Agricultural use of grassland is favorable to the development of earthworm communities

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Introduction

Herbage utilization in grasslands by mowing and grazing strongly alters plant functional structure and diversity, favouring short and early flowering species (Greenwood and McKenzie, 2001; Louault et al., 2005; Ludvíková et al., 2014). These changes in the litter traits strongly impact the soil decomposer communities (Milcu et al., 2006; Sabais et al., 2011), including earthworms (Zaller and Arnone, 1999; Eisenhauer et al., 2009). In grazed grasslands, animal trampling often results in increased soil compaction (Mikola et al., 2009), which is detrimental to earthworm communities (Cluzeau et al., 1992; Muldowney et al., 2003) whereas, the return of organic matter to the soil through animal faeces stimulates the development of earthworm communities (Hendriksen, 1991). The effect of grassland management, whether abandoned, mowed or grazed on earthworm communities has been extensively studied (Muldowney et al., 2003; Curry et al., 2008; Schon et al., 2017) however, to our knowledge, no study assessed the combined effect of herbage utilization by grazing or by mowing compared to an abandoned grassland on earthworm communities.

The objective of this study was to assess the long-term effects of an increasing herbage utilization by grazing and mowing on plant and earthworm communities

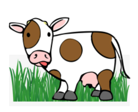
Materials & methods

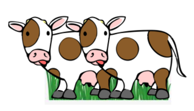
Study site

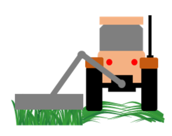
Long-term observatory ANAEE_F SOERE-ACBB (Theix) composed of upland grassland plots. In 2005, **5 treatments** were established:

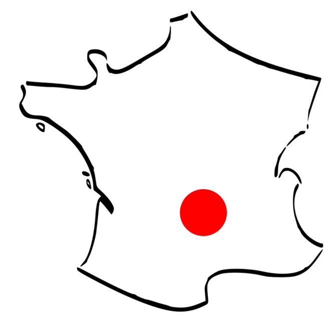
Abandonned grassland neither grazed or mowed — AB 

Grazed pasture with sheep at low level of herbage utilization — SH- 

Grazed pasture with cows at low level of herbage utilization — CO- 

Grazed pasture with cows at high level of herbage utilization — CO+ 

Mowed grassland with plant biomass exportation (3 cuts/year) — M 



Each treatment are repeated in 4 **blocks**, resulting in a total of 20 plots.

Earthworm and vegetation sampling and laboratory analysis

Field campaign was conducted in spring 2019. In each plot, in 3 different square meters plant species abundance was visually assessed.

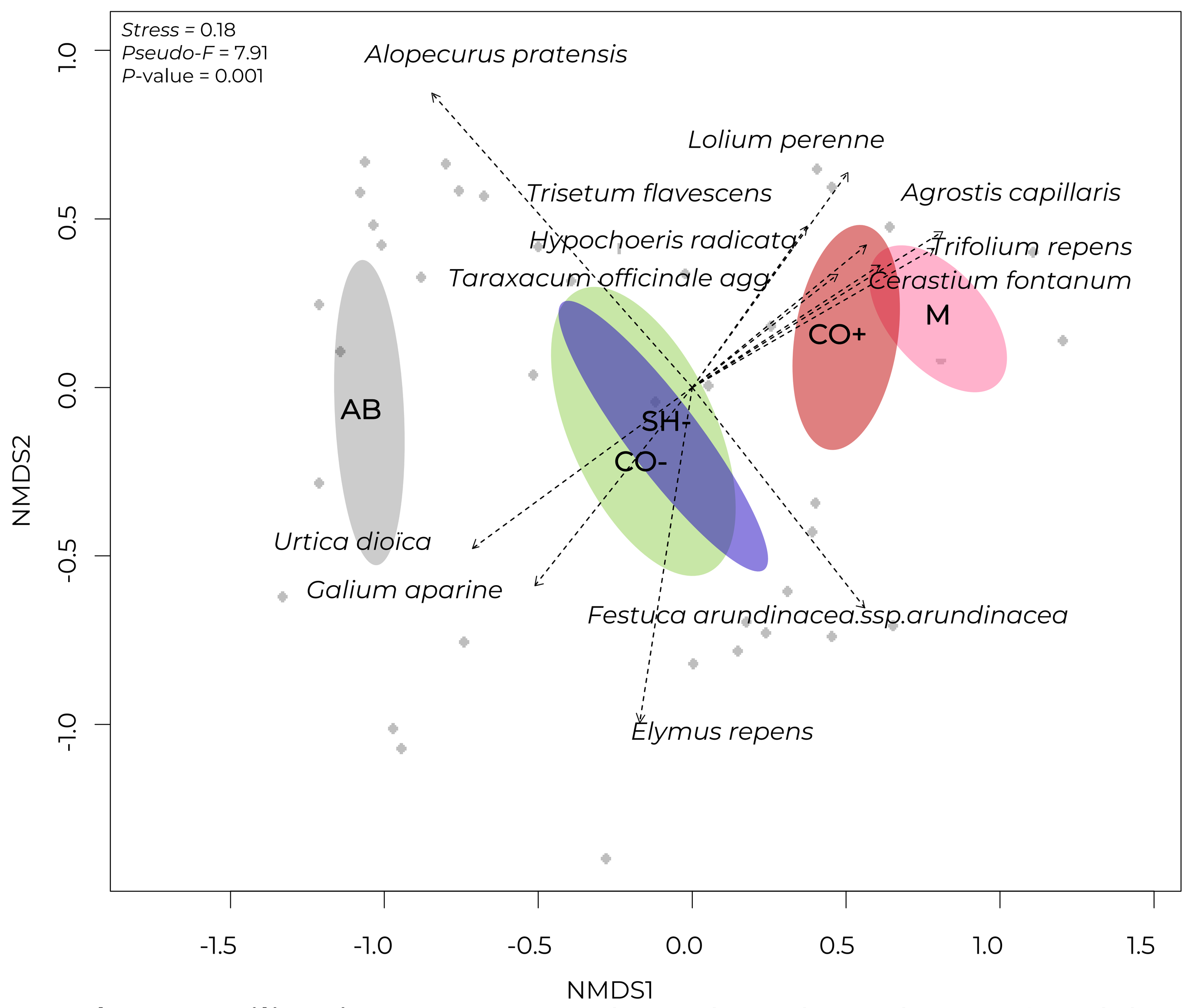
Then earthworms were sampled at the same location according to the ISO 23611-1 (2011) method:

Chemical extraction (on 1m² during 45 minutes) — Hand sorting (block of soil 25x25x20 cm)

Collected earthworms were identified to the species level, assigned to a ecological categories (epigeic, ***Lumbricus***-anecic, ***Aporrectodea***-anecic or endogeic) and individually weighed.

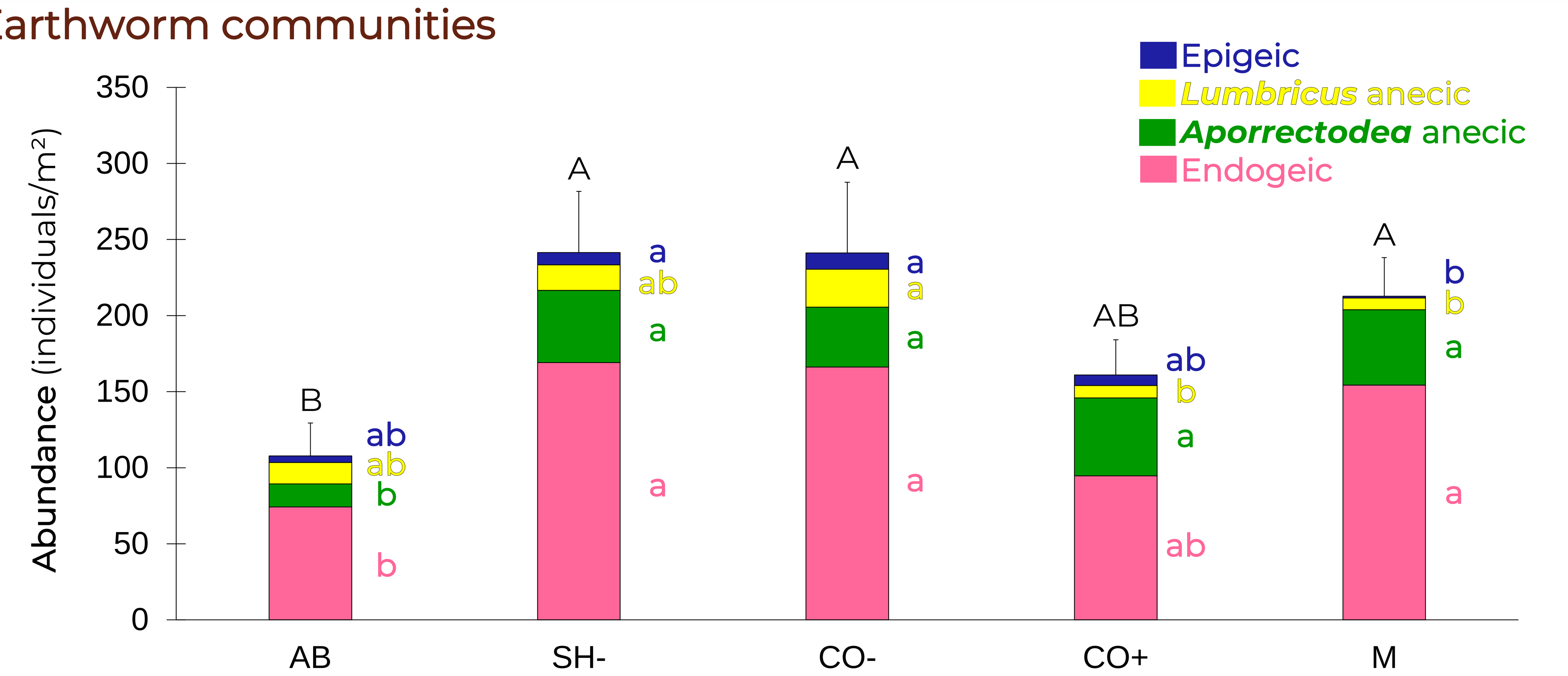
Results

Plant communities



- **Herbage utilization:** compared to abandoned grassland (AB), grazed pastures (SH+, CO- and CO+) or mowed grassland (M) significantly changed plant communities. Abandonment also lead to the lower plant species richness (data not shown).
- **Animal presence:** compared to mowed grassland (M), grazed pastures (SH-, CO-, CO+) significantly changed plant communities
- **Intensity of herbage utilization** (CO- *vs* CO+) significantly modified plant communities
- **Animal type** (SH- *vs* CO-) did not modified plant communities

Earthworm communities



- **Herbage utilization:** compared to abandoned grassland (AB), grazed pastures with a low herbage utilization (SH-, CO-) and mowed grassland (M) significantly increased total earthworm abundance, biomass and diversity. Mainly due to ***Aporrectodea*** anecic and endogeic (significant)
- **Animal presence:** compared to mowed grassland (M), grazed pastures by sheep or cows (SH-, CO- and CO+) did not modify total earthworm abundance, biomass and diversity, **BUT** it modified functional structure: epigeic abundance increased at low herbage utilisation (SH- and CO-, significant) and at high herbage utilisation (CO+, trend); ***Lumbricus*** **anecic** abundance increased at low herbage utilisation (CO- significant, SH- trend); ***Aporrectodea*** anecic abundance was not impacted; endogeic abundance decreased at high herbage utilisation (CO+, trend).
- **Intensity of herbage utilization** (CO- *vs* CO+) did not modify earthworm abundance, biomass and diversity, **BUT** it modified functional structure: ***Lumbricus*** anecic and endogeic abundance decreased at high herbage utilization (CO+, significant for ***Lumbricus*** anecic , trend for endogeic), while no effect was observed for ***Aporrectodea*** anecic and epigeic abundance.
- **Animal type** (SH- *vs* CO-) did not modified total earthworm abundance, biomass and diversity and no effect was observed on the ecological categories.

Conclusions

The increase in the grassland herbage utilization led to an increase in plant diversity.

Faced with this gradient in grassland herbage utilization, the characteristics of the environment also evolved towards an environment with less plant litter, small plant species with more leguminous plants, until a nutrient-poor one when mowing without inputs.

As a result, the increase in grassland herbage utilization, regardless of the intensity, has altered the earthworm communities with an increase in earthworm biomass and richness.

Grassland management practices have also specifically impacted the structure of earthworm communities particularly within anecic and to a lesser extent within endogeic earthworms.

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