Comparing the influence of invasive Acacia species and native legumes on the soil and the foliar nitrogen status of the surrounding vegetation:
A useful tool to detect early invasions?

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Introduction

- The genus *Acacia* contains some the worst invasive species worldwide. As legumes, they are able to fix N_2 and have a strong impact on the surrounding soil.
- Especially nutrient poor ecosystems, such as the Portuguese coastline, are affected.
- These changes can be traced in space[1,2] by measuring the foliar nitrogen (N) and $\partial^{15}N$ levels of the native shrub *Corema album.* In contrast, native legumes like *Stauracanthus spectabilis*, do not seem to influence the surrounding plants.

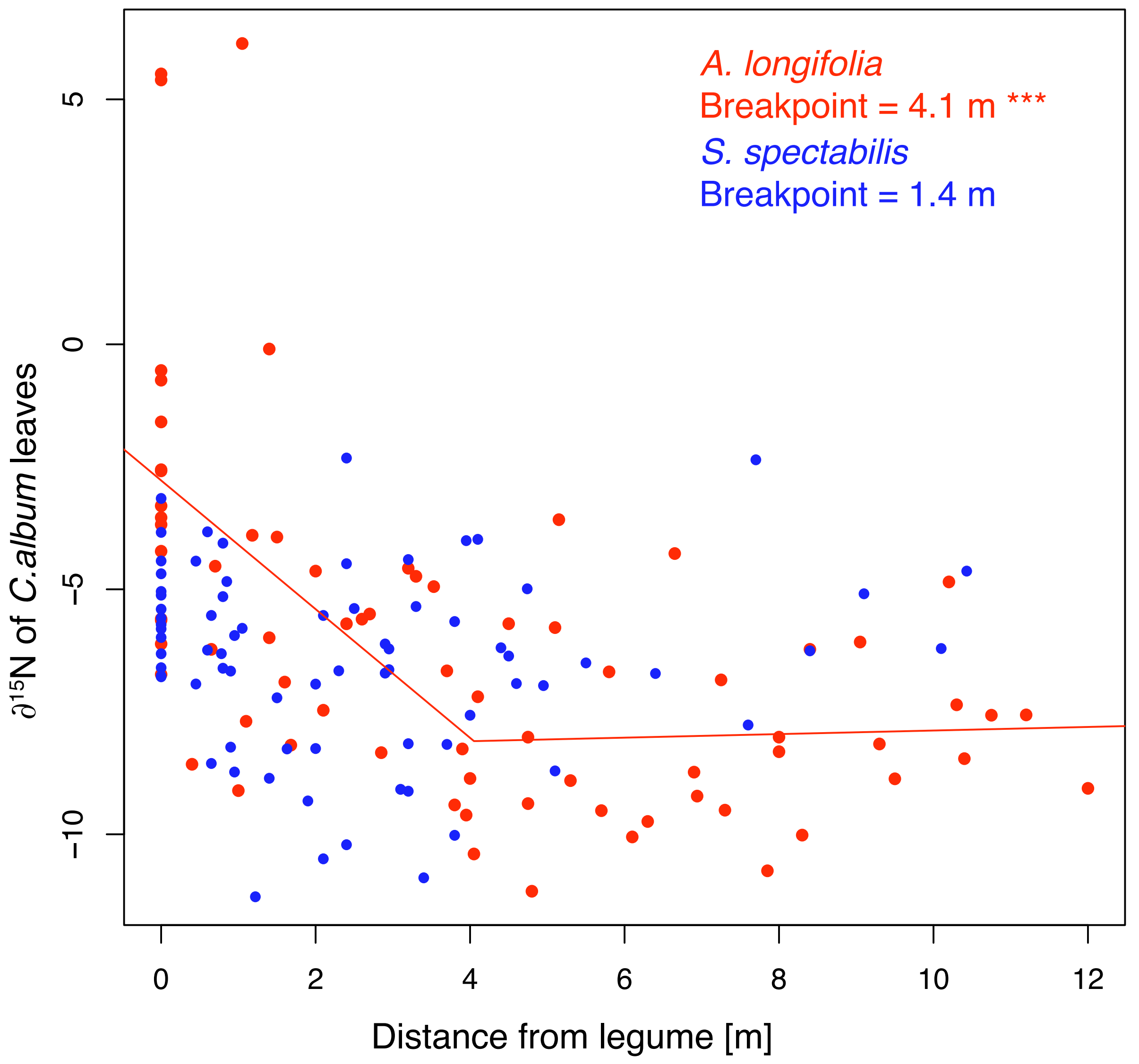


Figure 1:
Spatial relationships found for both legumes. The impact of the invasive exceeds the canopy by several meters (4.051 ± 0.958 standard error), while the impact of the native is not significant (Davies test).

Goals

- Use a simple, transect - based method with less sample and cost intensity to model the impact of Acacias on the surrounding vegetation.
- Find related soil parameters underneath invasive and native legume.
- Transfer the method to Mussununga, a comparable ecosystem in Brazil, with *Acacia mangium* as invasive, *Andira fraxinifolia* a native legume and *Marcetia taxifolia* used as a reporter plant.

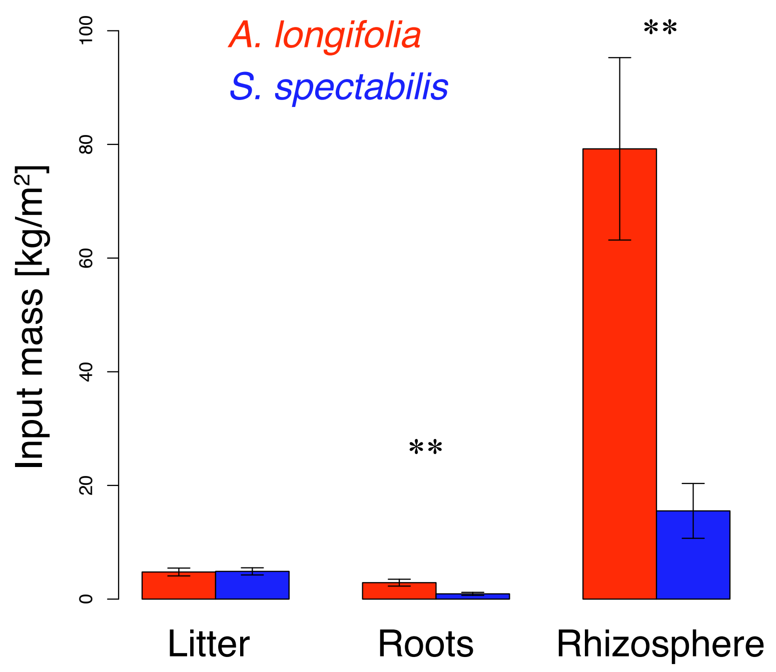
Results

- Only the invasive lugume exhibits a significant effect on *C. album,* which exceeds the canopy by ca. 4 m **(figure 1)**.
- Organic matter in *A. longifolia* soil is still in the range of a non-invaded soil[1], NH_4^+ and NO_3^- are within range of a recent invasion[3] **(table 1)**.
- There is significantly higher roots and rhizosphere mass per area underneath the invasive (**figure 2**).

Soil nutrients	A.longifolia	S.spectabilis
Organic matter [%]	0.42 ± 0.03	0.34 ± 0.01
NO_3^- [mg/kg]	2.62 ± 0.33	2.00 ± 0.24
NH_4^+ [mg/kg]	3.28 ± 0.14	2.76 ± 0.10

Table 1:
Organic matter (OM) content as well as NO_3^- and NH_4^+ concentrations measured underneath both plants. All measured parameters are slightly higher underneath *A.longifolia*, but none show significant differences.

Figure 2:
The main compartments of organic matter deposition. While there is no significant difference in litter quantity detectable, there is a significant accumulation of both roots and rhizosphere underneath the invasive *A.longifolia* observable.



- The size of these compartments is positively correlated with foliar N and $\partial^{15}N$ levels of *C. album* plants growing in the canopy of *A. longifolia* (**figure 3**).
- Data from the same setup used in the Mussununga, suggests a related, but weaker response **(figure 4).**

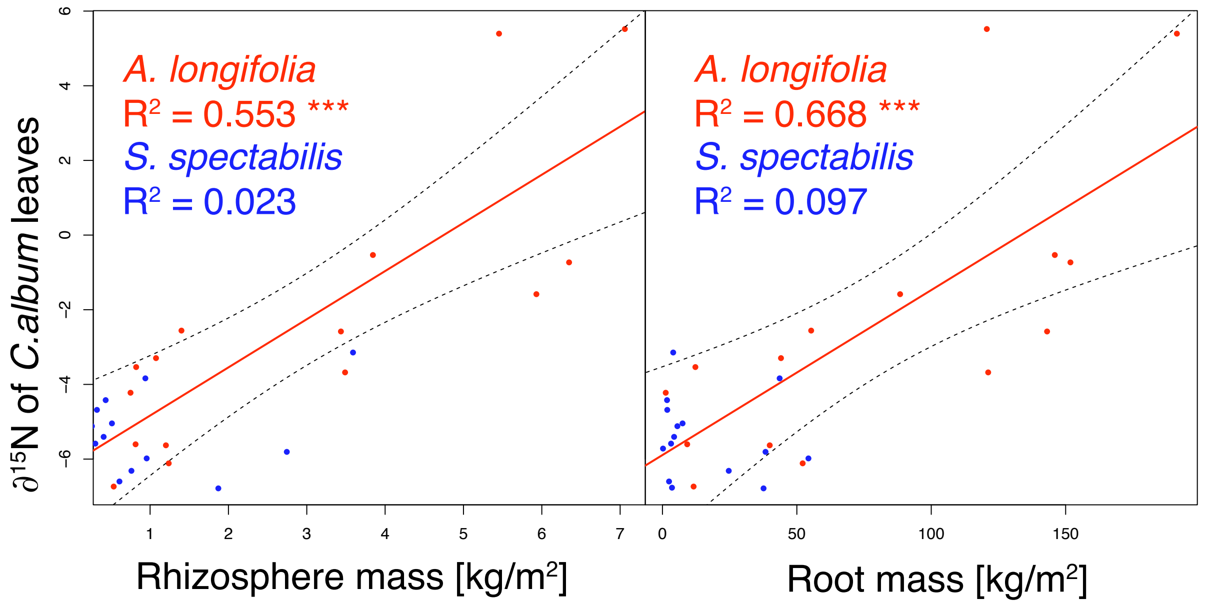


Figure 3:
Effects of both roots and rhizosphere mass on the foliar $\partial^{15}N$ values of *C.album* growing in the canopy of the respective legume. The trends for total Nitrogen are similar and significant, but slightly less pronounced.

Summary

- The sampling method used here proved effective in determining the spatial impact of *A.longifolia*.
- The root/rhizosphere system could be a putative source for the observed effect.
- This method could potentially be applied to other ecosystems with low soil nutrient availability.

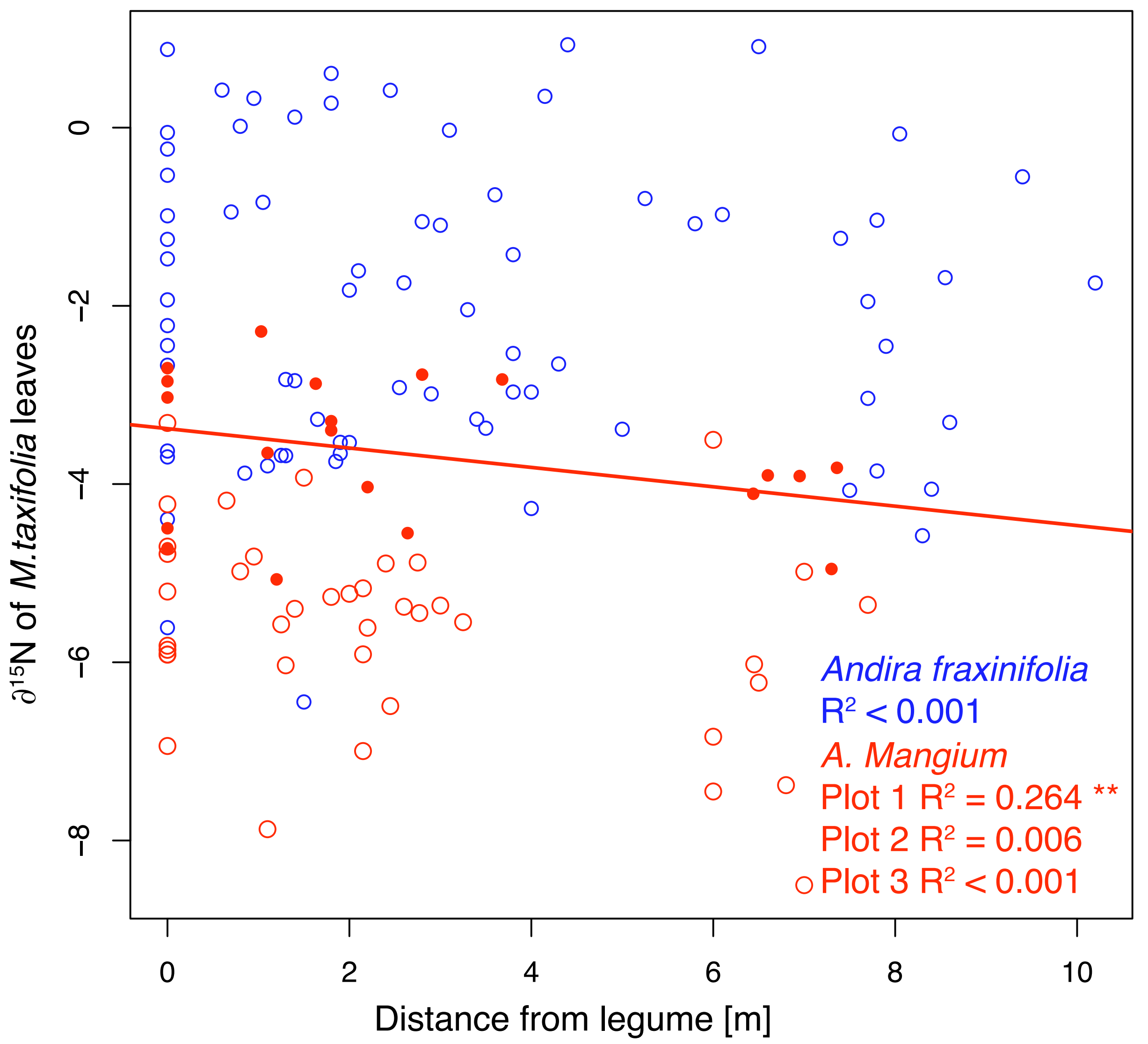


Figure 4:
Spatial relationships found for both legumes in the Mussununga. A linear relationship was used as the Davis test rejected a segmented relationship. Only plot 1 showed a significant relationship in this pre-experiment.

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Materials, methods and statistical treatment: Sampling was carried out in Pinheiro da Cruz, Portugal (N 38°15.2', W 8°45.8') from 21st to 23rd May 2012 and in southern Bahia in November 2013. Foliage of 5 C. album plants was sampled along transects, starting under the canopy of the legume (n = 5 with 3 transects each). Root/soil cores were taken from the same spots and separated manually into litter (dead plant material), roots, sand and sand closely attached to the roots (rhizosphere). Samples were dried at 50° to constant weight and powdered using a ball mill (Retsch, Haan, Germany). Organic matter was determined by the loss on ignition method. Samples were analysed by continuous flow isotope mass spectrometry for total N and isotopes, the latter shown here in delta notation. Soil nutrient analysis was done from aqueous soil extracts with a 1:10 (w/v) ratio using colorimetric reactions in microplate scale (Berthelot reaction for NH4 and VCl3/Griess method for NO3-). Asterisks point to different levels of significance (* = <0.05, ** = <0.01, *** = <0.001). Data treatment and statistical analysis was done in R 3.0.2[4]. Figure 1 was produced using breakpoint estimation and Davis test of the "segmented" package[5]. Significant differences in figure 2 were found using a linear mixed model with sample error of sub samples as mixed effect. Measurements were log-transformed to ensure homoscedasticity. Values are means ± standard error.

Literature: [1] **Hellmann et al. (2011):** Acta Oecologica, 37(1), 43-50.; [2] **Rascher et al. (2012):** Ecology letters, 15(5), 484-491.; [3] **Marchante et al. (2008b):** Appl. Soil Ecol. 40, 210e217.; [4] **R Core Team (2013):** R Foundation for Statistical Computing, Vienna, Austria. URL: http://www.R-project.org/.; [5] **Vito M. R. Muggeo (2013):** R News, 8/1, 20-25. URL: http://cran.r-project.org/doc/Rnews/.