Plant Diversity, Litter Feedbacks and Soil Nutrient Cycling

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Background

- Hobbie (2015) hypothesized that plant species have the ability to generate positive feedback mechanisms that influence nutrient cycling rates.
- Positive effects on decomposition rates have been observed with greater plant diversity (Tresch et al., 2018).
- A study at the Koffler Scientific Reserve showed that restored plant communities with higher diversity occurred in more nutrient rich soils.
- It is unclear if plant diversity directly influences decomposition rates and soil conditions or, instead, if both variables respond to underlying soil conditions.

Research Questions

- How do local conditions and plant diversity alter decomposition rates?
- Is decomposition driven by nutrient levels (availability/total) in the soil or in the plant litter?
- Do plots with lower soil nutrient levels display a greater response to litter? (i.e., increased decomposition → increased soil nutrient availability to plants)
- Do we observe an effect of litter type and nutrient composition?

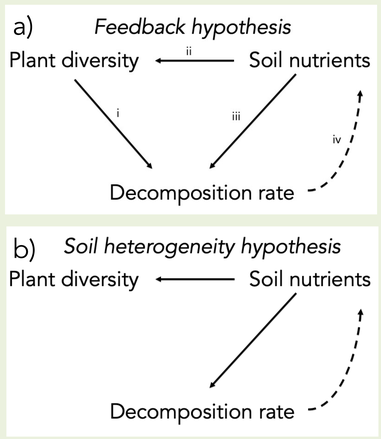

Figure 1: The arrows are tested via i) paired plots that differ in diversity and plant litter effects on decomposition; ii) correlation between plant diversity and soil nutrients; iii) rate of decomposition in plots that differ in nutrients. The dashed arrow, iv), is not tested but is implied in both hypotheses through a simple loss/gain model of nutrient inputs and losses from the system. If feedbacks are not present, the best-fit model will exclude pathway i) (b).

Hypotheses

<u>Feedback Hypothesis</u>

This hypothesis posits that a positive feedback between soil nutrients and plant diversity is mediated by the influence of plant diversity on decomposition rate (Figure 1a).

<u>Soil Heterogeneity Hypothesis</u>

This hypothesis posits that there is not a significant influence of plant diversity on decomposition rate and feedbacks between soil nutrients and plant diversity are absent (Figure 1b).

Methods

- This experiment is being conducted at Koffler Scientific Reserve in King City, Ontario.
- Paired 2m by 2m plots in non-restored fields were measured and marked next to 28 restored plots (56 plots total). Paired plots provide an indication of the affect of plant diversity in a similar initial environment (soil nutrients in restored versus non-restored plots). Diversity surveys were completed for each plot.
- Leaf litter of four selected species was collected and dried for three different types of litter bags – forb (*Solidago canadensis)*, grass *(Bromus inermis)* and legume (mix of *Trifolium repens* and *Vicia cracca;* Figure 2) to understand how the diversity and identity of plants influence decomposition rates.

Figure 2: *T. repens*, *V. cracca*, *B. inermis* and *S. canadensis* (left to right).

- 10 X 10 cm porous mesh bags, each with 1 g of one litter type, were placed in plots. 392 bags were made in total – 186 bags of *Solidago canadensis*, 186 bags of *Bromus inermis* and 56 bags of the legume mix.

Figure 3: Labelled leaf litter bags, sewn, strung together (left) and placed in a plot (right).

- Two soil samples were collected from each of the 56 plots at depths of 0cm to 10cm and 10cm to 20cm.

Future Data Collection and Analysis

- Leaf litter of each species and soil samples will be analyzed for nutrient composition.
- Leaf litter bags will be removed sequentially, dried and weighed to evaluate decomposition rate.
- Structural equation models will be used to distinguish between our hypotheses.

Figure 4: Restored and paired plots with flagged litter bags.

Discussion

- If we reject our null hypothesis (soil heterogeneity) and observe a positive feedback between soil nutrients and plant diversity, our findings will indicate that plant diversity has a fundamental role in nutrient cycling and has a significant influence on decomposition rates.
- This could be relevant in terms of implications for future nutrient cycling and ecosystem functioning in environments with changing plant diversity.

References

Hobbie, S. (2015). Plant species effects on nutrient cycling: Revisiting litter feedbacks. *Trends in Ecology & Evolution*, *30*(6), 357–363. https://doi.org/10.1016/j.tree.2015.03.015

Tresch, S., Frey, D., Le Bayon, R.-C., Zanetta, A., Rasche, F., Fliessbach, A., & Moretti, M. (2019). Litter decomposition driven by soil fauna, plant diversity and soil management in Urban Gardens. *Science of The Total Environment*, *658*, 1614–1629. https://doi.org/10.1016/j.scitotenv.2018.12.235