**Title:** Light availability and rhizobium variation interactively mediate the outcomes of legume-rhizobium symbiosis

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**Related works:** In addition to this paper (Heath et al. 2020 AJB) please see:

Weese, D. J., Heath, K. D., Dentinger, B. T. M., & Lau, J. A. (2015). Long‐term nitrogen addition causes the evolution of less‐cooperative mutualists. Evolution, 69(3), 631–642. http://doi.org/10.1111/evo.12594

Gordon, B. R., Klinger, C. K., Weese, D. J., Lau, J. A., Burke, P. V., Dentinger, B. T. M., & Heath, K. D. (2016). Decoupled genomic elements and the evolution of partner quality in nitrogen-fixing rhizobia. Ecology and Evolution, 6(5), 1317–1327. http://doi.org/10.1002/ece3.1953

Klinger, C. K., Lau, J. A., & Heath, K. D. (2016). Ecological genomics of mutualism decline in nitrogen-fixing bacteria. Proceedings of the Royal Society B-Biological Sciences, 283(1826), 20152563. http://doi.org/10.1098/rspb.2015.2563

Lau JA, Hammond MD, Schmidt J, Weese DJ, Yang WH, Heath KD. Contemporary evolution influences soil nitrogen availability in experimental mesocosms*. In review at the time of this submission.*

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**Abstract:**

**Premise of the study:** Nutrients, light, water, and temperature are key factors limiting the growth of individual plants in nature. Mutualistic interactions between plants and microbes often mediate resource limitation for both partners. In the mutualism between legumes and rhizobia, plants provide rhizobia with carbon in exchange for fixed nitrogen.

Because partner quality in mutualisms is genotype-dependent, within-species genetic variation is expected to alter the responses of mutualists to changes in the resource environment. Here we ask whether partner quality variation in rhizobia mediates the response of host plants to changing light availability, and conversely, whether light alters the expression of partner quality variation.

**Methods:** We inoculated clover hosts with 11 rhizobium strains that differed in partner quality, grew plants under either ambient or low light conditions in the greenhouse, and measured plant growth, nodule traits, and foliar nutrient composition.

**Key results:** Light availability and rhizobium inocula interactively determined plant growth, and rhizobium partner quality variation was more apparent in ambient light.

**Conclusions:** Our results suggest that variation in the costs and benefits of rhizobium symbionts mediate host responses to light availability, and that rhizobium variation might more important in higher-light environments. Our work adds to a growing appreciation for the role of microbial intraspecific and interspecific diversity in mediating extended phenotypes in their hosts and suggests an important role for light availability in the ecology and evolution of legume-rhizobium symbiosis.

**Interpretation of Columns in Dataset (from left to right):**

|  |  |
| --- | --- |
| **Pot Number** | Experimental unit (tag number and pot order from greenhouse) |
| **Inoculated** | Y = inoculated with Rhizobium; N = not inoculated |
| **Strain** | Genotype of *Rhizobium leguminosarum* |
| **FertHistory** | C = strain was previously isolated from control plot at Kellogg Biological Station (KBS); N = strain was isolated from N fertilized plot at KBS |
| **Fieldplot** | KBS field plot; X = uninoculated plants |
| **Light** | uncovered ambient light versus shadecloth treatment in the greenhouse |
| **Block** | Greenhouse bench |
| **Exclude** | Plants that died at the cotyledon stage were excluded from further analysis |
| **HarvestDate** | early versus normal harvest date (see paper for full methods) |
| **Leaflets** | Number of leaflets (leaves are trifoliate) at week 7 |
| **Rootmass** | Mass of dried root system (g) |
| **Shootmass** | Mass of dried shoot (g) |
| **Nodules** | Total number of nodules on the root system |
| **Noduleweight** | Average per-nodule weight (mg) based on sample of ten nodules for each plant |
| **Biomass** | Rootmass + Shootmass |
| **BiomassPerNod** | Biomass divided by nodules |
| **delta15N** | Foliar tissue δ15N |
| **delta13C** | Foliar tissue δ13C |
| **wtpercentN** | Foliar tissue percent nitrogen on a dry weight basis |
| **wtpercentC** | Foliar tissue percent carbon on a dry weight basis |
| **Cnratio** | wtpercentN divided by wtpercentC |