	.	1	.
<i>Cerastium holosteoides</i>	.	.	+	.	+	+	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+
<i>Ranunculus repens</i>	.	1	.	.	1	+	+	1	.	.	.	.	.	.	.	.	.	.	+	+	+	.	1	.	1	.	.	.	.	.	+
<i>Galium verum</i>	+	+	+	
<i>Poa pratensis</i>	.	.	.	.	.	.	+	1	.	1	.	.	.	.	.	.	.	.	1	1	2	1	1	1	1	+	.	.	.	.	.
<i>Trifolium montanum</i>	.	1	.	1	2	1	1	.	2	1	1	.	1	2	
<i>Knautilia arvensis</i>	.	+	.	.	+	.	+	+	.	r	+	
<i>Festuca pratensis</i>	.	.	.	1	+	.	.	.	.	.	.	.	.	.	.	.	.	.	1	2	2	2	.	2	.	1	+	.	.	.	.
<i>Carex pallascens</i>	2	2	.	.	1	2	.	.	1	
<i>Veronica serpyllifolia</i>	+	.	+	.	1	.	+	.	+	1	.	+
<i>Myosotis arvensis</i>	.	+	+	+
<i>Deschampsia cespitosa</i>	1	+	1	1	1	.	.	.	1	+
<i>Carlina acutis</i>	r	+	.	.	+	.	.	+	r

Table 8: Relevés of the alliance *Bromion erecti* Koch 1926.

Tabela 8: Popisi zveze *Bromion erecti* Koch 1926.

No. of relevés	143	149	125	147	144	127	88	145	90	89	94	146
Character species												
<i>Avenella flexuosa</i>	.	.	.	+	1	+	.	3	.	.	.	1
<i>Avenula pubescens</i>	+	1	1	+	2	2	1	.	2	2	2	1
<i>Brachypodium pinnatum</i>	.	.	4	+	.	.	2	.	.	2	.	2
<i>Campanula persicifolia</i>	+	.	r	.	1	r	.	.	.	.	.	+
<i>Geranium sanguineum</i>	2	r	2	1	+	+	.	.	.	2	.	2
<i>Silene nutans</i> s.lat.	+	.	r	+	+	.	.	.	.	.	.	+
<i>Trifolium alpestre</i>	1	+	+	1	+	+	+	.	.	+	.	1
<i>Anthoxanthum odoratum</i>	.	2	+	2	.	+	+	1	2	1	2	1
<i>Arrhenatherum elatius</i>	1	2	+	2	2	+	.	2	1	2	2	2
<i>Festuca rubra</i>	2	3	2	2	2	2	1	2	2	.	1	1
<i>Luzula campestris</i>	+	.	+	+	+	+	+	1	1	1	+	.
<i>Pimpinella saxifraga</i>	1	+	.	1	+	+	+	1	+	+	+	+
<i>Brachypodium pinnatum</i>	.	.	4	+	.	.	2	.	.	2	.	2
Other species												
<i>Dianthus carthusianorum</i>	1	+	.	+	1	+	+	+	+	.	+	.
<i>Briza media</i>	+	.	1	1	2	+	+	+	1	.	.	1
<i>Euphorbia cyparissias</i>	+	.	+	+	+	.	+	1	1	.	+	1
<i>Lychnis viscaria</i>	+	.	+	+	+	.	+	+	+	+	.	+
<i>Rumex acetosa</i>	+	.	+	r	+	+	+	.	+	1	+	.
<i>Rosa canina</i> s.lat.	r	.	r	r	+	r	r	+	r	.	1	.
<i>Plantago lanceolata</i>	.	+	+	1	.	+	.	+	+	+	+	+
<i>Lotus corniculatus</i>	.	+	+	+	+	+	+	+	+	+	.	+
<i>Achillea millefolium</i>	.	.	+	+	.	+	+	+	1	1	1	+
<i>Hypericum perforatum</i>	+	+	1	+	+	.	.	.	+	.	1	+
<i>Trisetum flavescens</i>	+	+	1	+	.	+	.	2	1	.	.	2
<i>Stellaria graminea</i>	+	.	+	+	+	+	.	+	.	+	.	+
<i>Thymus pulegioides</i>	.	+	+	+	+	.	.	+	+	.	1	+
<i>Leontodon hispidus</i>	.	.	1	2	2	+	1	.	1	1	.	2
<i>Trifolium montanum</i>	.	.	+	1	+	+	1	.	1	1	.	2
<i>Veronica chamaedrys</i>	.	.	+	.	+	1	+	+	.	+	+	1
<i>Rumex acetosella</i> s.lat.	2	+	+	.	2	+	.	1	+	.	.	.
<i>Fragaria vesca</i>	2	.	.	.	1	.	+	1	2	2	.	1
<i>Galium verum</i>	1	1	.	.	1	.	+	.	+	+	+	.
<i>Agrostis capillaris</i>	1	.	+	2	1	1	.	1	.	.	.	1
<i>Centaurea jacea</i>	.	r	.	+	+	.	1	.	1	.	1	+
<i>Knautia arvensis</i>	.	.	+	+	r	.	1	.	.	1	r	+
<i>Thesium linophyllum</i>	1	.	+	+	2	+	.	.	.	.	.	1
<i>Hieracium pilosella</i>	+	+	.	+	1	.	.	1	.	.	.	+
<i>Filipendula vulgaris</i>	.	.	2	+	.	+	1	.	.	1	.	+
<i>Salvia pratensis</i>	.	.	+	1	.	.	2	.	1	1	.	+
<i>Cruciata glabra</i>	.	.	+	+	+	1	.	+	.	.	.	1
<i>Trifolium pratense</i>	.	.	.	+	.	.	1	.	1	1	1	+
<i>Poa angustifolia</i>	.	+	+	.	+	+	.	+	.	.	.	.
<i>Vicia sepium</i>	.	+	.	.	.	.	+	.	1	+	+	.
<i>Viola canina</i>	.	.	+	.	.	2	.	+	.	1	+	.
<i>Ranunculus bulbosus</i>	.	.	+	.	.	+	.	.	1	2	+	.
<i>Leucanthemum vulgare</i>	.	.	r	+	.	+	.	.	1	.	.	+
<i>Leontodon autumnalis</i>	.	.	.	1	1	+	.	.	.	.	1	1
<i>Ranunculus repens</i>	.	.	.	1	.	.	+	+	r	.	.	+
<i>Teucrium chamaedrys</i>	2	.	.	+	.	.	.	+	.	.	1	.
<i>Potentilla argentea</i> agg.	1	1	.	.	.	.	+	.	+	.	.	.

No. of relevés	143	149	125	147	144	127	88	145	90	89	94	146
<i>Hieracium baubini</i>	1	.	.	+	.	.	.	.	r	.	.	+
<i>Carex caryophylla</i>	+	1	+	.	.	.	+	.	.	.	.	.
<i>Poa compressa</i>	+	.	.	.	+	.	+	.	.	.	1	.
<i>Trifolium campestre</i>	.	1	+	.	.	.	.	.	+	.	.	+
<i>Luzula multiflora</i> s.lat.	.	1	.	.	.	+	.	+	.	.	.	+
<i>Sanguisorba minor</i>	.	+	1	+	.	.	.	.	1	.	.	.
<i>Cerastium holosteoides</i>	.	+	+	+	.	.	.	+
<i>Veronica officinalis</i>	.	+	r	.	.	.	.	+	.	.	.	+
<i>Centaurea phrygia</i>	.	r	.	.	1	.	.	+	.	.	.	+
<i>Alchemilla xanthochlora</i>	.	.	1	1	.	+	.	.	.	.	.	1
<i>Dactylis glomerata</i>	.	.	.	1	.	+	+	.	.	.	.	+
<i>Hypochaeris maculata</i>	.	.	.	+	2	r	.	.	.	.	.	+
<i>Carlina acaulis</i>	.	.	.	+	1	r	.	.	.	.	.	+
<i>Tragopogon orientalis</i>	.	.	.	+	+	1	+
<i>Phleum pratense</i>	1	.	+	.	+	.	.	.	.	.	.	.
<i>Primula elatior</i>	.	.	1	+	.	1	.	.	.	.	.	.
<i>Anthyllis vulneraria</i>	.	.	+	2	.	+	.	.	.	.	.	.
<i>Potentilla erecta</i>	.	.	+	.	.	1	.	.	.	.	.	+
<i>Trifolium repens</i>	.	.	.	+	+	+
<i>Nardus stricta</i>	.	.	.	+	.	1	.	2	.	.	.	.
<i>Polygala vulgaris</i>	.	.	.	+	.	+	+
<i>Bromus erectus</i>	.	.	.	+	.	.	2	.	.	2	.	.
<i>Trifolium ochroleucon</i>	.	.	.	+	.	.	+	+
<i>Alopecurus pratensis</i>	+	+	.	1	.	.	.
<i>Poa pratensis</i>	1	.	2	1	.	.
<i>Vicia tetrasperma</i>	+	.	+	.	+	.
<i>Orchis morio</i>	1	+	.	r

Table 9: Relevés of the association *Onobrychido viciifoliae-Brometum erecti* T.Müller 1966.

Tabela 9: Popisi asociacije *Onobrychido viciifoliae-Brometum erecti* T.Müller 1966.

No. of relevés	107	124	105	126	106	No. of relevés	107	124	105	126	106
Character species						<i>Rosa canina</i> s.lat.	+	r	r	.	r
<i>Bromus erectus</i>	3	+	3	+	3	<i>Pimpinella saxifraga</i> s.str.	+	.	+	+	+
<i>Avenula pubescens</i>	2	+	+	2	1	<i>Tragopogon orientalis</i>	+	.	+	+	+
<i>Campanula rapunculoides</i>	+	.	.	r	+	<i>Knautia arvensis</i>	+	.	r	+	+
<i>Linum catharticum</i>	.	1	+	1	+	<i>Centaurea scabiosa</i>	+	.	r	+	r
<i>Medicago falcata</i>	.	+	+	+	.	<i>Cerastium holosteoides</i>	.	+	2	+	1
<i>Medicago lupulina</i>	.	+	1	1	1	<i>Lotus corniculatus</i>	.	+	1	+	2
<i>Primula elatior</i>	1	+	r	.	1	<i>Trisetum flavescens</i>	.	+	+	1	+
<i>Ranunculus bulbosus</i>	r	+	1	+	1	<i>Vicia cracca</i>	2	.	.	+	2
<i>Sanguisorba minor</i>	.	+	+	2	r	<i>Arrhenatherum elatius</i>	1	+	.	.	+
<i>Securigera varia</i>	.	+	1	.	1	<i>Prunus domestica</i>	1	.	+	.	r
<i>Dactylis glomerata</i>	+	1	+	+	+	<i>Polygala vulgaris</i>	+	+	.	+	.
<i>Dianthus carthusianorum</i>	+	+	+	+	+	<i>Euphorbia cyparissias</i>	+	+	.	.	+
<i>Festuca rubra</i>	2	2	1	2	1	<i>Trifolium montanum</i>	+	+	.	.	+
<i>Plantago lanceolata</i>	+	+	2	1	1	<i>Anthyllis vulneraria</i>	+	.	.	2	1
<i>Salvia pratensis</i>	+	+	1	2	2	<i>Leontodon hispidus</i>	.	+	r	2	.
<i>Geranium sanguineum</i>	.	3	.	.	.	<i>Trifolium repens</i>	.	.	2	1	1
Other species						<i>Trifolium pratense</i>	.	.	2	2	2
<i>Poa angustifolia</i>	1	+	.	+	1	<i>Leucanthemum vulgare</i>	.	.	1	+	+
<i>Leontodon autumnalis</i>	+	+	+	1	.	<i>Veronica chamaedrys</i>	.	.	+	+	+
<i>Carex caryophylla</i>	+	+	.	+	+						

Appendix

Table 1: Original relevé number, coordinates, altitude /m/, aspect, slope, heath-index, cover of herb layer /%/, number of species:

Association *Holcetum lanati* (Group No. 1). **Sites:** **1.** N48°27'55" E18°43'43", 238, -, 0°, 0.00, 70, 37; **4.** N48°28'4" E18°45'57", 251, NE, 10°, 0.59, 80, 38; **20.** N48°27'16" E18°49'16", 500, E, 10°, 0.59, 70, 33; **69.** N48°29'43" E18°47'31", 777, -, 0°, 0.00, 100, 31; **91.** N48°22'21" E18°38'37", 387, -, 0°, 0.00, 100, 42; **93.** N48°25'44" E18°40'54", 231, E, 1°, 1.42, 90, 25; **103.** N48°30'30" E18°46'37", 261, -, 0°, 0.00, 80, 38; **104.** N48°30'4" E18°48'38", 323, NEE, 10°, -0.59, 85, 42; **118.** N48°30'4" E18°50'22", 369, E, 5°, -3.09, 100, 33;

Association *Pastinaco sativae-Arrhenatheretum elatioris* - intensified meadows (Group No. 2). **Sites:** **2.** N48°27'44" E18°43'46", 233, -, 0°, 0.00, 95, 34; **3.** N48°27'41" E18°43'43", 235, -, 0°, 0.00, 100, 35; **98.** N48°23'22" E18°38'50", 278, -, 0°, 0.00, 85, 28; **101.** N48°23'2" E18°38'11", 277, -, 0°, 0.00, 80, 37; **102.** N48°23'31" E18°38'29", 369, -, 0°, 0.00, 85, 26;

Association *Pastinaco sativae-Arrhenatheretum elatioris* (Group No. 3) **Sites:** **5.** N48°28'7" E18°45'55", 459, W, 15°, 0.75, 95, 48; **10.** N48°28'10" E18°45'40", 489, W, 10°, -0.57, 100, 31; **12.** N48°28'14" E18°45'28", 462, SE, 5°, -2.80, 95, 37; **13.** N48°28'15" E18°45'21", 438, -, 0°, 0.00, 85, 27; **19.** N48°27'16" E18°49'10", 476, E, 5°, -3.09, 80, 30; **30.** N48°26'26" E18°47'30", 608, NE, 10°, 0.59, 95, 56; **31.** N48°26'22" E18°47'30", 610, E, 15°, -0.78, 75, 42; **34.** N48°26'14" E18°47'45", 619, -, 0°, 0.00, 100, 31; **38.** N48°26'10" E18°48'16", 712, NW, 12°, 0.03, 95, 41; **39.** N48°26'19" E18°48'17", 623, S, 10°, -0.03, 100, 32; **40.** N48°26'39" E18°48'2", 596, S, 10°, -0.03, 95, 50; **54.** N48°28'44" E18°49'47", 772, NE, 25°, -0.12, 100, 36; **59.** N48°26'9" E18°47'46", 609, W, 5°, 2.95, 100, 44; **60.** N48°26'3" E18°47'42", 611, SE, 15°, -0.71, 100, 35; **79.** N48°30'53" E18°47'30", 391, SW, 5°, 2.95, 95, 54; **85.** N48°20'1" E18°40'31", 489, -, 0°, 0.00, 90, 34; **96.** N48°25'41" E18°41'24", 249, E, 1°, 1.42, 85, 36; **97.** N48°25'54" E18°41'28", 232, E, 1°, 1.42, 80, 35; **100.** N48°23'23" E18°38'21", 279, -, 0°, 0.00, 85, 33; **110.** N48°32'2" E18°56'39", 690, -, 0°, 0.00, 85, 40; **112.** N48°32'29" E18°55'60", 617, NW, 1°, -0.07, 90, 38; **113.** N48°32'12" E18°56'20", 690, NEE, 3°, 0.13, 95, 37; **114.** N48°32'59" E18°57'17", 653, SE, 3°, -0.12, 95, 43; **115.** N48°32'52" E18°57'23", 643, E, 5°, -3.09, 90, 46; **116.** N48°33'23" E18°56'28", 658, SSW, 3°, -0.01, 95, 44; **120.** N48°31'5" E18°50'41", 488, NE, 3°, -0.13, 100, 45; **123.** N48°29'41" E18°51'51", 735, N, 1°, 1.29, 100, 36; **136.** N48°26'47" E18°51'50", 312, NEE, 7°, -0.79, 90, 22; **138.** N48°26'14" E18°50'42", 472, SW, 1°, -1.36, 85, 38; **139.** N48°26'49" E18°52'7", 586, SW, 1°, -1.36, 85, 30;

140. N48°28'43" E18°52'16", 583, S, 3°, 0.01, 90, 41; **152.** N48°24'38" E18°45'19", 806, NW, 1°, -0.07, 80, 45;

Association *Alchemillo - Arrhenatheretum elatioris* (Group No. 4)

Sites: **18.** N48°27'19" E18°49'5", 458, -, 0°, 0.00, 80, 28; **26.** N48°26'28" E18°47'4", 602, -, 0°, 0.00, 95, 53; **33.** N48°26'12" E18°47'41", 619, -, 0°, 0.00, 80, 51; **37.** N48°25'59" E18°48'19", 687, W, 15°, 0.75, 100, 41; **58.** N48°25'55" E18°47'53", 599, -, 0°, 0.00, 90, 43; **62.** N48°29'17" E18°52'56", 593, SW, 10°, -0.57, 85, 48; **77.** N48°30'45" E18°47'56", 370, SW, 5°, 2.95, 95, 39; **82.** N48°23'40" E18°45'5", 369, -, 0°, 0.00, 95, 42; **86.** N48°20'1" E18°41'43", 349, -, 0°, 0.00, 90, 42; **92.** N48°25'39" E18°40'52", 246, -, 0°, 0.00, 90, 38; **108.** N48°30'2" E18°50'11", 623, S, 5°, 0.15, 95, 51; **111.** N48°32'16" E18°56'53", 580, NNW, 7°, 0.03, 80, 49; **117.** N48°33'40" E19°0'8", 471, S, 7°, -0.04, 85, 44; **121.** N48°31'5" E18°50'45", 512, S, 7°, -0.04, 90, 43; **122.** N48°29'52" E18°51'56", 527, NE, 1°, 1.42, 90, 54; **129.** N48°34'25" E18°54'17", 223, SW, 7°, -0.76, 100, 35; **130.** N48°31'9" E18°51'1", 250, SW, 1°, -1.36, 100, 34; **131.** N48°31'15" E18°51'9", 582, -, 0°, 0.00, 90, 44; **132.** N48°29'58" E18°55'51", 595, NW, 1°, -0.07, 100, 37; **133.** N48°31'53" E18°51'50", 648, NNW, 1°, 1.35, 75, 43; **134.** N48°31'39" E18°52'51", 679, SW, 1°, -1.36, 80, 54; **137.** N48°26'31" E18°51'7", 469, N, 5°, -2.80, 80, 53; **141.** N48°28'60" E18°45'8", 356, SSW, 30°, -0.34, 75, 16; **142.** N48°28'42" E18°45'6", 418, SWW, 20°, 1.96, 90, 46; **148.** N48°27'41" E18°52'51", 734, NNE, 3°, 0.12, 80, 38; **150.** N48°28'28" E18°49'28", 376, NE, 3°, -0.13, 90, 44; **153.** N48°23'20" E18°38'37", 793, -, 0°, 0.00, 95, 41;

Alliance *Arrhenatherion elatioris* - succession stages (Group No. 5)

Sites: **6.** N48°28'14" E18°46'2", 475, W, 15°, 0.75, 100, 43; **7.** N48°28'20" E18°46'9", 497, NW, 10°, -0.03, 95, 45; **11.** N48°28'11" E18°45'33", 473, W, 5°, 2.95, 85, 41; **14.** N48°28'19" E18°45'12", 434, SW, 5°, 2.95, 80, 45; **15.** N48°27'23" E18°47'26", 417, S, 5°, 0.15, 90, 49; **16.** N48°27'24" E18°48'22", 461, E, 20°, 2.04, 75, 50; **17.** N48°27'15" E18°49'1", 433, W, 15°, 0.75, 95, 31; **28.** N48°26'28" E18°47'15", 617, SW, 5°, 2.95, 95, 63; **29.** N48°26'28" E18°47'20", 620, NE, 5°, -3.09, 95, 66; **32.** N48°26'22" E18°47'33", 604, -, 0°, 0.00, 75, 51; **35.** N48°25'54" E18°48'0", 620, NE, 10°, 0.59, 100, 31; **36.** N48°26'2" E18°48'30", 623, SW, 10°, -0.57, 95, 24; **41.** N48°26'32" E18°48'9", 563, -, 0°, 0.00, 80, 43; **42.** N48°27'32" E18°46'12", 536, NE, 20°, 2.04, 70, 51; **43.** N48°28'10" E18°49'40", 391, NW, 20°, -0.10, 100, 30; **44.** N48°28'10" E18°49'30", 606, NW, 20°, -0.10, 95, 48; **46.** N48°28'7" E18°49'10", 594, SE, 10°, 0.54, 80, 42; **48.** N48°28'51" E18°49'34", 506, SW, 25°, 0.12, 100, 49; **55.** N48°25'48" E18°47'49", 738, -, 0°, 0.00, 95, 35; **57.** N48°25'51" E18°47'52", 604, -, 0°, 0.00, 85, 35; **61.** N48°28'47" E18°52'56", 617, SW, 10°, -0.57, 95, 39; **64.** N48°28'41" E18°52'54", 816, -, 0°, 0.00, 80, 48; **70.** N48°29'58" E18°47'2", 687, N, 10°, 0.54, 95, 31; **74.** N48°29'57" E18°48'2", 402, -, 0°, 0.00, 80, 47; **75.** N48°30'42"

E18°47'39", 411, -, 0°, 0.00, 85, 42; **76.** N48°30'34" E18°47'54", 437, N, 5°, -2.80, 95, 41; **78.** N48°30'58" E18°47'49", 404, -, 0°, 0.00, 95, 53; **80.** N48°30'15" E18°49'3", 362, -, 0°, 0.00, 80, 62; **81.** N48°30'11" E18°49'23", 334, S, 5°, 0.15, 100, 42; **83.** N48°23'54" E18°45'8", 485, -, 0°, 0.00, 95, 60; **84.** N48°24'7" E18°45'22", 511, 0, 0°, 0.00, 100, 43; **87.** N48°19'54" E18°41'39", 322, SW, 5°, 2.95, 90, 47; **135.** N48°26'51" E18°51'52", 307, NW, 3°, 0.01, 80, 45;

Association *Anthoxantho odorati* – *Agrostietum tenuis* (Group No. 6) **Sites:** **8.** N48°28'19" E18°46'11", 522, -, 0°, 0.00, 100, 53; **9.** N48°28'8" E18°45'45", 512, -, 0°, 0.00, 100, 54; **21.** N48°27'19" E18°49'22", 518, -, 0°, 0.00, 75, 38; **22.** N48°27'18" E18°49'21", 548, SW, 10°, -0.57, 95, 44; **23.** N48°27'12" E18°49'33", 544, SW, 10°, -0.57, 95, 42; **24.** N48°27'12" E18°49'19", 574, -, 0°, 0.00, 80, 40; **25.** N48°26'24" E18°46'59", 521, -, 0°, 0.00, 60, 32; **27.** N48°26'32" E18°47'13", 612, NE, 15°, -0.78, 85, 60; **45.** N48°28'10" E18°49'16", 603, -, 0°, 0.00, 70, 44; **47.** N48°28'47" E18°49'37", 536, -, 0°, 0.00, 80, 45; **49.** N48°28'41" E18°49'14", 737, W, 15°, 0.75, 95, 51; **50.** N48°28'37" E18°48'48", 766, W, 5°, 2.95, 85, 54; **51.** N48°28'42" E18°50'4", 729, W, 10°, -0.57, 95, 55; **52.** N48°28'39" E18°50'17", 696, NE, 15°, -0.78, 95, 41; **53.** N48°28'49" E18°49'57", 756, NE, 20°, 2.04, 100, 44; **56.** N48°25'46" E18°47'45", 683, SW, 15°, 0.75, 100, 55; **63.** N48°28'52" E18°53'10", 761, NE, 5°, -3.09, 80, 28; **65.** N48°28'37" E18°52'44", 773, S, 10°, -0.03, 75, 28; **66.** N48°28'35" E18°52'45", 782, -, 0°, 0.00, 75, 36; **67.** N48°28'36" E18°52'55", 748, N, 10°, 0.54, 90,

39; **68.** N48°28'52" E18°51'23", 750, N, 10°, 0.54, 80, 33; **71.** N48°29'35" E18°46'52", 414, NE, 5°, -3.09, 80, 46; **72.** N48°30'2" E18°47'17", 350, NW, 10°, -0.03, 75, 50; **73.** N48°29'54" E18°48'10", 413, -, 0°, 0.00, 95, 43; **95.** N48°25'18" E18°41'28", 323, SSW, 3°, -0.01, 90, 27; **99.** N48°23'33" E18°38'50", 360, S, 1°, -0.07, 95, 36; **109.** N48°30'44" E18°55'19", 626, -, 0°, 0.00, 95, 54; **m119.** N48°30'55" E18°51'10", 620, -, 0°, 0.00, 85, 55; **128.** N48°18'17" E18°35'40", 686, NNW, 5°, -0.12, 80, 48; **151.** N48°27'47" E18°43'39", 266, NE, 5°, -3.09, 95, 33;

Alliance *Bromion erecti* (Group No. 7) **Sites:** **88.** N48°20'49" E18°42'5", 476, -, 0°, 0.00, 100, 39; **89.** N48°20'49" E18°41'55", 452, -, 0°, 0.00, 95, 36; **90.** N48°21'12" E18°42'44", 452, -, 0°, 0.00, 90, 43; **94.** N48°25'12" E18°41'32", 294, SW, 5°, 2.95, 90, 30; **125.** N48°29'42" E18°51'50", 680, SW, 25°, 0.12, 90, 57; **127.** N48°28'54" E18°51'46", 743, SE, 3°, -0.12, 90, 52; **143.** N48°29'41" E18°44'18", 872, NWW, 3°, -0.12, 70, 34; **144.** N48°25'40" E18°41'52", 859, SW, 3°, 0.12, 75, 44; **145.** N48°17'51" E18°38'26", 837, W, 10°, -0.57, 85, 33; **146.** N48°29'59" E18°55'32", 795, SWW, 1°, 1.37, 80, 56; **147.** N48°27'59" E18°52'58", 784, NW, 5°, 0.15, 85, 59; **149.** N48°30'13" E18°48'22", 373, SWW, 3°, -0.13, 80, 33;

Association *Onobrychido viciifoliae*-*Brometum erecti* (Group No. 8) **Sites:** **105.** N48°30'7" E18°48'40", 403, SW, 3°, 0.12, 100, 60; **106.** N48°30'0" E18°49'9", 427, SE, 5°, -2.80, 95, 53; **107.** N48°30'1" E18°50'40", 412, W, 17°, -3.05, 80, 37; **124.** N48°29'30" E18°51'51", 750, N, 25°, -0.11, 75, 47; **126.** N48°29'2" E18°51'54", 761, NNW, 5°, -0.12, 75, 42