GfÖ Ecological Society of Germany, Austria and Switzerland

Basic and Applied Ecology xxx (2016) xxx–xxx

Basic and Applied Ecology

www.elsevier.com/locate/baae

Managing towards extinction: Diverging developments of plant and ground beetle assemblages following restoration of calcareous grasslands

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Received 18 May 2016; accepted 12 August 2016

Abstract

Central European calcareous grasslands are particularly rich in species, harbouring an endangered flora and fauna. In this study, we analyse how invertebrates, like ground beetles, react on vegetation changes in these habitats. We ask if and how species of both groups may react on local environmental changes associated with conservation management regimes. For this reason, vascular plant and ground beetle communities were assessed at six semi-natural calcareous grasslands in Luxembourg before (1988–1992) and after (2008–2010) restoration had started. All studied grassland sites are protected as nature reserves and managed to preserve an open and diverse plant species composition. Our data indicate diverging trends for plant and ground beetle composition: Richness and abundance of species increased for plants and decreased for ground beetles, particularly for forest and Red List species. Functional diversity of plants and ground beetles remained stable, although the abundance of nitrogen-loving plant species increased. In ground beetles, we identified increased proportions of species with strong habitat associations. These findings underline that plant species, in particular typical calcareous grassland species, benefited from ongoing conservation management, while many ground beetle species, mostly the non-grassland specialists, suffered under the applied management regimes. These results highlight the general dilemma in nature conservation of how to prioritise management regimes in situ.

Zusammenfassung

Kalkmagerrasen in Mitteleuropa beherbergen eine außerordentlich hohe Vielfalt seltener und gefährdeter Pflanzen- und Tierarten. In dieser Arbeit untersuchen wir, wie Invertebraten, hier Laufkäfer, auf Veränderungen in der Vegetationszusammensetzung reagieren. Wir analysieren, ob und wie die Arten der beiden Taxa auf lokale Umweltveränderungen

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http://dx.doi.org/10.1016/j.baae.2016.08.004

reagieren, die durch Pflegemaßnahmen des Naturschutzes hervorgerufen werden. Hierfür wurde die Artenzusammensetzung von Gefäßpflanzen- und Laufkäfergemeinschaften auf sechs Kalkmagerrasen in Luxemburg aufgenommen, unter Berücksichtigung der Zeit bevor (1988–1992) und nachdem (2008–2010) die Pflegemaßnahmen durchgeführt wurden. Alle untersuchten Magerrasenstandorte sind aktuell als Naturschutzgebiete ausgewiesen und ihr offener Charakter mit einer großen Pflanzenvielfalt wird durch entsprechende Pflegemaßnahmen bewahrt. Unsere Ergebnisse zeigen unterschiedliche Trends der Artenzusammensetzung von Pflanzen und Laufkäfern. Während die Vielfalt und Abundanz der Gefäßpflanzenarten anstieg, nahm sie bei den Laufkäfern ab, hiervon sind besonders Wald- und Rote Liste-Arten betroffen. Die funktionelle Diversität blieb für beide Taxa (Gefäßpflanzen und Laufkäfer) stabil, allerdings stieg der Anteil stickstoffliebender Gefäßpflanzenarten deutlich an. Laufkäfer mit hoher Habitatspezialisierung und somit einer starken Bindung an intakte Kalkmagerrasen stieg deutlich an. Diese Daten zeigen, dass vor allem typische Kalkmagerrasenarten von den Pflegemaßnahmen profitieren, während Laufkäferarten, die nicht auf offene Magerrasenflächen spezialisiert sind, unter den Pflegemaßnahmen leiden. Diese Ergebnisse untermauern das generelle Dilemma der Priorisierung im angewandten Naturschutz, und die Notwendigkeit einer objektiven, wissenschaftlich fundierten Gestaltung von Pflegemaßnahmen.

Keywords: Carabidae; Conservation management; Community shift; Ellenberg indicator values; Habitat changes; Habitat property; Species richness; Vascular plants

Introduction

Oligotrophic grasslands have a prime position in the conservation of agro-ecosystem biodiversity (Knop, Kleijn, Herzog, & Schmid 2006; Krauss, Steffan-Dewenter, & Tscharntke 2003). Among these, calcareous grasslands are of particular conservation value and rank among the most species-rich (Rösch, Tscharntke, Scherber, & Batáry 2013; WallisDeVries, Poschlod, & Willems 2002) but also the most threatened habitats of Europe (Habel et al. 2013). Therefore, the ongoing trend towards an intensive use of grassland ecosystems doubtlessly has fatal consequences on the organisms linked to these habitats (Marini, Fontana, Scotton, & Klimek 2008). However, also long-term abandonment of grasslands is argued to be responsible for the severe decline of these highly diverse ecosystems (van Swaay 2002), but also note the rewilding debate (Merckx & Pereira 2015). Most of the remaining semi-natural calcareous grasslands therefore represent geographically isolated and small patches, embedded in an intensively used and/or abandoned agricultural landscape matrix (WallisDeVries et al. 2002); however, the degree of isolation of semi-natural sites has been shown to be frequently correlated with their extinction risk (Hendrickx et al. 2007; Steffan-Dewenter & Tscharntke 2002). Consequently, the few remaining patches today act as refuges for many endangered plant and animal species (Déri et al. 2011; Ellis, Klein, Siebert, Lightman, & Ramankutty 2010).

Different management strategies of grasslands have been applied, either to conserve the oligotrophic and open conditions or to restore them (Carvell 2002). These strategies include the removal of trees and bushes, grazing with cows or sheep or various mowing regimes (Mortimer, Hollier, & Brown 1998; WallisDeVries et al. 2002). Different habitat management strategies have led to different disturbance levels and thus have resulted in diverse habitat conditions, ranging from open to shrubby, with remarkable differences in their communities (Bakker & Berendse 1999; Déri et al. 2011). Furthermore, insect species compositions respond to changes in plant species assemblages (Öckinger, Eriksson, & Smith, 2006; Déri et al. 2011). Species with specific habitat requirements and restricted dispersal behaviour in particular respond very sensitive to alterations in habitat structure and plant species composition (Habel et al. 2016).

However, traditional conservation strategies for the maintenance of highly diverse plant communities of nutrient-poor open grassland habitats, e.g. yearly mowing of the entire swards, are assumed to fail to conserve the highly complex conditions produced by the traditional land use, often representing a fine-grained patchwork of extensive agriculture and temporal abandonment. However, it is this mosaic being in part responsible for the safeguarding of many highly specialised and consequently often endangered invertebrate species. These differential responses of various floral and faunal groups are resulting in a still ongoing conservation debate (Merckx 2015).

Ground beetles and vascular plants are excellent ecological indicator groups, frequently used to study habitat conditions, like specific successional stages. Furthermore, both groups were often shown to perform parallel shifts in their communities according to changes in habitat structure (Dolek & Geyer 2002; Driscoll & Weir 2005; Koivula 2011; Pearce & Venier 2006). In contrast to these studies, other surveys have shown a high plasticity of particular species to react to fast environmental changes via adaptation. Hence, their presence or absence is not triggered by specific habitat conditions (Jump & Peñuelas 2005). Furthermore, some species may show extinction resilience, i.e. they survive even if their habitat requirements are not or partly not fulfilled for a certain time (Colling, Matthies, & Reckinger 2002). Thus, different systematic groups may show different or at least

Please cite this article in press as: Habel, J. C., et al. Managing towards extinction: Diverging developments of plant and ground beetle assemblages following restoration of calcareous grasslands. *Basic and Applied Ecology* (2016), http://dx.doi.org/10.1016/j.baae.2016.08.004