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Wild Pollinator Diversity in Landscapes Surrounding Cranberry Bogs in Quebec (Canada) and their Usefulness to Harbour Species Providing Crop Pollination

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Introduction

The self-sterile flowers of cultivated cranberries depend on the transfer of pollen by insects to ensure cross-pollination and high yield fruit production. Because natural landscapes surrounding these crop fields are being cleared and transformed for agricultural purposes, it was considered important learn more about the wild pollinators that inhabit and use these natural habitats and determine the factors that influence their presence. The conservation or management of these habitat types and their ecological characteristics could ensure pollinator presence on the flowers, high pollination rates and, ultimately, sustainable yields. The main objective of this study was to document the biodiversity of wild pollinators present in cranberry plantations in Quebec (Canada) and in the natural environments mainly surrounding this culture (bog, forest or fallow). Cranberry felids located in the Centre-du-Québec are established either on sandy mineral soil or organic soil. These types of soil were chosen as dependent variables for our study (sand *vs* peat). Also, the project aimed to assess the impact of management schemes (conventional *vs* organic) on the communities of native pollinators found in the fields.

Material and Methods

Twelve experimental sites were selected based on four treatments including two variables: soil type (sand or peat) and crop management (organic or conventional). Each treatment was repeated three times. In cranberry fields, nine pan traps were placed in groups of three (yellow, white, blue) on two parallel transects at 0, 12, 5 and 25 meters from the edge of the field to the inside. In front of this sample scheme, another transect was established at 0, 25 and 50 meters from the edge towards the inside of the natural environment. Each week during the flowering period (days without rain) pan traps were filled with soapy water and left for 48 hours before being emptied. To increase the sampling effort and the diversity of catches, manual sampling using a sweep net was performed for 10 minutes at each visit. Each native pollinator either flying or on a flower

was captured. Native bees and hoverflies were examined. The specimens were pinned and identified to species level by Amélie Gervais at Valerie Fournier's laboratory at Laval University, as well as at Cory Sheffield's laboratory at the Royal Saskatchewan Museum (Canada). Univariate and multivariate statistical tests (software R) helped to highlight biodiversity (species richness and abundance) of pollinators according to the variables « soil type » (peat or sand) and « management » (conventional or organic). We also examined the species similarities between the communities of cranberry field and those of the natural habitat. The natural environment elements (characteristics) that determined the composition of communities were also noted and analyzed for their importance to determine commit structures.

Results and Discussion

Species richness

In the fields, a total of 1814 bees (90 species) and 461 syrphid flies (33 species) was collected and identified. Results are given in table 1. The specimens caught were over 30 times, the majority of halictides (Halictidae) and bumblebees (Apidae . Bombus sp). On the other hand, more than 1065 specimens of bees, grouped into 106 species, were captured in the wild during the flowering cranberry. The dominant species are: Bombus ternarius (121) , Bombus vagans (107) Lasioglossum admirandum (61) Lasioglossum versatum (46) Lasioglossum planatum (46) Mellita americana (40) and Hylaeus modestus (30). Overall, 28 species were found in only one copy in the sampling carried out over two years.

Soil type

According to our results, the type of soil would affect the structure of the community of bees (Apidae), but not for that of hoverflies. The presence of two species of bees was positively correlated with sandy soil: Lasioglossum oblongum (r = 0.2792, n = 22, P = 0.0819) and Halictus rubicondus (r = 0.325, n = 22, P = 0, 0450), while two bumblebee species there were negatively correlated: Bombus ternarius (r = 0.4162, n = 22, P = 0.0116) and Bombus vagans (r = 0.419, n = 22, P = 0, 0111). Soil type also affects the composition of the communities' most abundant group, the nesting ground. There is a greater abundance and diversity of soil breeding on farms on sandy soil than in those on peat soil. This is consistent with our expectations (hypothesis) based on a study Cane (1991) who also found that the presence of ground nesting was associated with a high percentage of sand in the soil (up 100%).

Crop management

The crop management did not seem to be a determining factor for specific compositions of bee communities and hoverflies. Overall, fans on sandy soil with conventional management had the highest abundance and richness of wild bees. One species was positively correlated with conventional management: Lasioglossum versatum (r = 0.3234 , n = 22 , P = 0.0461) .

Table 1. Number of bee specimens found in the four treatments

Treatment	Number specimens	Number species	Expected numbers	95% C.I
Organic-peat	353	48	42.6	40.6-44.
Organic-sand	449	48	41.7	39.7-43.
Conventional- peat	454	50	42.1	39.8-44.
Conventional- sand	495	61	49.5	46.9-52.

Fields vs natural habitats

The bee community was different between fields and habitats. This could be explained by the fact that the cranberry fields offer almost exclusively a source of specific pollen and nectar. The greater abundance of bees in the field could logically be explained by the flowering period of cranberries, with access to a large amount of food. The similarity between the fields and three natural environments were also examined. Wasteland have a most similar bee community to the one found in the fields and the number of species in common was slightly higher than 82.9% of the forest and 52.8% of the bog . These results are consistent with other studies.

Melita Americana (Smith)

Significant findings included capture of large numbers of *Melitta americana* (Smith), an Ericaceae specialist (Payette, 2013), on almost all sites. The pollen loads of the 26 *M. americana* specimens captured by hand netting was 91.75 ± 2.97% cranberry pollen, with a mean of 465.74 ±114 cranberry pollen tetrads per sample.

Conclusions and Outlook

The biodiversity of wild bees present in the cranberry bogs of the Quebec and their natural surrounding areas was fully described. In addition, the biodiversity of hoverflies present in these environments was identified for the first time in North America. Our study shows the importance of the soil types used in agricultural systems, especially when pollinators are needed to increase fruit production. Pollinator diversity was similar in cranberry bogs established on the same soil type and that this factor was determinant for the presence of certain species. Since most wild pollinators nest in the ground (Cane, 1991), our study highlights the importance of preserving undisturbed sandy areas to favour these species during the pollination period. This can result in an increase pollination services (Kremen et al., 2004) and thus a higher fruit set and crop volume. The management scheme, organic or conventional, was not an important factor to characterize pollinator biodiversity, as found by Schneider et al. (2014). This latter result was nonetheless surprising and contradictory since it was foreseeable that organic production would foster a greater biodiversity of pollinators (Gabriel, 2013). Many studies have shown that agricultural sites under organic management are usually associated with a greater diversity of native bees as sites in conventional management (e.i. Moradin et al., 2005; Clough et al., 2007). There are many possibilities to explain the conflicting results we have achieved, but a more plausible is related to

the use of a bio-pesticide, spinosad (Entrust), known for its high level of toxicity to bees. One desirable avenues for the preservation of beneficial species in agricultural environments would be to find less harmful insecticides to non-target organisms, such as native pollinators. The development of alternative means to pesticides (cultural practices, biocontrol, etc.) would also be very beneficial. Our results provide the most exhaustive survey of pollinating fauna of Quebec cranberry to date and understanding the factors that influence their presence. The results obtained will serve as a decision -making tool for the protection of the biodiversity of wild pollinators in the management of a production. To encourage greater abundance and diversity of theses pollinators in cranberries, a better understanding of which pollinators are present and the impact of of environmental factors, such as soil type, farm management and alternative flower resources are needed. This is the first exhaustive study to document the diversity and abundance of native pollinators in Quebec's cranberry farms. Determining the effect of environmental factors on community assemblages will help the preservation of these pollinating species essential for optimum cranberry crop production

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