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Philippe Jeanneret, Stéphanie Aviron, Felix Herzog, Henryk Luka, Stefano Pozzi, Thomas Walter

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Jeanneret Ph.[1], Aviron S.[1], Herzog F.[1], Luka H.[2], Pozzi S.[3] and Walter T.[1]
[1]*Agroscope FAL Reckenholz, Federal Research Station for Agroecology and Agriculture, CH-8046 Zürich, Switzerland*
[2]*Research Institute of Organic Agriculture (FiBL), CH-5070 Frick, Switzerland*
[3]*Agroscope RAC Changins, Federal Research Station for Plant Production, CH-1260 Nyon, Switzerland*

Abstract
In Switzerland, efforts have been made to reduce the negative impact of intensive management in grassland ecosystems on biodiversity by introducing low-input meadows within an agri-environmental scheme. The management of low-input meadows is regulated in order to achieve environmental goals: restrictions in fertilisation, prescribed dates for mowing. This paper aims to compare temporal trends in species composition of spider, carabid beetle and butterfly communities in low-input and intensive meadows in two regions in Switzerland 1997-2004. Furthermore, temporal scale of changes in arthropod communities is stressed and consequences for management are discussed.

Keywords: agri-environmental scheme, low-input meadow, biodiversity, arthropods, temporal trend, principal response curve

Introduction
In the early 1990s the growing costs for the regulation of agricultural markets and increased awareness of environmental damage caused by agriculture led to the introduction of agri-environmental programmes in Europe. In Switzerland, from 1993 onwards, farmers had to increasingly provide ecological services in order to qualify for direct payments and additional incentives were given for specific measures. One of these measures is the introduction of ecological compensation areas (ECA) within the utilised agricultural area (UAA) of the entire country. The Swiss agri-environmental programme requires that each participating farmer has to convert 7 % of his or her farmland to ECA. The catalogue of ECA encompasses traditional landscape elements as well as new types of biotopes which were designed for the purpose of enriching the agricultural landscape. The management of ECA is regulated in order to achieve environmental goals (restrictions in fertilisation, pesticide use, prescribed dates for mowing of meadows, etc.). Agricultural management must be continued (no abandonment). For most types of ECA farmers have to commit themselves for at least 6 years. The main purpose of ECA is to stabilise and enhance populations of wild animals and plant species in agriculture (Forni *et al.*, 1999).
This paper aims to compare species composition of spider, carabid beetle and butterfly assemblages in extensively used and low-input meadows (grassland ECA types), and intensively used meadows in two regions of the Swiss plateau, over time. Because most of the time, species

richness of the communities were not significantly different from each other over time, we focussed our analysis on the species composition.

Regions, sampling methods

The study was carried out in 2 regions of the central Swiss Plateau: region 1, Nuvilly, 30 km W of Fribourg, altitude 580-720 m and region 2, Ruswil, 20 km NW of Lucerne, altitude 650-800 m.

Region 1 comprises a total surface of 515 hectares, consisting of grassland (37%), arable land (55%), forests (6%). Three grassland ECA types, usually small areas of approx. 400 m^2, can be found in the perimeter, namely extensively used meadows (EUM, no fertilisation, late mowing), low-input meadows (LIM, restricted fertilisation, late mowing), and meadows in traditional orchards with standard fruit trees (TO, considered as intensively used in this study because fertilisation and mowing are not restricted). One intensively managed grassland type is considered in this region, namely permanent intensive meadows (PIM).

Region 2 comprises a total surface of 885 hectares, mainly consisting of grassland (59%), arable land (15%) and forests (17%). In region 2, the same ECA types occur and leys (seeded meadows, SM) were found and added to the intensively managed grasslands.

Spiders, carabid beetles in 1997-2003 (3 and 4 sampling years in region 1 and 2, respectively) and butterflies in 2000-2004 (3 sampling years in both regions) were recorded in 13 EUM, 3 LIM, 7 TO and 5 PIM in region 1, and in 10 EUM, 7 LIM, 7 TO, 3 PIM and 2 SM in region 2. Details about spider and carabid beetle collections, and butterflies observation are presented in Jeanneret *et al.* (2003).

On the species assemblages, analysis of the management intensity impact over time was carried out with Principal Response Curve (PRC, Van den Brink and Ter Braak, 1998). This multivariate method for the analysis of repeated measurement designs is based on redundancy analysis (RDA) and partial RDA (Ter Braak, 1996). It allows to focus on the time-dependent treatment effects. In RDA, the significance of time-dependent treatment effect is assessed by Monte Carlo testing (bootstrapping). In our study, treatments encompass the above described grassland types.

Results

The PRC analysis indicates for the spider and carabid beetle assemblages that the overall variation among the grassland types is higher than that among sampling years in both regions (Table 1). On the contrary, in both regions, the sampling year is more important for butterfly assemblages than the grassland type.

Table 1. Percentages of the total variance that can be attributed to time and grassland type for spider, carabid beetle and butterfly assemblages in two regions. The grassland type component includes the interaction between type and time. The remaining fraction of the variance is residual. First and second numbers are given for region 1 and 2, respectively.

	% of variance accounted for by	
Data set	Time	Grassland type
Spiders	7 / 12	17 / 17
Carabid beetles	5 / 7	16 / 19
Butterflies	14 / 12	11 / 11

Figure 1. Principal Response Curves (PRC) for spider assemblages in region 1 and 2, (a) and (b) respectively, and carabid beetle assemblages, (c) and (d), indicating the changes over time in extensively used meadows (EUM), low-input meadows (LIM), traditional orchards (TO), permanent intensive meadows (PIM) and seeded meadows (SM). PIM is set as reference.

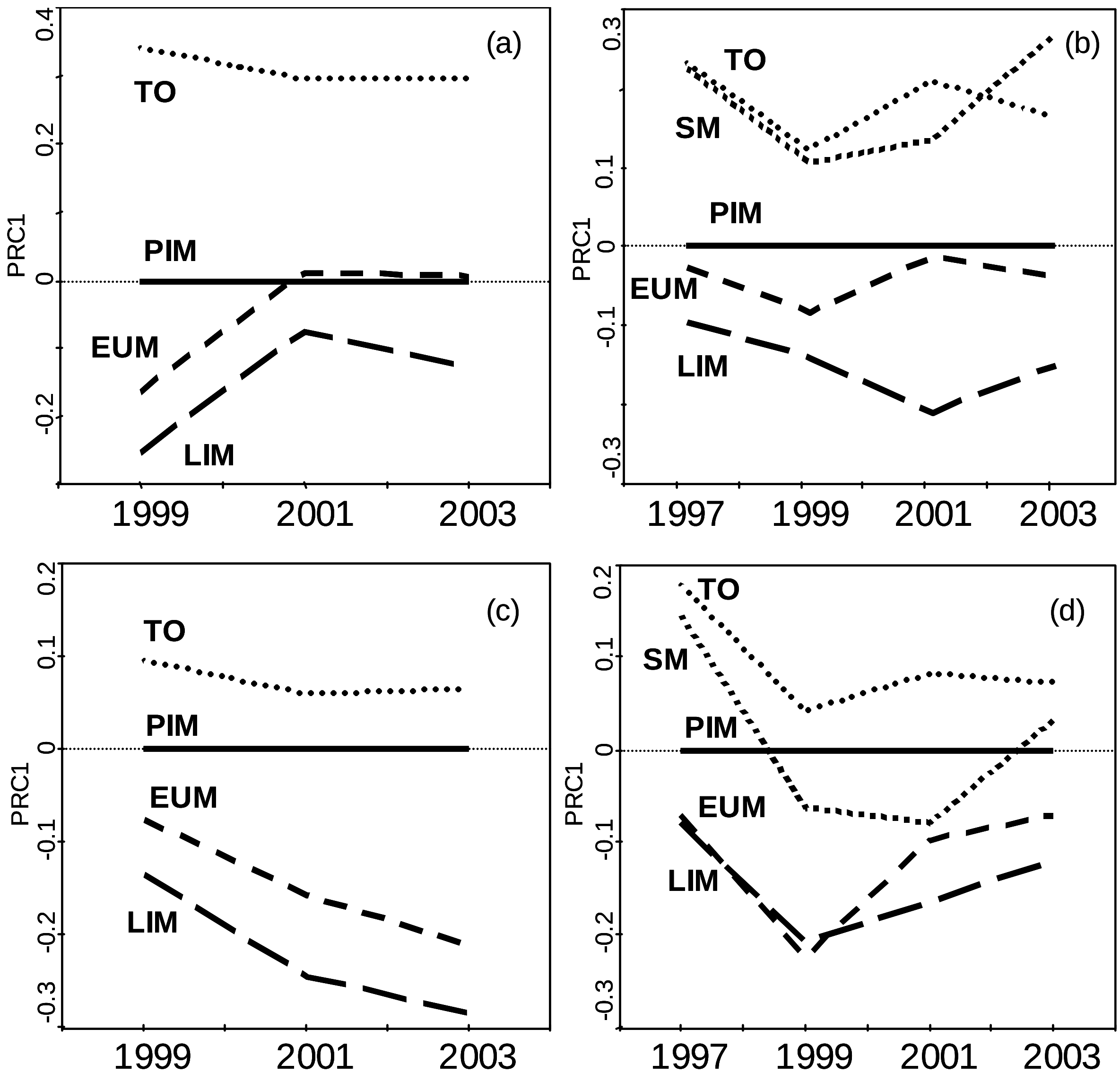

Figure 1 shows that high differences among spider and carabid beetle assemblages in the grassland types already existed in the first year of investigation (the same pattern was indicated by butterfly assemblages as well). However, grassland ECA types (EUM and LIM) show distinctive assemblages for both organisms compared to intensive managed ones, PIM (reference) and TO in region 1 [(a) and (c)], and to PIM, TO and SM in region 2 [(b) and (d)]. Furthermore, these differences are higher by spider [(a) and (b)] than by carabid beetle assemblages [(c) and (d)]. Annual fluctuations are higher in region 2 than in region 1 for both organisms. Nevertheless, end-points (2003) are on the same level as start-points (1997) in region 2 for spider assemblages [(b)] indicating only small temporal trend while carabid beetle assemblages in TO and SM gather to PIM [(d)] over time. In contrast, spider assemblages in EUM and LIM go in the direction of

PIM in region 1 [(a)] while carabid beetle assemblages in these grassland types markedly differenciate from PIM and TO [(c)].

Discussion

The PRC method gives immediately discernible information on how biological communities develop in the grassland types over time. The analysis shows that management intensity (grassland type) has a significant influence on spider, carabid beetle and butterfly assemblages in both regions. Furthermore, organism assemblages differenciate between extensively used and low-input meadows (EUM and LIM) on the one side, and permanent intensive (PIM), seeded meadows (SM) and traditional orchards (TO) on the other side. Nevertheless, excepted for the carabid beetles in region 1, no clear management effect over time could be revealed.

Differences between years were more important for butterflies than for soil dwelling arthropods, showing that butterflies were more strongly influenced by weather conditions form one year to the next.

In addition, spider and carabid beetle assemblages gave different response depending on the region. Spiders showed an evolution of the grassland ECA types (EUM and LIM) toward the permanent intensive meadows (PIM) in region 1 and not in region 2, while carabid beetles demonstrate a high differenciation of the meadow types over time in region 1.

Conclusions

Our study showed that management of grassland has an impact on arthropods. Nevertheless, the responses and trends over time depend on the organisms and the region. Consequently, the impact of the grassland ECA types on biodiversity has to be differenciated onto organisms and to be investigated in several regions.

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