

Heteroptera coenoses in Mesobromion grasslands of southern Styria

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With 7 figures and 3 tables

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Summary: Heteroptera coenoses in Mesobromion grasslands of southern Styria. – Mesobromion grasslands are known as regional centers of biodiversity and are protected by the Habitats Directive of the European Union. Despite a severe decline in area size, a relatively high density of this habitat type can still be found in southern Styria. Heteroptera communities of eleven Mesobromion grasslands and one species-rich mesic meadow were studied using a suction sampler. Altogether, 2581 bugs representing 105 species were detected. Three species (*Tinicephalus hortulanus* (MEYER-DÜR, 1843), *Omphalonotus quadriguttatus* (KIRSCHBAUM, 1856) and *Scolopostethus lethierryi* JAKOVLEV, 1877) were recorded for the first time in Styria. Differences in incidence and abundance were high between the sites, ranging from 10 to 40 species and 32 to 1042 individuals. At least one of the 22 recorded Red List species was found in each site. However, the eight actually endangered species (i.e. without species considered as 'near threatened') were restricted to five Mesobromion grasslands. The sample sites revealed a high heterogeneity with respect to dominance structure, abundance and incidence. Differences between the coenoses were mainly influenced by the occurrence of the ubiquitous mirid *Halictus apterus apterus* (LINNAEUS, 1758). Heteroptera densities were higher in pastures than in hayfields, but distinct differences between the management types according to ecological traits were absent. Consequently, differences between mown and grazed Mesobromion grasslands seemed to be impacted rather by quantitative than by qualitative traits. Thirty-two species were designated as character species of Styrian Mesobromion grasslands.

Zusammenfassung: Wanzenzönosen südsteirischer Halbtrockenrasen (Heteroptera). – Halbtrockenrasen gelten als regionale Zentren der Biodiversität und sind durch die Fauna-Flora-Habitat-Richtlinie der Europäischen Union geschützt. Trotz starken Flächenverlusts findet sich in der Südsteiermark noch eine relativ hohe Dichte dieses Habitattyps. Die Wanzenzönosen von elf Halbtrockenrasen und einer artenreichen Fettwiese wurden mit einem Bodensauger erhoben. Insgesamt wurden 2581 Individuen aus 105 Arten registriert. Drei Arten (*Tinicephalus hortulanus* (MEYER-DÜR, 1843), *Omphalonotus quadriguttatus* (KIRSCHBAUM, 1856) und *Scolopostethus lethierryi* JAKOVLEV, 1877) wurden das erste Mal in der Steiermark nachgewiesen. Die Unterschiede in Auftreten und Abundanz zwischen den Flächen waren hoch und lagen zwischen 10 und 40 Arten und 32 und 1042 Individuen. Auf jeder Fläche wurde mindestens eine der insgesamt 22 aufgefundenen Rote Liste-Arten gefunden; die acht gefährdeten Arten (i.e. ohne Arten der Stufe „Gefährdung droht“) waren auf fünf Halbtrockenrasen beschränkt. Bezüglich Dominanzstruktur, Abundanz und Häufigkeiten der Wanzenarten waren die Probeflächen äußerst heterogen. Unterschiede zwischen den Zönosen wurden primär vom Auftreten der kommunen Miride *Halictus apterus apterus* (LINNAEUS, 1758) beeinflusst. Individuenzahlen waren in Weiden höher als in Mähwiesen, doch deutliche Unterschiede zwischen den Bewirtschaftungsmethoden hinsichtlich ökologischer Ansprüche waren nicht erkennbar. Folglich erschienen die Unterschiede zwischen gemähten und beweideten Halbtrockenrasen mehr von quantitativer als qualitativer Natur. 32 Arten wurden als Charakterarten steirischer Halbtrockenrasen ausgewiesen.

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1. Introduction

Semi-natural Mesobromion grasslands are regarded as regional centers of biodiversity, especially concerning vascular plants and invertebrates (BEINLICH et al. 2009, ELLENBERG & LEUSCHNER 2010). Thus, they are considered as habitats of European concern and protected by the Habitats Directive of the European Union (EUROPEAN COMMISSION 2013). During the last decades this habitat type has undergone a severe decline in area. Thus, they are listed as endangered habitats in the Austrian Red List of Threatened Biotope Types (ESSL et al. 2004). Despite legal protection, the overall condition of Austrian Mesobromion grasslands is insufficient (ELLMAUER et al. 2013). A relatively high density of Mesobromion grasslands is still present in southern Styria (ÖKOTEAM & STIPA, 2009). While information about the Mesobromion true bugs (Heteroptera) in East Styria in the St. Anna am Aigen region exists (KORN et al. 2015, PROSCHEK 2001), intensive studies about the southern Styria Mesobromion grasslands lacked just until now.

Using quantitative and qualitative traits of the recorded true bug coenoses, conclusions about the quality of the observed Mesobromion grasslands will be inferred. Furthermore, differences in species composition will be basis for analyzing differences between the management methods mowing and pasturing. Finally, character species for Styrian Mesobromion grasslands will be identified by means of the recorded species.

2. Study area

The Styrian Alpine foothill is dominated by clastic tertiary sediments and can—beside the river valleys, which are treated as independent subunits—be separated into four regions: West Styrian Riedelland, Sausal, Windische Bühel and East Styrian Riedelland. The landscape is characterized by the so-called 'Riedel'. Those are spacious, often asymmetric hill ranges with low relief energy with a typical altitude difference of less than 100 m (LIEB 1991). The sample sites were located within the Windische Bühel (Fig. 1). Similar to the Riedelland, the region is built up of tertiary unconsolidated material, but concerning relative altitude and relief its landscape is more similar to the Sausal (LIEB 1991).

Climate and weather in 2013: The Styrian climate is influenced by the Alpine as well as the Pannonian climate (KABAS 2005). The foothill climate is moderately continental with distinct differences between winter and summer temperature. Winters are cold and designated by low stratus and little sunshine. Contrasting, summers are warm with long sunshine hours and tendency to mugginess, thunderstorms and hailing. Due to the relief of this hilly region, valleys with low winter temperatures are contrasted by milder climated slopes (PILGER et al. 2010). Except from east, the Alpine foothill is shielded against rain-laden winds by mountain ranges; thus, the amount of rainfall is comparatively low and summer thunderstorms are responsible for a bulk of annual precipitation (WAKONIGG 1970).

The year 2013 was one of the warmest since begin of registration in the year 1767. It can be divided into a first 'too cold' ($-0.1\text{ }^{\circ}\text{C}$) and a second 'too warm' ($+1.0\text{ }^{\circ}\text{C}$) part. July has been the fourth hottest July ($+2.1\text{ }^{\circ}\text{C}$). Annual average temperature accounted for $+0.8\text{ }^{\circ}\text{C}$ due to a particularly warm January, April and July in the southeastern Alpine foothill (if not stated otherwise, long-term average corresponds to the period from 1981 to 2010). In contrast, relatively late ice days were registered in March. May was the most rain-intense since 1965, contrary to the most arid July (-66%) compared

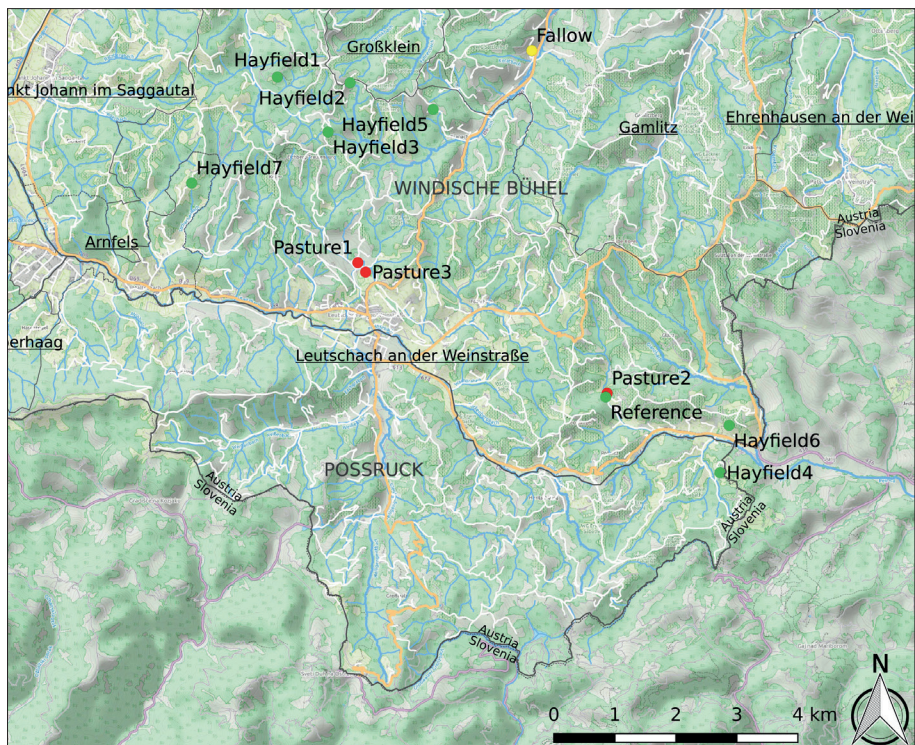


Fig. 1: Position of the sample sites within the Windische Bühel in the Alpine foothill of southern Styria (map source: DATA.GV.AT 2017).

Abb. 1: Lage der Probeflächen innerhalb der Windischen Bühel im südsteirischen Alpenvorland (Kartengrundlage: DATA.GV.AT 2017).

to long-time since 1858. Also, April and December were rain-poor (-37% and -50%) (ZAMG 2014b).

Monthly precipitation amounts from 1981 to 2010 (reference time period adapted from ZAMG 2014b) for the three nearby weather stations Bad Gleichenberg, Deutschlandsberg and Maribor were compared with those of 2013 (Fig. 2). Whereby the Slovenian station might be the best representative of the Windische Bühel due to geographical proximity and landscape similarity. The East Styrian Bad Gleichenberg is more continentally influenced, while Deutschlandsberg is characterized by a more Alpine climate as it is bordering the Styrian Randgebirge.

As typical for the continental climate, a clear precipitation peak is apparent during summer. Regarding 2013, precipitation in May was relatively high, followed by a relatively dry June. Rainfall amounts of July can be regarded as atypically low. In August, Bad Gleichenberg and Maribor registered relatively low rainfall, whereas precipitation in Deutschlandsberg was on average. Precipitation amounts in September followed a quite 'normal' pattern.

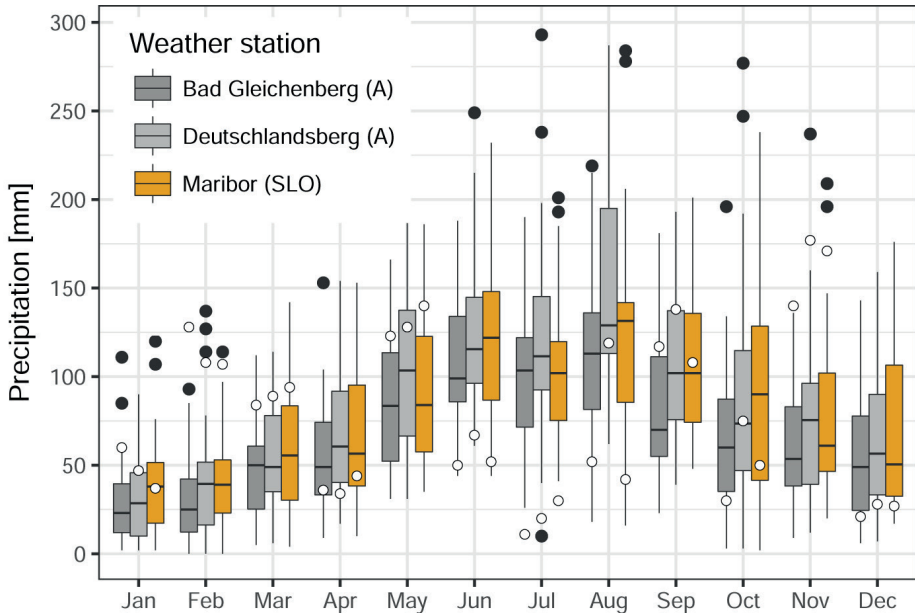


Fig. 2: Long-term precipitation (1981 to 2010) from three nearby weather stations (whiskers are $Q_3 + 1.5 \times IQR$ and $Q_1 - 1.5 \times IQR$, filled circles demark outliers) with empty circles representing the precipitation amounts in the year 2013 (data source: ZAMG 2014a).

Abb. 2: Langzeitniederschläge (1981 bis 2010) von den drei nächstgelegenen Wetterstationen (Whiskers sind $Q_3 + 1.5 \times IQR$ und $Q_1 - 1.5 \times IQR$, gefüllte Kreise sind Ausreißer) mit leeren Kreisen als Niederschlagsmengen des Jahres 2013 (Datenquelle: ZAMG 2014a).

3. Mesobromion grasslands

A Mesobromion grassland is an anthropogenic induced and thus, 'secondary' type of grassland that settles on potential forest sites. Nutrient-poor soils, aridity and high sun radiation are typical traits of Mesobromion sites. Soils are often, but not necessarily shallow. Usually, Mesobromion grasslands appear on calcareous soil, but some also on acidic parent material. Dominating life-form are chamaephytes and hemicryptophytes. Characteristic Mesobromion plant species are adapted to nutrient-poor soils and light. They are outcompeted by fast-growing species in nitrogen-rich habitats and are intolerant to shade (ELLENBERG & LEUSCHNER 2010).

Calcareous grasslands are protected by the Habitats Directive of the European Union as '6210 Semi-natural dry grasslands and scrubland facies on calcareous substrates (*Festuco-Brometalia*)'. This order subsume steppic, subcontinental grasslands (*Festucetalia valesiaca*) and more oceanic, submediterranean grasslands (*Brometalia erecti*). The latter comprises primary Xerobromion ('dry') and secondary Mesobromion ('semi-dry') grasslands with the character species *Bromus erectus* (EUROPEAN COMMISSION 2013). The most frequent type in Central Europe is Mesobromion grassland on calcareous soils (SCHMIDT et al. 2007). Mesobromion grasslands are distinguished from Xerobromion ones by fully covering vegetation, dominating broadleaf grasses of medium height and largely lack of prostrate shrubs, succulent and annual plants (ESSL et al. 2004).

The Mesobromion floristic species pool is composed of autochthonous forest and

non-forest species as well as non-Central European plants. About half of the typical Mesobromion species are also found in natural non-forest sites, such as outcrops; e.g. *Brachypodium pinnatum*, *Centaurea scabiosa*, *Euphorbia cyparissias*, *Hippocrepis comosa*, *Origanum vulgare*, *Pimpinella saxifraga*, *Primula veris* and *Viola hirta* (SCHMIDT et al. 2007). However, several Mesobromion species are non-autochthonous. For example the eponymous character species *Bromus erectus*, but also *Festuca rupicola*, *Salvia pratensis* and *Sanguisorba minor* (POSCHLOD & WALLISDEVRIES 2002). Introduction from non-Central Europe regions, e.g. from the Mediterranean, via transhumant flocks seems plausible (POSCHLOD & WALLISDEVRIES 2002, SCHMIDT et al. 2007). Some plant species were also cultivated intentionally, for example the Mediterranean *Onobrychis viciifolia*, that is nowadays designated as typical species for mown Mesobromion grasslands or *Anthyllis vulneraria* (POSCHLOD & WALLISDEVRIES 2002).

Fallow Mesobromion grasslands: If Mesobromion grasslands become fallow, species composition and vegetation structure changes. Usually, this is a relatively slow process due to the low productivity (ELLMAUER & ESSL 2005). Species composition remains unchanged over a longer period in more nutrient poor and drier areas and vice versa (OIKOS & STIPA 2008). Some Mesobromion grasslands are known to resist succession for decades (ELLENBERG & LEUSCHNER 2010).

In the long term, tree and bush seedlings initiate the early succession stages of a forest. This process can be enforced by woody species that reproduce vegetatively via root suckers, e.g. *Populus tremula*, *Prunus spinosa*, *P. fruticosa*, *Robinia pseudacacia* and *Rosa pimpinellifolia* (ELLENBERG & LEUSCHNER 2010, ELLMAUER & ESSL 2005).

Increasing species richness was observed in early successional stages of Mesobromion grasslands—a reason to reconsider recent conservation strategies. Only landscapes with all successional stages—including open grasslands, shrublands and forests—provide shelter for the whole species spectrum (POSCHLOD & WALLISDEVRIES 2002) as heterogeneous structures offer higher niche diversity (DIACON-BOLLI et al. 2012). Areas of this barely known habitats are disappearing; either by turning into intensely used land or by restoration driven by conservation practices that focus on the initial stage of Mesobromion grasslands (BALMER & ERHARDT 2000).

Distribution and development: Climatically defined range of Mesobromion grasslands is (sub-) continental East and Submediterranean South Europe (OIKOS & STIPA 2008). Nonetheless, they exist in all Austrian natural regions mainly from the colline to the submontane zone up to 800 m with a maximal altitude above 1 000 m in inner Alpine dry valleys (ELLMAUER & ESSL 2005). Before the neolithic age, Mesobromion grasslands probably were a rare habitat type occurring only on steep slopes, gravel banks of the Alpine rivers and outcrops. Forest clearing began about 7 000 years ago; the influence of herbivorous megafauna on the evolution of these grasslands is still uncertain. Palynological and macrofossil data suggest an expansion of Mesobromion grasslands since the Roman Empire, a circumstance which might be connected with the emergence of hay harvesting at this time. However, systematic hay harvesting is believed to start about 1 000 years ago or much later. Most meadows were created during the Middle Ages, with maximum extent during the 15th and 16th century—in this time period large transhumant sheep flocks existed in Central Europe. These herds connected habitats over a hundred kilometers in distance by carrying seeds in their fur. Also techniques like alternate husbandry, alternate arable field-pasture farming systems, hayseed sowing and field rotation systems contributed to the development of Mesobromion grasslands (POSCHLOD & WALLISDEVRIES 2002, WALLISDEVRIES et al. 2002). This diverse land-use led to a high species and habitat diversity (POSCHLOD et al. 2005).

Importance: Mesobromion grasslands are one of the most species-rich habitats of Central Europe (ELLENBERG & LEUSCHNER 2010, WALLISDEVRIES et al. 2002) and

therefore, regarded as regional centers of biodiversity (BEINLICH et al. 2009). Although they cover only small proportions of the European landscape, they host relatively high amounts of rare and/or endangered plant and invertebrate species (BEINLICH et al. 2009, ELLENBERG & LEUSCHNER 2010). Numerous invertebrate species are dependent on its unique conditions (WALLISDEVRIES et al. 2002, DIACON-BOLLI et al. 2012, ÖKOTEAM & STIPA 2009). In contrast, only a few bird species are tied to this habitat type (WALLISDEVRIES et al. 2002). In some cases, Mesobromion grasslands are last refuge areas for Central European xerothermophilous species, whose initial habitats (e.g. flood plains or primary Xerobromions) were destroyed (NAGEL 2000).

Another point of view may arise regarding the anthropogenic origin of Mesobromion grasslands with prior destruction of natural forests: the species pool is mostly composed of xerothermophilous species with Mediterranean or eastern origin that normally would be absent in Central Europe. Therefore, the high species diversity is a result of an artificial introduction and support of non-autochthonous species. Consequently, high effort is put in the maintenance of a habitat that is incompatible with the natural potential vegetation and that is stochastically composed of non-indigenous species which are not endangered in their natural range. This suggests that recent nature conservation practices favor quantitative (i.e. the high species diversity) over qualitative (i.e. potential natural conditions) values. Based on these considerations, Mesobromion grassland conservation seems to be more motivated by socio-cultural ideas obtaining a historical cultural landscape rather than by nature conservation (NAGEL 2000).

Endangerment: 20th century agricultural techniques (including land consolidation, livestock housing, drainage and amelioration of peat- and wetlands, peat mining and lowland afforestation), the discovery of chemical fertilizers and cheap agricultural imports replaced traditional techniques and thus, changed the rural landscape. A great amount of nutrient-poor and wet grasslands disappeared during the second half of the 20th century (POSCHLOD et al. 2005, WALLISDEVRIES et al. 2002). Especially Mesobromion grasslands suffered a distinct area loss due to abandonment followed by succession with shrubs during the last decades (ELLMAUER & ESSL 2005). Thus, Mesobromion grasslands in different formations are classified as endangered or critically endangered habitats in Austria (ESSL et al. 2004).

Habitat fragmentation is a direct consequence of the abandonment of traditional agricultural practices in former extensive semi-natural habitats (POSCHLOD & WALLISDEVRIES 2002). This phenomenon is related to (i) the insular biogeography paradigm (biodiversity on islands (i.e. isolated habitats) is higher in larger islands with shorter distance to the mainland (i.e. similar habitats) due to extinction rates inversely proportional to area and immigration rates inversely proportional to distance), (ii) the small population paradigm (a smaller genetic pool leads to a higher extinction probability caused by genetic drift, increased inbreeding and larger effects of stochastic events) and (iii) the metapopulation paradigm (population viability depends on immigration from near-by populations and on recolonization; thus, being a function of inter-habitat distance and species mobility) (BISTEAU & MAHY 2005).

Landscapes management: For maintaining species-rich Mesobromion grasslands, the continuation of extensive usage is crucial (ELLMAUER & ESSL 2005). An important point of view is to regard livestock, especially sheep, as mobile vectors of plant seeds. They can connect distant plant populations, which often have only limited dispersal abilities. Even seeds normally regarded as non-epizooic and without adhesive devices were found on sheep (FISCHER et al. 1996, POSCHLOD et al. 1998). Especially plant species without persistent diaspore bank and low self-dispersal abilities are highly threatened by habitat fragmentation; transmission by livestock could mitigate the impacts of a fragmented landscape for them (FISCHER et al. 1996). Besides dispersal and (re-)

introduction of species into habitats, sheep also create structures by trampling, grazing and dung deposition (BÜRGI et al. 2013, FISCHER et al. 1996).

Although invertebrate diversity in Mesobromion grasslands is high, most conservation strategies are mainly focusing on vegetational requirements. The most important impact on arthropod life is heterogeneously structured vegetation providing diverse niches, which can be regulated by variable or less regular management (BOURN & THOMAS 2002, WALLISDEVRIES et al. 2002).

Conservation methods for Mesobromion grasslands that occurred during the 1970ies focused on the preservation of the grasslands by mowing and removal of regrowing shrubs. These practices ignored the origin of Mesobromion grasslands that developed in a landscape mosaic of hayfields, pastures, fallow lands and surroundings. This could be implemented via a landuse that creates a habitat complex with heterogeneous areas, e.g. rotational management (BÜRGI et al. 2013, POSCHLOD & WALLISDEVRIES 2002).

4. Biodiversity indication

As biodiversity is hardly measurable as a whole, representative groups that correlate with total organismal diversity are used to obtain an approach to regional biodiversity (MCGEOCH 1998, OBRIST & DUELLI 1998). For this, either representative (qualitative, such as indicator species or Red List species) or correlative (quantitative) taxa are used (DUELLI & OBRIST 1998, OBRIST & DUELLI 1998). Favorable indicator groups should meet four criteria: (i) presence in various habitats and strata in moderate species numbers, (ii) various ecological and habitat requirements, (iii) various feeding regimes and (iv) various life parameters (ACHTZIGER et al. 2007). However, establishing universal rules for biodiversity indicators arise difficulties due to the various aims that the indicators are used for (BÜCHS 2003). Often, a combination of several indicator groups is suggested (e.g. BÜCHS 2003, DUELLI & OBRIST 2003, SÖDERSTRÖM et al. 2001, ZULKA et al. 2014). Many studies attest different animal groups excellent suitability as indicator organisms (HOLZINGER 2010), but taxa selection is often arbitrary or subjective and lack statistical foundation (MCGEOCH 1998). In addition, the availability of Red Lists and experts for taxonomic groups are influencing factors for the choice of the used indicators (DUELLI & OBRIST 2003).

Due to their species richness, high levels of biomass and their role in ecosystem functioning, various insect taxa are widely used as biodiversity indicators in terrestrial systems (MCGEOCH 1998). True bugs, as they fulfill all four of the preceding criteria, seem to be a promising indicator group. Moreover, their high species numbers combined with relatively low abundances result in a favorable workload with high expressiveness (ACHTZIGER et al. 2007, DUELLI & OBRIST 1998).

5. Material and methods

Samples were taken standardized once in the mid of each month from June to September 2013 within a series of three days to keep temporal influences to a minimum. At each event 3.39 m² were sampled with a suction sampler, i.e. a modified leaf blower ('Husqvarna Partner GBV 325'). Thus, the total sampled surface was 3.39 × 4 = 13.56 m². For three sites, it was impossible to perform suction sampling as the hay was still drying on the surface (Hayfield3 in June, Hayfield4 in July and Hayfield5 in August). The content of the net was emptied into a box (bottom 22.5 × 32.5 cm, height 24.0 cm) immediately after sampling. From there, all adult Heteroptera were taken with

Table 1: Sample sites (data source: Ökoteam & Stipa (2009) and GIS-Steiermark (2014)). Abbr.: n. e.—not evaluated, NSG—Naturschutzgebiet (nature reserve).

Tab. 1: Probeflächen (Datenquelle: Ökoteam & Stipa (2009) und GIS-Steiermark (2014)). Abk.: n. e. –nicht evaluiert, NSG – Naturschutzgebiet.

	Hayfield1	Hayfield2	Hayfield3
Coordinates [WGS 84]	15°26'56"E 46°42'08"N	15°27'52"E 46°42'05"N	15°27'35"E 46°41'39"N
Altitude [m]	515	560	535
Surface [ha]	0.5	1.04	0.22
Habitat type	Mesobromion grassland	Mesobromion grassland	Mesobromion grassland
Soil reaction	Alkaline rich	Alkaline rich	Alkaline rich
Management	Mowing	Mowing	Mowing
Conservation	NSG §5 Z.2 lit.c	-	-
	Hayfield7	Pasture1	Pasture2
Coordinates [WGS 84]	15°25'50"E 46°41'12"N	15°27'58"E 46°40'30"N	15°31'10"E 46°39'21"N
Altitude [m]	470	370	340
Surface [ha]	0.14	0.32	0.2
Habitat type	Mesobromion grassland	Mesobromion grassland	Mesobromion grassland
Soil reaction	Alkaline rich	Alkaline rich	Alkaline rich
Management	Mowing	Pasture	Pasture
Conservation	-	-	-
	Hayfield4	Hayfield5	Hayfield6
Coordinates [WGS 84]	15°32'37"E 46°38'39"N	15°28'56"E 46°41'51"N	15°32'44"E 46°39'04"N
Altitude [m]	350	460	330
Surface [ha]	0.27	1.18	29.67
Habitat type	Mesobromion grassland	Mesobromion grassland	Mesobromion grassland
Soil reaction	Alkaline rich	Alkaline rich	Alkaline rich
Management	Mowing	Mowing	Mowing
Conservation	-	-	-
	Pasture3	Fallow	Reference
Coordinates [WGS 84]	15°28'04"E 46°40'25"N	15°30'12"E 46°42'22"N	15°31'09"E 46°39'19"N
Altitude [m]	380	335	325
Surface [ha]	0.3	0.52	0.14
Habitat type	Mesobromion grassland	Fallow Mesobromion grassland	Species-rich mesic meadow
Soil reaction	n. e.	Alkaline poor	n. e.
Management	Pasture	Fallow land	Mowing
Conservation	-	-	-

an aspirator during a twenty minute period, dispatched in an ethyl acetate atmosphere and stored in a refrigerator.

Sample sites: The twelve sites were located in the Windische Bühel close to the Slovenian border (Fig. 1; Tab. 1). All but three (Pasture2, Pasture3, Reference) sample sites have been object of a previous study (ÖKOTEAM & STIPA 2009). Eleven sample sites were Mesobromion grasslands (Hayfield1, Hayfield2, Hayfield3, Hayfield4, Hayfield5, Hayfield6, Hayfield7, Pasture1, Pasture2, Pasture3, Fallow). Ten of them are 'Central European Mesobromion grasslands on alkaline rich soil', only Fallow is located on alkaline poor soil (ÖKOTEAM & STIPA 2009). Three of them were used as pastures, the others were hayfields. However, two of them have been grazed in the past, but management has changed to mowing (Hayfield2, Hayfield6). Hayfield4 was additionally extensively grazed. Reference was classified as species-rich mesic meadow.

Heteroptera determination: Determination followed WAGNER (1952, 1966, 1967) with visual orientation following 'CORISA' (STRAUSS 2012). Additionally, *Nabis* species followed PÉRICART (1987); *Orthops basalis* and *O. kalmi* RIEGER (1985); *Scolopostethus* species PÉRICART (1998) and *Carpocoris* species LUPOLI et al. (2013). Female specimens that fitted either *Nabis pseudoferus pseudoferus* or *N. punctatus punctatus*, were assigned to one of both species if males were present. If males were absent, they were treated as *Nabis* sp. Nomenclature and taxonomy of Heteroptera taxa are in accordance with RABITSCH (2005). After determination, the bugs were either stored dry or in 70 % ethanol.

5.1 Data analysis

Data analysis was run in R 3.3.3 (R CORE TEAM 2017) on Rstudio 0.99.463 (RSTUDIO TEAM 2016). Graphics were generated with the packages *reshape* (WICKHAM 2007), *ggplot2* (WICKHAM 2009), *gttable* (WICKHAM 2012) and *gridExtra* (AUGUIE 2012).

Kleidocerys resedae and *Oxycarenus lavaterae* were excluded from the analysis as they feed on broadleaved trees.

5.1.1 Descriptive statistics

Red list and endangered (i.e. without early warning stage NT, hence CR, EN or VU species) species composition were examined. Additionally, dominant species (defined by above-average abundance) for each site were calculated.

As measurement of diversity, Rényi diversity profiles H_α (Eq. (1); RÉNYI 1961) were generated with the *vegan* package (OKSANEN et al. 2015). They transfer information about both species richness and evenness. Richness is reflected in the height of the profile (i.e. a higher profile equals to higher richness), evenness in the slope (i.e. a horizontal profile referring to absolute evenness, i.e. same abundance for all species). Rényi profiles are based on the parameter α . The corresponding value at $\alpha = 0$ is the logarithm of species richness. The position at $\alpha = \infty$ corresponds to the proportion of the most dominant species. The value at $\alpha = 1$ is equal to Shannon's entropy H (SHANNON 1948), at $\alpha = 2$ to the logarithm of the reciprocal Simpson diversity index (SIMPSON 1949, KINDT & COE 2005).

$$H_{\alpha} = \frac{1}{1-\alpha} \log \sum_{i=1}^q p_i^{\alpha} \quad (1)$$

with $\alpha = 0, 1, \dots, \infty$; q the species number and p_i the relative frequency of species i .

Influence of management: To evaluate impacts of the management regime, the sites were compared with respect to α -diversity, absolute and relative abundances as well as with regard to ecological types and habitat requirements. Hereby, the current and dominating management was assumed to be most influencing, even if the management has changed in the last years. Three ecological types were ignored due to low occurrences and abundances (i.e. HO, MW and UK each with two species and two individuals; compare Tab. 2).

5.1.2 Inferential statistics

Species numbers were normalized and transformed into Bray-Curtis dissimilarities D_{14} (Eq. (2)). This index gives equal weights to differences between rare as well as abundant species and can be applied on normalized count data (LEGENDRE & LEGENDRE 2003). Data transformation and indices were calculated using the *vegan* package (OKSANEN et al. 2015).

$$D_{14}(x_1, x_2) = \frac{\sum_{j=1}^p |y_{1j} - y_{2j}|}{\sum_{j=1}^p (y_{1j} + y_{2j})} = 1 - \frac{2W}{A+B} \quad (2)$$

with y_{1j} and y_{2j} as site vectors, p the species number, W the sum of the minimum abundance of the species and A and B the total abundances of all species of the two sites (LEGENDRE & LEGENDRE 2003).

Cluster analysis: First, the hierarchical, agglomerative UPGMA (Unweighted Pair Group Method with Arithmetic mean) method was applied. UPGMA arranges clusters via mean intercluster similarity (LEGENDRE & LEGENDRE 2003). Second, the non-hierarchical AP Clustering (Affinity Propagation Clustering) was run. It identifies exemplars (i.e. cluster centers that arise from actual data points) that are most representative for a particular cluster. Initially, each data point is considered as potential exemplar. The final exemplars are identified by passing real-valued messages between the data points (FREY & DUECK 2007). AP was calculated with the *apcluster* package (BODENHOFER et al. 2011).

5.2 Character species

Character species for Styrian Mesobromion grasslands were defined on basis of the results and known occurrences of other species (similar as in NATURSCHUTZ IM LAND SACHSEN-ANHALT 2002).

6. Results

6.1 Descriptive analysis of community composition

A total of 2 581 individuals belonging to 105 species in 14 families were recorded in the twelve sample sites (Tab. 2). The highest species numbers were recorded in Hayfield6 and Reference (36 and 40 species). The sites with the lowest species number was Hayfield3 with only 10 species, followed by Fallow with only 12 species. Regarding individual numbers, Reference was home to 40.4 % of all recorded individuals.

Red list species: 22 species (20.95 %) were listed as threatened in different categories in Styria (Tab. 2). They accounted for 150 individuals (5.8 %) in five families (Tingidae, Miridae, Lygaeidae s. l., Berytidae and Pentatomidae). However, only eight species (7.62 %, 36 individuals) were actually endangered.

At least one Red List species was found in each site. The highest amounts were found in Hayfield6 and Pasture1 with each six Red List species. However, only five sample sites (Hayfield2, Hayfield4, Hayfield6, Pasture1 and Fallow) harbored actually endangered species in the categories EN and VU. Hayfield6 showed the highest values (four endangered species), followed by Pasture1 and Fallow (each with three endangered species). Two endangered species were recorded in Hayfield4 and one in Hayfield2. Five of these species were categorized as endangered (EN) and three as vulnerable (VU).

Rényi diversity profiles: The Rényi profiles revealed sites Hayfield2 and Hayfield6 as most divers—incorporating richness and evenness (KINDT & COE 2005)—as their profiles continuously lied above the median (Fig. 3). Also Hayfield5 is located above intermediate diversity. Contrasting, lowest diversity revealed Hayfield3 and Fallow. Intermediary diversity was found in Hayfield1, Hayfield4, Hayfield7, Pasture1, Pasture2 and Pasture3. The coenosis of Reference showed a very high species richness combined with quite low evenness. Also Fallow revealed a low evenness. The majority of sites showed intermediary evenness. Most balanced abundances were found in Hayfield2 and Hayfield5, to some extent also Pasture2.

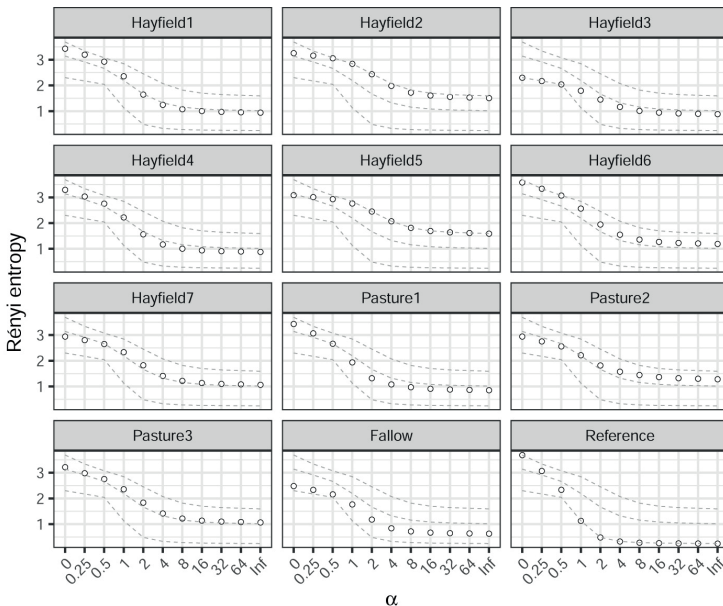


Fig. 3: Rényi entropy profiles for each sample site. Dots—realisations of α , dashed lines—median, minimum and maximum of the dataset.

Abb. 3: Rényi-Entropie-Profil der Probefflächen. Kreise – Realisationen von α , gestrichelte Linien – Median, Minimum und Maximum aller Probefflächen.

Table 2: Abundances of Heteroptera species by sample site. *Nabis* sp. refers to females of either *N. pseudoferus pseudoferus* or *N. punctatus punctatus*. Abbr.: RL—Red List categories (after FRIESS & RABITSCH 2015): EN—endangered, VU—vulnerable, NT—near threatened, LC—least concern, DD—data deficient, NE—not evaluated; endangered and DD species highlighted in red. ET—ecological types (after FRIESS & RABITSCH 2015): UK—ubiquist, eurytopic pioneer species, hemerophilous species or cave dwellers, HO—hygrophilous open-land species, MO—mesophilous open-land species, MS—mesophilous edge species, MW—mesophilous wood species, XO—xerothermophilous open-land species, XS—xerothermophilous edge species; HR—habitat requirements: EG—endo- or epigeic, herbi-, carni- and/or granivorous, HG—hypergeic, herbi- or carnivorous, ontogeny on and/or food supply from herbaceous dicots, GR—hypergeic, gramin- or carnivorous, ontogeny on and/or food supply from graminoids, AR—arboricolous, ?—uncertain affiliation.

Tab. 2: Abundanz der Wanzenarten pro Probefläche. *Nabis* sp. bezieht sich auf Weibchen von entweder *N. pseudoferus pseudoferus* oder *N. punctatus punctatus*. Abk.: RL – Rote-Liste-Kategorien (nach FRIESS & RABITSCH 2015): EN – stark gefährdet, VU – gefährdet, NT – potenziell gefährdet, LC – nicht gefährdet, DD – ungenügende Datengrundlage, NE – nicht beurteilt; stark gefährdete und nicht beurteilte Arten in rot hervorgehoben. ET – ökologische Typen (nach FRIESS & RABITSCH 2015): UK – Ubiquist, eurytope Pionierart, hemerophile Art oder Höhlenbewohner, HO – hygrophile Offenlandart, MO – mesophile Offenlandart, MS – mesophile Saumart, MW – mesophile Waldart, XO – xerothermophile Offenlandart, XS – xerothermophile Saumart; HR – Habitatsprüche: EG – endo- oder epigäisch, herbi-, carni- und/oder granivor, HG – hypergäisch, herbi- oder karnivor, Ontogenie auf und/oder Ernährung von krautigen Dicotylen, GR – hypergäisch, gramin- oder karnivor, Ontogenie auf und/oder Ernährung von Graminoiden, AR – arboricol, ? – unsichere Zuordnung.

	Hayfield							Pasture			Fal-low	Refer-ence	Sum	RL	ET	HR
Taxa	1	2	3	4	5	6	7	1	2	3						
Ceratocombidae																
<i>Ceratocombus coleopratus</i> (Zetterstedt, 1819)	1	.	1	.	2	1	.	8	5	20	1	5	44	LC	MO	EG
Tingidae																
<i>Acalypta carinata</i> (Panzer, 1806)	.	.	.	1	.	.	.	.	.	.	.	.	1	LC	MW	EG
<i>Catoplatus fabricii</i> (Stål, 1868)	.	.	.	.	.	.	.	.	.	4	.	.	4	LC	XO	EG
<i>Copium clavicornae clavicornae</i> (Linnaeus, 1758)	.	.	.	.	.	.	1	.	.	.	.	.	1	NT	XO	HG
<i>Dictyla humuli</i> (Fabricius, 1794)	.	.	.	.	.	.	.	.	.	.	.	4	4	LC	MO	HG
<i>Kalama tricornis</i> (Schränk, 1801)	.	.	.	1	.	.	1	1	.	7	.	.	10	LC	MO	EG
<i>Lasiacantha capucina capucina</i> (Germar, 1837)	3	5	14	.	.	.	5	13	26	15	.	.	81	LC	XO	EG
<i>Oncochila scapularis</i> (Fieber, 1844)	.	.	.	.	.	.	.	7	.	.	.	.	7	LC	XO	HG
<i>Tingis auriculata</i> (A. Costa, 1847)	.	.	.	.	.	.	.	1	.	.	.	.	1	EN	MO	HG
<i>Tingis reticulata</i> Herrich-Schäffer, 1835	.	.	.	.	.	1	.	.	4	.	.	.	5	LC	MS	HG

	Hayfield							Pasture			Fal- low	Refe- rence	Sum	RL	ET	HR
Taxa	1	2	3	4	5	6	7	1	2	3						
Miridae																
<i>Bothynotus pilosus</i> (Boheman, 1852)	.	.	.	1	.	.	.	.	.	.	.	.	1	EN	XS	EG
<i>Adelphocoris lineolatus</i> (Goeze, 1778)	.	5	.	4	.	5	2	4	.	4	.	.	24	LC	MO	HG
<i>Adelphocoris seticornis</i> (Fabricius, 1775)	1	.	.	4	1	1	.	2	.	1	.	19	29	LC	MS	HG
<i>Capsodes gothicus gothicus</i> (Linnaeus, 1758)	.	.	.	4	.	.	.	.	1	.	.	.	5	LC	MO	HG
<i>Capsus ater</i> (Linnaeus, 1758)	.	.	.	.	.	1	.	.	.	.	.	.	1	LC	MO	GR
<i>Charagochilus gyllenhalii</i> (Fallén, 1807)	.	.	.	.	1	.	.	.	.	.	.	.	1	LC	MO	HG
<i>Charagochilus weberi</i> Wagner, 1953	.	.	.	.	.	1	.	.	.	.	.	.	1	DD	MO	HG
<i>Lygus pratensis</i> (Linnaeus, 1758)	.	1	.	.	.	.	.	.	.	.	.	1	2	LC	MO	HG
<i>Lygus wagneri</i> Remane, 1955	.	2	.	.	.	.	.	1	.	.	.	3	6	LC	MO	HG
<i>Orthops basalis</i> (A. Costa, 1853)	.	.	.	.	.	1	1	.	.	.	.	3	5	LC	MO	HG
<i>Orthops kalmii</i> (Linnaeus, 1758)	1	.	1	1	.	.	.	.	.	5	.	14	22	LC	MO	HG
<i>Polymerus microphthalmus</i> (Wagner, 1951)	.	.	.	.	2	1	.	.	.	.	.	.	3	LC	MO	HG
<i>Polymerus unifasciatus</i> (Fabricius, 1794)	1	2	.	.	1	6	.	2	.	.	.	.	12	LC	XO	HG
<i>Stenotus binotatus</i> (Fabricius, 1794)	25	.	.	5	6	.	.	1	.	6	.	.	43	LC	MS	GR
<i>Leptopterna dolabrata</i> (Linnaeus, 1758)	.	.	.	4	2	.	.	.	.	.	.	.	6	LC	MO	GR
<i>Megaloceroea recticornis</i> (Geoffroy, 1785)	3	.	.	12	1	.	.	.	.	2	.	.	18	LC	MO	GR
<i>Notostira elongata</i> (Geoffroy, 1785)	.	.	.	.	.	1	.	.	.	.	.	.	1	LC	MO	GR
<i>Stenodema calcarata</i> (Fallén, 1807)	.	.	.	.	.	.	.	.	.	1	.	.	1	LC	HO	GR
<i>Stenodema laevigata</i> (Linnaeus, 1758)	2	.	.	.	3	.	.	.	.	.	1	1	7	LC	MO	GR
<i>Trigonotylus caelestialium</i> (Kirkaldy, 1902)	.	6	.	4	.	.	.	6	.	3	.	2	21	LC	MO	GR

	Hayfield							Pasture			Fal- low	Refe- rence	Sum	RL	ET	HR
Taxa	1	2	3	4	5	6	7	1	2	3						
<i>Halticus apterus apterus</i> (Linnaeus, 1758)	61	17	.	93	12	60	.	137	20	93	.	814	1307	LC	MO	HG
<i>Omphalonotus quadriguttatus</i> (Kirschbaum, 1856)	.	.	.	.	.	.	.	1	.	.	2	.	3	EN	XO	EG
<i>Orthocephalus saltator</i> (Hahn, 1835)	.	.	.	.	.	.	.	.	1	.	1	2	4	LC	XO	HG
<i>Globiceps fulvicollis</i> Jakovlev, 1877	7	3	.	.	3	.	.	.	1	.	.	.	14	LC	XS	HG
<i>Chlamydatus pulicarius</i> (Fallén, 1807)	15	8	.	.	.	35	.	91	3	20	.	52	224	LC	MO	HG
<i>Criocoris crassicornis</i> (Hahn, 1834)	.	.	.	.	1	.	.	.	.	.	.	6	7	LC	MO	HG
<i>Criocoris nigripes</i> Fieber, 1861	.	1	.	.	.	.	.	.	.	.	.	.	1	NT	XO	HG
<i>Hallodapus montandoni</i> Reuter, 1895	.	.	.	5	.	12	.	5	.	.	1	.	23	VU	XO	EG
<i>Orthonotus rufifrons</i> (Fallén, 1807)	.	.	.	1	.	.	.	.	.	.	.	.	1	LC	MS	HG
<i>Placochilus seladonicus seladonicus</i> (Fallén, 1807)	.	.	.	2	.	.	.	.	.	.	.	.	2	NT	XO	HG
<i>Plagiognathus chrysanthemi</i> (Wolff, 1804)	4	2	.	29	1	1	.	2	2	17	.	2	60	LC	MO	HG
<i>Plagiognathus fulvipennis</i> (Kirschbaum, 1856)	.	.	.	.	.	.	.	.	1	.	.	.	1	NT	MO	HG
<i>Tinicephalus hortulanus</i> (Meyer-Dür, 1843)	.	.	.	.	.	.	2	.	.	.	.	.	2	DD	XO	HG
Nabidae																
<i>Nabis brevis brevis</i> Scholtz, 1847	1	3	.	2	.	6	.	2	.	.	.	40	54	LC	MO	EG?
<i>Nabis pseudoferus pseudoferus</i> Remane, 1949	.	.	.	.	.	.	.	1	1	.	.	.	2	LC	XO	EG?
<i>Nabis punctatus punctatus</i> A. Costa, 1847	.	.	.	.	.	1	.	1	.	.	.	.	2	LC	XO	EG?
<i>Nabis rugosus</i> (Linnaeus, 1758)	1	.	.	.	.	.	.	.	.	.	.	2	3	LC	UK	HG
<i>Nabis</i> sp.	.	2	.	.	.	.	2	.	.	.	1	1	6	LC	XO	EG?

	Hayfield							Pasture			Fal- low	Refe- rence	Sum	RL	ET	HR
Taxa	1	2	3	4	5	6	7	1	2	3						
Anthocoridae																
<i>Orius minutus</i> (Linnaeus, 1758)	.	.	1	.	.	.	.	.	.	.	.	1	2	LC	UK	AR
<i>Orius niger</i> (Wolff, 1811)	.	4	.	.	.	1	2	5	.	1	.	.	13	LC	MO	HG
Reduviidae																
<i>Rhynocoris iracundus</i> (Poda, 1761)	1	.	.	.	.	.	.	.	.	.	.	.	1	LC	XO	HG
Lygaeidae s. l.																
<i>Nysius senecionis</i> <i>senecionis</i> (Schilling, 1829)	.	.	.	.	.	2	.	.	.	.	.	10	12	LC	XO	HG
<i>Kleidocerys resedae</i> <i>resedae</i> (Panzer, 1797)	.	.	.	.	.	.	1	.	.	.	.	.	1	LC	MW	AR
<i>Geocoris</i> <i>erythrocephalus</i> (Lepeletier & Serville, 1825)	.	.	.	.	2	.	.	.	1	.	.	.	3	NT	XO	EG
<i>Platyplox salviae</i> (Schilling, 1829)	2	.	.	.	2	.	.	.	.	.	.	.	4	LC	XO	EG?
<i>Macroplox preyssleri</i> (Fieber, 1837)	4	.	.	.	.	.	9	.	.	.	.	.	13	NT	XO	EG
<i>Metopoplax origani</i> (Kolenati, 1845)	1	.	.	.	.	.	.	.	1	.	.	.	2	LC	XO	HG
<i>Oxycarenus lavaterae</i> (Fabricius, 1787)	.	.	.	.	1	.	.	.	.	.	.	.	1	NE	UK	AR
<i>Oxycarenus pallens</i> (Herrich-Schäffer, 1850)	.	.	.	.	.	1	.	2	.	1	.	.	4	NT	XO	EG
<i>Ischnocoris</i> <i>hemipterus</i> (Schilling, 1829)	.	1	6	.	2	.	23	15	16	1	.	.	64	NT	XO	EG
<i>Scolopostethus</i> <i>lethierryi</i> Jakovlev, 1877	.	.	.	.	.	.	.	.	.	.	.	1	1	DD	HO	EG
<i>Scolopostethus</i> <i>thomsoni</i> Reuter, 1875	.	.	.	.	.	.	.	.	.	1	.	1	2	LC	MO	HG
<i>Emblethis griseus</i> (Wolff 1802)	.	.	.	.	.	1	.	.	.	.	.	.	1	VU	XO	EG
<i>Pterotmetus</i> <i>staphyliniformis</i> (Schilling, 1829)	.	.	.	.	.	1	.	.	.	.	.	.	1	LC	XO	EG
<i>Trapezonotus</i> <i>arenarius</i> arenarius (Linnaeus, 1758)	.	1	.	.	.	.	.	.	.	.	.	.	1	LC	MO	EG

	Hayfield							Pasture			Fal- low	Refe- rence	Sum	RL	ET	HR
Taxa	1	2	3	4	5	6	7	1	2	3						
<i>Megalonotus antennatus</i> (Schilling, 1829)	.	.	.	1	.	.	.	.	.	2	.	1	4	LC	MO	EG
<i>Megalonotus chiragra</i> (Fabricius, 1794)	1	1	.	.	.	.	1	1	.	10	.	.	14	LC	XO	EG
<i>Megalonotus emarginatus</i> (Rey, 1888)	.	.	.	.	.	3	.	.	.	.	.	.	3	EN	XO	EG
<i>Megalonotus hirsutus</i> Fieber, 1861	2	.	.	.	.	1	.	.	1	.	.	.	4	NT	XO	EG
<i>Plinthisus brevipennis</i> (Latreille, 1807)	.	.	.	.	.	.	.	.	.	.	3	.	3	NT	MO	EG
<i>Plinthisus pusillus</i> (Scholtz, 1847)	1	1	4	.	.	.	1	1	.	.	.	.	8	NT	XO	EG
<i>Graptopeltus lynceus</i> (Fabricius, 1775)	.	1	.	.	.	.	.	.	.	.	.	.	1	NT	XO	EG
<i>Peritrechus geniculatus</i> (Hahn, 1832)	.	.	1	4	.	8	.	.	.	.	.	1	14	LC	MO	GR?
<i>Peritrechus gracilicornis</i> Puton, 1877	.	1	.	1	1	4	.	.	.	.	.	.	7	LC	XO	EG
<i>Raglius alboacuminatus</i> (Goeze, 1778)	.	2	.	3	.	.	3	.	.	.	.	.	8	LC	MS	EG
<i>Rhyparochromus pini</i> (Linnaeus, 1758)	.	.	.	.	.	1	.	.	.	.	.	4	5	LC	XS	EG
<i>Xanthochilus quadratus</i> (Fabricius, 1798)	.	1	.	.	.	.	.	.	.	.	.	.	1	EN	XO	EG
<i>Acompus rufipes</i> (Wolff, 1804)	.	.	.	1	.	.	.	.	.	.	.	.	1	LC	MO	HG
<i>Stygnocoris rusticus</i> (Fallén, 1807)	.	.	.	.	4	.	.	.	.	2	.	14	20	LC	MO	HG
Piesmatidae																
<i>Piesma capitatum</i> (Wolff, 1804)	.	1	.	.	.	.	.	.	.	.	1	.	2	LC	MO	HG
Berytidae																
<i>Berytinus clavipes</i> (Fabricius, 1775)	1	3	4	16	1	1	6	5	5	24	.	16	82	LC	MO	EG
<i>Berytinus minor</i> (Herrich-Schäffer, 1835)	.	.	1	.	.	.	1	1	1	29	.	2	35	LC	MO	EG
<i>Berytinus montivagus</i> (Meyer-Dür, 1841)	.	.	.	.	.	.	.	.	.	.	.	4	4	NT	XO	EG?
<i>Berytinus signoreti</i> (Fieber, 1859)	3	.	.	2	.	7	1	.	3	.	.	1	17	LC	XO	EG?

	Hayfield							Pasture			Fal- low	Refer- ence	Sum	RL	ET	HR
Taxa	1	2	3	4	5	6	7	1	2	3						
Alydidae																
<i>Alydus calcaratus</i> (Linnaeus, 1758)	.	.	.	.	.	.	1	1	.	.	.	.	2	LC	XO	HG
Coreidae																
<i>Ulmicola spinipes</i> (Fallén, 1807)	1	.	.	.	.	.	.	.	.	.	.	.	1	LC	MO	HG
Rhopalidae																
<i>Myrmus miriformis</i> <i>miriformis</i> (Fallén, 1807)	2	.	.	1	6	11	.	.	.	.	1	.	21	LC	MO	GR
<i>Corizus hyoscyami</i> <i>hyoscyami</i> (Linnaeus, 1758)	.	.	.	.	.	.	.	.	.	.	.	1	1	LC	MO	HG
<i>Rhopalus conspersus</i> (Fieber, 1837)	.	.	.	.	.	.	.	3	.	1	.	.	4	LC	XO	HG
<i>Rhopalus</i> <i>parumpunctatus</i> Schilling, 1829	3	.	1	.	.	1	.	.	.	.	.	1	6	LC	MO	HG
<i>Rhopalus subrufus</i> (Gmelin, 1790)	.	.	.	.	.	1	.	1	.	.	.	1	3	LC	MO	HG
<i>Stictopleurus abutilon</i> <i>abutilon</i> (Rossi, 1790)	1	.	.	.	.	.	.	.	.	1	.	.	2	LC	MO	HG
<i>Stictopleurus</i> <i>crassicornis</i> (Linnaeus, 1758)	.	.	.	.	.	.	.	.	.	.	1	.	1	LC	MO	HG
Plataspididae																
<i>Coptosoma</i> <i>scutellatum</i> (Geoffroy, 1785)	5	.	.	22	.	15	.	1	.	.	17	1	61	LC	XO	HG
Scutelleridae																
<i>Eurygaster</i> <i>testudinaria</i> <i>testudinaria</i> (Geoffroy, 1785)	1	.	.	.	.	.	.	.	.	.	.	.	1	LC	HO	GR
Pentatomidae																
<i>Graphosoma</i> <i>lineatum</i> (Linnaeus, 1758)	.	1	.	.	.	.	1	.	.	.	.	1	3	LC	MS	HG
<i>Podops inunctus</i> (Fabricius, 1775)	.	.	.	1	.	2	.	.	.	.	.	2	5	LC	MO	EG
<i>Sciocoris cursitans</i> <i>cursitans</i> (Fabricius, 1794)	.	.	.	.	.	.	4	.	.	.	.	.	4	LC	XO	EG

	Hayfield							Pasture			Fal- low	Refe- rence	Sum	RL	ET	HR
Taxa	1	2	3	4	5	6	7	1	2	3						
<i>Aelia acuminata</i> (Linnaeus, 1758)	.	.	.	.	.	.	.	.	1	.	.	.	1	LC	MO	GR
<i>Eysarcoris aeneus</i> (Scopoli, 1763)	.	.	.	.	.	1	.	1	.	.	.	2	4	LC	MS	HG
<i>Eysarcoris ventralis</i> (Westwood 1837)	1	.	.	.	4	.	.	.	.	.	.	.	5	NT	MO	HG
<i>Carpocoris</i> <i>purpureipennis</i> (De Geer, 1773)	.	.	.	.	.	1	.	.	.	.	.	2	3	LC	MO	HG
<i>Dolycoris baccarum</i> (Linnaeus, 1758)	1	2	.	.	.	.	.	.	.	.	.	2	5	LC	MO	HG
<i>Rubiconia intermedia</i> (Wolff, 1811)	.	.	.	.	1	.	.	.	.	.	.	1	2	LC	MS	HG
<i>Eurydema dominulus</i> <i>dominulus</i> (Scopoli, 1763)	.	.	.	.	.	.	.	.	.	.	.	1	1	LC	MO	HG
<i>Vilpianus galii</i> (Wolff, 1802)	.	.	.	.	.	1	.	.	.	.	2	.	3	VU	XO	HG
Sum individuals	157	77	34	225	60	198	68	323	94	271	32	1042	2581			
Sum species	31	26	10	27	23	36	20	31	19	25	12	40	105			
Sum red list species	4	5	2	3	4	6	4	6	4	2	4	1	22			
Sum red list species [%]	12.9	19.2	20.0	11.1	17.4	16.7	20.0	19.4	21.1	8.0	33.3	2.5	21.0			
Sum endangered species	.	1	.	2	1	4	.	3	.	.	3	.	8			
Sum endangered species [%]	0.0	3.8	0.0	7.4	4.3	11.1	0.0	9.7	0.0	0.0	25.0	0.0	7.6			

Abundance and incidence: By far the most frequent species was the mirid *Halticus apterus apterus* with 1 307 individuals (50.6 %). The second most frequent species was *Chlamydatus pulicarius* accounting for 224 individuals (8.7 %). Most species were found in low numbers (Fig. 4). 18 species were found more than twenty times, while the other 87 were found less often. Furthermore, 28 species were found more than ten times, the remaining 77 less often. Eleven species (11.4 %) were detected four times, ten species (9.5 %) three times, another ten (9.5 %) twice and 28 species (26.7 %) were only found once.

The majority of species was found only in a single or two sites (37 and 26 species, respectively). The most incident species was *Berytinus clavipes*, which appeared in all sites but site Fallow. Three species, *Ceratocombus coleoptratus*, *Halticus apterus apterus* and *Plagiognathus chrysanthemi* occurred in nine sites.

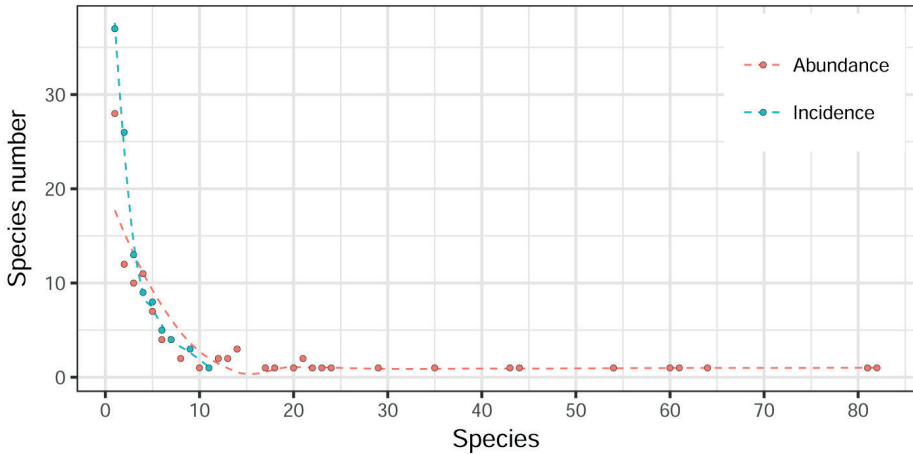


Fig. 4: Abundance (the two most frequent species *Halticus apterus apterus* and *Chlamydatius pulicarius* excluded) and incidence with local polynomial regression fitting.

Abb. 4: Abundanz (die zwei häufigsten Arten *Halticus apterus apterus* und *Chlamydatius pulicarius* exkludiert) und Auftreten der Arten auf den Probestflächen mit lokaler polynomialer Regressionsfitting.

Dominance: Composition of dominant species was quite various between sites (Fig. 5). All in all, 26 species (24.8 %) were above-average dominant. 16 (61.5 %) of them were dominant only in a single site. *Halticus apterus apterus* as single dominant species with about 80 % in Reference was remarkable. Additionally, it was also dominant in eight other sites with at least 20 %. Most similar sites hereby seemed to be Hayfield1 and Hayfield2 as they shared most of the species. Interestingly, Fallow showed a quite different composition than all the other sites with dominance of *Coptosoma scutellatum* and *Plinthisus brevipennis*.

Phenology: Mean species number was highest in June ($\bar{x} = 9.8$), equally low in July ($\bar{x} = 5.1$) and September ($\bar{x} = 5.7$) and lowest in August ($\bar{x} = 4.3$). Mean individual numbers was highest in June ($\bar{x} = 87.3$), lowest in July ($\bar{x} = 33.1$) and September ($\bar{x} = 35.4$), while intermediary in August ($\bar{x} = 59.3$).

Inspecting solely Mesobromion grasslands, a quite similar pattern was apparent (June: $\bar{x} = 9.9$, July: $\bar{x} = 4.3$, August: $\bar{x} = 3.8$, September: $\bar{x} = 5.5$). However, individual numbers were distinctly lower (June: $\bar{x} = 68.6$, July: $\bar{x} = 26.6$, August: $\bar{x} = 17.8$, September: $\bar{x} = 26.8$).

6.2 Cluster analysis

UPGMA revealed Fallow as clear outgroup soonest resembling Hayfield4 and Hayfield6, but with distinct differences to all other sites (Fig. 6a). Besides, two main groups were obvious: one large group with eight members (Hayfield1, Hayfield2, Hayfield4, Hayfield5, Hayfield6, Pasture1, Pasture3 and Reference) and a smaller one containing three members (Hayfield3, Hayfield7 and Pasture2). Hereby, Pasture2 revealed also large congruence with the larger cluster.

Likewise, AP Clustering supported the same three groups (Fig. 6b). Furthermore, the next similar members to Fallow were Hayfield4 and Hayfield6—just as in UPGMA clustering (Fig. 6a). Also, Pasture2 revealed high similarity with the larger cluster, but highest with Hayfield3.

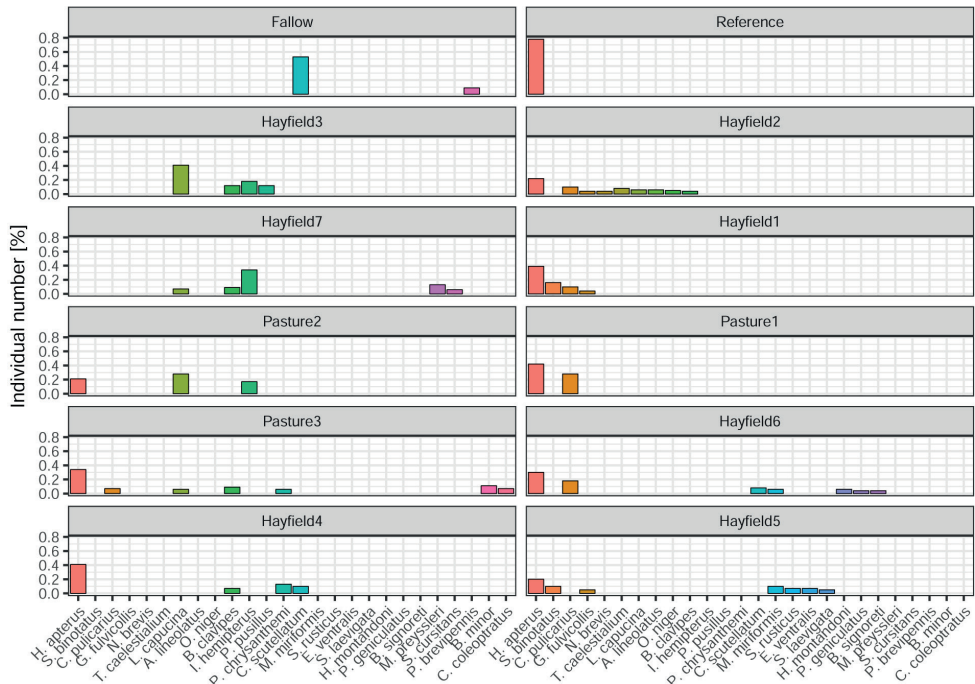


Fig. 5: Dominant species (i.e. species with above-average abundance) per site, mainly ordered by abundance and incidence of *Halticus apterus apterus*.

Abb. 5: Dominante Arten (i.e. Arten mit überdurchschnittlicher Abundanz) pro Probeffläche, vorwiegend geordnet nach Abundanz und Auftreten von *Halticus apterus apterus*.

6.3 Influences of management

Species numbers were similar between mown ($n = 8$, $\bar{x} = 24.4$) and grazed ($n = 3$, $\bar{x} = 25.0$) Mesobromion grasslands, although the deviation was much higher in mown ones ($min = 10$, $max = 36$, $Q_1 = 20.5$, $Q_3 = 29.0$) than in pastures ($min = 19$, $max = 31$, $Q_1 = 22.0$, $Q_3 = 28.0$).

Habitat requirements: The median of endo- or epigeic species was slightly higher in hayfields than in pastures (Fig. 7 left). Concerning individual numbers, the median was distinctly higher in pastures than in hayfields. Also regarding relative abundances, pasture medians were higher than those of hayfields, although the ranges were overlapping.

Grass dwelling species were found somewhat more often in hayfields, however showing strong variation hereby. The median of pastures was a little lower and the data showed a narrower distribution. Also grass dwelling individuals were less frequent in pastures than in hayfields. Herein, the difference was even greater regarding relative individual numbers. While the whole boxplot in pastures lied beneath 2.5 %, the data of hayfields varied from zero to over 20 %.

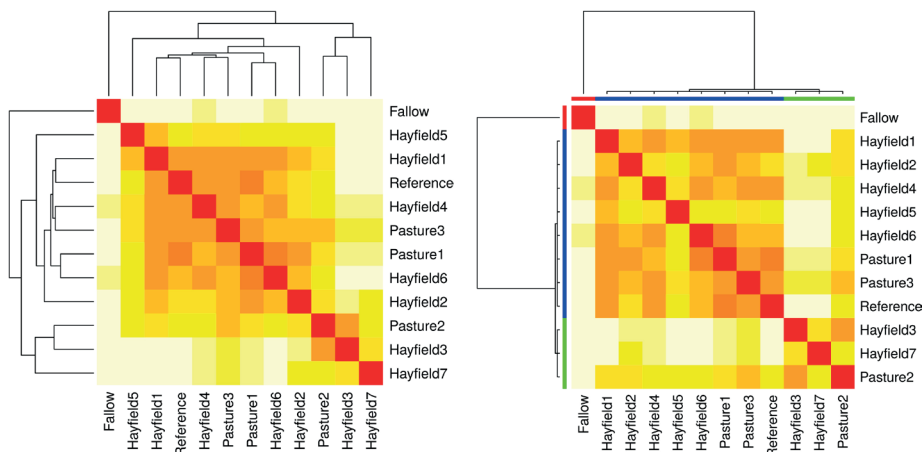


Fig. 6: Results of (a, left picture) UPGMA and (b, right picture) AP Clustering on normalized Bray-Curtis dissimilarities as heatmap.

Abb. 6: Ergebnisse der (a, linkes Bild) UPGMA- und (b, rechtes Bild) AP Clusteranalyse mit normalisierten Bray-Curtis-Unähnlichkeiten als Heatmap.

The medians of herb dwelling species were at the same height with higher variation in hayfields. Again, the median of absolute individual numbers was distinctly higher in pastures. Contrasting, the median of herb dwelling relative individual numbers was higher in hayfields, but also showed a higher degree of variation.

Ecological types: Regarding species numbers, mesophilous open-land species showed a similar median with higher variation in pastures (Fig. 7 right). Individual numbers were much higher in pastures; this effect was less prominent, but still distinct with respect to relative individual numbers. Also xerothermophilous open-land species numbers were similar, with a lower median in pastures. Individual numbers were somewhat higher in pastures, but reversed regarding relative numbers. Both types of edge species played a subordinate role in hayfields and even more in pastures. They showed a lower median and quite shorter whiskers in pastures than in hayfields.

6.4 Character species

Altogether, 32 species were defined as character species of Styrian Mesobromion grasslands (Tab. 3). Five additional species were included as they are known to inhabit Mesobromion grasslands in the region. Fifteen of them were regarded as ‘character species sensu stricto’ (s. s.) as they are restricted to this habitat type. The 17 remaining species were classified as ‘character species sensu lato’ (s. l.) as they occur also in other habitat types such as ruderal sites or dry and sparse forests.

Character species s. s. were found in all but one Mesobromion grassland (Hayfield4) and the reference site. Most character species s. s. were found in Hayfield7 (four species), followed by Hayfield6 and Pasture2 with three species. Furthermore, Hayfield7 also harbored the most individuals (35 specimens), followed by Pasture1 and Pasture2 with 16 and 18 specimens, respectively. Concerning character species s. l., Pasture1 revealed the highest value with seven species, followed by Hayfield6 with six and Hayfield1 and Hayfield2 with each five species.

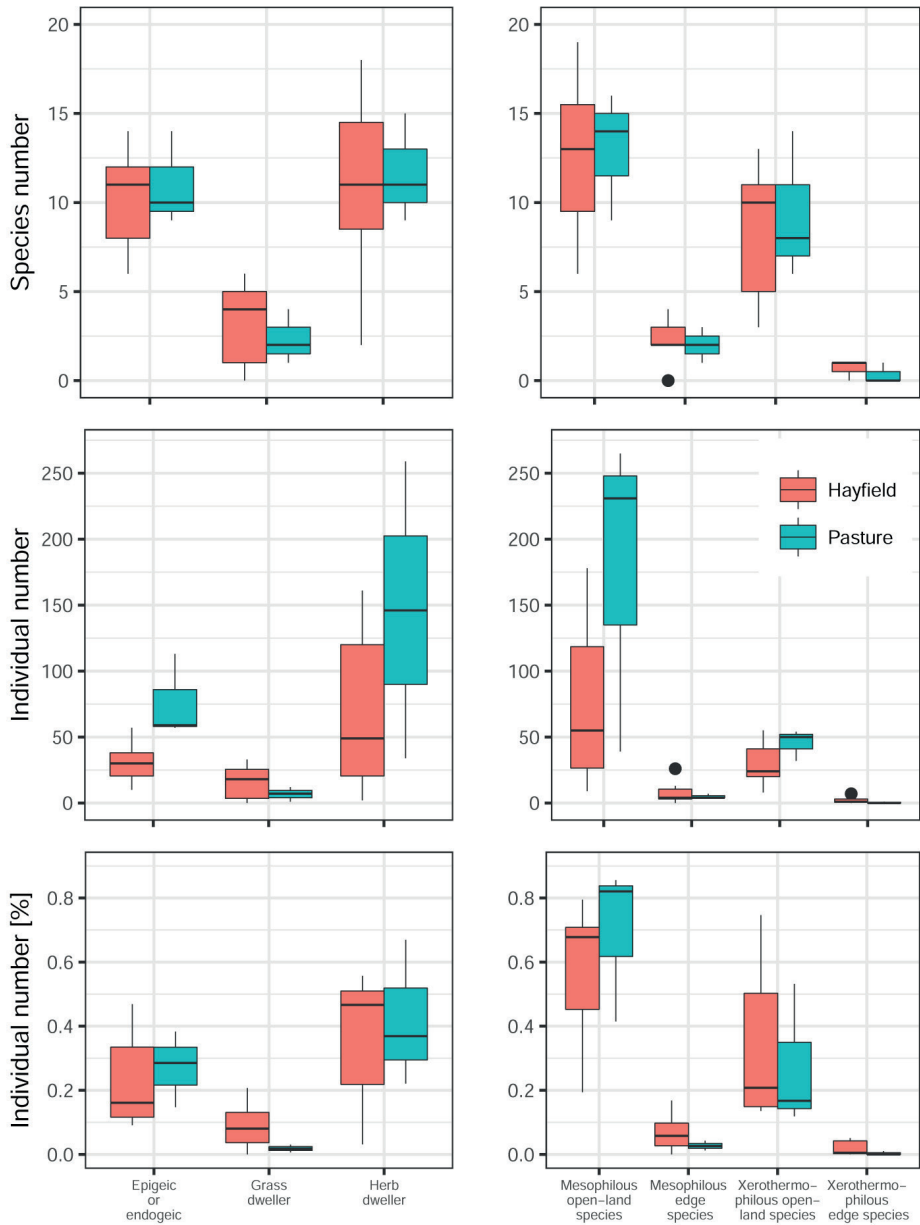


Fig. 7: Species, absolute and relative individual numbers according to habitat requirements (left column) and ecological types (right column) by management type ($n = 8$ for hayfields, $n = 3$ for pastures).

Abb. 7: Artenzahl, absolute und relative Individuenzahlen nach Habitatansprüchen (linke Spalte) und ökologischen Typen (rechte Spalte) je Managementregime ($n = 8$ für Mähwiesen, $n = 3$ für Weiden).

By far most frequent character species s. s. was *Ischnocoris hemipterus* that occurred 64 times in seven sites. The next abundant species was *Macroplax preysleri* with 13 specimens in two sites. Most frequent character species s. l. was *Lasiacantha capucina capucina* with 81 individuals in seven sites and *Coptosoma scutellatum* with 61 individuals in six sites. Also *Hallodapus montandoni* occurred 23 times in four sites.

Table 3: Character species for Styrian Mesobromion grasslands. Abbr.: s. l.–sensu lato, s. s.–sensu stricto.

Tab. 3: Charakterarten steirischer Halbtrockenrasen. Abk.: s. l. - sensu lato, s. s. - sensu stricto.

Character species s. l.	Character species s. str.
<i>Alydus calcaratus</i>	<i>Copium clavicorne clavicorne</i>
<i>Canthophorus impressus</i> ²	<i>Emblethis verbasci</i> ¹
<i>Coptosoma scutellatum</i>	<i>Geocoris dispar</i> ²
<i>Criocoris nigripes</i>	<i>Geocoris erythrocephalus</i>
<i>Emblethis griseus</i>	<i>Ischnocoris hemipterus</i>
<i>Graptopeltus lynceus</i>	<i>Macroplax preysleri</i>
<i>Hallodapus montandoni</i>	<i>Megalonotus emarginatus</i>
<i>Lasiacantha capucina capucina</i>	<i>Megalonotus hirsutus</i>
<i>Metopoplax origani</i>	<i>Odontotarsus purpureolineatus</i> ^{2,3}
<i>Oncochila scapularis</i>	<i>Omphalonotus quadriguttatus</i>
<i>Oxycarenus pallens</i>	<i>Peirates hybridus</i> ⁴
<i>Peritrechus gracilicornis</i>	<i>Systellonotus triguttatus</i> ²
<i>Placochilus seladonicus seladonicus</i>	<i>Tinicephalus hortulanus</i>
<i>Platyplax salviae</i>	<i>Vilpianus galii</i>
<i>Plinthisus pusillus</i>	<i>Xanthochilus quadratus</i>
<i>Pterotmetus staphyliniformis</i>	
<i>Sciocoris cursitans cursitans</i>	
¹ Not recorded herein, but present in Styria (FRIESS & RABITSCH 2015)	
² Not recorded herein, but present in Styria (KORN et al. 2015)	
³ Not recorded herein, but present in Styria (ÖKOTEAM & STIPA 2009)	
⁴ Not recorded herein, but present in Styria (leg. J. Gunczy 2015)	

7. Discussion

7.1 Analysis of the coenoses

A single reference site opposing eleven Mesobromion grasslands is far too low for a statistically robust evaluation. Therefore, the study’s focus was repositioned to compare solely the Mesobromion grasslands (i.e. eight hayfields with two of them previous pastures, three pastures and one fallow land).

The Mesobromion coenoses turned out to be highly heterogeneous with regard to species composition, abundance, incidence and dominance structure. Consequently, cluster analysis techniques applied on Bray-Curtis dissimilarities showed the same

signal—namely, the partition into three groups. These groups seemed to be strongly influenced by the occurrence of the ubiquitous mirid *Halticus apterus apterus* as well as species and individual richness. Other effects seemed to be absent.

Interestingly, high differences in species richness between the sample sites were found. The site with the lowest species number (Hayfield3) was early mown and rarely regrew until autumn. However, this fact alone hardly explains the species-poorness as this was true also for other sites with higher species numbers (e.g. Hayfield2).

Due to the unusually dry and hot weather conditions during the sample season the vegetation developed only slowly. This effected especially Hayfield3 and Hayfield7 that both were mown early and rarely regrew until September. But also on the other sites the vegetation remained unusually low. Thus, an only incomplete picture of the Mesobromion Heteroptera fauna can be presented. Subsequent studies with the same sample design would be of high interest—particularly with respect to species composition during drought years compared to ‘normal’ ones and the viability of populations after droughts. Higher species numbers for all sites can be expected as (i) the weather conditions during the sample period were suboptimal, (ii) extension of sampling to the habitat edges and (iii) the use of additional sampling techniques can be expected to increase the recorded species numbers (particularly herb and grass dwelling ones). Concerning the latter, the same sample design with additional sweepnetting during the same season revealed similar results concerning species numbers, species composition and occurrence of ecological types (KORN et al., 2015). Thus, suction sampling alone can be regarded as a sufficient estimate of true bug fauna in Mesobromion grasslands. However, the high occurrence of rare and low-abundant species—as typical for Mesobromion true bug communities—calls for a generally higher sample intensity to account for their stochastic capture.

Two sites (Hayfield6 and Pasture1) harboured comparatively outstanding high species, Red List and endangered species numbers. Contrasting, low numbers of Red List and endangered species were found in Mesobromion grasslands Hayfield2 and Pasture3 as well as in Reference. However, considering the more or less random process suction sampling (especially with rare and therefore, hard to detect species) and the outstanding weather conditions in 2013, resampling might lead to different results. Reference revealed high species number, but was mostly composed of ubiquitous species. It is possible that the site was used as alternative habitat by xerothermophilous species as their original habitat was exceptionally dry. This could easily be verified by resampling in a more ‘normal’ season.

A comparison with the study of ÖKOTEAM & STIPA (2009) revealed huge discrepancies. Those mainly stem from different sampling methods. While ÖKOTEAM & STIPA (2009) focused on more or less easily detectable indicator species, the recent study used systematic sampling. Thus, the detected species could and can be expected to differ. Especially small, rare and cryptic species are prone to be overlooked using a ‘quick and dirty’ method. Therefore, it seems plausible and desirable to apply an integrated approach using various methods and indicator groups for nature conservation practices (e.g. BÜCHS 2003, DUELLI & OBRIST 2003, SÖDERSTRÖM et al. 2001, ZULKA et al. 2014).

A similar study was conducted in the same year in the East Styrian St. Anna am Aigen around the nature reserve ‘Höll’. There, the focus was a comparison of two Mesobromion sites with each an adjacent restoration site. Moreover, the methodical approach included the use of a sweep net, but the sites were visited only three times.

In St. Anna a. A., 84 species were recorded in four sites, opposing 105 species in the twelve sites of the recent study. Thus, this region relatively showed a trend of higher α -diversity; however, total species numbers per site were quite comparable

between both studies. One of the restoration sites in St. Anna a. A. (R1) was a ruderal site with outstanding plant species richness, harbouring mesophilous, edge as well as Mesobromion bug species and thus, significantly contributed to the recorded local species richness. Similarly, Reference harboured several species that were absent in the Mesobromion sites and thus, increased regional true bug species richness.

The percentage of red list and endangered species was distinctly higher in southern Styria (21 % vs. 14 % or 8 % vs. 7 % respectively). Hereby, non-Mesobromion species were excluded (i.e. *Scolopostethus lethierryi*, *Jalla dumosa* and *Pachybrachius fracticollis*).

Concerning ecological types, Mesobromion grasslands of both regions were dominated by openland species (Fig. 7), edge species played a subordinate role. Meso- as well as xerothermophilous species occurred quite balanced in both regions. Hygrophilous species were distinctly more common in the St. Anna a. A. region. These referred in most cases to *Stenodema calcarata*, a species that occasionally appears also in dry habitats (WACHMANN et al. 2004). It was found only once in the southern Styrian sample sites. Another hygrophilous species in St. Anna a. A. was the endangered *Pachybrachius fracticollis*.

The herein dominant *Halticus apterus apterus* was also numerous in St. Anna a. A., but was even outnumbered by *Nysius senecionis senecionis*—a xerothermophilous species that was present in both restoration sites in high densities. Contrasting, latter was found only twice in southern Styria.

To conclude, similarities as well as differences between the two regions were found. They may mainly have been caused by differences in applied methods, habitat type of non-Mesobromion grasslands, sampling intensity as well as stochastic effects.

New records for Styria: Three species were recorded for the first time in Styria. The two small mirids are typical Mesobromion species and most probably, their presence has been overlooked until now.

Omphalonotus quadriguttatus is a xerothermophilous, mirid with main distribution in the Mediterranean and the Black Sea region. It lives beneath low vegetation and is assumed to be zoophytophagous. Both sexes are wing polymorphic, with the macropterous form being the rare one (WACHMANN et al. 2004). The species was also detected in St. Anna a. A. (KORN et al. 2015). Furthermore, *O. quadriguttatus* is known from the Pannonian region in Lower Austria and Burgenland, where its populations are regarded to be stable (RABITSCH 2007, 2012). Contrasting, the species is considered as endangered in Styria (FRIESS & RABITSCH 2015).

The mirid *Tinicephalus hortulanus* is known from the British islands, Central and Eastern Europe, the Mediterranean basin, Asia Minor and the Caucasus. It feeds on *Helianthemum nummularium* (Cistaceae). Thus, its habitat is limited to the distribution of its host plant (WACHMANN et al. 2004). In Carinthia, its populations are considered to be vulnerated (FRIESS & RABITSCH 2009), while its populations are more stable in Lower Austria and Burgenland (RABITSCH 2007, 2012).

In Austria, *Scolopostethus lethierryi* is only known from the region around the Lake Neusiedl in Burgenland, where it is critically endangered (RABITSCH 2012). Populations of this lygaeid are also known from the Hungarian part of the Lake Neusiedl (BAKONYI et al. 2002). The species shows an eastern distribution with records from eastern Central Europe, Southeast Europe, Eastern Europe, the Caucasus region of Near Asia and Central Asia (HEISS et al. 2001). *Scolopostethus lethierryi* lives in moist, but open to semi-open habitats (WACHMANN et al. 2007). The record of this species is the most surprising of this study. However, further records are desirable for a definitive confirmation of the presence of a local population. Until then, an artificial introduction is, although quite improbable, possible.

7.2 Impact of management

Pastures were distinctly richer in individuals than hayfields. This might be explained by a higher amount of refuges that remained in the extensively grazed pastures in comparison to the uniformly cut hayfields. This effect might have been enforced by the low precipitation in the year 2013. These higher individual numbers in pastures evoked a distinct effect when examining by ecological traits. Importantly, this effect disappeared or even reversed most times when regarding relative individual numbers.

Endo- or epigeic species were found in all sites in similar frequencies. Interestingly, the percentage of grass dwellers was very low. This could be result of either the low vegetation that probably lacked appropriate niches for grass dwelling species or of a possibly insufficient detection level by the suction sampler. Mesophilous open-land species were more or less equally frequent in hayfields and pastures. Edge species were less frequent in pastures than in hayfields regarding species abundances as well as absolute and relative individual numbers. This seems plausible as hayfields exhibit an evenly grown and cut vegetation, whereas grazing mammals selectively and therefore, unevenly feed on the vegetation. Furthermore, relative individual numbers of edge-species were less frequent in pastures, while mesophilous open-land species were more frequent. Concluding, differences in true bug communities between mown and grazed Mesobromions seemed to be more influenced by quantitative and structural than by qualitative nature; similar is known for Mesobromion vegetation (SCHMIDT et al. 2007).

7.3 Résumé

Although the anthropogenic origin of Mesobromion grasslands might be dubious (compare NAGEL 2000), they are home to several rare species. Considering the fact that natural Mesobromion-like habitats as previously found at gravel banks or forest edges nowadays are mainly destroyed, Mesobromion grasslands seem to be at least a sufficient proxy for them. Thus, they provide shelter and increase habitat connectivity for unique assemblages of xerothermophilous species.

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