EVOLUTION OF LEGUME-RHIZOBIA MUTUALISM AFTER 18 YEARS OF ELEVATED CO_2 AND N AVAILABILITY

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INTRODUCTION

Anthropogenic global change drivers: Atmospheric CO_2 + Soil N

→ **Benefits to legume species from rhizobial bacteria**

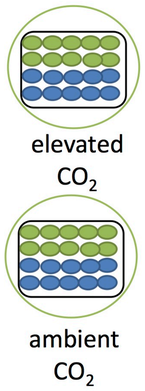
→ Reduced rhizobial density
→ Reduced legume nodulation rates

→ **Biodiversity-Ecosystem Function**

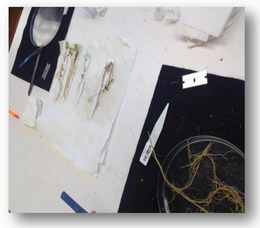
METHODS

Seeds are acid scarified to remove seed coats for planting

Four soil cores are harvested and aggregated from all *Lesp.* monocultures.



Seedlings are placed in their original CO_2 conditions and novel CO_2 conditions ; half receive ambient N, the other half receive elevated N



After ~40 days, all *Lesp.* plants are harvested, nodules are counted, and biomass is weighed

OBJECTIVES

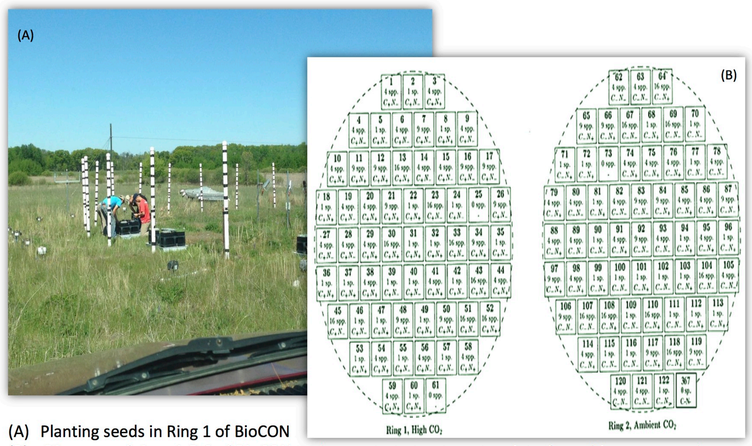
1) Determine how the evolutionary responses of rhizobia to CO_2 and N enrichment affect the legume-rhizobia symbiosis under altered conditions
   - Hypothesis: Ancestral rhizobial bacteria are present therefore nodulation rate will be unaffected when *Lesp.* Is grown under original conditions

2) Determine the stability of the altered legume-rhizobia relationship when placed in novel conditions
   - Hypothesis: Increased CO_2 is predicted to increase rhizobial density/benefit while increased N decreases density/benefit; these predictions will hold true but the mutualism will be degraded under novel conditions – affecting density and nodulation

STUDY SITE

Lespedeza capitata seedlings were grown in an existing long-term resource manipulation experiment; the BioCON experiment at Cedar Creek LTER, Minnesota USA manipulates:

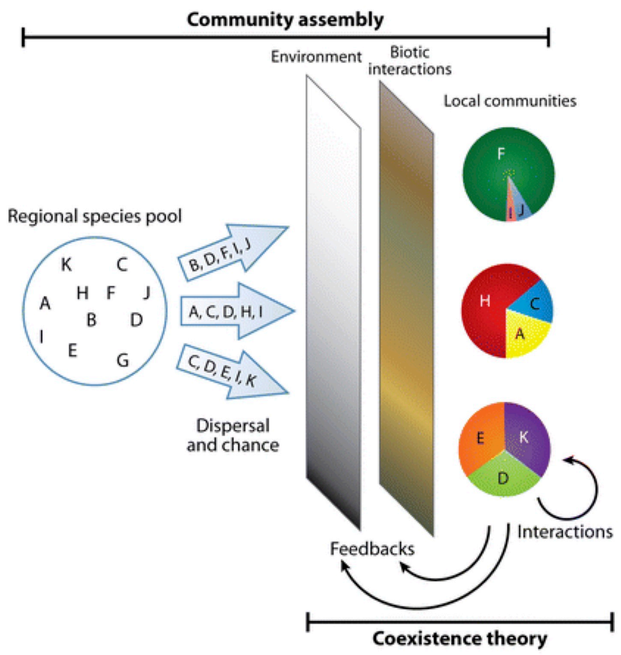
- CO2 (ambient vs enriched air [+192ppm])
- N (ambient vs enriched soil N [+4g/m2/yr])
- legume species identity (4 spp grown in monoculture)



(A) Planting seeds in Ring 1 of BioCON
(B) Diagrams of rings 1 & 2 of BioCON to demonstrate treatment variety, from biocon.umn.edu

THEORY

Mutualism theory suggests that specialist rhizobia are essentially more beneficial to host legumes; indigenous rhizobia have adapted to support their host and seem to support the host plant more readily despite changing conditions.



HilleRisLambers J, et al. 2012. Annu. Rev. Ecol. Evol. Syst. 43:227–48

RESULTS

Ancestral conditions had a significant effect on nodule number and data shows that increased CO_2 reduces nodule formation; whereas the effects of novel treatments on the number of nodules formed was not significant ($p > 0.05$) and did not override ancestral effect).

The effects of nitrogen treatments were overall not significant.

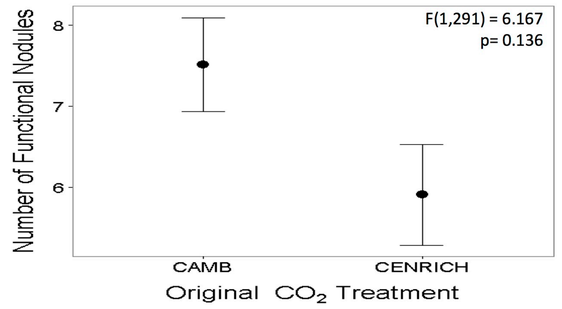
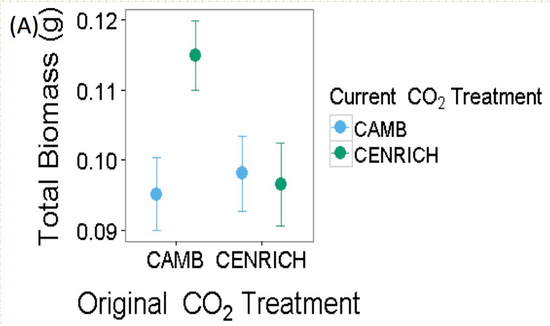
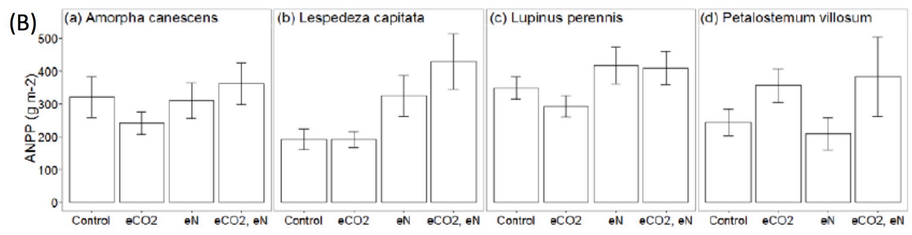


Figure 1: Nodules Formed v Original CO_2 Treatment



(A) There is a significant interaction between current and prior CO_2 treatments in terms of overall biomass; again no N significance.

(B) Effects of elevated CO_2 and N on aboveground net primary productivity across all four BioCON legume species



CONCLUSIONS

1) Nodulation rate of ancestral rhizobial bacteria was altered under original ambient conditions yet little effect was observed when novel conditions were induced showing that the symbiosis is relatively stable .
2) Predicted positive effects of CO_2 and N hold true under ambient CO_2 conditions but behavior relative to nodule formation remains stable under novel conditions. Moreover, legumes vary in their response to CO_2 and N in terms of their NPP; interactions with rhizobia could underlie these observed differences.

ACKNOWLEDGEMENTS

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