Auchenorrhyncha and host plant networks in extensively managed grasslands in the Swiss lowlands

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Abstract

Plant- and leafhoppers (Auchenorrhyncha) are one of the most abundant insect groups in temperate semi-natural grassland ecosystems where they fulfil an essential role in the nutrient cycle. Although Auchenorrhyncha have been demonstrated to be a good indicator of grassland ecological quality, the networks they establish with plants remain understudied. The objective of this study was to fill this gap in knowledge for semi-natural grasslands. To that purpose, 72 extensively-managed grasslands well spread across the Swiss lowlands were selected. Sixty of them fulfilled the botanical standards for low ecological quality and 12 for high ecological quality, according to the Swiss agri-environmental regulations. Grasslands of high ecological quality were, on average, older (> 20 years) than grasslands of lower quality (mostly 5–15 years old). In spring 2018, the plant and Auchenorrhyncha communities of these 72 study sites were assessed, along with several abiotic variables. Multivariate model analyses showed that the abundance of Auchenorrhyncha was positively correlated with the cover of bare ground and the cover of grasses (Poaceae). The Auchenorrhyncha networks found within our grasslands exhibiting a high ecological quality were less well connected than the networks developing in grasslands with low ecological quality, meaning that Auchenorrhyncha-host plant networks were more specialised in grasslands with higher botanical diversity. In addition, the grasslands with high ecological quality harboured the vast majority of the least abundant, i.e. rarest species of Auchenorrhyncha recorded in this study. The presence and abundance of grasses appeared as a crucial factor determining the structure of the observed Auchenorrhyncha communities, which sheds some new light on the conservation and restoration of extensively-managed grasslands. Grassland age also played an important role, providing conditions for species that are never encountered in younger semi-natural grasslands. The maintenance of ancient grasslands in agro-ecosystems in general must remain a top measure to fight against the erosion of farmland biodiversity.

Keywords: Auchenorrhyncha, Networks, Plant-herbivore, Extensive management, Grasslands

1. Introduction

Even though, central Europe is not famous for its high biodiversity, it is home to the European semi-natural grassland ecosystem. This habitat holds the world records for vascular plant species richness on the grain size ≤50 m^2: 44 species on 0.25 m^2 in the Czech Republic and 98 species on 10 m^2 in Romania (Wilson et al., 2012). Many other taxa (e.g. butterflies and plant- and leafhoppers) depend directly or indirectly on this ecosystem (Nickel, 2015; WallisDeVries & Van Swaay, 2009). Plant- and leafhoppers, known as Auchenorrhyncha (Hemiptera: Fulgoromorpha and Cicadomorpha) are hemimetabolous insects that feed on plant sap. They are globally distributed and more than 26'000 species have been described worldwide (Biedermann & Niedringhaus, 2009). Auchenorrhyncha differ extremely in their habitat requirements and cover the whole range from xero- to hydrophilic habitats. In central Europe they are most abundant in shrub- and grasslands and 61% depend strictly on grassland (Nickel et al., 2002). One of the main factors affecting their assemblage is vegetation diversity and composition (Biedermann et al., 2005). Most of the Auchenorrhyncha species in central Europe show a close relationship to their host plant. About 60% are monophagous, meaning they feed on a single plant species or genus, 25% are oligophagous, feeding on one or few plant families and 15% are polyphagous that feed on many plant families (Kunz et al., 2011). The local assemblage of Auchenorrhyncha species is influenced by different factors e.g. land use intensity, soil conditions, climate, area and vegetation (Biedermann et al., 2005). Auchenorrhyncha play an important role in the food web. They are food source for spiders, assassin and damsel bugs, some plant bugs, birds, ants and parasitoids (Biedermann & Niedringhaus, 2009; Moreby & Stoate, 2001; Sanders et al., 2008). Auchenorrhyncha are also known to be a good bioindicator of grasslands because of their numerical abundance, taxonomic diversity and strong and immediate response to changes in their habitat (Andrey et al., 2016; Biedermann et al., 2005; Buri et al., 2016; Nickel & Hildebrandt, 2003). Further, they are an essential part of the nutrient cycle as they act as primary consumers (Andrzejewska, 1979). Apart from the factors mentioned above, little is known about the network that Auchenorrhyncha build in grasslands. Hitherto, there is no distribution map as well as no Red list for Auchenorrhyncha available for Switzerland.

The main goal of this study was to investigate the Auchenorrhyncha communities inhabiting semi-natural lowland grasslands and to better understand their host plant networks. It also aims to identify differences of these networks according to meadow ecological quality (based on plant species assemblage, see Materials and Methods section below). Therefore, 72 extensively-managed meadows of different grassland ecological quality were sampled in spring 2018, including plant species composition and cover, topographic variables and Auchenorrhyncha. Specifically, our objectives were: 1) to identify the main factors that influence Auchenorrhyncha community composition in extensively managed lowland meadows; 2) to describe Auchenorrhyncha-host plant networks in these same meadows; and 3) to compare the outputs between the meadows of the two different ecological qualities (mostly botanical). We hypothesized that factors like plant species richness, grasses species richness or cover of grasses would affect Auchenorrhyncha abundance and/or species richness (Biedermann et al., 2005). Further, Auchenorrhyncha and host plant networks were expected to be less connected when network size (i.e. more plant species) is higher (Blüthgen et al., 2006).

This master thesis was part of the Grassland restoration project of the division of Conservation Biology of the University of Bern. It was a Swiss National Science Foundation founded project (grant number 31003A_172953 allocated to Prof. Raphaël Arlettaz). It was launched in 2018 with the selection of the study sites across the Swiss lowlands and a thorough effort in sampling baseline data, including among others plants and Auchenorrhyncha. This study made use of these baseline data.

2. Materials and methods

2.1. Study sites

To launch the above mentioned Grassland restoration project, 72 extensively managed grasslands across the Swiss lowland were selected as study sites in 2018 (Fig. 1). They were dispersed among twelve regions. All grasslands have been extensively managed for at least 5 years (range: 5 – 25 years). They had to have a minimal size of 0.1 ha (range: 0.14 – 5.2 ha) and ranged in altitude between 419 and 758 m a.s.l.. The grasslands within a region were apart from each other by at least 0.4 km but located within a radius of 2.5 km. Twelve regions in the Swiss lowlands were selected for this project. Every region consisting of six extensively managed grasslands. All grasslands were managed according to the Swiss biodiversity promotion area (BPA) regulations (Bundesrat, 2013b). Five grasslands per region fulfilled the

BPA standards for quality level 1 and one fulfilling the BPA standards for quality level 2. A grassland fulfilling the standard for quality level 2 needs to have at least 6 plant indicator species, that serve as an indicator for high grassland quality (Bundesrat, 2013b). Note that it has been demonstrated that in similar BPA meadows, overall plant species richness positively correlates with the number of quality 2 indicator plant species (Weinrich et al., 2018). All quality 2 grasslands included in this project consisted of 10+ plant indicator species.

2.2. Vegetation and topographic variables sampling

The plant species composition and percentage cover in every grassland was ascertained within two plots as in Van Klink et al. (2017). Specifically, each plot was 2 x 4 m, they were separated by 8 m and the first plot was randomly placed in the grassland with a minimum of 10 m buffer zone to the field margin to avoid edge effects (Fig. 2). Soil properties (Landolt values) were derived from plant species composition of the meadows (Landolt et al., 2010). Topographic variables (i.e. slope, size and elevation) of the meadows as well as years of extensive management were recorded (see Table 1 for details). Surveys were carried out in spring 2018.

2.3. Auchenorrhyncha sampling

Auchenorrhyncha were collected using a suction sampler (Stihl SH86, Stihl, Waibling, Germany; Fig. 3) as in (Andrey et al., 2016; Buri et al., 2016; Sanders & Entling, 2011). The nozzle of the suction sampler was equipped with a gauze in it to retain the sucked in arthropods (Fig. 4). All grasslands were sampled twice during the vegetation period. Once before (end of May – mid of June 2018) and once after the grasslands were mown (mid of July – end of July 2018). At each study site, five subplots for the Auchenorrhyncha sampling were defined based on the position of the vegetation sampling plots (Fig. 2). One subplot in the centre and one in every cardinal direction at 6 m distance from the centre. Each subplot covered an area of 0.2 m^2. Therefore, the total amount of sampling cover at each grassland was 1 m^2. The subplots were vacuumed for at least 20 seconds from the standing vegetation present within an open metal cylinder of 50 cm height and 51 cm diameter that was placed on the ground. Sampling was carried out between 10.00 a.m. and 18.00 p.m., under dry vegetation conditions and with no to moderate wind. The sampling material from every subplot was transferred into a zip lock bag and stored after in a deep freezer at -20°C. In total, 720 samples were collected.

2.4. Sorting and identification

For this master thesis, the 360 samples from the second session (higher adult abundance) were analysed. The arthropods of each subsample were sorted and grouped as follows: Arachnida, Gastropoda, Auchenorrhyncha, Orthoptera, Coleoptera, Heteroptera, Thysanoptera and Others. The specimens of each group were transferred into a 2 ml microtube and stored again in the deep freezer at -20°C. All adult Auchenorrhyncha individuals were identified to species level. For the identification, the key by Biedermann and Niedringhaus (2009) "The Plant- and Leafhoppers of Germany" as well as the "Photographic Atlas of the Planthoppers and Leafhoppers of Germany" by Kunz, Nickel and Niedringhaus (2011) were used.

2.5. Networks

Network theory is widely applied in ecology. Namely in species interaction, spatial ecology, epidemiology and evolution in social groups (Bascompte, 2007). Here, the network of interest is a species interaction network. In other words, a plant-herbivore food-web. The Auchenorrhyncha species and hostplant network looked at here, is a bipartite network, consisting of two levels. The higher level representing the Auchenorrhyncha species and the lower level the plant species. Interactions between these two levels can be analysed in two ways, depending the way, the data were collected. If data on the interaction frequency is available, networks can be analysed with quantitative indices, e.g. H'2, linkage density, species strength. If the data provides no information on the interaction frequencies, the network can be analysed using qualitative indices, e.g. connectance, links per species, nestedness (Dormann et al., 2009). The way, data were collected in this study, allows for qualitative indices. Connectance and links per species were selected for the network analysis in this thesis. Not only, because they are commonly used in food web analysis (Blüthgen et al., 2006; Kaiser-Bunbury & Blüthgen, 2015) but also, both indices are appropriate to describe network complexity and/or the level of specialisation of a network.

Beforehand running network analysis, an Auchenorrhyncha species and host plant species interaction table had to be build. This was done by creating a matrix, in which, columns represent all the Auchenorrhyncha species that were found, and rows all plant species that were recorded (Dormann et al., 2008). The host plant species of all Auchenorrhyncha species were looked up in the following literature: ''Verzeichnis der Zikaden Deutschlands, Österreichs und der Schweiz'' (Mühlethaler et al., 2018) and "The Plant- and Leafhoppers of Germany" (Biedermann & Niedringhaus, 2009). Every interaction, meaning the host plant of a given Auchenorrhyncha species was present in the plant species pool from the survey, in the matrix was assigned a 1. All non-interactions were assigned a 0.

2.6. Statistical analysis

Statistical analysis was performed in RStudio version 1.3.1073 with R version 4.0.2 (RStudio_Team, 2020). Auchenorrhyncha species richness and abundance were ascertained by pooling the data from the five suction sampling subplots per meadow. Auchenorrhyncha species richness and abundance were used as response variables each with four categories 'total', 'monophagous' (feeding on one plant species or genus), 'oligophagous' (feeding on one to two plant families or on maximum six different plant species from different families) and 'polyphagous' (feeding on seven or more plant species from three or more plant families). Analysis on Auchenorrhyncha abundance and species richness was based on adult individuals (nymphs were disregarded). Plant and vegetation data were obtained by merging the data of the two vegetation plots per meadow. The network indices were extracted per meadow using the package 'bipartite' (Dormann et al., 2019). 'connectance' and 'links per species' were used as response variables. An overview of all response and explanatory variables that were used is given in Table 1.

Analyses were done in three steps. First, univariate linear mixed effect models with 'region' as random factor were ran, using the package 'lme4' (Bates et al., 2020). 'Auchenorrhyncha species richness' (total, monophagous, oligophagous and polyphagous), 'Auchenorrhyncha abundance' (total, monophagous, oligophagous and polyphagous), 'connectance' and 'links per species' were used as response variables and were tested with all explanatory variables. Second, all explanatory variables that showed a p-value ≤ 0.1 in one of the univariate models were retained to build multivariate models (see Table 1), using the package 'lme4' (Bates et al., 2020) with 'region' as random factor. Model selection was then performed using the function dredge() from the package 'MuMIn' (Barton, 2020) and ranked according to the AICc value. As a third and last step, model averaging was done including all models within ≤Δ2 using the model.avg() function from the package 'MuMIn' (Barton, 2020).

Last, all variables (response and explanatory) that are shown in Table 1 were tested against the 'quality level' of the meadows (categorical: 'quality 1' and 'quality 2') with 'region' set as random factor.

2.7. Gamma diversity

The experimental design of the long term grassland restoration project (see introduction) allowed to subdivide the meadows with quality level 1 into five groups: c; hh; hp; sc; and sn (these abbreviations have not importance in the frame of this master study). This meadow groups consist each of one randomly chosen quality 1 meadow from every region (n = 12). Further, all meadows with quality level 2 (one per region) were put into a 6^{th} group (d). Furthermore, Auchenorrhyncha species were categorized according to their recorded abundance. The most abundant species, representing 95% of the total abundance, were considered as 'common' species. The remaining 5% were divided into 'rare' (4%) and 'very rare' (fewest 1%) species (see Fig. 5). Then, the gamma diversity, i.e. the overall number of Auchenorrhyncha species for each meadow group (d, c, hh, hp, sc, and sn) was calculated computed. This descriptive data was not statistically analysed.

2.8. Data

Due to travel restrictions, following the pandemic situation in spring 2020, the Auchenorrhyncha data could not be double-checked by an expert on-site as foreseen. Therefore, samples were send abroad for verification later on that same year. In the meantime, statistical analysis was performed. At the time, this thesis was supposed to end, the double-checked data reached us. Because of a lack of time, only a part of the analysis could be done again. It was possible to update the species list (Fig. 5) as well as the species distribution (gamma diversity) per quality level (Fig. 9). All other model outputs and network analyses are based on the data before verification, though, we do not expect any qualitative differences as the large majority of the specimens (95%) were correctly identified at first.

3. Results

A total of 2663 adults and 2548 nymphs were found. 2461 adults (92.4%) were identified to species level. 75 adults (2.8%) could only be identified to genus level and for 127 individuals

(4.2%), identification to genus or species level was not possible due to damage or only female individuals presence. Oligophagous species were the most abundant (1513 adult individuals, 56.8%), followed by monophagous species (596 adult individuals, 22.4%) and polyphagous species (352 adult individuals, 13.2%) on third place. Overall, 46 Auchenorrhyncha species were found (Table 2 and Fig. 5). The most abundant species were *Anoscopus serratulae* (628 individuals), *Javesella pellucida* (279 individuals), *Anaceratagallia ribauti* (264 individuals) and *Laodelphax striatella* (219 individuals). *Anoscopus serratulae* makes almost a quarter (24.3%) of all adult individuals identified. The four most abundant species make more than half (53.7%) of all adult individuals identified. The fewest 5% consists of 22 species what is almost half (47.8%) of all species found. The mean abundance of Auchenorrhyncha per meadow was 37.0 individuals per 1 m^2 (SD ± 17.5) with a minimum of 4 and a maximum of 87. The mean species richness of Auchenorrhyncha per meadow was 9.2 species per 1 m^2 (SD ± 2.8) with a minimum of 2 and a maximum of 15.

3.1. Auchenorrhyncha abundance

Total Auchenorrhyncha abundance correlated positively with cover of bare and cover of grasses. Monophagous species abundance correlated positively with slope and cover of bare ground. Oligophagous species abundance correlated positively with species richness of grasses. Polyphagous species abundance correlated positively with cover of grasses. A table with all outputs is given in Appendix 1 Table S1 (univariate models) and Appendix 2 Table S2 (multivariate models).

3.2. Auchenorrhyncha species richness

Total species richness of Auchenorrhyncha and species richness of polyphagous species did not significantly correlate with any of the explanatory variables. Whereas species richness of monophagous species correlated positively with slope and species richness of oligophagous species correlated positively with cover of grasses. A table with all outputs is given in Appendix 3 Table S3 (univariate models) and Appendix 4 Table S4 (multivariate models).

3.3. Network indices

Connectance correlated positive with grasses species richness and negatively with plant species richness. Links per species correlated positive with cover of grasses (Fig. 6). A table with all outputs is given in Appendix 5 Table S5 (univariate models) and Appendix 6 Table S6 (multivariate models).

3.4. Meadow quality level

Slope, reaction (Landolt value), plant species richness, grasses species richness and cover of forbs were higher in quality 2 compared to quality 1 meadows (Fig. 8). In contrary, Moisture and nitrogen values (Landolt), cover of grasses, connectance and links per species were lower in meadows with quality level 2 (Fig. 7). Finally, Auchenorrhyncha species richness (alpha diversity) of meadows with quality level 1 did not significantly differ from meadows with quality level 2 (Fig. 8). A table with all outputs is given in Appendix 7 Table S7.

3.5. Gamma diversity

Although, quality 1 and 2 meadows did not significantly differ according to alpha diversity, they differed considering gamma diversity. Meadows with quality level 2 did not only have the highest value for overall gamma diversity (34 species), but they also showed the highest value of gamma diversity considering the ‘very rare’ species (7 species; Fig. 9).

4. Discussion

The main goal of this study was to better understand Auchenorrhyncha communities inhabiting extensively managed grasslands and their host plant networks. Multivariate models revealed that abundance of Auchenorrhyncha was positively correlated with the proportion of bare ground and percentage cover of grasses. These findings confirm that the abundance of grasses play a key role for Auchenorrhyncha (Biedermann et al., 2005). Network analyses showed that meadows with higher numbers of plant indicator species (ecological quality level 2) have significantly lower values for connectance and links per species when compared to meadows with quality level 1. This demonstrates, that meadows of different botanical quality levels, also harbour different Auchenorrhyncha and host plant networks. In the next paragraphs, the results are discussed in more detail following the structure of the results section, followed by a conclusion with some conservation-relevant recommendations.

4.1. Auchenorrhyncha abundance and species richness

Our study supports the general importance of grasses (*Poaceae*) for Auchenorrhyncha abundance, as it was also shown by (Everwand et al., 2014) and (Koroesi et al., 2012). Regarding the different feeding guilds of Auchenorrhyncha (monophagous, oligophagous and polyphagous), monophagous and oligophagous were the most abundant Auchenorrhyncha groups (80.4%). This was also demonstrated in semi-natural grasslands of comparable management type (1 cut per year, no fertilizer input) by Nickel and Achtziger (2005).

Total Auchenorrhyncha species richness in general could not be explained with the variables tested in this study. This finding is in line with the work done by Buri et al. (2016) and Weinrich et al. (2018). They found no difference in Auchenorrhyncha species richness while comparing Swiss lowland extensively managed meadows with different mowing regimes. In the present study, only extensively managed meadows were sampled and could be compared to each other. Meaning that all meadows were managed similarly with usually two, maximum three uses per year and that all harboured a relatively rich plant species composition (mean ± standard deviation = 26.4 ± 6 per 16 m2) compare to intensively managed grasslands (Aviron et al., 2009). This may partly explain, why it is difficult to identify single important variables. Whereas, while comparing meadows of different management type, several factors were demonstrated to directly influence Auchenorrhyncha communities. Higher land use intensity negatively affected abundance and species richness of mono- and oligophagous species (Nickel & Achtziger, 2005). Higher level of disturbance was negatively correlated with total abundance and species richness of monophagous species (Nickel & Hildebrandt, 2003) and higher fertilizer input negatively affected monophagous species richness as well as total species richness (Achtziger et al., 1999).

4.2. Network indices

Multivariate models showed, that connectance was positively related to grasses species richness and negatively related to plant species richness. 44.7% of all Auchenorrhyncha species in central Europe feed on grasses (Biedermann & Niedringhaus, 2009). In our study, the vast majority of monophagous (80%) and oligophagous species (81.8%) that were found, feed on grasses (*Poaceae*). Thus, Auchenorrhyncha communities of extensively managed meadows are more linked to grass species than to other plant species. Connectance values were higher when grasses species richness was increased, and lower when plant species richness, including forbs, legumes (*Fabaceae*) and grasses, was increased. In a similar way, links per species was positively correlated with cover of grasses. Meaning, the more a meadow is covered with grasses, it provides more possible (host plant) links for Auchenorrhyncha. As cover of forbs was significantly negatively correlated with connectance and links per species, their presence drive the Auchenorrhyncha communities in the opposite direction.

4.3. Meadow quality level

Regarding meadow ecological quality level, the analysis reflected quite good, what is commonly associated with the respective botanical quality of a grassland. It showed that ancient meadows with quality level 2 (i.e. more indicator plant species) were generally steeper (more difficult to manage), had a lower Landolt index for reaction (lower pH), increased plant and grasses species richness and cover of forbs (about 15% more), which are often indicator plant species. See also Ettlin et al. (2019) and Weinrich et al. (2018). In contrast, meadows with quality level 1 had increased Landolt values for moisture (wetter) and nitrogen (more fertile) and had a higher cover of grasses (about 20% more).

Recent findings by Heleno et al. (2012) showed that the interpretation of connectance needs to be context specific. Meaning that connectance values, in respect of the network of interest, antagonistic (i.e. plant-herbivore) or mutualistic (i.e. plant-pollinator) can have different meanings. They state that the commonly used positive relationship between networks with high connectivity and the associated higher value for conservation did not derive from empirical data and needs further research. More consent seems to be about that lower connectance increases the function of a network and characterizes networks with a higher level of specialisation i.e. harbour more specialised species. Whereas, networks with higher connectance provide greater stability of function and are characterized by the presence of more generalized species (Blüthgen et al., 2006; Dunne et al., 2002; Tylianakis et al., 2010). Welti et al. (2017) investigated plant-herbivore networks in 12 temperate grassland plots (60 x 60 m). They found, that connectance was significantly lower in plots with high plant diversity (about 28 species) when compared to plots with low (about 14) and very low plant species richness (about 8 species). These findings are in line with the results from our study, were meadows with quality level 2 (higher plant species richness) showed a significant lower value for connectance when compared to meadows with quality level 1 (lower plant species richness). This confirms our second hypothesis, in which we expected Auchenorrhyncha and host plant networks to be less connected, if the network size (i.e. more plant species) is increased.

These outcomes imply that Auchenorrhyncha and host plant networks in extensively managed meadows with quality level 2 have a higher level of specialisation, regarding the network structure. Moreover, meadows with quality level 2 showed the highest values for gamma diversity according to 'total species' (34 species) and 'very rare species' (3 times more). Hence, meadows with quality level 2 are home to networks with a higher level of specialisation and harbour a different species pool of Auchenorrhyncha. To sum up, extensively managed meadows with quality level 2 provide a special habitat for the least common plant- and leafhopper species found in this study.

4.4. Conclusion

Grasses species richness in combination with cover of grasses seems to be a good indicator for the level of specialisation of an Auchenorrhyncha and host plant network in extensively managed meadows. By protecting and maintaining ancient high quality grasslands, also highly specialised Auchenorrhyncha networks with very rare species are protected. They can act as a source population for nearby, newly created or restored grasslands. Further, extensively managed meadows with quality level 1 should be considered for active restoration (e.g. hay transfer) as it was shown that also living invertebrates (including Auchenorrhyncha) were transferred from ancient, high quality donor grasslands (Stöckli et al., 2020).

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Table 1. Response and explanatory variables used in the analyses. The first column shows the names of the response and explanatory variables. The second column gives a definition for the respective variable. In square brackets the units that were used accordingly. Landolt values are used to describe soil characteristics. They are based on plant species composition and their respective cover in a given habitat. Explanatory variables marked with an asterisks were retained for the multivariate model analysis.

Variables	Definition / unit
Response variables	
Auchenorrhyncha abundance total	Abundance of adult individuals [individuals / m^2]
Auchenorrhyncha abundance monophagous	Abundance of adult monophagous individuals [individuals / m^2]
Auchenorrhyncha abundance oligophagous	Abundance of adult oligophagous individuals [individuals / m^2]
Auchenorrhyncha abundance polyphagous	Abundance of adult polyphagous individuals [individuals / m^2]
Auchenorrhyncha species richness total	Species richness of adult individuals [species / m^2]
Auchenorrhyncha species richness monophagous	Species richness of adult monophagous individuals [species / m^2]
Auchenorrhyncha species richness oligophagous	Species richness of adult oligophagous individuals [species / m^2]
Auchenorrhyncha species richness polyphagous	Species richness of adult polyphagous individuals [species / m^2]
Connectance	Fraction of all possible links that are realized in a network (Dunne et al. 2002)
Links per species	Mean number of links per species in a network (Dormann et al. 2020)
Explanatory variables	
Slope*	Slope of the meadow [°]
Area	Size of the meadow [m^2]
Extensive since	Years since the extensive management of the meadow [years]
Elevation*	Elevation of the meadow [meters above sea level]
Moisture	Landolt value for moisture (very dry - very wet) [1-5]
Light	Landolt value for light exposure (in shade - in full light) [1-5]
Reaction	Landolt value for reaction (low pH - high pH) [1-5]
Nitrogen*	Landolt value for soil nutrient availability (infertile - over-fertilized) [1-5]
Plant species richness*	Plant species richness per 16 m^2 [species / 16 m^2]
Grasses species richness*	Grasses species richness per 16 m^2 [species / 16 m^2]
Cover of grasses*	Mean cover of grasses per 8 m^2 [%]
Cover of fabaceae	Mean cover of fabaceae per 8 m^2 [%]
Cover of forbs*	Mean cover of forbs per 8 m^2 [%]
Bare ground*	Mean cover of bare ground per 8 m^2 [%]

Table 2. List of the Auchenorrhyncha species found in this study. The first column gives the names of the species. The second column shows the associated feeding guild based on Mühlethaler et al. (2018). The third column provides total abundance of the respective species. The fourth and fifth column give information, whether a species was present in meadows with quality level 1 (Q1) and/or quality level 2 (Q2).

Species names	**Feeding guild**	**Abundance**	**Q1**	**Q2**
Acanthodelphax spinosa	Monophagous	17	yes	yes
Anaceratagallia ribauti	Monophagous	264	yes	yes
Anoscopus albifrons	Oligophagous	18	yes	no
Anoscopus albiger	Oligophagous	9	yes	yes
Anoscopus serratulae	Oligophagous	628	yes	yes
Aphrodes bicincta	Oligophagous	26	yes	yes
Aphrodes diminuta	Oligophagous	2	yes	no
Aphrophora alni	Polyphagous	2	no	yes
Arthaldeus pascuellus	Oligophagous	16	yes	yes
Artianus interstitialis	Oligophagous	1	yes	no
Chlorita paolii	Oligophagous	3	yes	no
Deltocephalus pulicaris	Oligophagous	50	yes	yes
Dicranotropis hamata	Oligophagous	115	yes	yes
Dictyophara europaea	Polyphagous	1	no	yes
Ditropsis flavipes	Monophagous	7	yes	yes
Emelyanoviana mollicula	Polyphagous	3	no	yes
Empoasca decipiens	Polyphagous	1	yes	no
Errastunus ocellaris	Oligophagous	84	yes	no
Eupelix cuspidata	Monophagous	1	yes	no
Eupteryx notata	Polyphagous	71	yes	yes
Euscelis incisus	Oligophagous	117	yes	yes
Graphocraerus ventralis	Oligophagous	1	no	yes
Hardya tenuis	Monophagous	35	yes	yes
Hyledelphax elegantula	Oligophagous	31	yes	yes
Jassargus pseudocellaris	Oligophagous	3	yes	no
Javesella dubia	Monophagous	32	yes	no
Javesella obscurella	Polyphagous	11	yes	no
Javesella pellucida	Polyphagous	279	yes	yes
Laodelphax striatella	Oligophagous	219	yes	yes
Macrosteles laevis	Polyphagous	41	yes	yes
Megadelphax sordidula	Monophagous	108	yes	yes
Megophtalmus scanicus	Oligophagous	6	yes	yes
Muellerianella fairmairei	Monophagous	15	yes	no
Philaenus spumarius	Polyphagous	41	yes	yes
Psammotettix cephalotes	Monophagous	15	yes	yes
Psammotettix confinis	Oligophagous	12	yes	yes
Psammotettix helvolus	Oligophagous	67	yes	yes
Recilia coronifer	Oligophagous	23	yes	yes
Ribautodelphax albostriata	Monophagous	7	yes	yes

Ribautodelphax angulosa	Monophagous	73	yes	yes
Ribautodelphax collinus	Monophagous	3	yes	yes
Streptanus aemulans	Oligophagous	46	yes	yes
Tettigometra impressopunctata	Monophagous	1	no	yes
Tettigometra virescens	Monophagous	3	no	yes
Xanthodelphax stramineus	Monophagous	34	yes	yes
Zyginidia scutellaris	Oligophagous	45	yes	yes

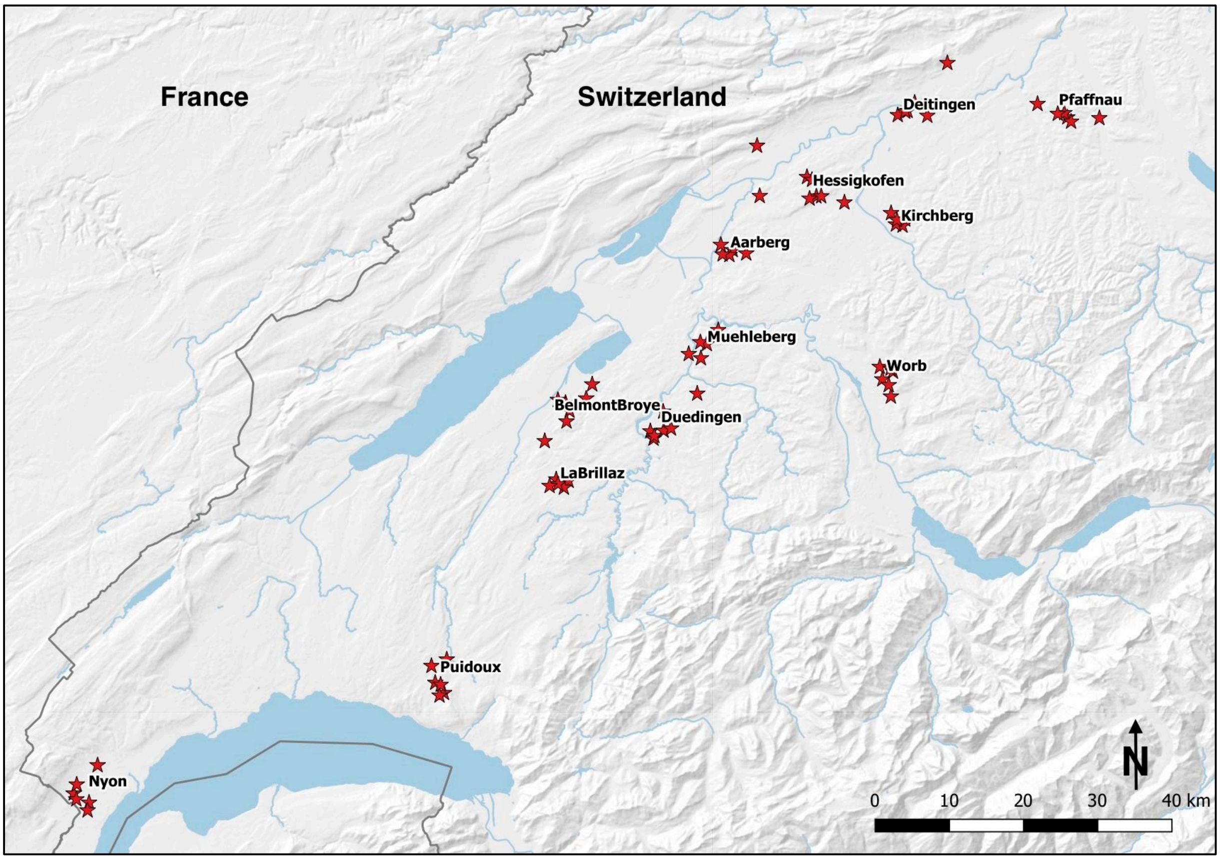

Figure 1. Study sites in the Swiss lowlands. Names indicate study regions. Red stars represent the respective six study sites, five meadows with quality level 1 and one meadow with quality level 2, per region.

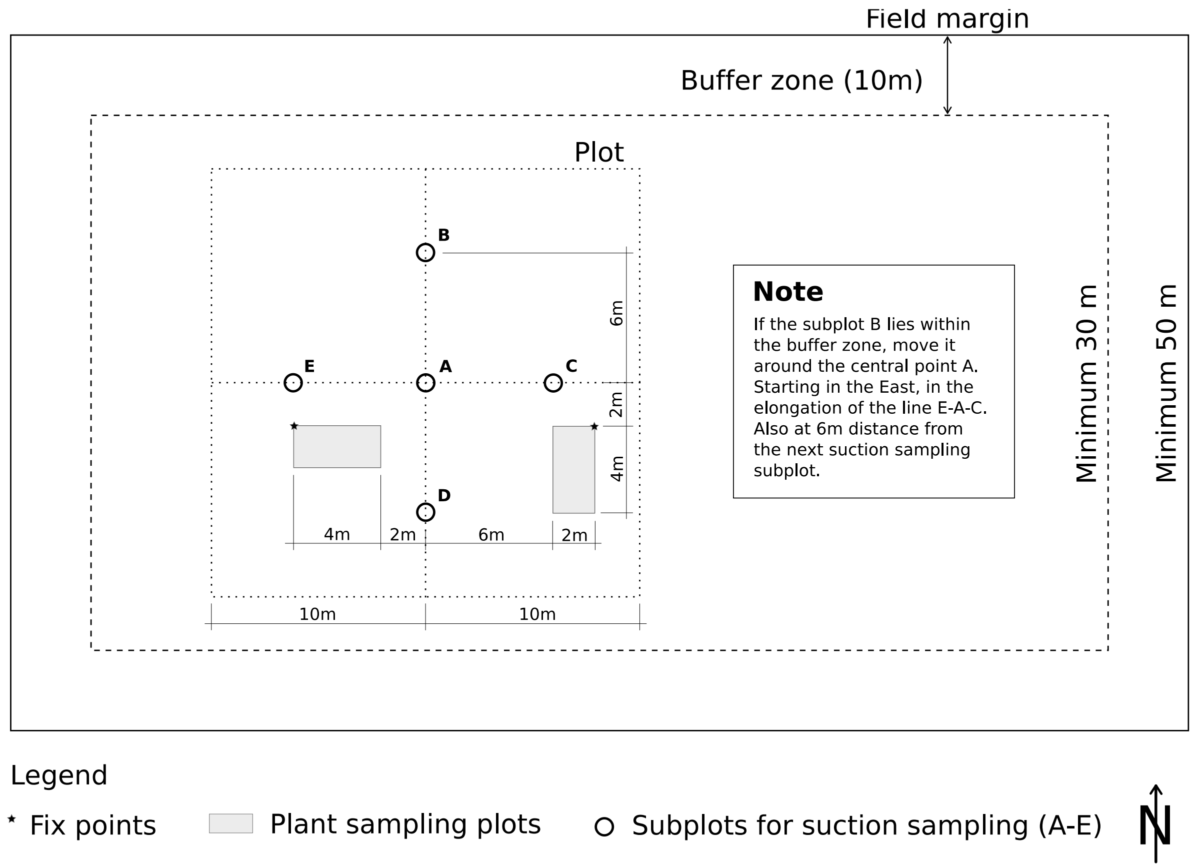

Figure 2. Vegetation and suction sampling design.

Figure 3. Suction sampling.

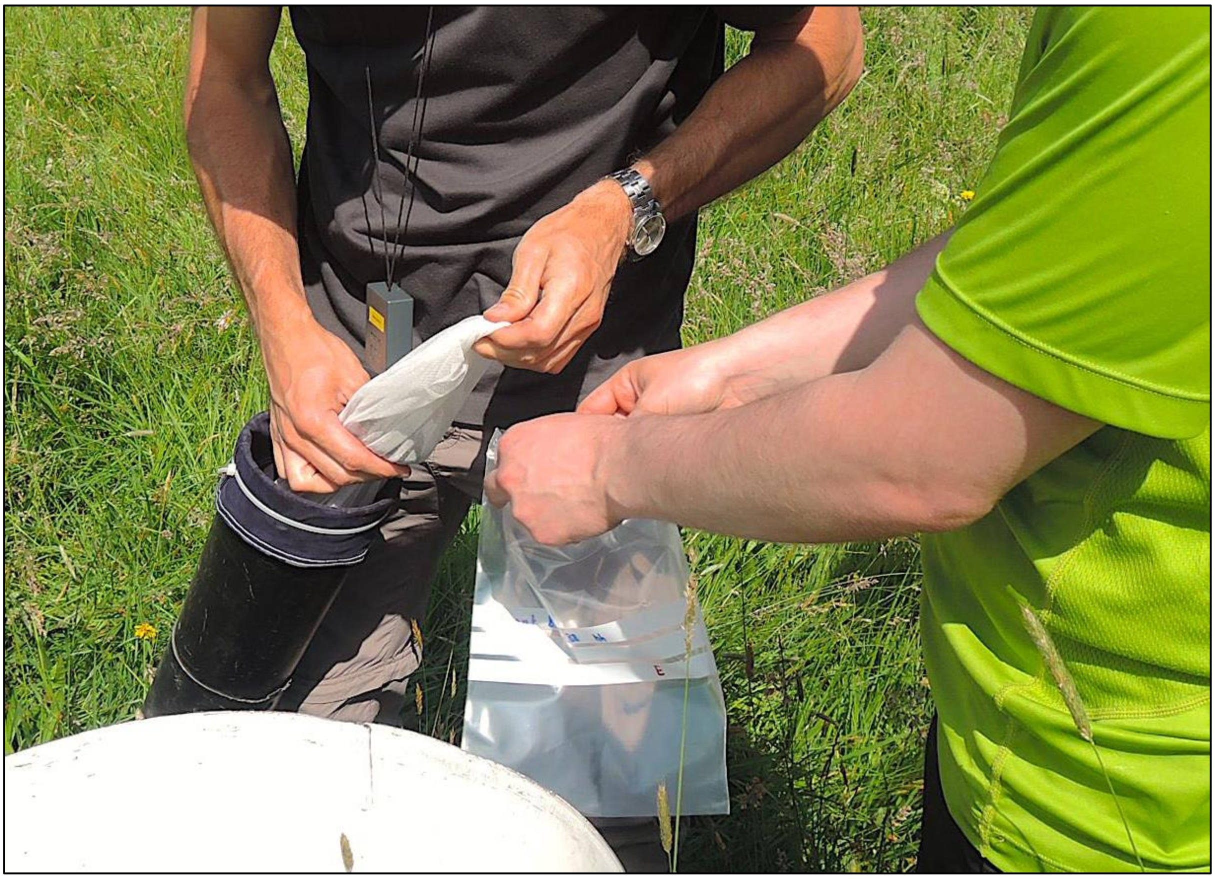

Figure 4. The nozzle of the suction sampler was equipped with a gauze in it to retain the sucked in arthropods. The picture shows the transfer of the sucked in arthropods from the gauze into a plastic bag.

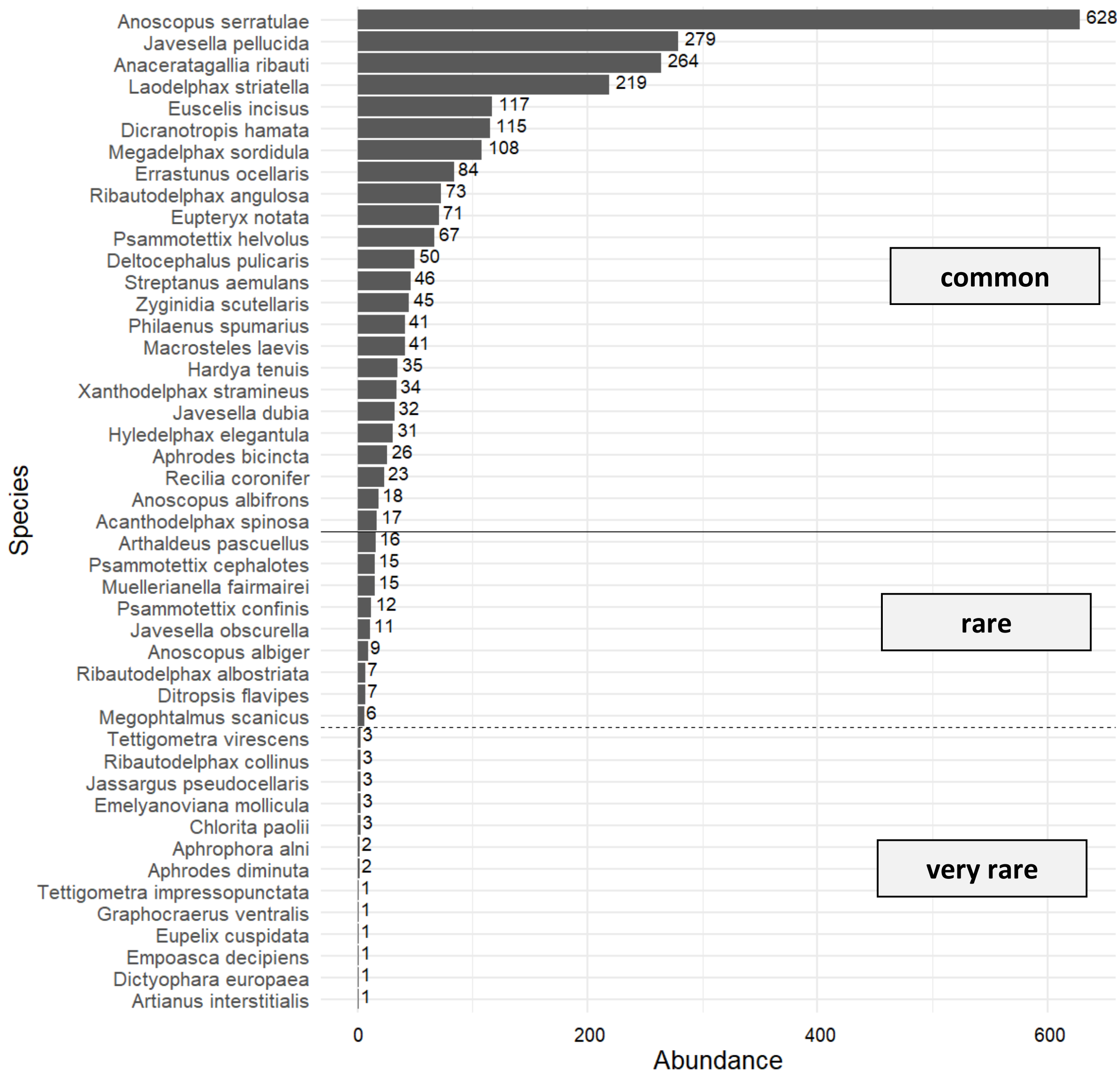

Figure 5. Auchenorrhyncha abundance per species. The most abundant species, representing 95% of the total abundance (above the solid line), were considered as ‘common’. Following the abundance, the remaining 5% were divided into ‘rare’ (4%, dashed line) and ‘very rare’ (about 1%).

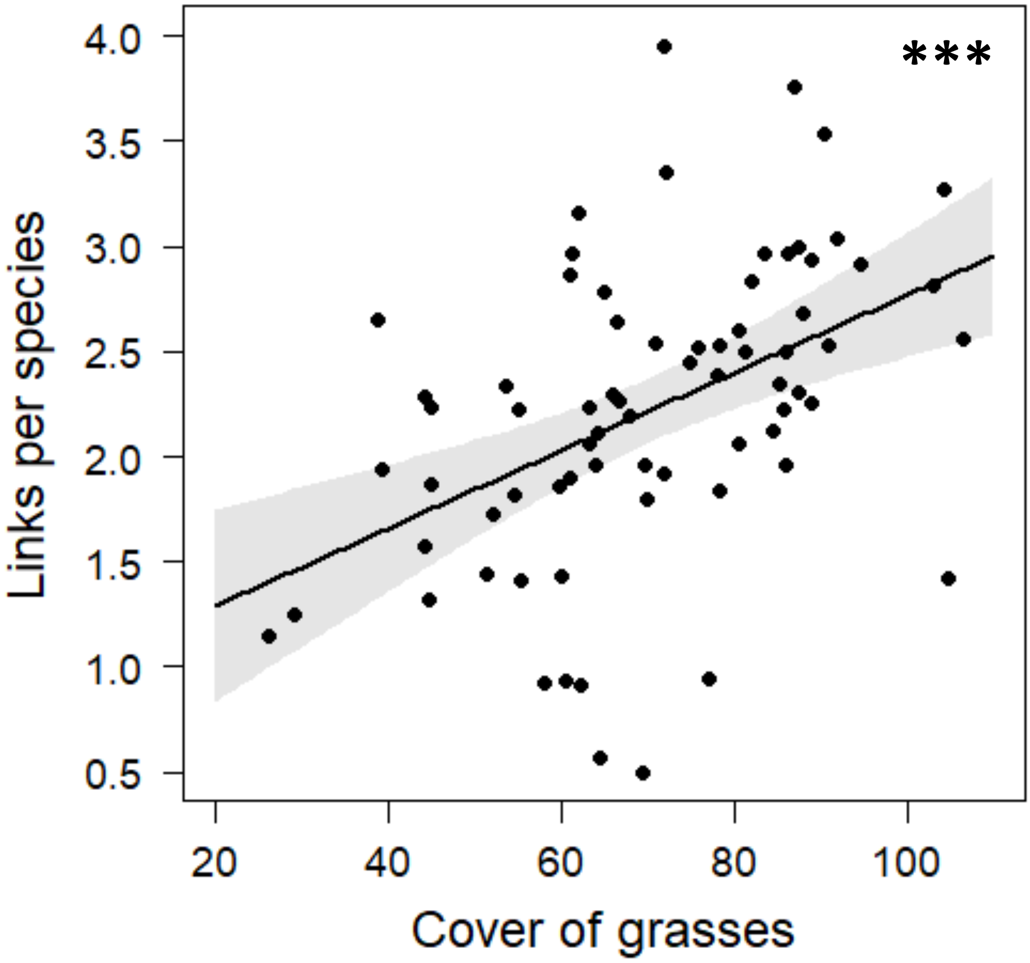

Figure 6. Relationship between number of links per species and cover of grasses. Regression line (solid black line) of the univariate linear mixed effect model and 95% confidence intervals (grey polygon) are shown. *P* < 0.001 (***). See Appendix 6, Table S6 for detailed test statistics.

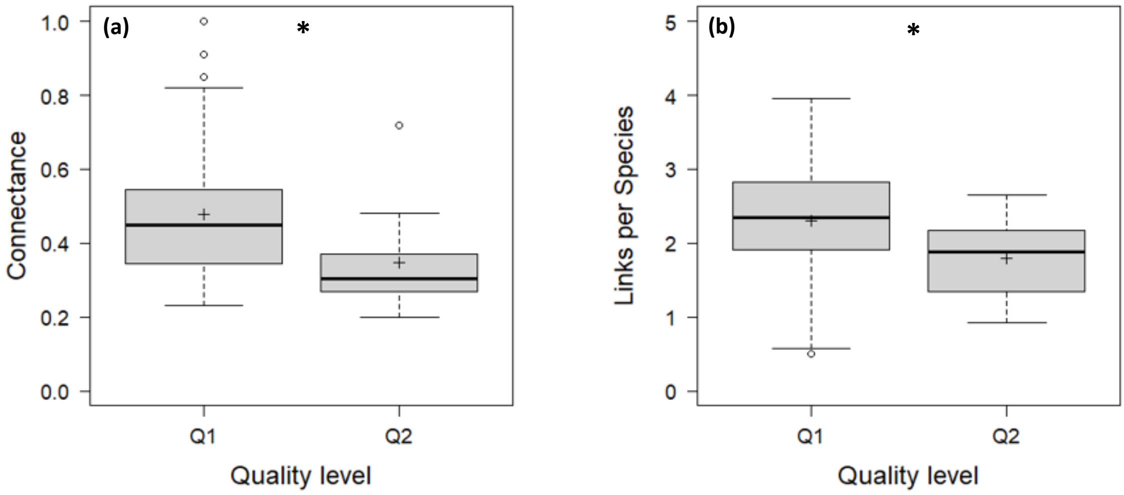

Figure 7. Differences of connectance (a) and links per species (b) according to quality level. Quality level 1 (Q1, n = 60) are meadows with lower ecological quality (5 or less plant indicator species) and quality level 2 (Q2, n = 12) represent meadows with higher ecological quality (6 or more plant indicator species). In this study, all Q2 meadows harbored 10 or more plant indicator species. Bold lines represent medians, crosses the means, boxes the first and third quantiles, whiskers the inter-quartile distance multiplied by 1.5 and dots the outliers. $P < 0.05$ (*). For detailed test statistics see Appendix 7 Table S7.

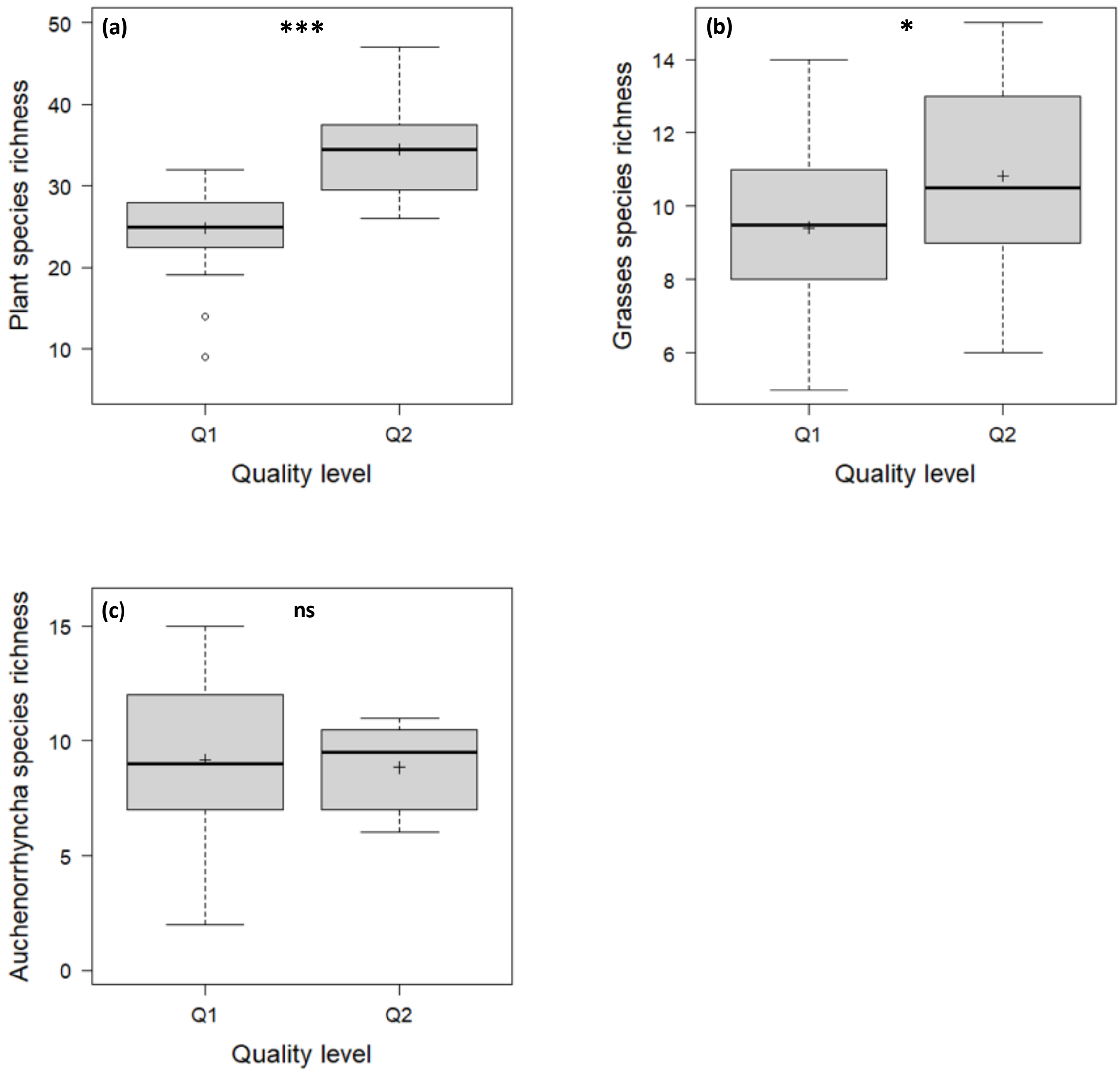

Figure 8. Differences of plant species richness (a), grasses species richness (b) and Auchenorrhyncha species richness (alpha diversity) according to quality level. $P < 0.001$ (***), $P < 0.05$ (*). For quality level abbreviations and box-plot features see legend Fig. 7. For detailed test statistics see Appendix 7 Table S7.

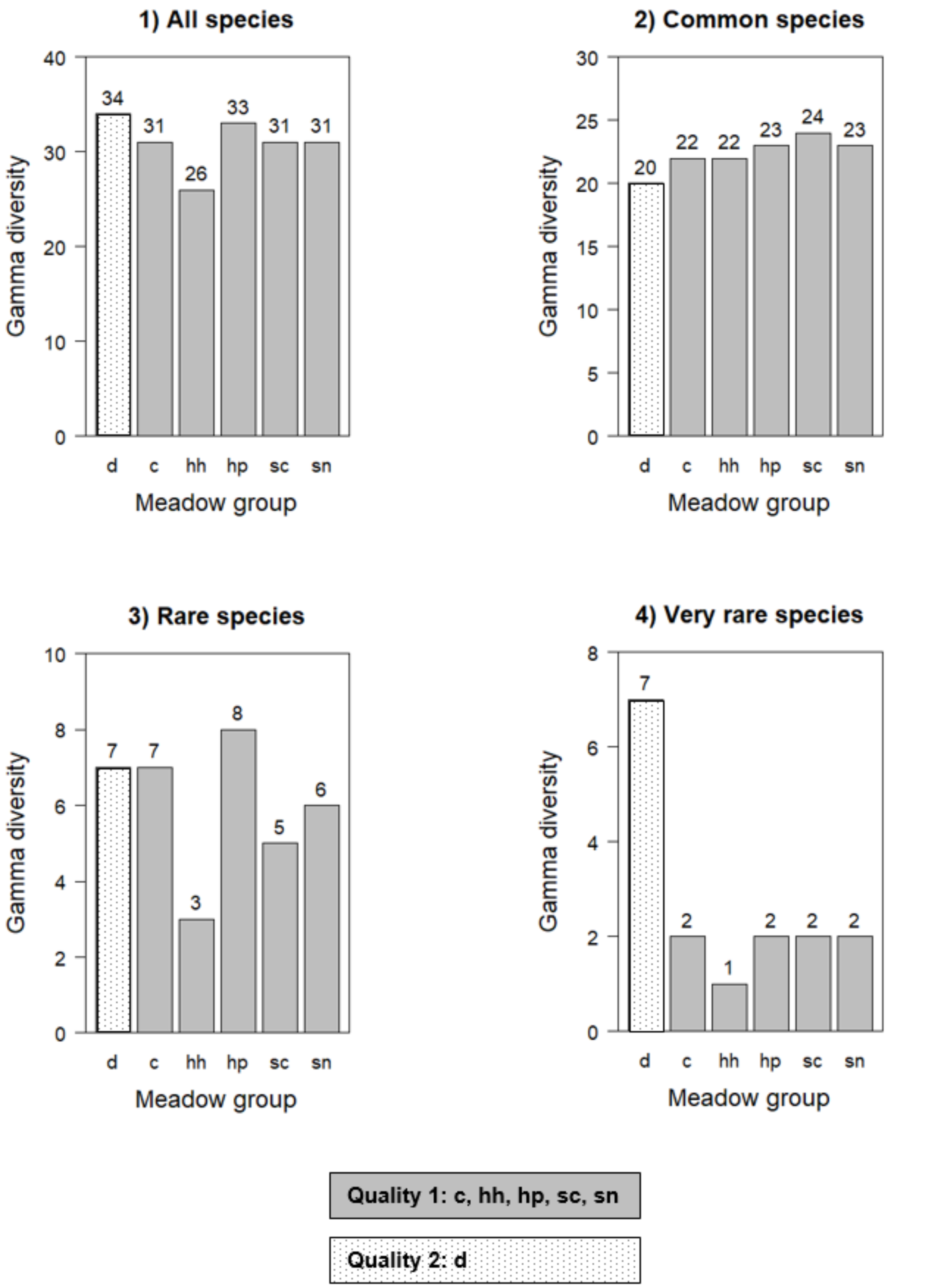

Figure 9. Gamma diversity per meadow group according to the relative abundance of the sampled species: 1) all species; 2) common species (95% of total abundance); 3) rare species (4% of total abundance); and 4) very rare species (1% of total abundance; see Fig. 5). Meadows

with quality level 1 were divided into 5 groups (c, hh, hp, sc and sn). This groups consist each of one randomly chosen quality 1 meadow from every region (n = 12). Group d includes all meadows with quality level 2 (one per region, i.e. n = 12).

Appendix 1. Table S1. Outputs of univariate linear mixed effect models with the respective Auchenorrhyncha abundance (total, monophagous, oligophagous and polyphagous) as response variable. Estimate, SE (standard error), df (degrees of freedom), t-value and p-value are given.

Response variable	Explanatory variables	Estimate	SE	df	t-value	p-value
Auchenorrhyncha abundance total	Slope	0.354	0.359	69.872	0.983	0.329
	Area	0.000	0.000	69.170	-0.241	0.810
	Extensive since	-0.164	0.303	64.748	-0.542	0.590
	Elevation	0.009	0.026	25.724	0.361	0.721
	Moisture	9.443	10.083	65.920	0.936	0.352
	Light	7.147	10.989	68.773	0.650	0.518
	Reaction	-15.150	15.740	67.640	-0.962	0.339
	Nitrogen	9.170	7.779	66.129	1.179	0.243
	Plant species richness	0.117	0.346	67.935	0.337	0.737
	Grasses species richness	1.313	0.956	69.379	1.373	0.174
	Cover of grasses	0.172	0.115	69.267	1.498	0.139
	Cover of fabaceae	-0.177	0.207	69.976	-0.855	0.396
	Cover of forbs	-0.185	0.158	67.137	-1.171	0.246
	Bare ground	0.250	0.336	67.158	0.744	0.459
Auchenorrhyncha abundance monophagous	Slope	0.416	0.129	69.999	3.239	0.002
	Area	0.000	0.000	69.950	0.070	0.944
	Extensive since	-0.094	0.115	65.688	-0.817	0.417
	Elevation	0.001	0.009	20.830	0.089	0.930
	Moisture	-2.296	3.860	67.264	-0.595	0.554
	Light	-1.049	4.181	69.860	-0.251	0.803
	Reaction	-0.090	6.035	69.265	-0.015	0.988
	Nitrogen	-1.804	2.985	67.327	-0.604	0.548
	Plant species richness	0.075	0.131	69.321	0.570	0.570
	Grasses species richness	-0.341	0.365	69.960	-0.934	0.353
	Cover of grasses	-0.074	0.043	69.953	-1.704	0.093
	Cover of fabaceae	0.015	0.078	68.426	0.191	0.849
	Cover of forbs	-0.006	0.061	69.103	-0.091	0.928
	Bare ground	0.376	0.120	67.697	3.135	0.003
Auchenorrhyncha abundance oligophagous	Slope	-0.181	0.255	68.330	-0.710	0.480
	Area	0.000	0.000	69.488	-1.103	0.274
	Extensive since	-0.006	0.217	65.181	-0.028	0.978
	Elevation	0.009	0.018	24.312	0.511	0.614
	Moisture	7.952	7.188	66.514	1.106	0.273
	Light	5.929	7.817	69.048	0.759	0.451
	Reaction	-13.060	11.210	68.410	-1.166	0.248
	Nitrogen	9.658	5.485	66.578	1.761	0.083
	Plant species richness	0.251	0.245	68.149	1.027	0.308
	Grasses species richness	1.412	0.669	69.405	2.113	0.038
	Cover of grasses	0.107	0.082	69.905	1.302	0.197
	Cover of fabaceae	-0.112	0.147	69.458	-0.763	0.445
	Cover of forbs	-0.035	0.114	68.101	-0.309	0.758
	Bare ground	-0.008	0.238	65.331	-0.035	0.972
Auchenorrhyncha abundance polyphagous	Slope	0.041	0.159	70.000	0.259	0.796
	Area	0.000	0.000	70.000	0.244	0.808
	Extensive since	-0.053	0.139	70.000	-0.382	0.704
	Elevation	0.004	0.010	70.000	0.425	0.672
	Moisture	5.336	4.590	70.000	1.163	0.249
	Light	0.603	4.979	70.000	0.121	0.904

Reaction	-0.109	7.200	70.000	-0.015	0.988
Nitrogen	2.969	3.568	70.000	0.832	0.408
Plant species richness	-0.217	0.155	70.000	-1.403	0.165
Grasses species richness	0.353	0.434	70.000	0.814	0.419
Cover of grasses	0.141	0.050	70.000	2.833	0.006
Cover of fabaceae	-0.111	0.092	70.000	-1.214	0.229
Cover of forbs	-0.124	0.071	70.000	-1.747	0.085
Bare ground	-0.141	0.146	70.000	-0.963	0.339

Appendix 2. Table S2. Outputs of the averaged multivariate linear mixed effect models, including all models within ≤Δ2 (numbers in brackets) with the respective Auchenorrhyncha abundance (total (3), monophagous (6), oligophagous (4) and polyphagous (4)) as response variable. Estimate, SE (standard error), Adj. SE (adjusted standard error), t-value and p-value are given.

Response variable	Explanatory variables	Estimate	SE	Adj. SE	z-value	p-value
Auchenorrhyncha abundance total	(Intercept)	-9.355	17.523	17.750	0.527	0.598
	Slope	0.130	0.274	0.277	0.470	0.638
	Bare ground	0.911	0.389	0.396	2.302	0.021
	Cover of grasses	0.373	0.135	0.137	2.721	0.007
	Grasses species richness	1.483	1.108	1.119	1.326	0.185
Auchenorrhyncha abundance monophagous	(Intercept)	4.508	5.776	5.840	0.772	0.440
	Slope	0.399	0.123	0.125	3.182	0.001
	Elevation	-0.001	0.004	0.004	0.230	0.818
	Nitrogen	0.252	1.156	1.170	0.215	0.830
	Bare ground	0.354	0.118	0.120	2.949	0.003
	Cover of grasses	0.005	0.020	0.021	0.225	0.822
	Cover of forbs	-0.010	0.031	0.031	0.317	0.751
	Grasses species richness	-0.074	0.209	0.211	0.353	0.724
Auchenorrhyncha abundance oligophagous	(Intercept)	-18.484	23.372	23.590	0.784	0.433
	Nitrogen	6.386	6.496	6.547	0.975	0.329
	Cover of grasses	0.038	0.071	0.072	0.525	0.599
	Grasses species richness	1.485	0.651	0.663	2.241	0.025
Auchenorrhyncha abundance polyphagous	(Intercept)	-7.082	4.921	4.994	1.418	0.156
	Slope	0.024	0.082	0.083	0.290	0.771
	Bare ground	0.021	0.083	0.084	0.254	0.800
	Cover of grasses	0.149	0.052	0.053	2.822	0.005
	Grasses species richness	0.130	0.301	0.304	0.428	0.669

Appendix 3. Table S3. Outputs of univariate linear mixed effect models with the respective Auchenorrhyncha species richness (total, monophagous, oligophagous and polyphagous) as response variable. Estimate, SE (standard error), df (degrees of freedom), t-value and p-value are given.

Response variable	Explanatory variables	Estimate	SE	df	t-value	p-value
Auchenorrhyncha species richness total	Slope	0.002	0.059	70.000	0.040	0.968
	Area	0.000	0.000	67.800	0.608	0.545
	Extensive since	-0.019	0.049	63.706	-0.397	0.692
	Elevation	-0.007	0.004	22.854	-1.827	0.081
	Moisture	0.126	1.635	64.605	0.077	0.939
	Light	0.450	1.785	67.602	0.252	0.802
	Reaction	1.960	2.561	66.846	0.765	0.447
	Nitrogen	1.459	1.256	64.964	1.161	0.250
	Plant species richness	-0.028	0.056	66.588	-0.497	0.621
	Grasses species richness	-0.048	0.157	68.513	-0.303	0.763
	Cover of grasses	0.032	0.018	67.428	1.754	0.084
	Cover of fabaceae	0.028	0.034	69.937	0.814	0.418
	Cover of forbs	-0.034	0.025	65.411	-1.339	0.185
	Bare ground	-0.045	0.055	69.266	-0.817	0.417
Auchenorrhyncha species richness monophagous	Slope	0.068	0.029	69.925	2.377	0.020
	Area	0.000	0.000	70.000	-0.083	0.934
	Extensive since	-0.017	0.025	66.453	-0.695	0.489
	Elevation	-0.002	0.002	70.000	-1.003	0.319
	Moisture	0.392	0.834	67.738	0.471	0.639
	Light	-0.475	0.898	69.989	-0.529	0.599
	Reaction	0.180	1.300	69.603	0.138	0.890
	Nitrogen	0.325	0.645	67.872	0.504	0.616
	Plant species richness	0.026	0.028	69.711	0.920	0.361
	Grasses species richness	-0.005	0.079	69.857	-0.065	0.949
	Cover of grasses	-0.010	0.009	69.999	-1.042	0.301
	Cover of fabaceae	0.027	0.016	70.000	1.647	0.104
	Cover of forbs	-0.004	0.013	69.286	-0.288	0.770
	Bare ground	0.003	0.027	59.836	0.121	0.904
Auchenorrhyncha species richness oligophagous	Slope	-0.074	0.036	70.000	-2.066	0.043
	Area	0.000	0.000	69.820	-0.029	0.977
	Extensive since	0.015	0.032	65.665	0.478	0.635
	Elevation	-0.004	0.002	19.646	-1.815	0.085
	Moisture	-0.811	1.046	66.240	-0.775	0.441
	Light	-0.351	1.140	69.745	-0.307	0.759
	Reaction	2.878	1.609	69.060	1.789	0.078
	Nitrogen	0.968	0.811	67.543	1.194	0.237
	Plant species richness	-0.028	0.036	68.868	-0.784	0.436
	Grasses species richness	-0.008	0.100	69.978	-0.080	0.937
	Cover of grasses	0.027	0.012	69.461	2.343	0.022
	Cover of fabaceae	0.010	0.021	68.990	0.456	0.650
	Cover of forbs	-0.021	0.016	67.629	-1.266	0.210
	Bare ground	-0.034	0.034	64.448	-0.992	0.325
Auchenorrhyncha species richness polyphagous	Slope	-0.005	0.019	70.000	-0.261	0.795
	Area	0.000	0.000	70.000	0.730	0.468
	Extensive since	-0.016	0.016	70.000	-1.007	0.317
	Elevation	-0.001	0.001	70.000	-0.471	0.639
	Moisture	0.726	0.532	70.000	1.366	0.176
	Light	0.600	0.574	70.000	1.045	0.300

Reaction	-0.667	0.833	70.000	-0.801	0.426
Nitrogen	0.218	0.416	70.000	0.525	0.601
Plant species richness	-0.007	0.019	70.000	-0.397	0.693
Grasses species richness	-0.040	0.050	70.000	-0.788	0.433
Cover of grasses	0.006	0.006	69.868	1.048	0.298
Cover of fabaceae	-0.009	0.011	70.000	-0.854	0.396
Cover of forbs	-0.001	0.008	70.000	-0.149	0.882
Bare ground	0.003	0.017	70.000	0.179	0.859

Appendix 4. Table S4. Outputs of the averaged multivariate linear mixed effect models, including all models within ≤Δ2 (numbers in brackets) with the respective Auchenorrhyncha species richness (total (7), monophagous (9), oligophagous (5) and polyphagous (4)) as response variable. Estimate, SE (standard error), Adj. SE (adjusted standard error), t-value and p-value are given.

Response variable	Explanatory variables	Estimate	SE	Adj. SE	z-value	p-value
Auchenorrhyncha species richness total	(Intercept)	11.153	3.618	3.652	3.054	0.002
	Slope	0.005	0.024	0.025	0.205	0.837
	Elevation	-0.006	0.005	0.005	1.181	0.237
	Nitrogen	0.146	0.587	0.592	0.247	0.805
	Cover of grasses	0.015	0.020	0.021	0.752	0.452
	Cover of forbs	-0.004	0.014	0.014	0.292	0.770
Auchenorrhyncha species richness monophagous	(Intercept)	1.919	2.565	2.582	0.743	0.457
	Slope	0.069	0.035	0.035	1.967	0.049
	Elevation	-0.001	0.002	0.002	0.605	0.545
	Nitrogen	0.340	0.602	0.606	0.561	0.575
	Cover of grasses	-0.002	0.006	0.006	0.314	0.754
	Cover of forbs	-0.004	0.010	0.010	0.401	0.688
Auchenorrhyncha species richness oligophagous	(Intercept)	4.814	1.634	1.653	2.913	0.004
	Slope	-0.018	0.033	0.033	0.538	0.591
	Elevation	-0.003	0.003	0.003	0.980	0.327
	Bare ground	0.005	0.018	0.019	0.246	0.806
	Cover of grasses	0.026	0.012	0.012	2.138	0.032
Auchenorrhyncha species richness polyphagous	(Intercept)	1.206	0.753	0.764	1.579	0.114
	Nitrogen	0.034	0.181	0.183	0.187	0.852
	Cover of grasses	0.002	0.004	0.004	0.377	0.706
	Grasses species richness	-0.007	0.027	0.027	0.277	0.782

Appendix 5. Table S5. Outputs of univariate linear mixed effect models with connectance and links per species as response variable. Estimate, SE (standard error), df (degrees of freedom), t-value and p-value are given.

Response variable	Explanatory variables	Estimate	SE	df	t-value	p-value
Connectance	Slope	-0.003	0.004	70.000	-0.836	0.406
	Area	0.000	0.000	70.000	0.437	0.664
	Extensive since	0.002	0.003	70.000	0.726	0.470
	Elevation	0.000	0.000	70.000	1.542	0.128
	Moisture	0.047	0.111	70.000	0.422	0.674
	Light	0.002	0.120	70.000	0.015	0.988
	Reaction	0.212	0.171	70.000	1.242	0.218
	Nitrogen	0.088	0.085	70.000	1.031	0.306
	Plant species richness	-0.010	0.004	70.000	-2.800	0.007
	Grasses species richness	0.001	0.010	70.000	0.052	0.959
	Cover of grasses	0.004	0.001	70.000	3.500	< 0.001
	Cover of fabaceae	-0.003	0.002	70.000	-1.235	0.221
	Cover of forbs	-0.004	0.002	70.000	-2.314	0.024
	Bare ground	-0.005	0.003	70.000	-1.482	0.143
Links per species	Slope	-0.022	0.015	69.782	-1.487	0.141
	Area	0.000	0.000	69.060	0.396	0.693
	Extensive since	0.007	0.012	64.513	0.548	0.586
	Elevation	0.001	0.001	23.630	0.480	0.635
	Moisture	0.267	0.415	65.760	0.642	0.523
	Light	-0.011	0.453	68.760	-0.025	0.980
	Reaction	0.483	0.650	67.879	0.744	0.459
	Nitrogen	0.953	0.302	66.085	3.154	0.002
	Plant species richness	-0.033	0.014	66.961	-2.401	0.019
	Grasses species richness	0.026	0.040	69.694	0.661	0.511
	Cover of grasses	0.020	0.004	66.288	5.026	< 0.001
	Cover of fabaceae	-0.005	0.009	69.956	-0.633	0.529
	Cover of forbs	-0.021	0.006	66.494	-3.419	0.001
	Bare ground	-0.023	0.014	69.359	-1.672	0.099

Appendix 6. Table S6. Outputs of the averaged multivariate linear mixed effect models, including all models within ≤Δ2 (numbers in brackets) with connectance (4) and links per species (12) as response variable. Estimate, SE (standard error), Adj. SE (adjusted standard error), t-value and p-value are given.

Response variable	Explanatory variables	Estimate	SE	Adj. SE	z-value	p-value
Connectance	(Intercept)	0.413	0.249	0.252	1.639	0.101
	Elevation	0.000	0.000	0.000	0.402	0.688
	Nitrogen	-0.012	0.043	0.043	0.272	0.785
	Cover of grasses	0.002	0.002	0.002	1.402	0.161
	Grasses species richness	0.029	0.013	0.013	2.176	0.030
	Plant species richness	-0.014	0.005	0.005	2.653	0.008
Links per species	(Intercept)	-0.138	1.129	1.296	0.107	0.915
	Nitrogen	0.264	0.325	0.328	0.805	0.421
	Bare ground	0.005	0.011	0.011	0.473	0.636
	Cover of grasses	0.018	0.005	0.005	3.341	0.001
	Cover of forbs	0.000	0.002	0.002	0.170	0.865
	Grasses species richness	0.046	0.057	0.057	0.797	0.426
	Plant species richness	-0.012	0.020	0.020	0.586	0.558

Appendix 7. Table S7. Outputs of univariate linear mixed effect models with the respective response variables and quality level as response variable. Estimate, SE (standard error), df (degrees of freedom), t-value and p-value are given. Positive estimates representing higher values for quality 2 meadows compared to quality 1 meadows. Negative estimates representing lower values for quality 2 meadows compared to quality 1 meadows.

Response variables	Explanatory variable	Estimate	SE	df	t-value	p-value
Slope	Quality level	6.933	1.480	59.000	4.684	< 0.001
Area	Quality level	4697.980	2818.270	59.000	1.667	0.101
Extensive since	Quality level	3.350	2.100	70.000	1.595	0.115
Elevation	Quality level	-14.220	16.340	59.000	-0.870	0.388
Moisture	Quality level	-0.174	0.061	70.000	-2.870	0.005
Light	Quality level	0.083	0.059	59.000	1.412	0.163
Reaction	Quality level	0.102	0.040	70.000	2.571	0.012
Nitrogen	Quality level	-0.385	0.069	70.000	-5.574	< 0.001
Plant species richness	Quality level	9.683	1.441	59.000	6.718	< 0.001
Grasses species richness	Quality level	1.417	0.645	59.000	2.196	0.032
Cover of grasses	Quality level	-21.143	4.914	59.000	-4.302	< 0.001
Cover of fabaceae	Quality level	1.443	3.049	59.000	0.473	0.638
Cover of forbs	Quality level	18.472	3.391	59.000	5.447	< 0.001
Bare ground	Quality level	1.229	1.801	59.000	0.682	0.498
Auchenorrhyncha abundance total	Quality level	-3.583	5.329	59.000	-0.672	0.504
Auchenorrhyncha abundance monophagous	Quality level	2.267	2.044	59.000	1.109	0.272
Auchenorrhyncha abundance oligophagous	Quality level	-2.717	3.815	59.000	-0.712	0.479
Auchenorrhyncha abundance polyphagous	Quality level	-4.567	2.430	70.000	-1.879	0.064
Auchenorrhyncha species richness total	Quality level	-0.133	0.857	59.000	-0.156	0.877
Auchenorrhyncha species richness monophagous	Quality level	0.150	0.447	59.000	0.336	0.738
Auchenorrhyncha species richness oligophagous	Quality level	-0.400	0.558	59.000	-0.717	0.476
Auchenorrhyncha species richness polyphagous	Quality level	0.167	0.289	70.000	0.577	0.566
Connectance	Quality level	-0.131	0.058	70.000	-2.260	0.027
Links per Species	Quality level	-0.518	0.209	59.000	-2.479	0.016

Erklärung

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LeiterIn der Arbeit:	Dr Jean-Yves Humbert und Prof. Dr Raphaël Arlettaz

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