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6th Belgian Agroecology Meeting

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Gembloux (ULiège - CRA-W) — 14th Novembre 2016



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Venue

Tuesday 14th November 2017, 9h00 — 18h00

Gembloux Agro-Bio Tech

Liège Université, Senghor auditorium ('Espace Senghor'), entrance n°7,
Avenue de la Faculté d'Agronomie, 5030 Gembloux (Belgium)

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Can organic arable and silvoarable micro-farms contribute to biodiversity conservation? A survey of wild bees community structure in the Brabant Wallon province (Belgium)

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Keywords — agroecology, micro-farms, agroforestry, fruit trees, market gardening, biodiversity conservation, plant-pollinator interaction networks, ecological intensification.

State-of-the-art

Agricultural intensification has led to the simplification and homogenization of landscapes, threatening farmland biodiversity and its associated ecosystem services in the process (Newbold et al. 2015; Potts et al. 2016). Several options have been put forward to mitigate these adverse impacts, including the agri-environmental schemes (AES, particularly “sown wildflower strips”, see Geslin et al. 2017), the promotion of organic agriculture and the increase of in-site plant diversity. The latter aspect is also expected to contribute to the sustainable intensification of production while reducing conventional agricultural inputs (pesticides, fertilizers, renting pollinators, etc.) and/or to optimize and stabilize ecosystem services in time and space (Lichtenberg et al. 2017).

In this context, we examined the contribution of organic diversified micro-farms (defined here as production sites of less than 2 hectares with high in-site plant diversity) to the conservation of wild bees in a network of production farms located in the Brabant Wallon province of Belgium. Because wild bees are ecologically, functionally and phylogenetically diverse, displaying sometimes highly specialized interactions with flowering plants and nesting in a wide variety of substrates (Vereecken 2017), the conventional use of species richness as the sole proxy for biodiversity generally fails to reflect the full impacts of land use and farming practices in particular on their communities.

Specifically, we asked the two following questions, (i) can arable and silvoarable micro-farms contribute to the conservation of wild bees as efficiently as semi-natural habitats or apple orchards?, (ii) do silvoarable micro-farms exhibit significant differences in functional and phylogenetic community structure compared to arable micro-farms in the same landscape context?

Methods

We focused our study on a network of silvoarable micro-farms (agroforestry) combining vegetable production and fruit trees, as well as on arable (market gardening) micro-farms cultivating only fruits and vegetables. We also conducted our study in low-input apple orchards and semi-natural habitats to allow for comparisons with potentially more “pollinator-friendly” sites at the same landscape scale. All these study sites were selected in

the Brabant Wallon province of Belgium in the framework of an ongoing research project on the ecological and economic benefits of diversified micro-farms combining trees and crops.

Bees were sampled from mid-March until early August, every fortnight using standardized protocols based on passive (i.e., pan traps) and active (i.e., netting) surveys (Westphal et al. 2009). Community structure metrics were computed with the *ape*, *BAT*, *car*, *ggpubr*, *ggsci*, *picante*, and *scales* packages in R, using a custom-made database of mixed qualitative/quantitative ecological/behavioural traits of wild bees (for the computation of functional diversity [FD] and its standardized effect size [SES]) and the hierarchical taxonomy of wild bees (for the computation of phylogenetic diversity [PD] and its standardized effect size) as a proxy for their phylogeny.

Results

Our results add to the growing body of evidence supporting the significant role of organic farming and in-site crop diversity for the conservation of arthropod biodiversity (Lichtenberg et al. 2017), including wild bees. In this study, we found no significant difference in the number of wild bee specimens (ANOVA, F -value=1.208, df =3, p =0.346) or species evenness (ANOVA on Pielou's J , F -value=0.723, df =3, p =0.556) among habitat categories (arable micro-farms vs. silvoarable micro-farms vs. orchards vs. semi-natural habitats), and no evidence for functionally- or phylogenetically-clustered or dispersed communities in arable or silvoarable micro-farms on average. There were no significant differences in effect sizes of FD and PD among habitat categories (ANOVA on SES of FD, F value = 1.427, df = 5, p -value = 0.28; ANOVA on SES of PD, t = 0.322, df = 3, p -value = 0.81), and communities of wild bees are neither significantly clustered nor dispersed compared to what is expected by chance alone (all values of $p > 0.05$), except for the semi-natural habitats which exhibit a phylogenetic clustering (one sample t -test on observed z -scores of PD with 0 as reference mean, t = -3.065, df = 5, p -value = 0.028).

When examining the effect size of FD at the site level, we found that arable farms (vegetable gardens, see "TdM" and "TCh") were more prone to a significant functional clustering than silvoarable micro-farms (except "Kam", a site managed only since 2016) (Figure 1). Two of the silvoarable micro-farms investigated in 2017 ("JdD" and "FdG") exhibited positive SES values for FD higher than any of the semi-natural habitats, with a score above +1. These are generally considered to be (very) large effect sizes, an effect size of +1 means that the FD value of these silvoarable micro-farms equal to 1 standard deviation above the average study site investigated here. By contrast, effect sizes of FD in semi-natural habitats were more or less symmetrically distributed around 0, from moderate (between -0.3 to -0.5 and 0.3 to 0.5) to high scores (-0.5 to -0.8 or below, and 0.5 to 0.8 or above). Finally, we found that apple orchards had small effect sizes of FD (-0.2 to 0.2), except for one site ("VdG") that exhibited a very high negative score (-1.211), indicating that the wild bee communities at this site were more similar from their ecological/behavioural traits (albeit not significantly).

The pattern of SES values for PD at the site level showed that one arable micro-farm ("TdM") that already characterized by a significant functional clustering also showed a significant phylogenetic clustering of its wild bee community composed of many species of *Andrena* (solitary mining bees, Andrenidae) and *Bombus* (social bumblebees, Apidae). By contrast, all the other arable micro-farms showed a trend for high and positive effect sizes of PD (0.8 or above), indicating that their wild bee communities were composed of species belonging to more phylogenetically-distant groups (albeit not significantly).

Discussion & conclusions

The benefits of agroforestry for biodiversity conservation have already been demonstrated in the tropics for a wide range of animals and plants (De Beenhouwer et al. 2013), including for bees (Jha & Vandermeer 2010). Our results shed new light to the environmental value of arable and silvoarable micro-farms characterized by agroecological practices in Belgium. Despite their high cultivation intensity and crop turnover (for vegetables), arable and silvoarable micro-farms with high in-site plant diversity appear to remain particularly attractive for wild bees. These results offer substantial opportunities for wildlife-friendly management of agricultural landscapes where agroforestry micro-farms embracing agroecological principles can positively impact the conservation of important groups of animals and plants.

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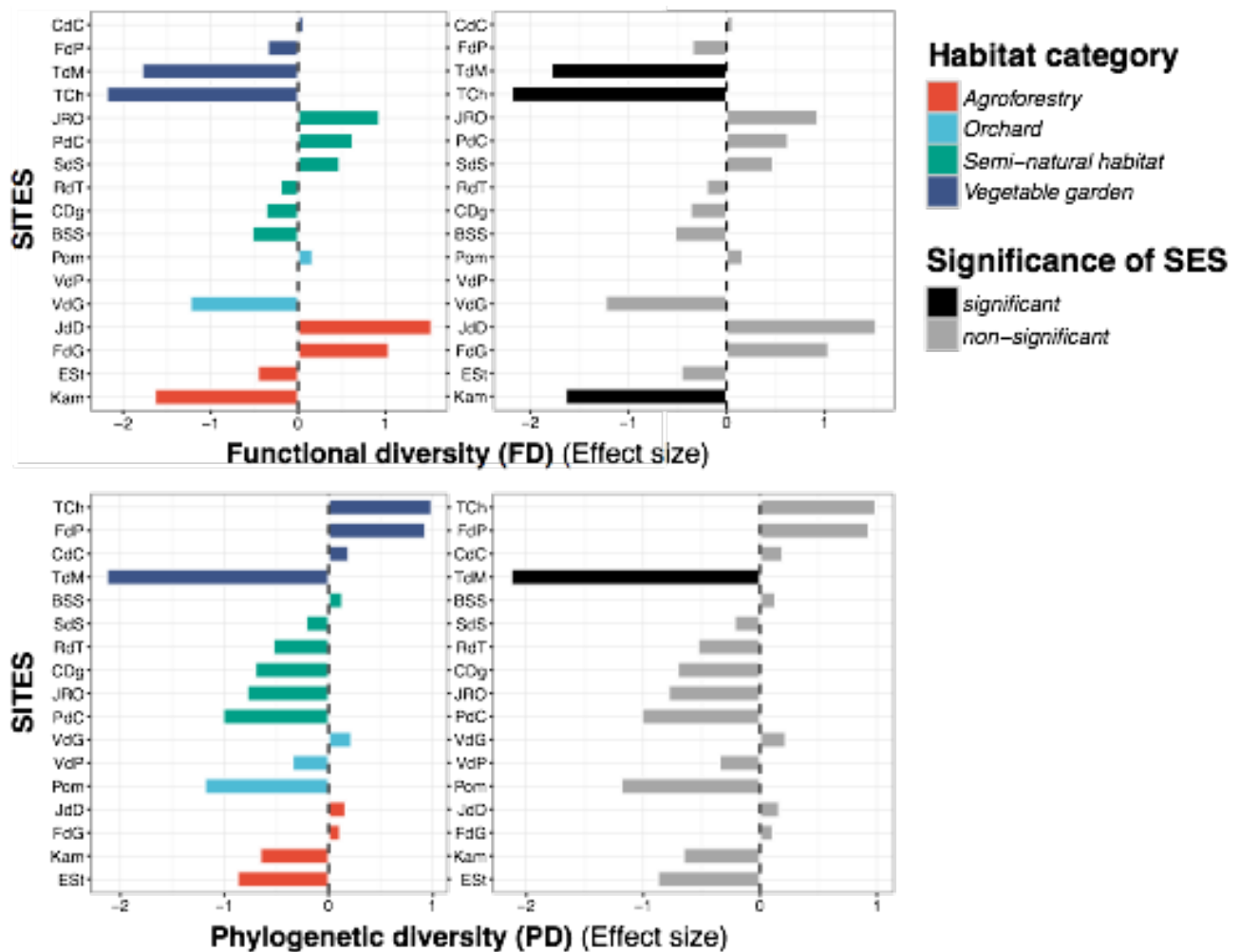


Figure 1 — Standardised effect sizes (SES) of the observed functional (upper panels) and phylogenetic (lower panels) diversity (FD and PD, respectively) of wild bees across sites and among habitat categories (“independentswap” algorithm, 999 replicates used for the null model). The black histograms indicate significant differences in FD (top right figure) and PD (bottom right figure). The results show varying levels of FD and PD across sites and among habitat types, with a trend in two vegetable gardens micro-farms (“TdM” and “TCh”) and one agroforestry micro-farm (“Kam”) to exhibit a significantly lower level of FD (functional trait clustering, i.e. species are more similar than expected by chance) ($p < 0.05$) (upper panels), and a significantly lower level of PD (phylogenetic clustering, i.e. species are more similar than expected by chance) in one of the vegetable garden micro-farms (“TdM”) (lower panels). These results do not include species of *Andrena* (subgenus *Micran-drena*), *Halictus*, *Lasioglossum*, and *Nomada* which still required identification at the time of the submission of this abstract in July 2017.