Restoration and management of calcareous grasslands: Is there a trade-off between species diversity of cryptogams and vascular plants?

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Abstract

In calcareous grasslands, vascular plants are usually used as target species for the evaluation of restoration success. Although vascular plants account for most of the plant-species diversity in calcareous grasslands, bryophytes and lichens also form vital parts of plant communities in terms of species diversity and vegetation cover. We investigated if cryptogams and vascular plants differ in their response to restoration and management measures and how these plant groups interact.

On sites without topsoil removal, establishment of xerophytic mosses was hampered due to shading by vascular plants. Our results indicate that different restoration and management measures favour certain plant groups, often at the cost of other groups, due to differences in the competitive abilities of plant groups. Topsoil removal changed the edaphic conditions in favour of cryptogams and xerophytic vascular plants.

Xerophytic cryptogam communities, consisting mainly of acrocarpous mosses and epigaeic lichens, were successfully transferred by raked cryptogam material from species-rich sites. In contrast, strewing of diaspore-containing hay favoured mainly vascular plants and pleurocarpous mosses at the cost of rare acrocarpous mosses.

In our study, species richness of vascular plants characteristic for calcareous grasslands was high in calcareous grasslands restored by transfer of hay or raking material, but still lower than in ancient grasslands. Pleurocarpous mosses were common on all sites, whereas acrocarpous mosses and lichens were most abundant on topsoil removal sites.

Keywords: 6210 Semi-natural dry grassland, new techniques for management, restoration of grazing and other management techniques, bryophytes, lichens, (re-)introduction, calcareous grassland

Introduction

On small scales, Central European calcareous grasslands belong to the most species-rich vegetation types worldwide (Dengler 2005), but they are strongly threatened due to changes in land use (WallisDeVries et al. 2002). Many authors have shown the effects of different restoration and management measures on calcareous grassland vegetation (e.g. Poschlod & Wallis DeVries 2002, Kiehl et al. 2006). Most studies focus on vascular plants, whereas cryptogams were rarely studied in calcareous grassland restoration (Tooren et al. 1990) even though they form an important part of the plant species diversity (Dengler 2005). Only few authors have studied interactions between vascular plants and cryptogams (e.g. Tooren 1988, Zamfir et al. 1999, Jeschke 2008).

Materials and methods

Between 2003 and 2008, 250 plots of 4 m² were recorded in or near the nature reserves "Garchinger Heide", "Kissinger Heide" (Bavaria, Germany) and "Merishausener Gräte" (Schaffhausen, Switzerland). Percentage cover of all vascular plant, bryophyte and lichen species present on the plots was recorded. The sites included ancient and newly restored grasslands with different restoration (topsoil removal, hay transfer) and management regimes (mowing, grazing, burning). Species richness of various plant groups (e.g. grasses, chamaephytes, acrocarpous and pleurocarpous mosses, fruticose lichens) was determined from the vegetation data.
Additionally, some data from an experiment on the effects of cryptogam transfer by raking material (Jeschke & Kiehl, submitted) will be presented.

Results and discussion

The ancient grassland "Merishausener Gräte" (MG) showed higher grass and lower chamaephyte species richness than the ancient grasslands of the Garchinger Heide (GH) and Kissinger Heide (KH) due to less xerophytic conditions (Fig. 1). In MG and KH (see also Jeschke et al. 2008, Jeschke 2008), mean vascular plant species richness was

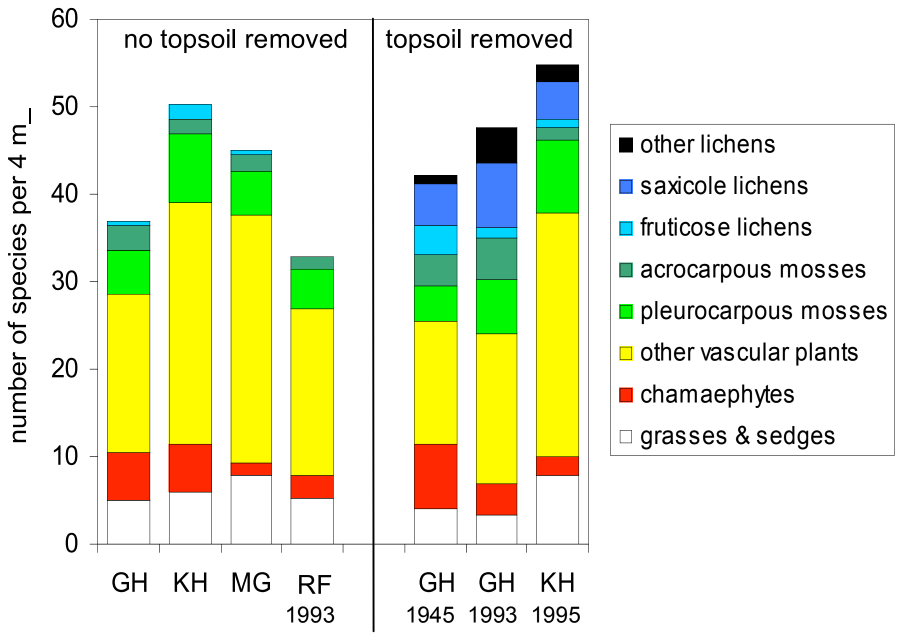

Figure 1. Mean species richness of different plant groups on sites without and with topsoil removal. (GH = Garchinger Heide, RF = Ex-arable field, KH = Kissinger Heide, MG = Merishausener Gräte)

higher than in GH because of litter accumulation in parts of GH. New data from 2008 showed that up to 54 species per 4m² can occur in GH on well managed sites. On restoration sites without topsoil removal (RF 1993), a dense canopy of vascular plants established successfully after hay transfer including many target species (Kiehl et al.

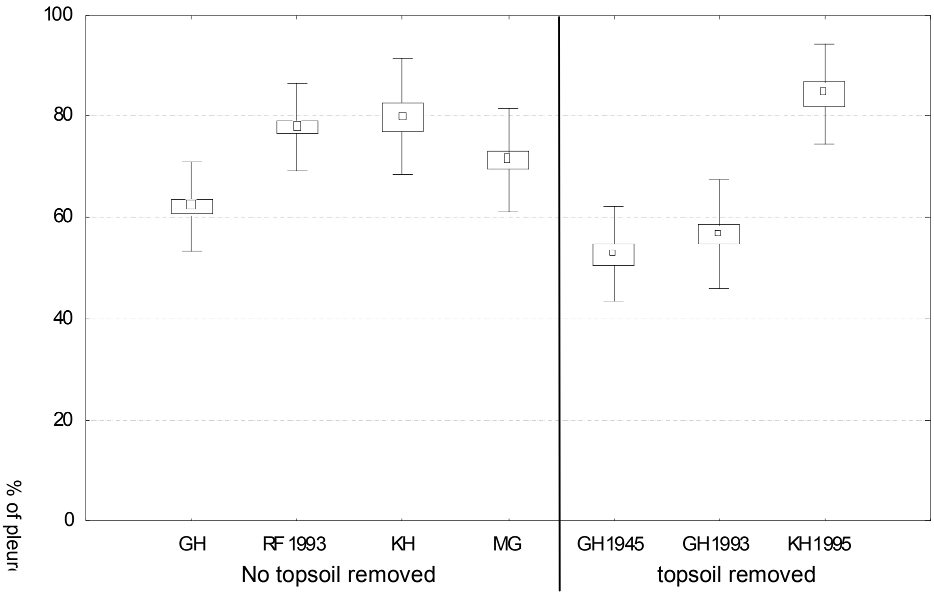

Figure 2. Pleurocarpous moss species numbers as ratio of all bryophyte species. (GH = Garchinger Heide, RF = Restoration field (GH), KH = Kissinger Heide, MG = Merishausener Gräte)

2006). Pleurocarpous mosses were favoured by hay transfer (Fig. 2, see also Jeschke & Kiehl 2006), showing fast clonal growth at the cost of acrocarpous moss diversity.

On nutrient-poor topsoil-removal sites, vascular plant cover was quite low even 12 years after the restoration, whereas bryophyte cover was high (Jeschke & Kiehl 2006). More or less dense bryophyte mats can even inhibit vascular plant establishment, as seeding experiments have shown (Tooren 1988, Jeschke & Kiehl 2008). Topsoil removal negatively affected grass species diversity but favoured dwarf shrubs and almost all cryptogam groups (Fig. 1, GH 1945, GH1993). On these sites, vascular plant species richness was negatively correlated with acrocarpous moss and lichen species richness (Pearsons r=-0,57 resp. -0,38; p<0.001), but positively with pleurocarpous moss diversity (r=0.45; p<0.001). The topsoil-removal plots at KH also favoured cryptogams, but the percentage of pleurocarpous mosses was very high (as in the nature reserve KH), and grass diversity was far higher than chamaephyte diversity.

In contrast to hay transfer, most xerophytic bryophytes and lichens of low-productive grasslands can be transferred with raked cryptogam material, along with low-growing vascular plants. Jeschke & Kiehl (submitted) transferred 19 bryophyte and lichen species including six red-list species successfully onto topsoil removal sites; without topsoil removal, this number was reduced to only 12 species.

Conclusions

Most restoration and conservation measures in calcareous grasslands are designed and evaluated for vascular plants. However, cryptogams should be taken into account not

only because they contribute considerably to the species diversity of calcareous grasslands, but also because they can influence vascular plants in many ways.
It is possible to create or restore calcareous grasslands that are rich both in vascular plant and cryptogam species, but this will require using a combination of methods to create a patchwork of differing subsites. No single restoration method can be universally commended, as the used method must be adapted to species composition of the target site and edaphic factors.
Topsoil removal will favour cryptogams and xerophytic vascular plants at the cost of more mesophytic plants. If hay transfer is used, pleurocarpous mosses will be favoured at the cost of acrocarpous mosses and low-growing vascular plants, especially on sites without topsoil removal. On topsoil–removal sites, only part of the site should be covered with hay, while the rest could be treated with raked cryptogam material.

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