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To cite this version:
Gaëtane Le Provost, Cyrille Violle, Isabelle Badenhausser, Marie d’Ottavio, Nicolas Gross. How local plant community and landscape context affect the morphological space of wild bee communities in grasslands?. Les prairies et l’agroécologie, Nov 2015, Vandoeuvre-les-Nancy, France. 2015. hal-02799448

HAL Id: hal-02799448
https://hal.inrae.fr/hal-02799448
Submitted on 5 Jun 2020

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How local plant community and landscape context affect the morphological space of wild bee communities in grasslands?

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General context

Growing concern about wild pollinator loss and the consequences for pollination service in intensive agricultural landscapes (e.g. Biesmeijer et al. 2006, Deguines et al. 2014, Potts et al. 2016)

Land-use intensification affects wild bee communities through habitat loss and fragmentation at the landscape scale (Bammarco et al. 2010, Kennedy et al. 2013); and less diverse plant communities at the local scale (De Palma et al. 2015, Rader et al. 2014)

Such disturbances are not expected to affect all bee species identically, rather they are likely to be mediated by the species’ traits (De Palma et al. 2015, Kozarske 2002, Murray, Ruhlman & Potts 2008)

Which traits may be involved in the response of wild bee communities to land-use intensification?

• Body size and dispersal traits (Gonzalez et al. 2007)
  1. Body length
  2. Wing length
  3. Distance between wing bases (Inter-Tegular Distance)

• Resource acquisition traits (Potters et al. 2013)
  1. Tongue length
  2. Prementum length

• Co-variation among wild bee morphological traits (PCA)

  Traits covary along three axes:
  - Axis 1: Body size and dispersal traits
  - Axis 2: Tongue length and resource acquisition traits
  - Axis 3: Prementum length and body size

In the subsequent analysis, we considered three independent traits:
• Inter-tegmental distance (ITD), related to dispersal abilities
• Digital ratio between tongue length and body size
• Digital ratio between prementum length and body size

Results and discussion

1. Trait by trait (CWM and CWV)

The diversity of traits related to dispersal abilities is lower in landscapes mostly composed of crop. In disturbed landscapes, individuals with low dispersal abilities may not reach the grasslands. (Stronenkoff et al. 2013, Wright, Roberts & Collins 2015) and diversity of dispersal traits will be lower in the focal grassland.

No significant affect on the CWM.

In grasslands with high herb diversity, bee diversity is higher. This may also happen in small-scale crops. With high herb diversity, individuals with low dispersal abilities may not reach the grasslands. (Stronenkoff et al. 2013, Wright, Roberts & Collins 2015)

No significant affect on the CWV.

In grasslands with high flower diversity, bee diversity is higher. This may also happen in small-scale crops. With high herb diversity, individuals with low dispersal abilities may not reach the grasslands. (Stronenkoff et al. 2013, Wright, Roberts & Collins 2015)

No significant affect on the CWV.

2. Morphological space (hypervolume)

In landscapes with high herb diversity, the morphological space occupied by the wild bee community is higher. This is also true for small-scale crops. With high herb diversity, individuals with low dispersal abilities may not reach the grasslands. (Stronenkoff et al. 2013, Wright, Roberts & Collins 2015)

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No significant affect on the CWV.

Conclusion

Importance of considering multiple scales and multiple interacting traits to understand the composition of local communities and their responses to land use intensification.

Landscape factors affect particularly the diversity of bee traits. Especially, grasslands provide a spillover of individuals with high resource acquisition traits through a mass-effect (Schmidle & Elton 1984).

External environmental filtering is detected when considering the morphological space instead of considering each trait separately. This suggests that the environment filters wild bees according to different trait combination and strategies.