



Interactions at the edge

Soil microbial impacts on
plant species coexistence
in a fragmented tropical forest

Gaurav Kandlikar, Vinayak Saini, Meghna Krishnadas

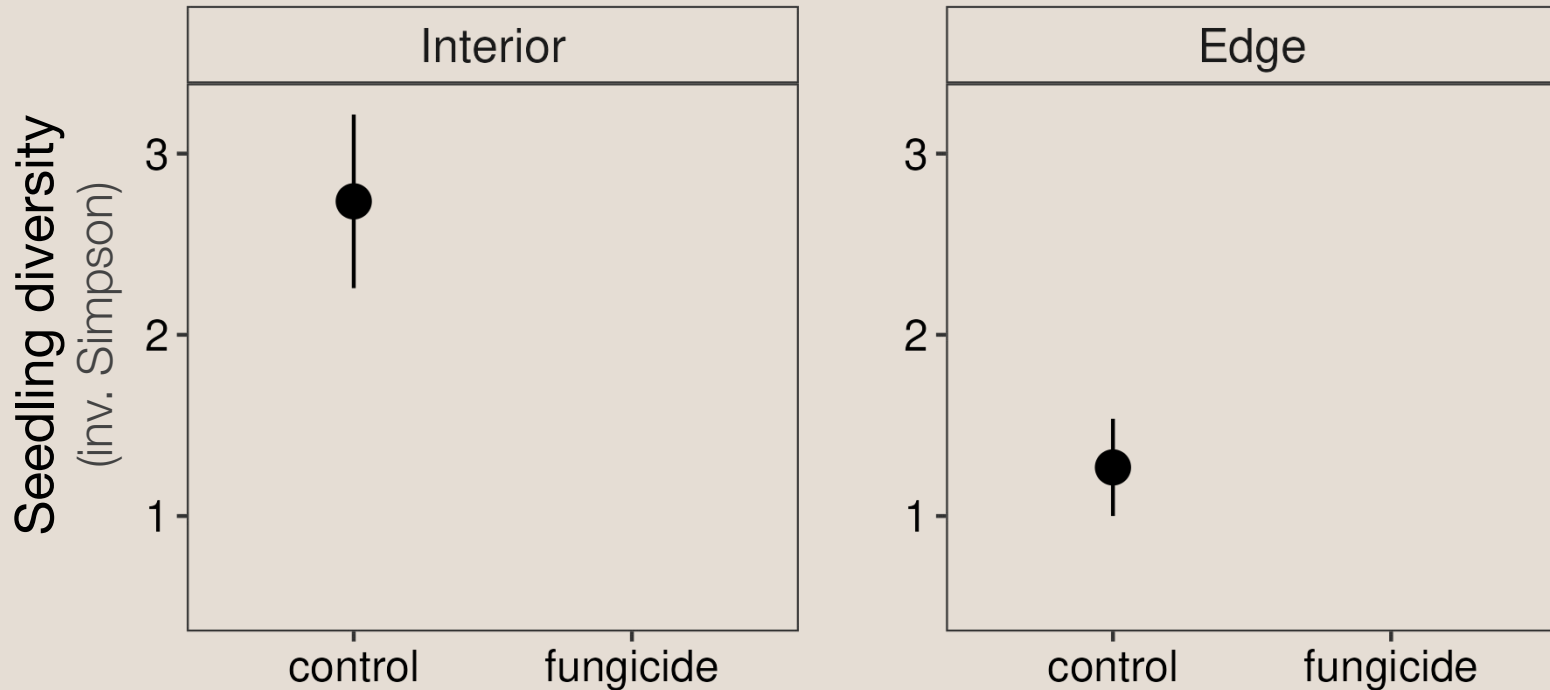


Hassan District, Karnataka, India
Image from Google Earth



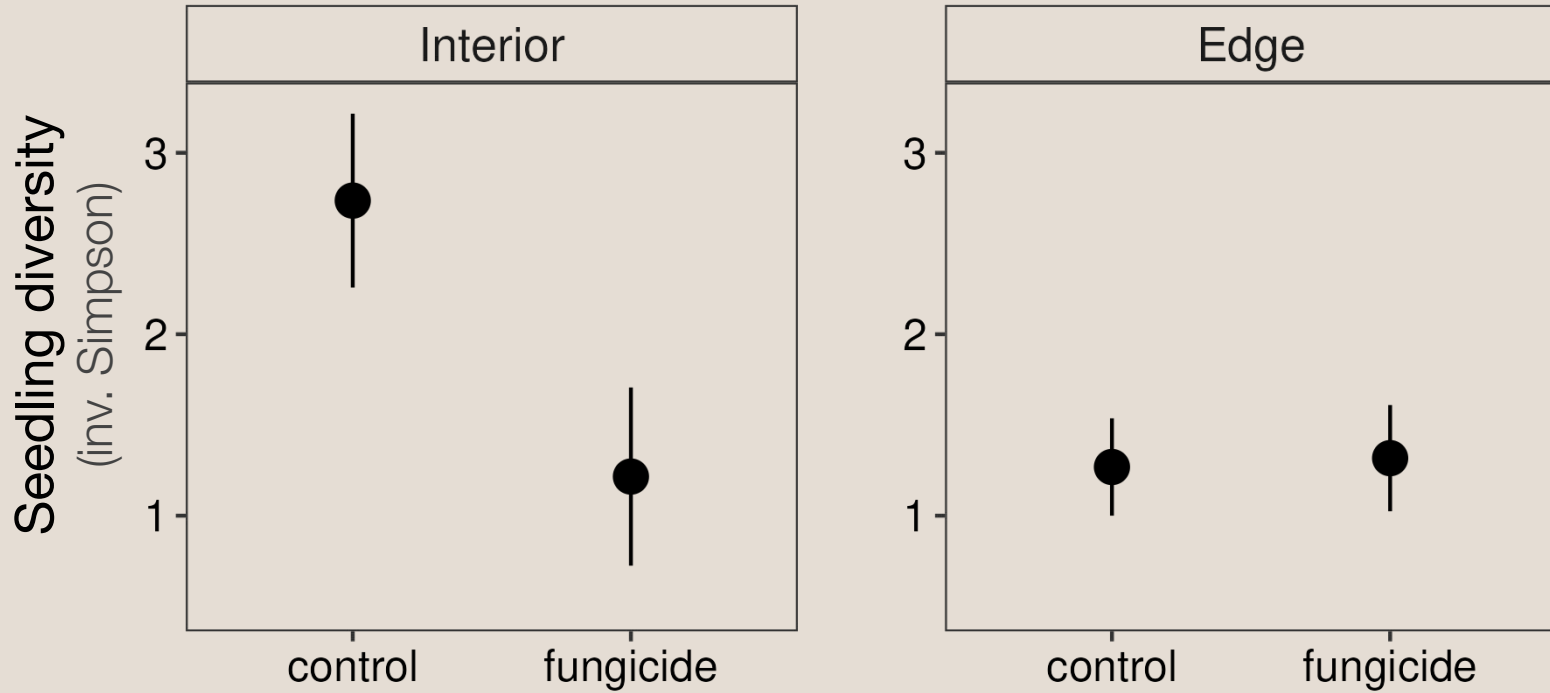
Hassan District, Karnataka, India
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Past result: Fungi promote seedling diversity in the forest interior, but not at edges



Data from Krishnadas et al. 2018, Nat. Comm.

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Question: Do abiotic conditions at fragment edges weaken microbially-mediated plant coexistence?

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Approach: Plant-soil feedback experiment under high/low **light** and **water** levels.

Experimental approach

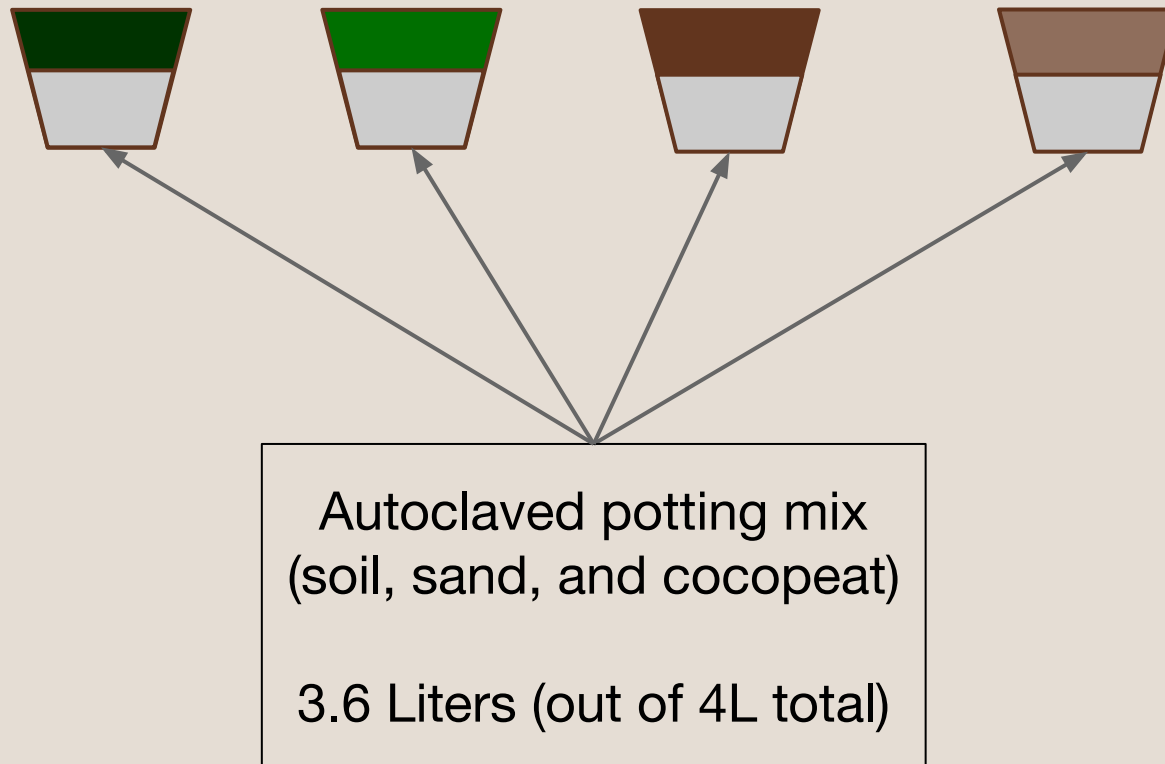
*Litsea
floribunda*



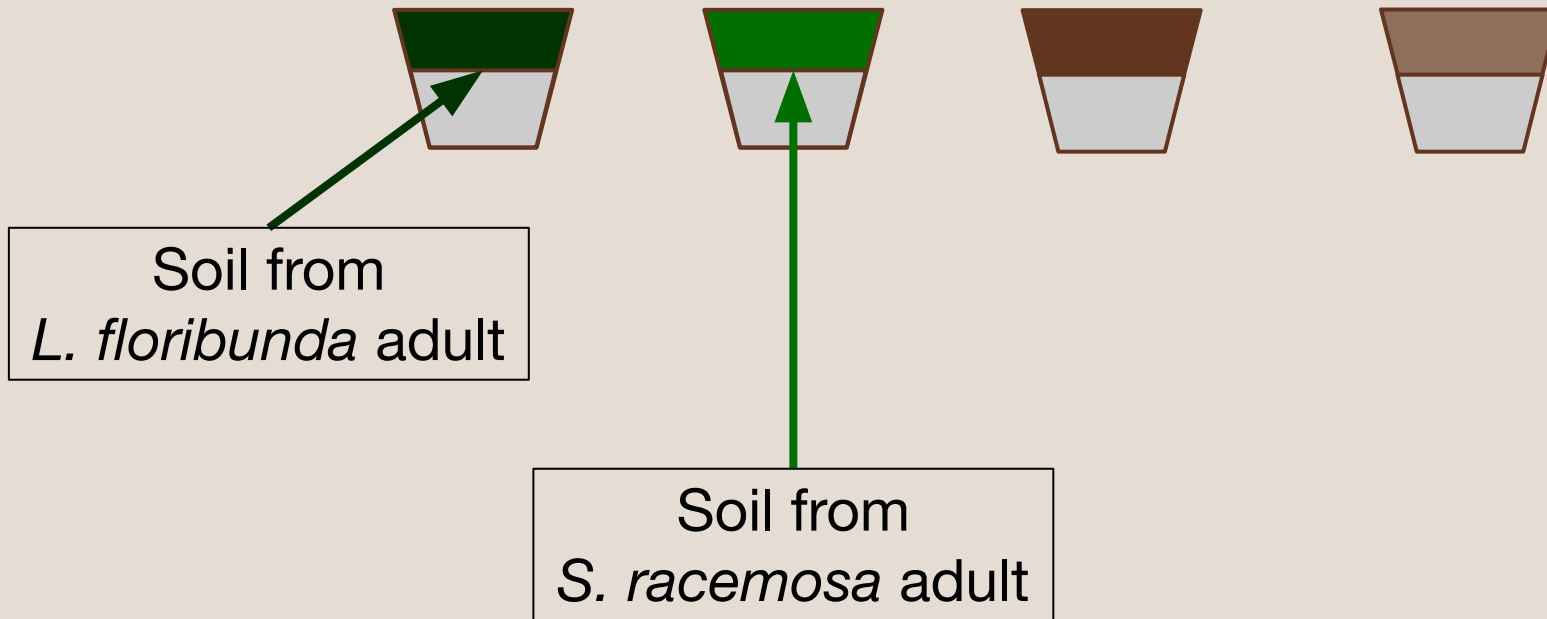
*Symplocos
racemosa*



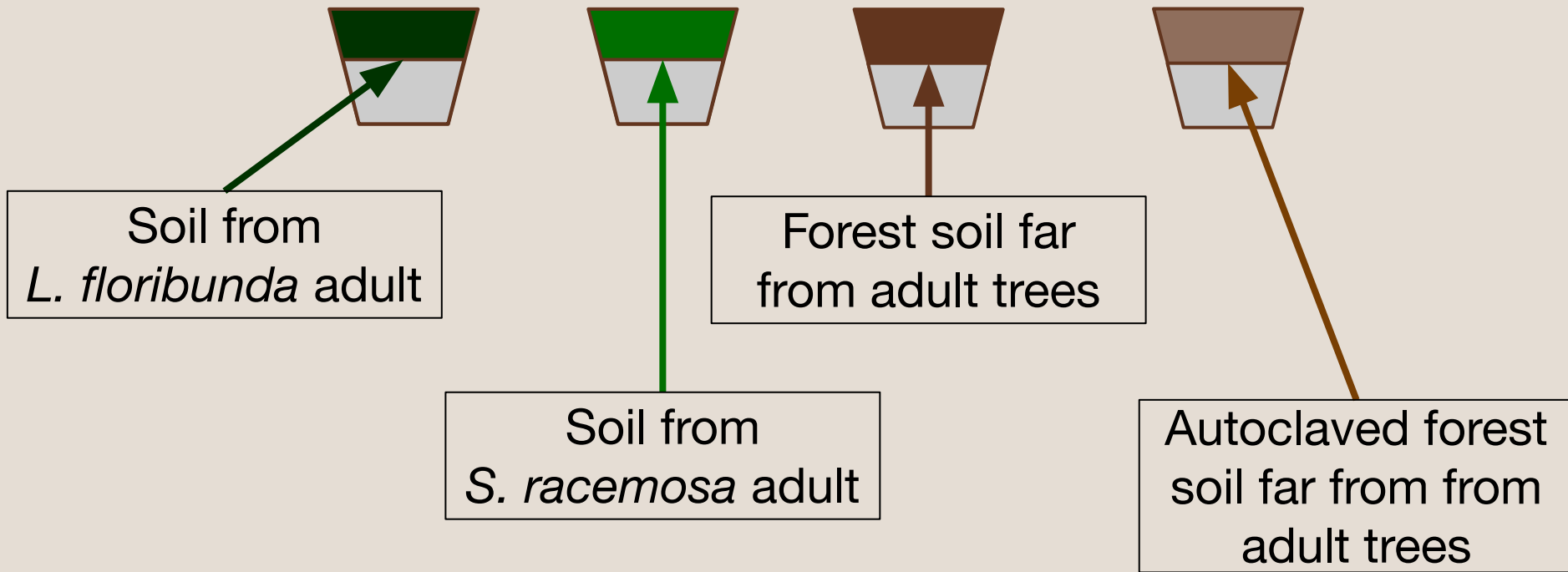
Experimental approach



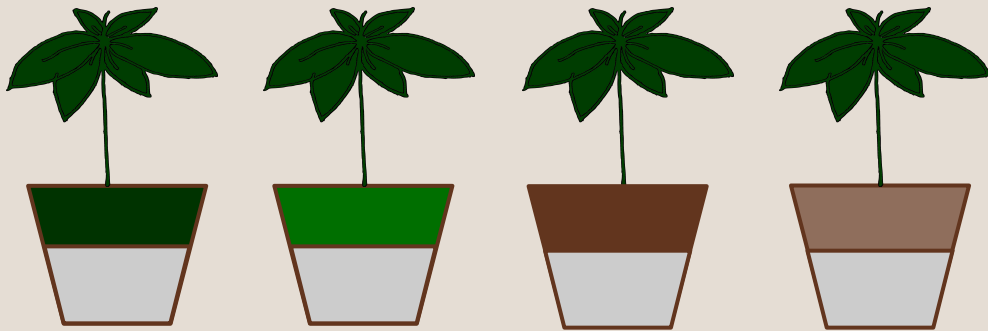
Experimental approach



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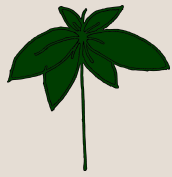
Experimental approach



All combinations
grown in four
environments
(High/Low water *
High/Low light),

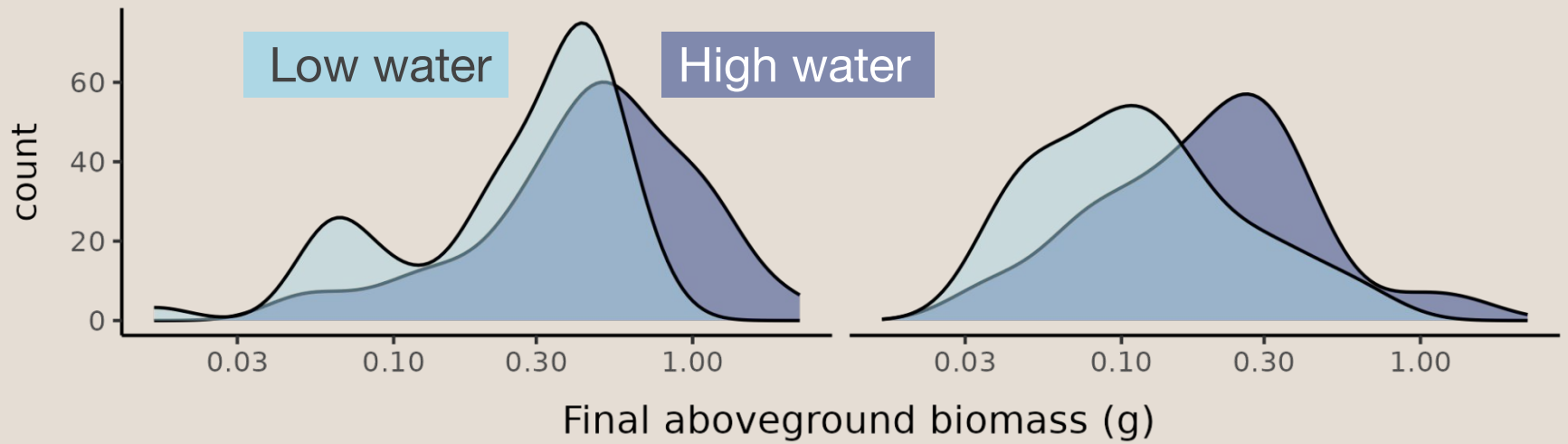
Replicated across
six blocks

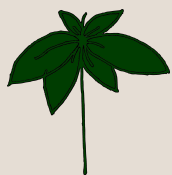
= 192 seedlings



L. floribunda

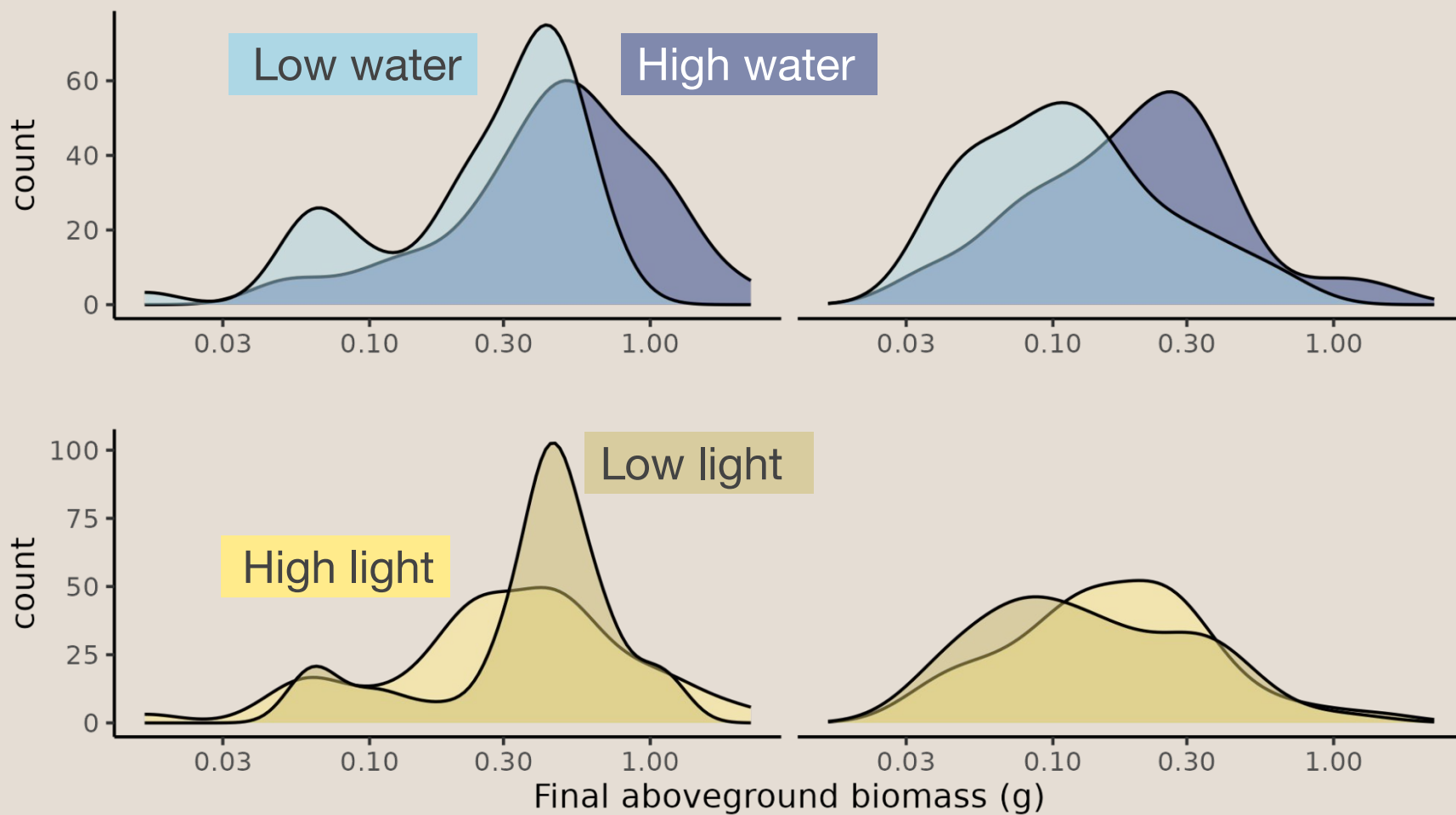
S. racemosa





L. floribunda

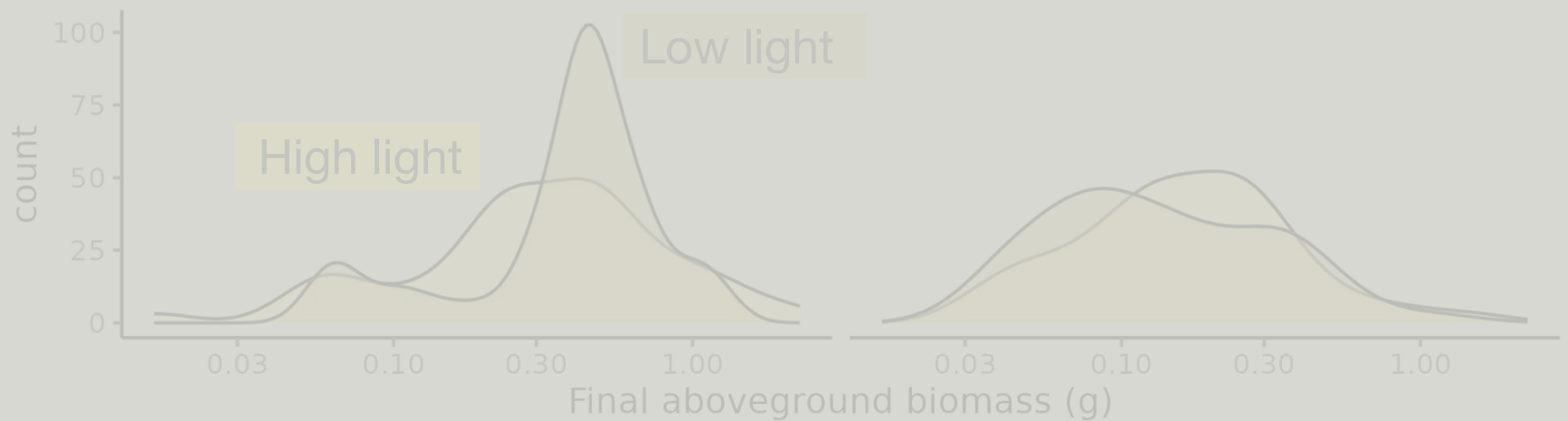
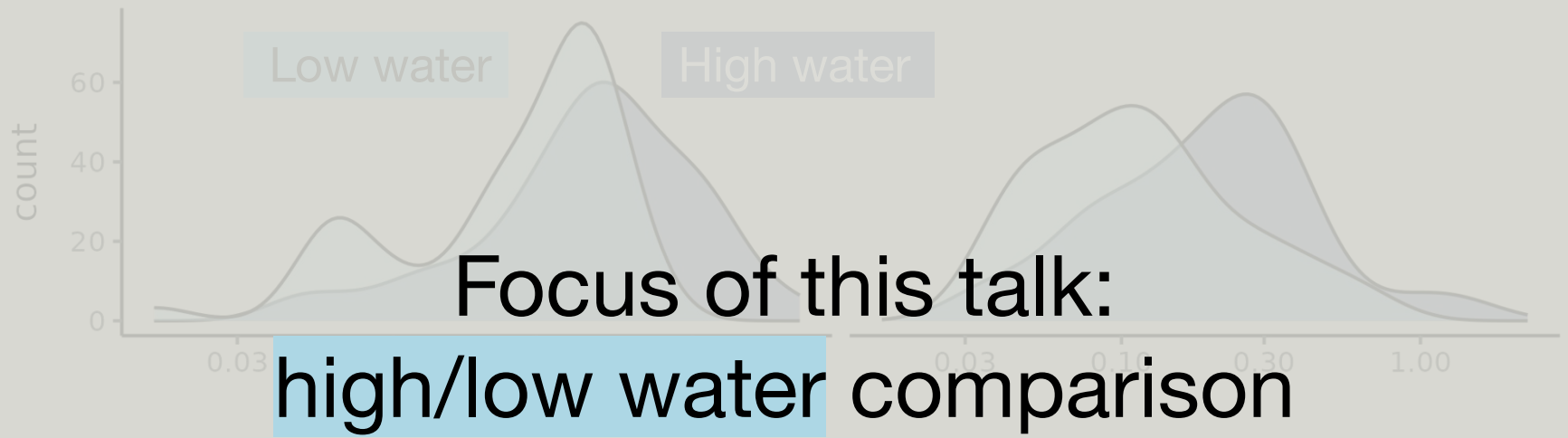
S. racemosa





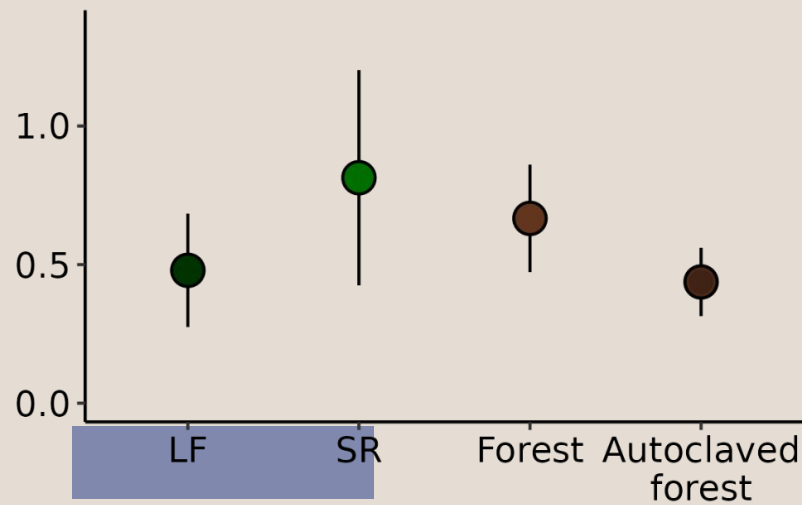
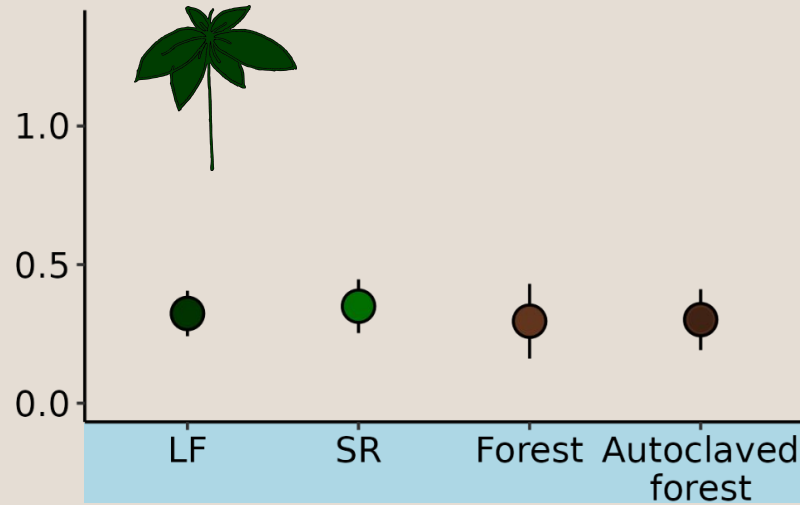
L. floribunda

S. racemosa



L. floribunda.

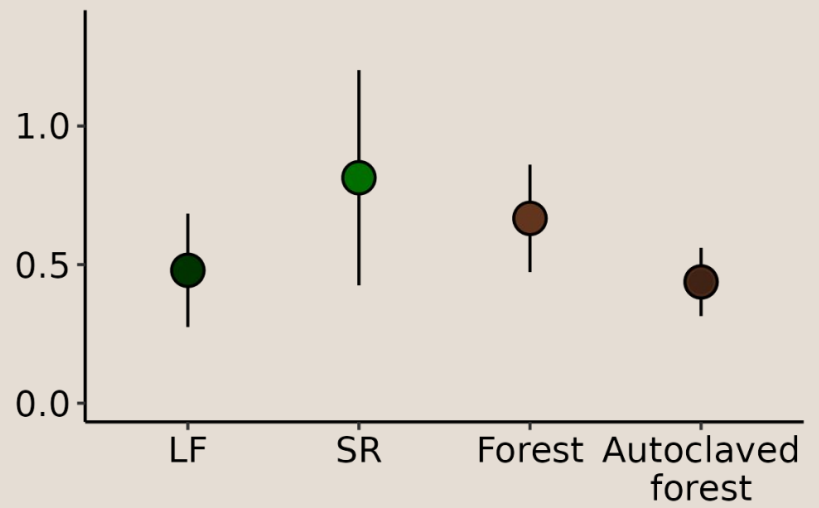
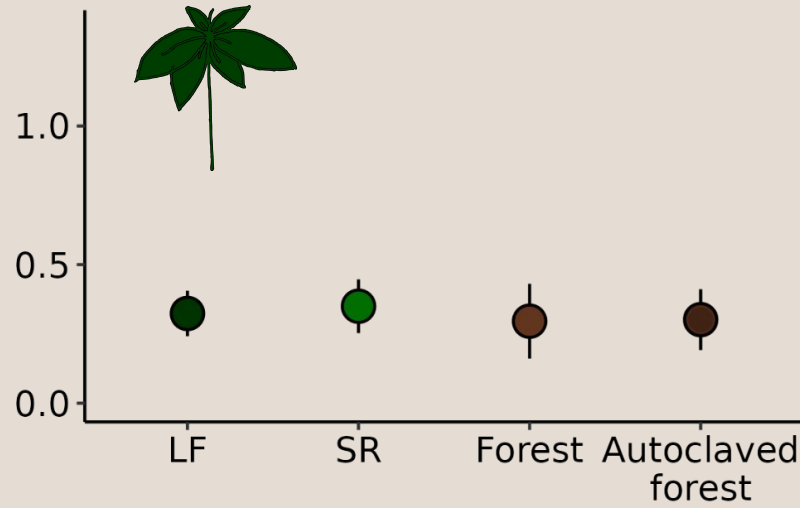
agb (g)



mean \pm SEM

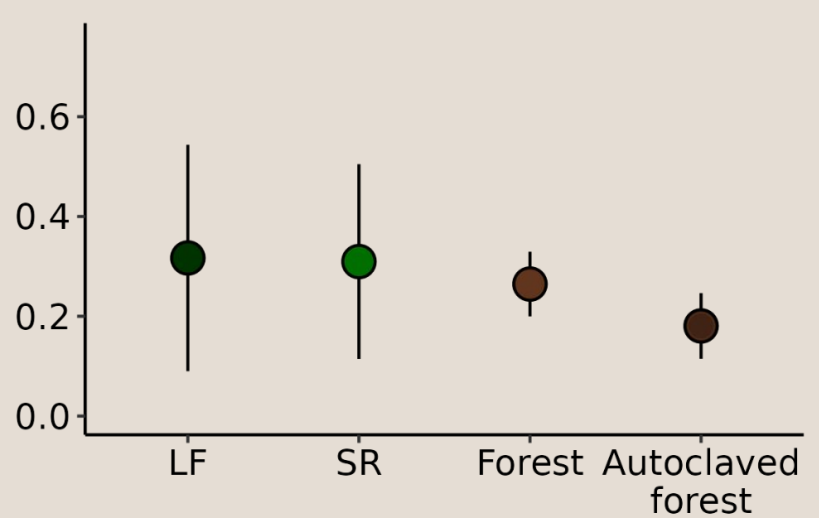
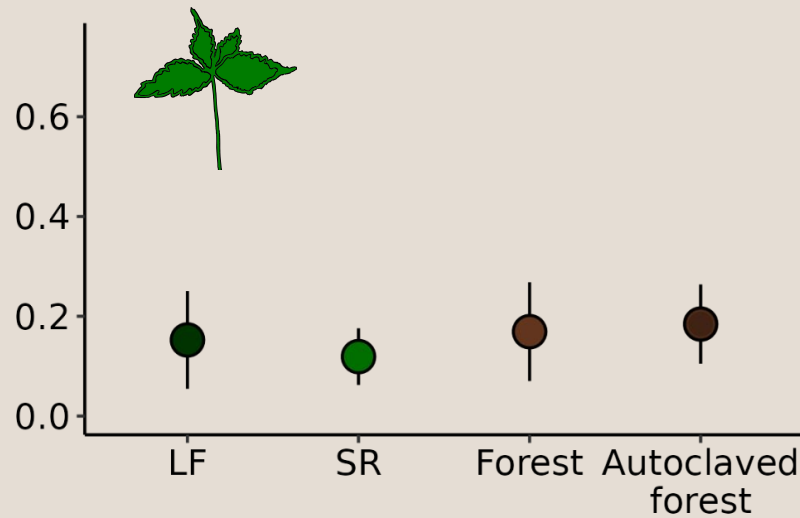
L. floribunda.

agb (g)



S. racemosa

agb (g)



mean \pm SEM

Analysis approach

Analysis approach

1. Compare biomass in cultivated soils vs. biomass in forest reference soil to quantify effects of microbial conditioning

$$m_{ij} = \log \left(\frac{\text{Biomass of species } i \text{ in species } j\text{'s soil}}{\text{Biomass of species } i \text{ in forest soil}} \right)$$

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2. Quantify strength of microbially mediated stabilization and fitness differences to infer microbially mediated coexistence outcomes

Analysis approach

Stabilization: difference between intra-specific and inter-specific microbial effects:

$$\text{Stabilization} = - \frac{1}{2} [(m_{SS} + m_{LL}) - (m_{SL} + m_{LS})]$$

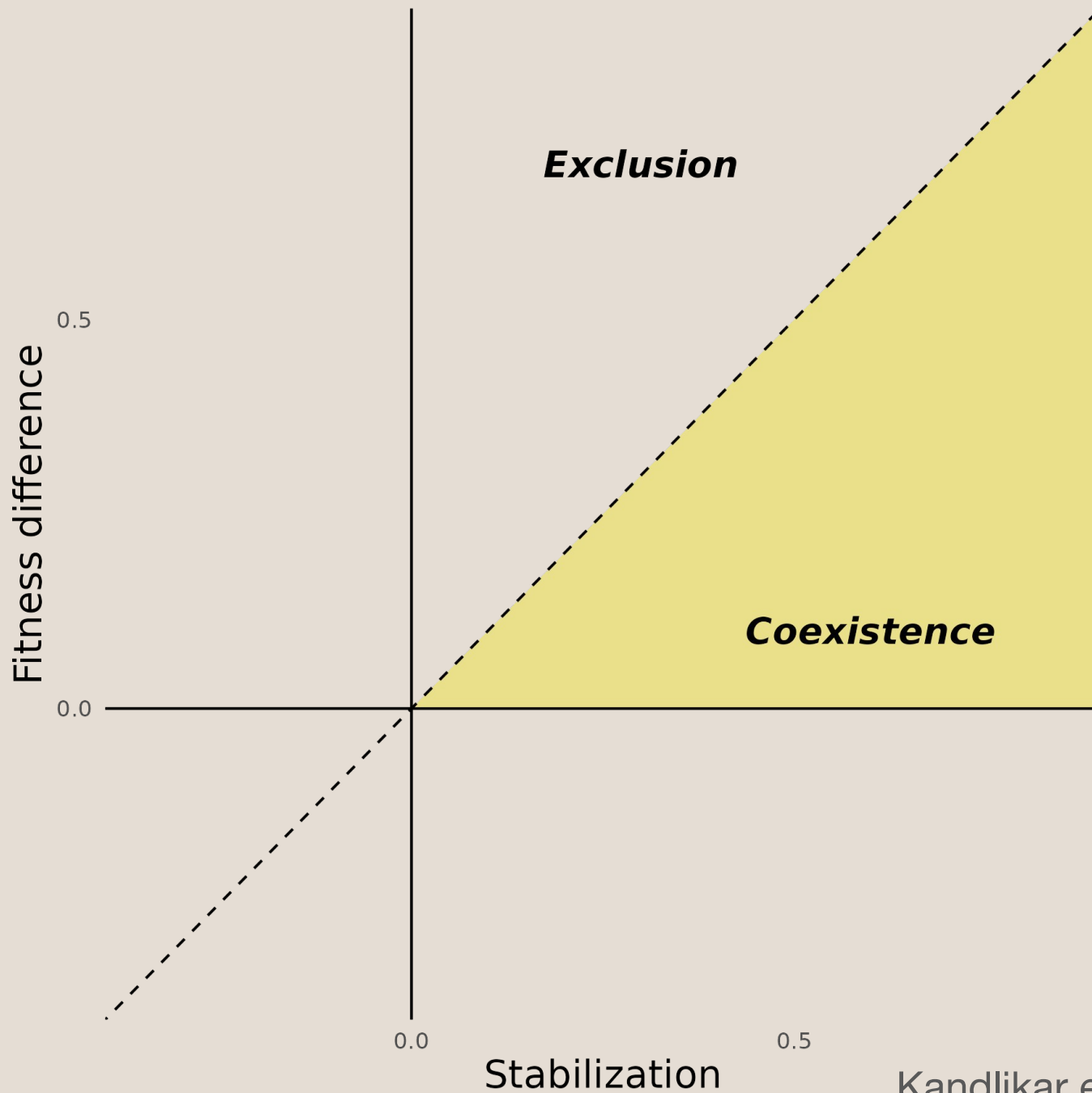
Analysis approach

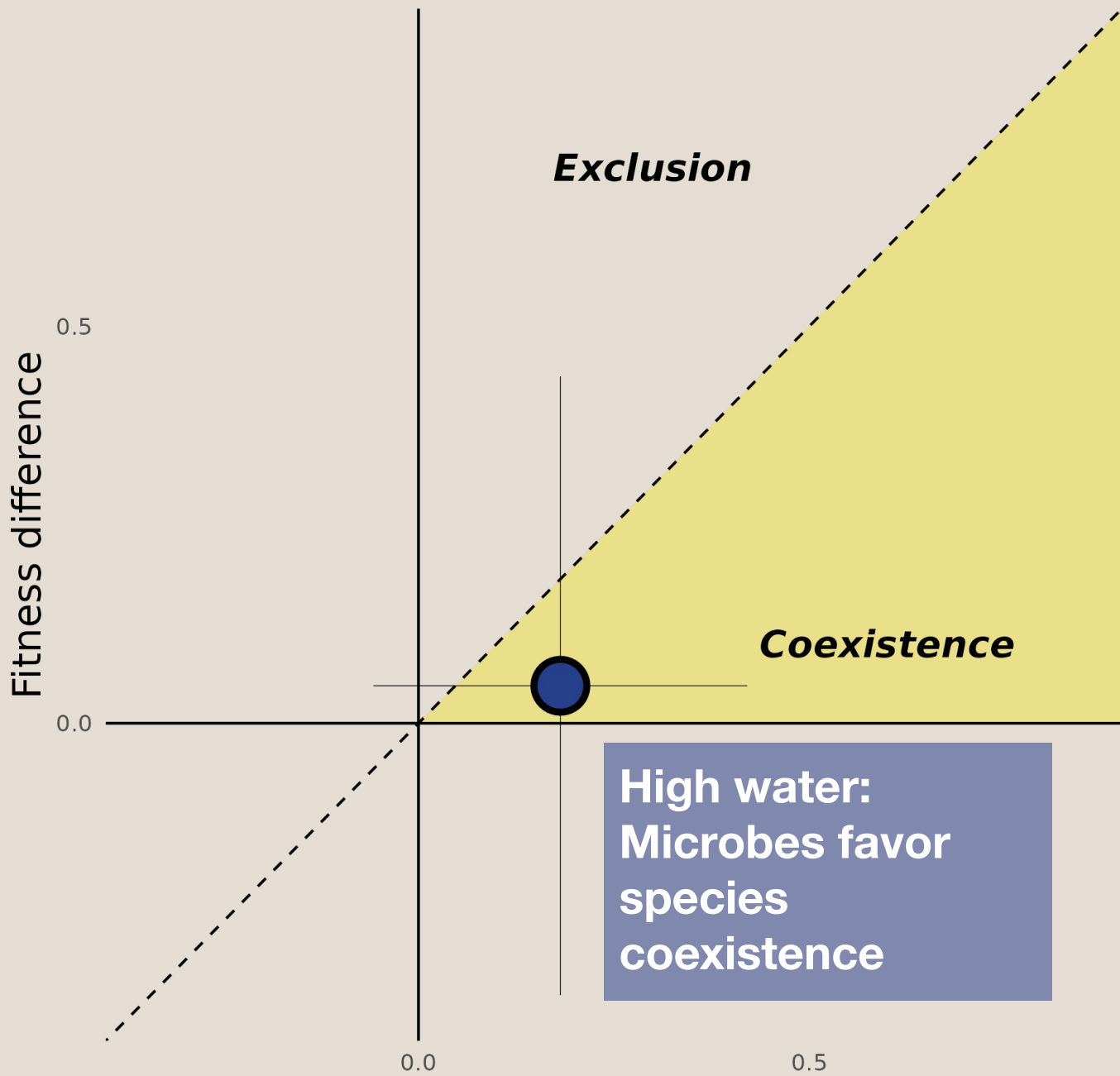
Stabilization: difference between intra-specific and inter-specific microbial effects:

$$\text{Stabilization} = -\frac{1}{2} [(m_{SS} + m_{LL}) - (m_{SL} + m_{LS})]$$

Fitness difference (FD): difference between total microbial effects on species i and species j

$$\text{FD} = \frac{1}{2} [(m_{SS} + m_{SL}) - (m_{LL} + m_{LS})]$$





Exclusion

Coexistence

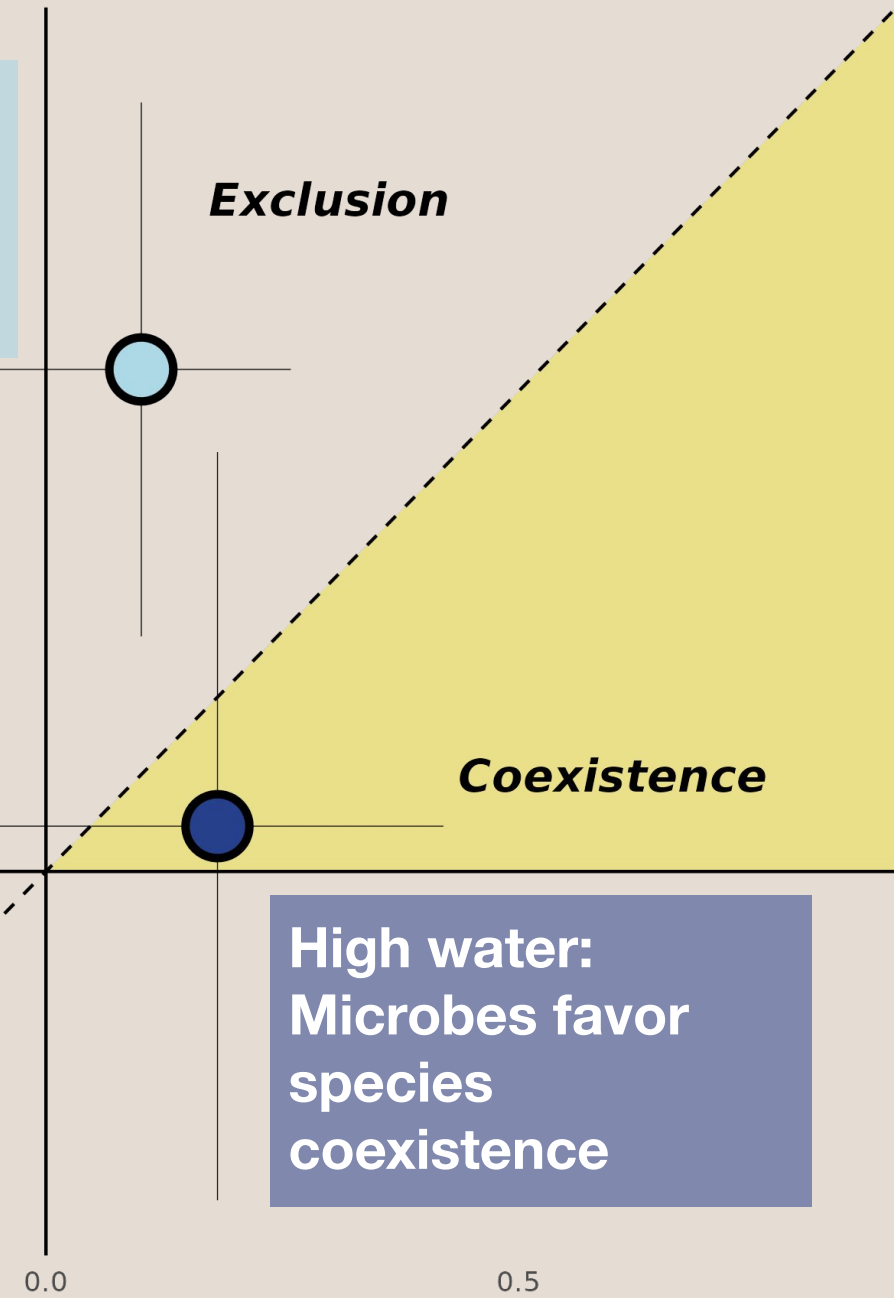
**High water:
Microbes favor
species
coexistence**

Stabilization

preliminary results

**Low water:
Microbes promote
dominance of
*L. floribunda***

Fitness difference
0.5
0.0



Exclusion

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0.0 0.5

Stabilization

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Fitness difference
0.5
0.0

Exclusion

**Drought
exaggerates fitness
inequalities, but has
minimal effects on
stabilization.**

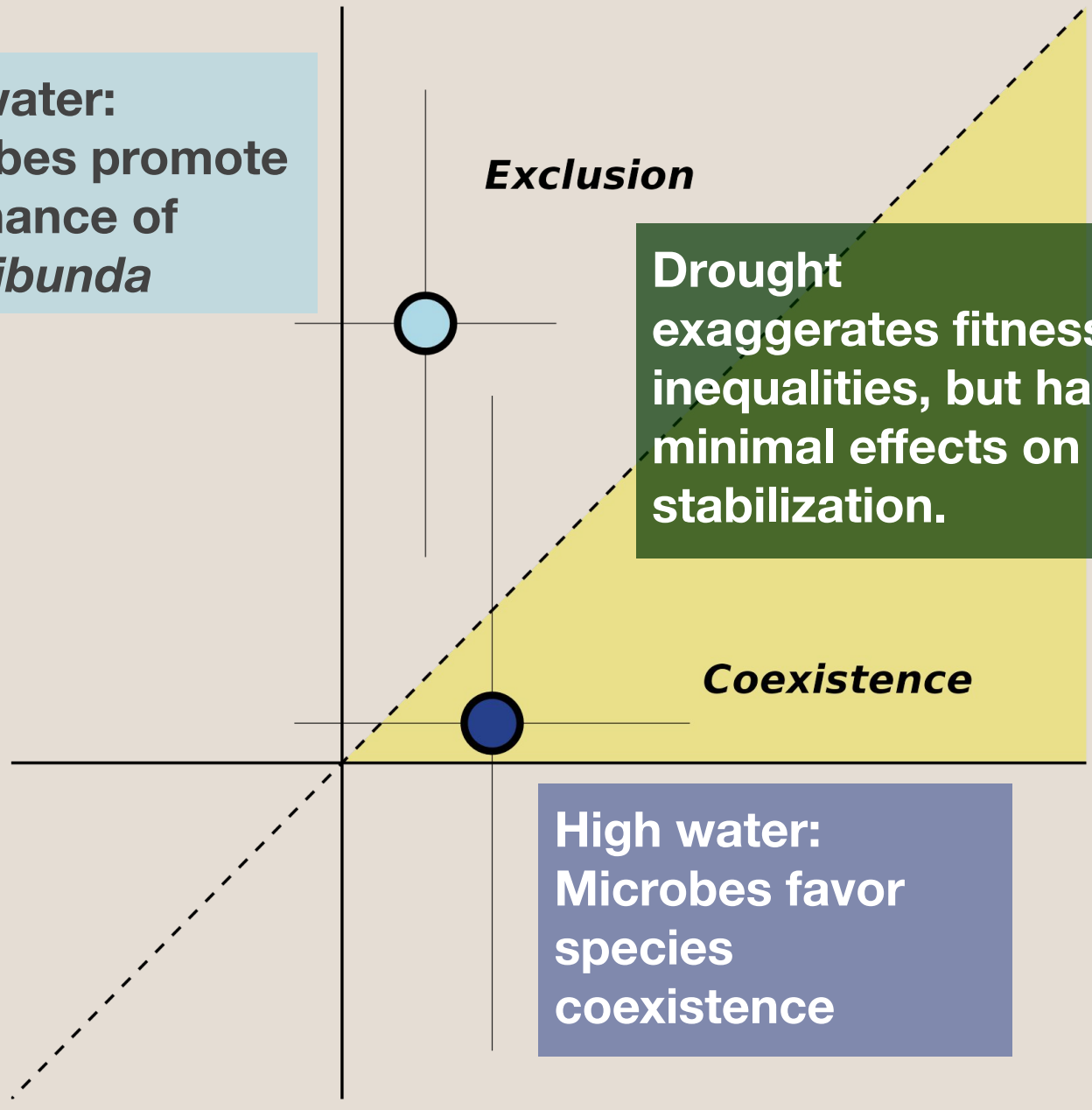
Coexistence

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0.0 0.5

Stabilization

preliminary results



Ongoing and future work

1. Root staining to evaluate mycorrhizal colonization in experimental treatments
2. Additional experiment to contextualize plant-microbe interactions relative to plant-plant competition.
3. DNA sequencing of rhizosphere soils from interior and edge environments

Take-home messages

The background of the slide is a vibrant, multi-colored mosaic. The mosaic consists of numerous small, irregular geometric shapes, primarily hexagons and pentagons, in shades of light blue, yellow, red, green, and purple. These shapes are separated by thin, light-colored grout lines. The overall effect is a complex, textured pattern that fills the entire frame.

Take-home messages

1. Shifts in microbially mediated fitness differences, rather than stabilization may underlie changes in coexistence outcomes

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2. Interactions between plants and soil microbes are highly variable across environments and are likely to be disrupted in fragmented landscapes

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1. Shifts in microbially mediated fitness differences, rather than stabilization may underlie changes in coexistence outcomes
2. Interactions between plants and soil microbes are highly variable across environments and are likely to be disrupted in fragmented landscapes
3. Habitat fragmentation can restructure forests by weakening the processes that maintain biodiversity

Acknowledgements

Institutional Affiliations

GK: Mizzou; Louisiana State University

VS and MK: LaConES, CCMB, India



Meghna
Krishnadas



Vinayak
Saini

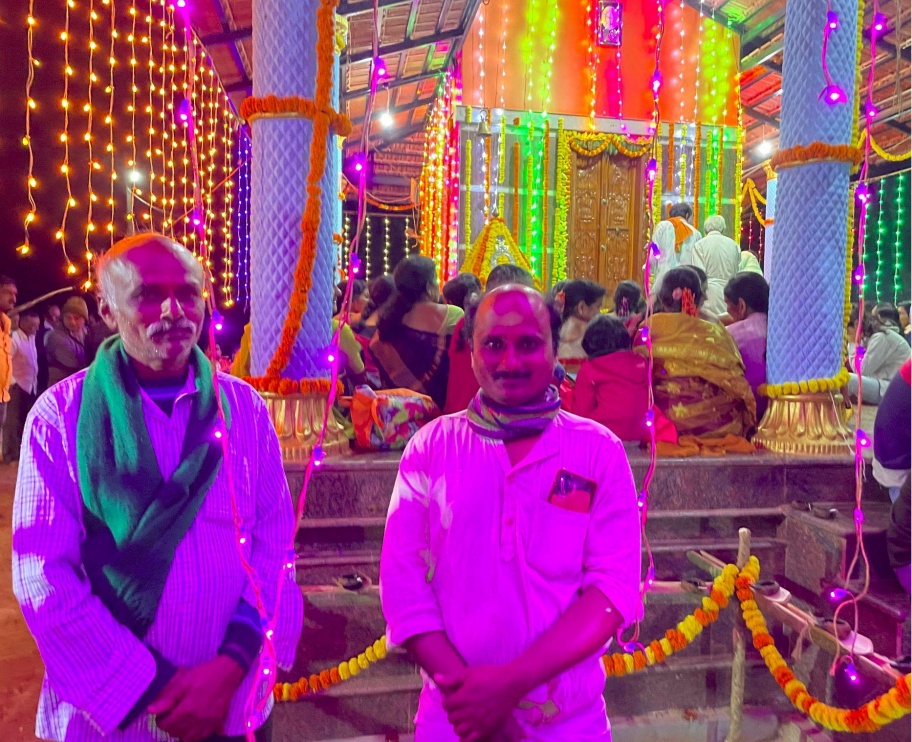
Funding

British Ecological Society; sDiv (Germany); University of Missouri
Division of Biological Sciences & Preparing Future Faculty postdoc
program; CSIR-India

Project discussions and assistance

Rishiddh Jhaveri, Angel Abraham, Ashish Nambiar, Shreya Riswadkar,
Souparna Chakrabarty, Chandrappa and Harish Gowda

Cover photo - Park Guell mosaics by [Raimond Klavins](#) on [Unsplash](#).



Work with me!

I am starting a new lab at Louisiana State University and am **recruiting graduate students and postdocs.**

Lab themes:

Plant community ecology

Plant-microbe interactions

Integrating experiments and theory

Pedagogy of ecology

Email me at gaurav.kandlikar@gmail.com!