EBERHARD KARLS
UNIVERSITÄT
TÜBINGEN

DECRyPT Workshop
Ecological Microbiome Studies
5-7 October, Tübingen

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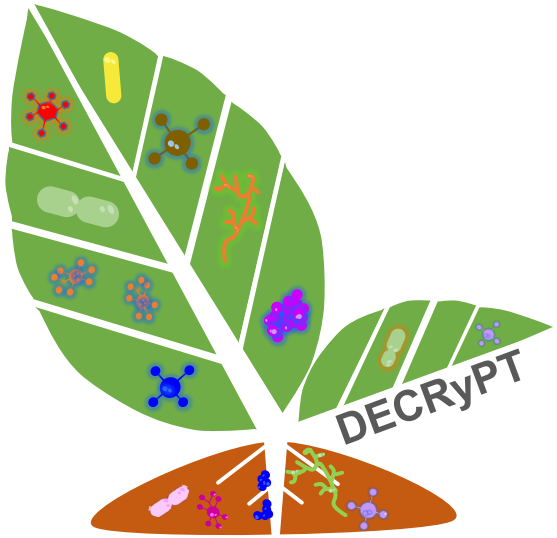
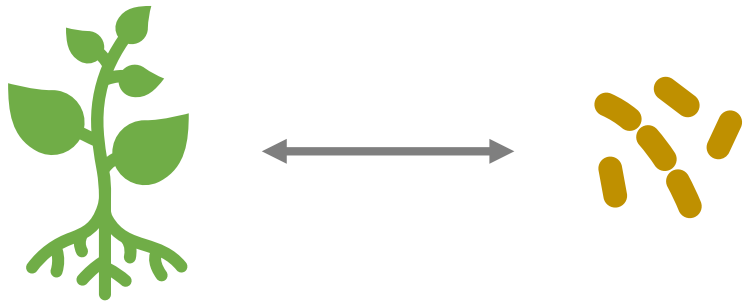
Madalin Parepa
Jun-Hee Jung
Oliver Bossdorf

DFG



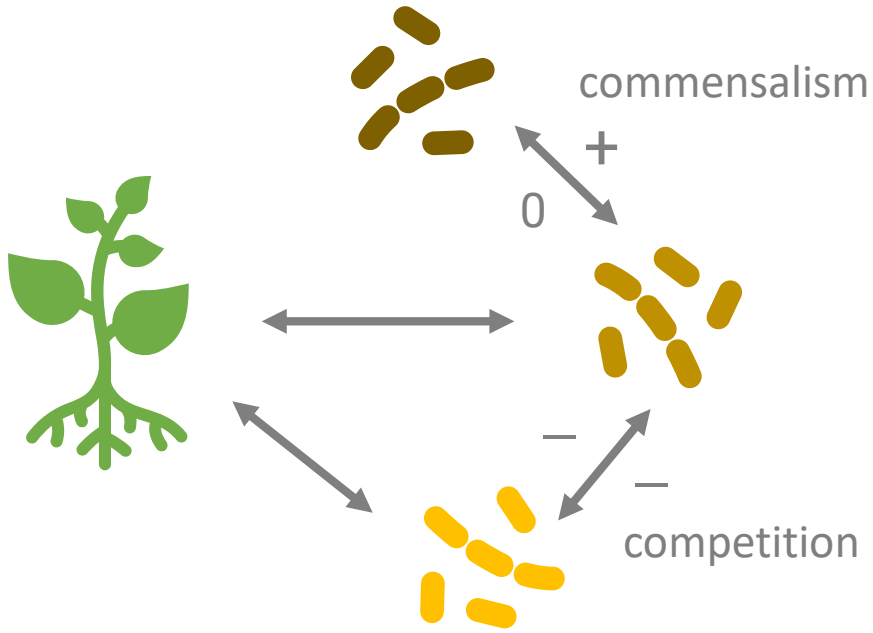
Ecological microbiome studies?

Ecology = Study of relationships between organisms and their environments

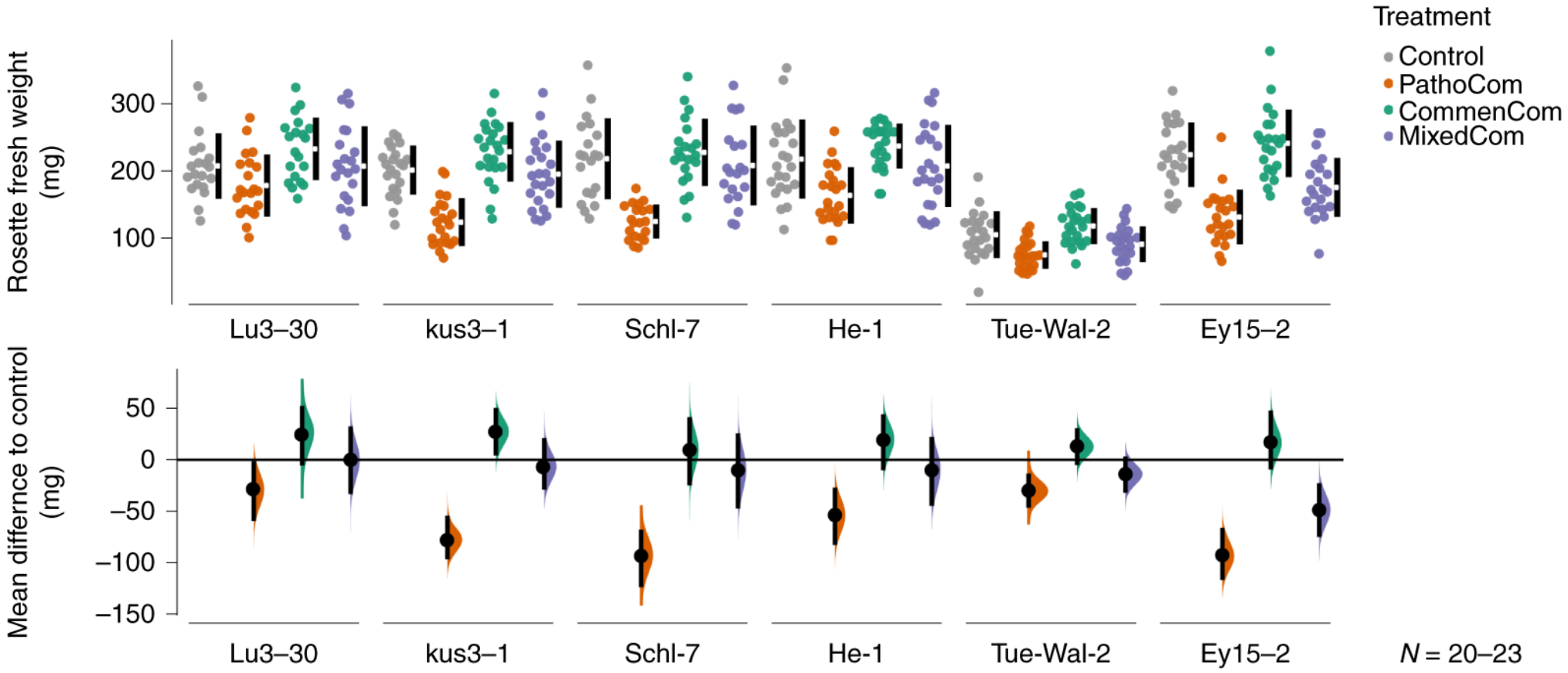


Microbe-microbe interactions

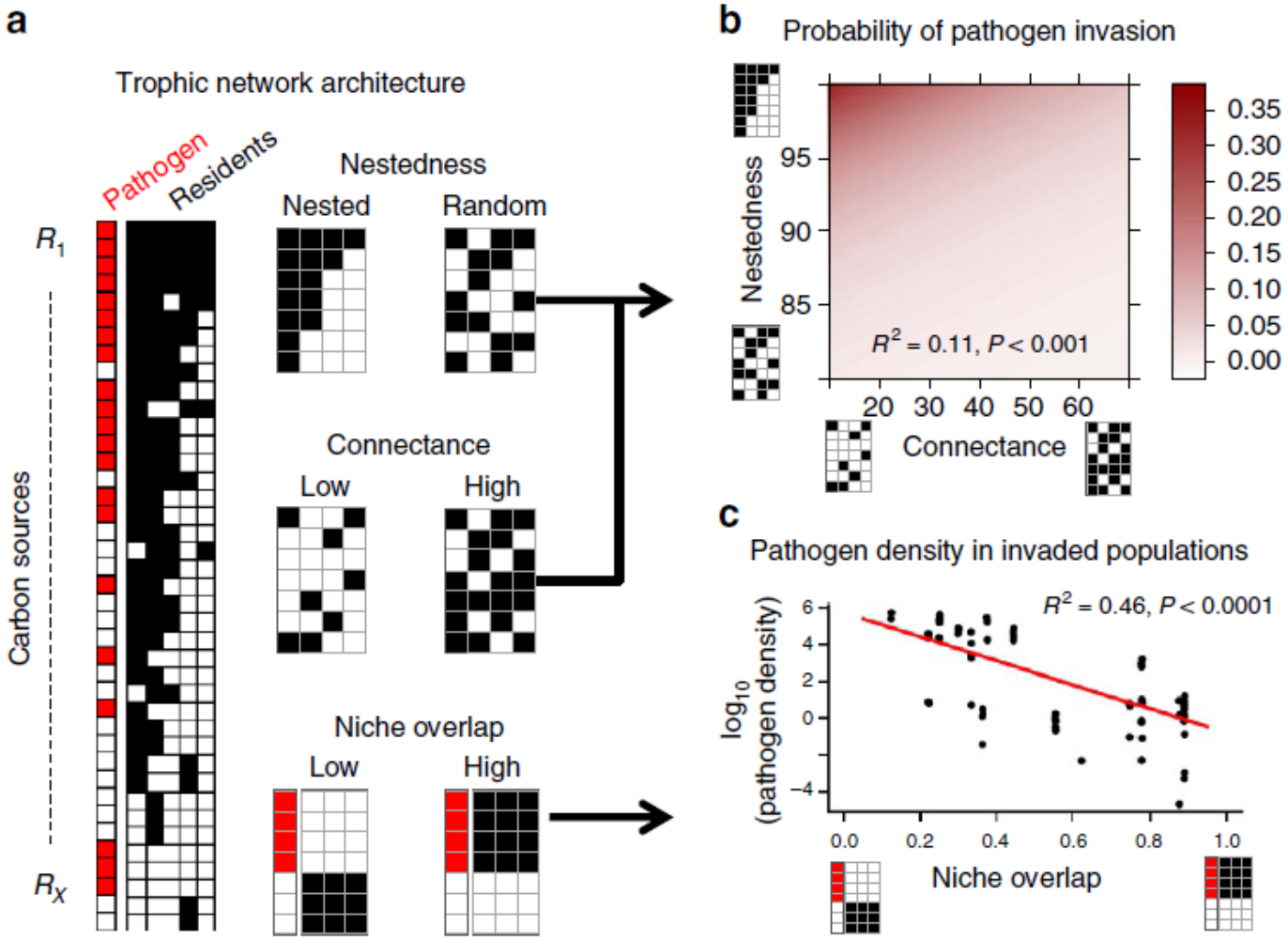
→ Direct and indirect effects of microbes on plants!



Commensal *Pseudomonas* strains protect *Arabidopsis* from pathogens

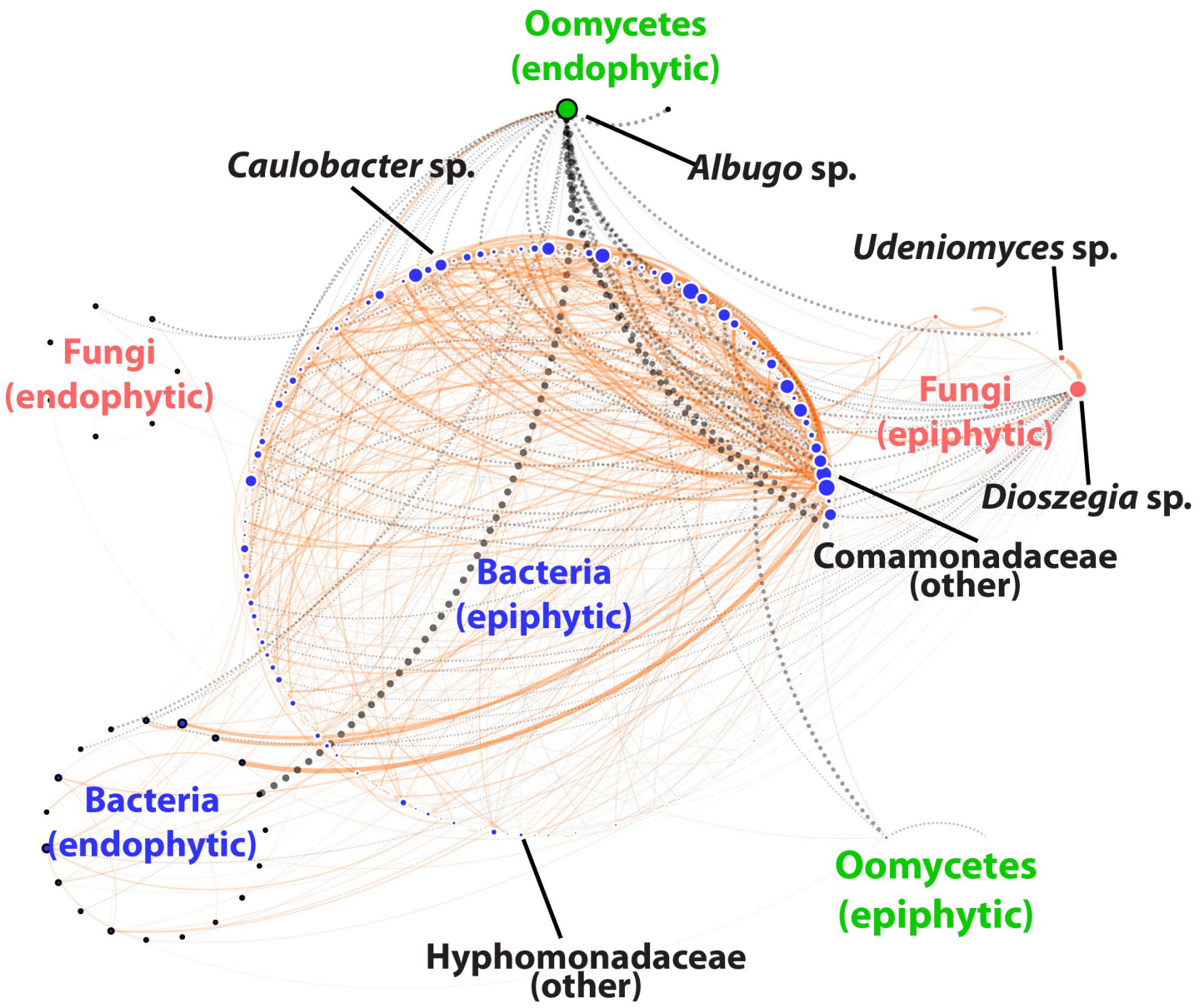


Shalev et al. (2022) *Nature Ecol Evol*



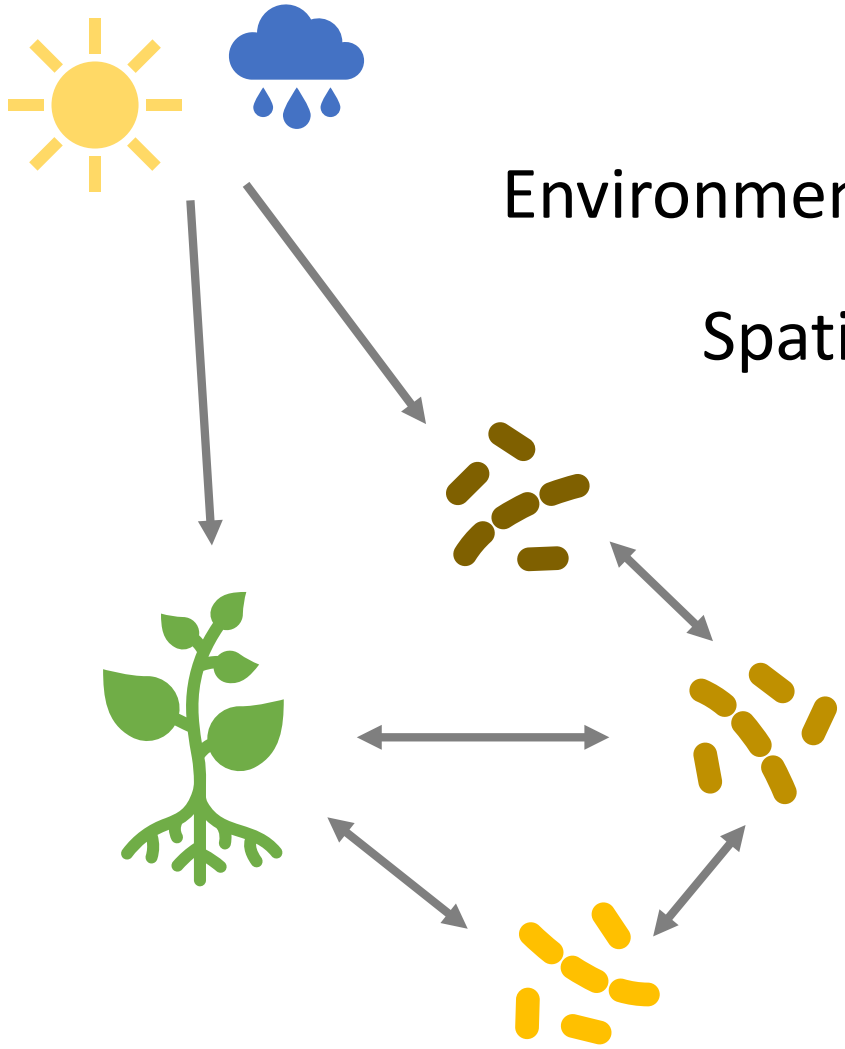
Bacterial community structure determines tomato pathogen resistance

Wei et al. (2015) *Nat Commun*



Network analyses try to understand microbe-microbe interactions from patterns of co-occurrence

Agler et al. (2016) *PLoS Biol*

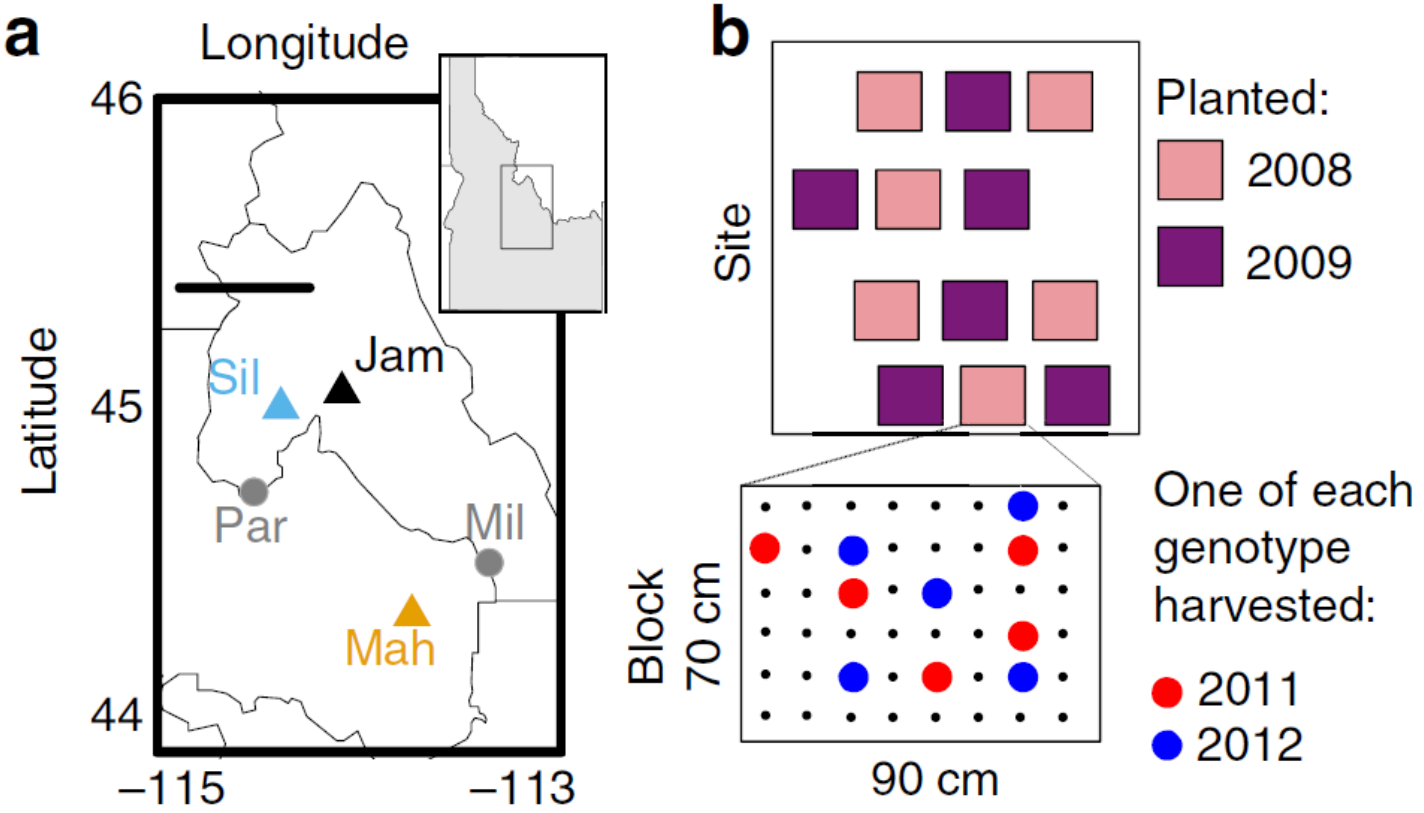


Environment affects plants and microbes

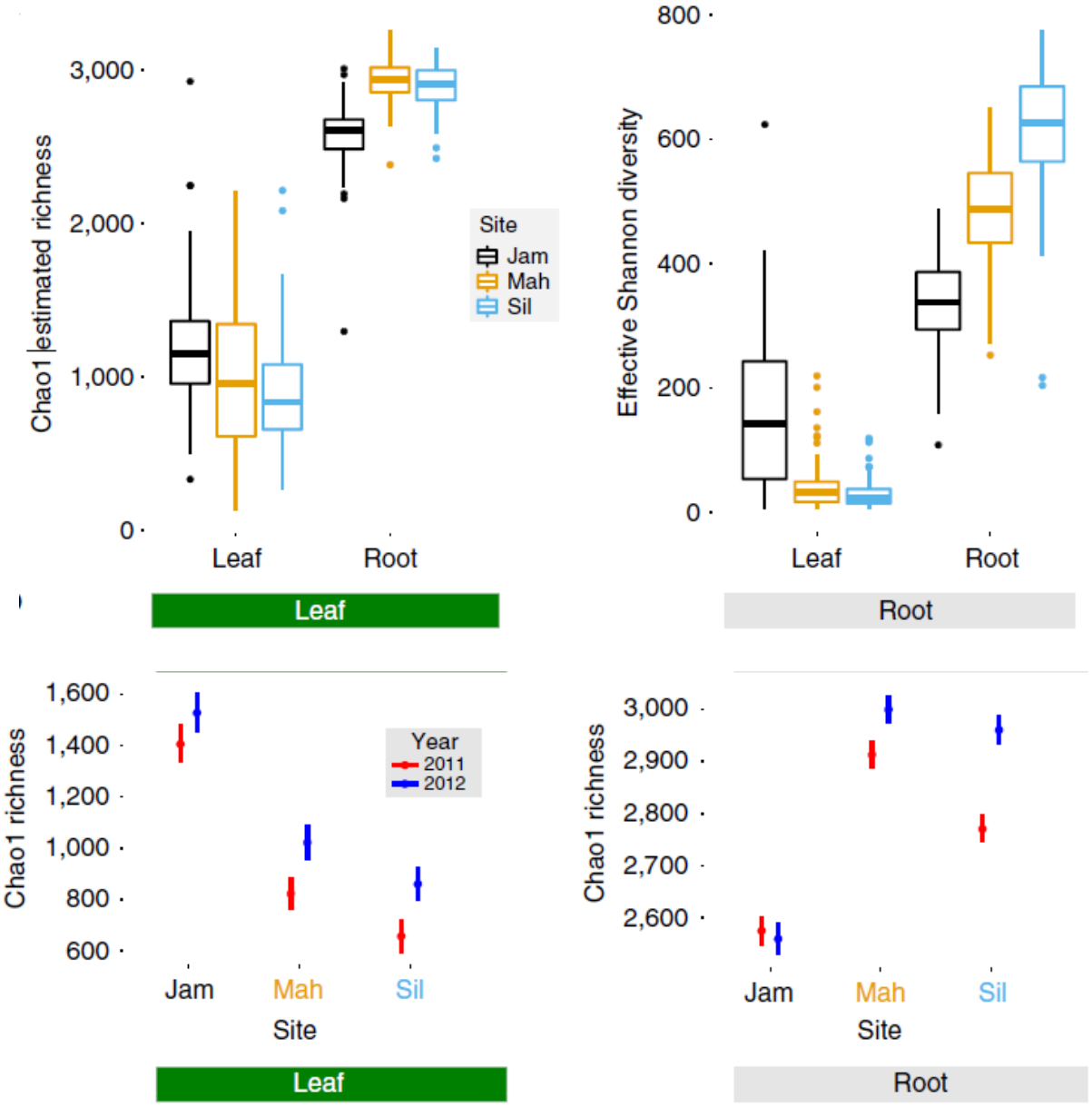
Spatial and temporal variation

Direct and indirect effects!

A multi-site field experiment to test environmental and host genotype effects on *Arabidopsis* microbiome



Wagner et al. (2015) *Nat Commun*

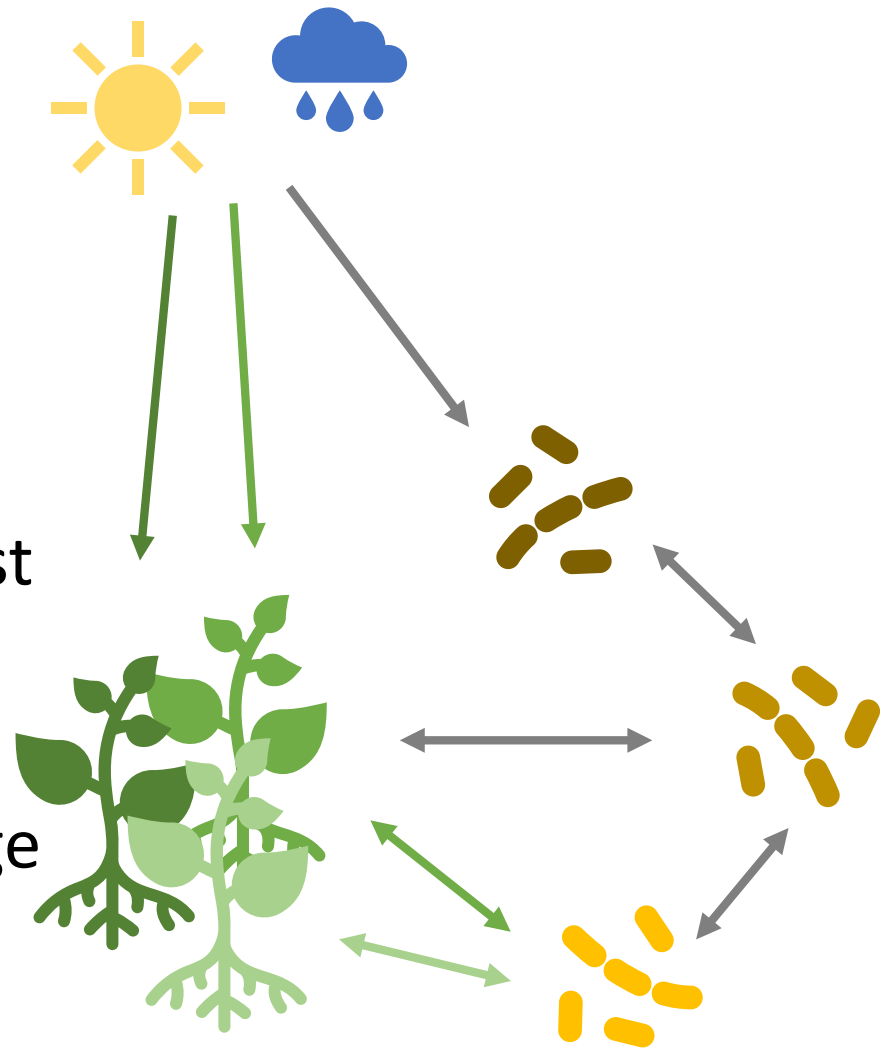


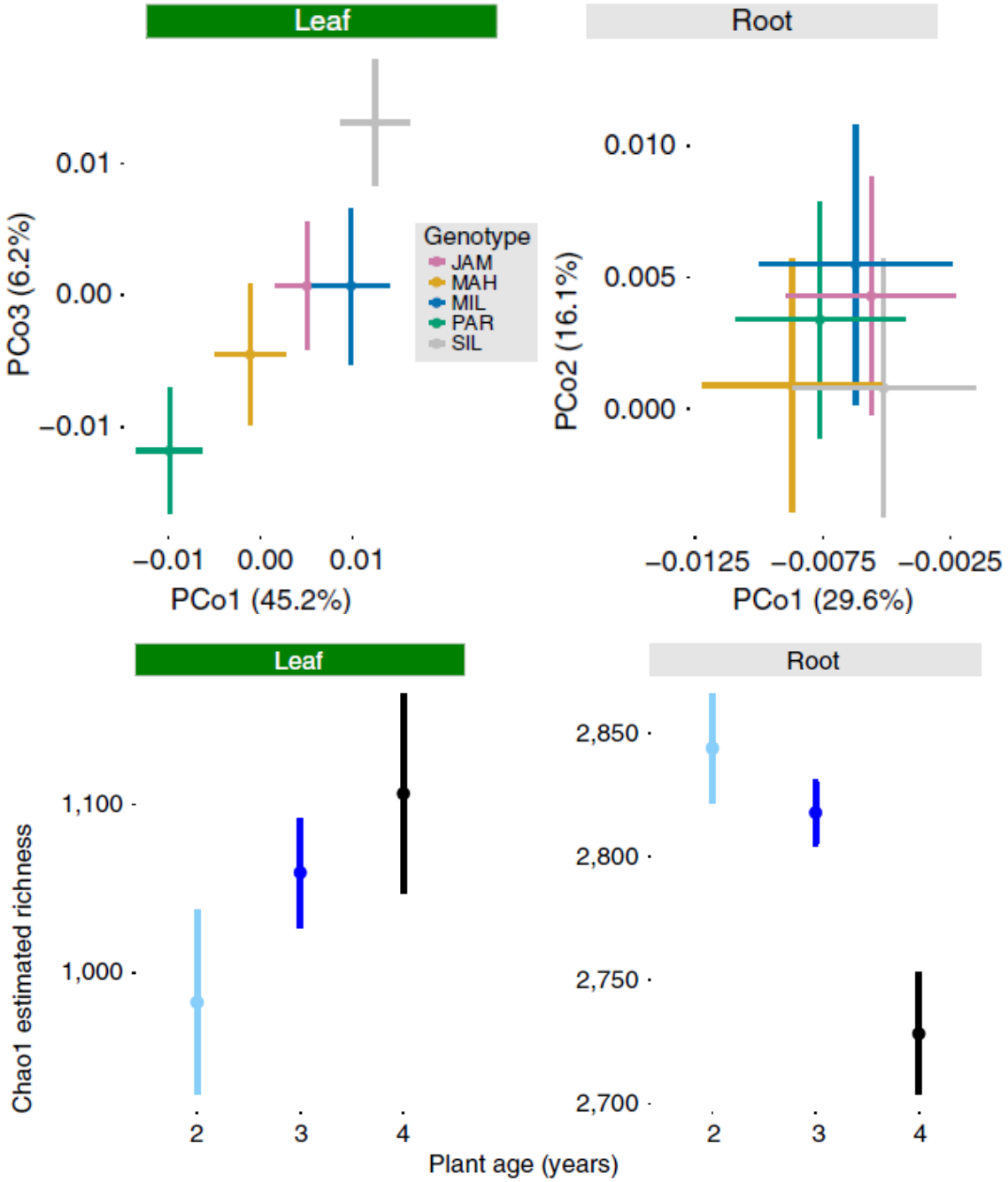
Differences in microbiome diversity and composition between sites and years!

Wagner et al. (2015) *Nat Commun*

Variation in plant host

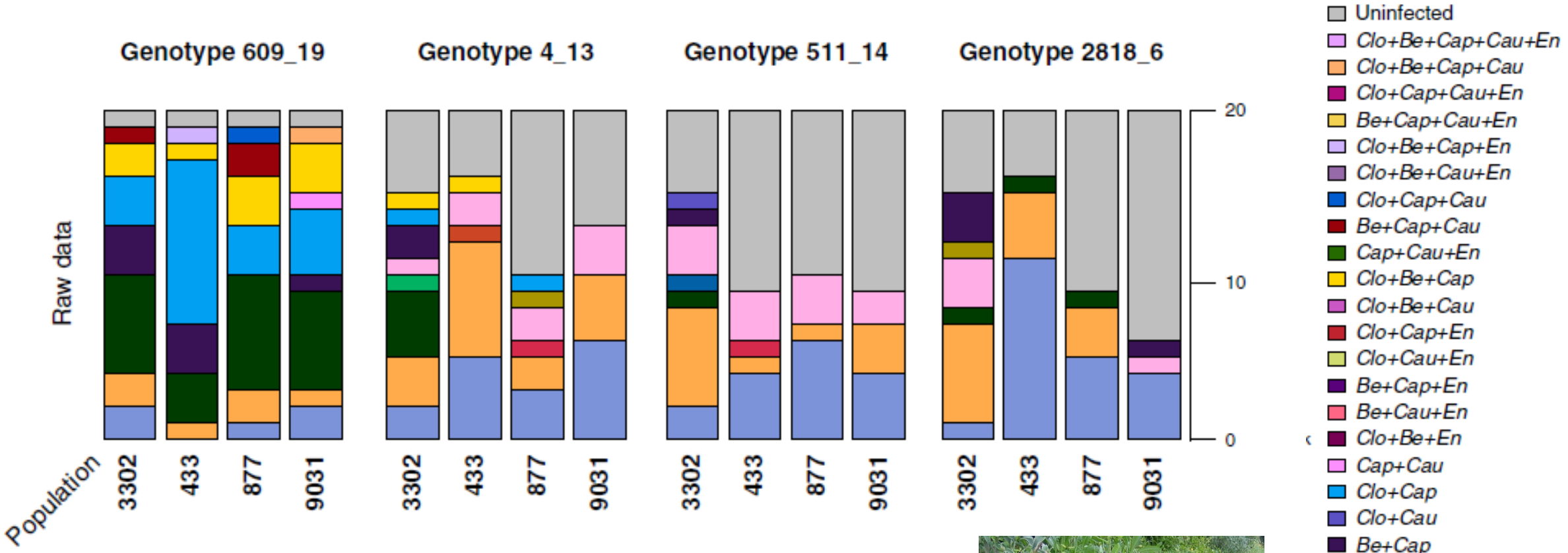
- genotype
- age
- developmental stage
- …





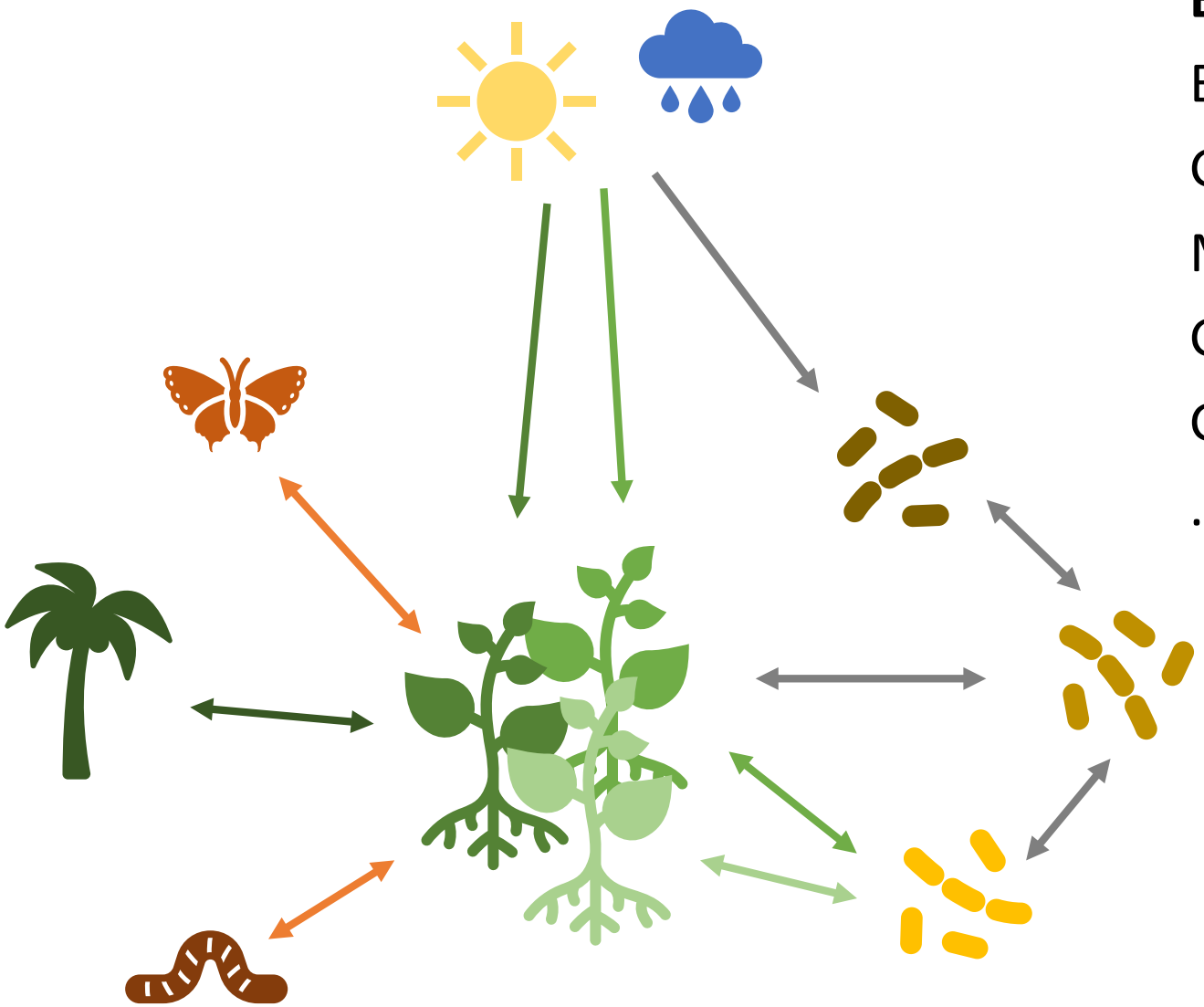
Arabidopsis microbiome differs between plant genotypes and plant age

Wagner et al. (2015) *Nat Commun*



Virus composition of *Plantago lanceolata* leaves depends on plant genotype

Sallinen et al. (2020) *Nat Commun*



Even more complexity:

Effects of other organisms

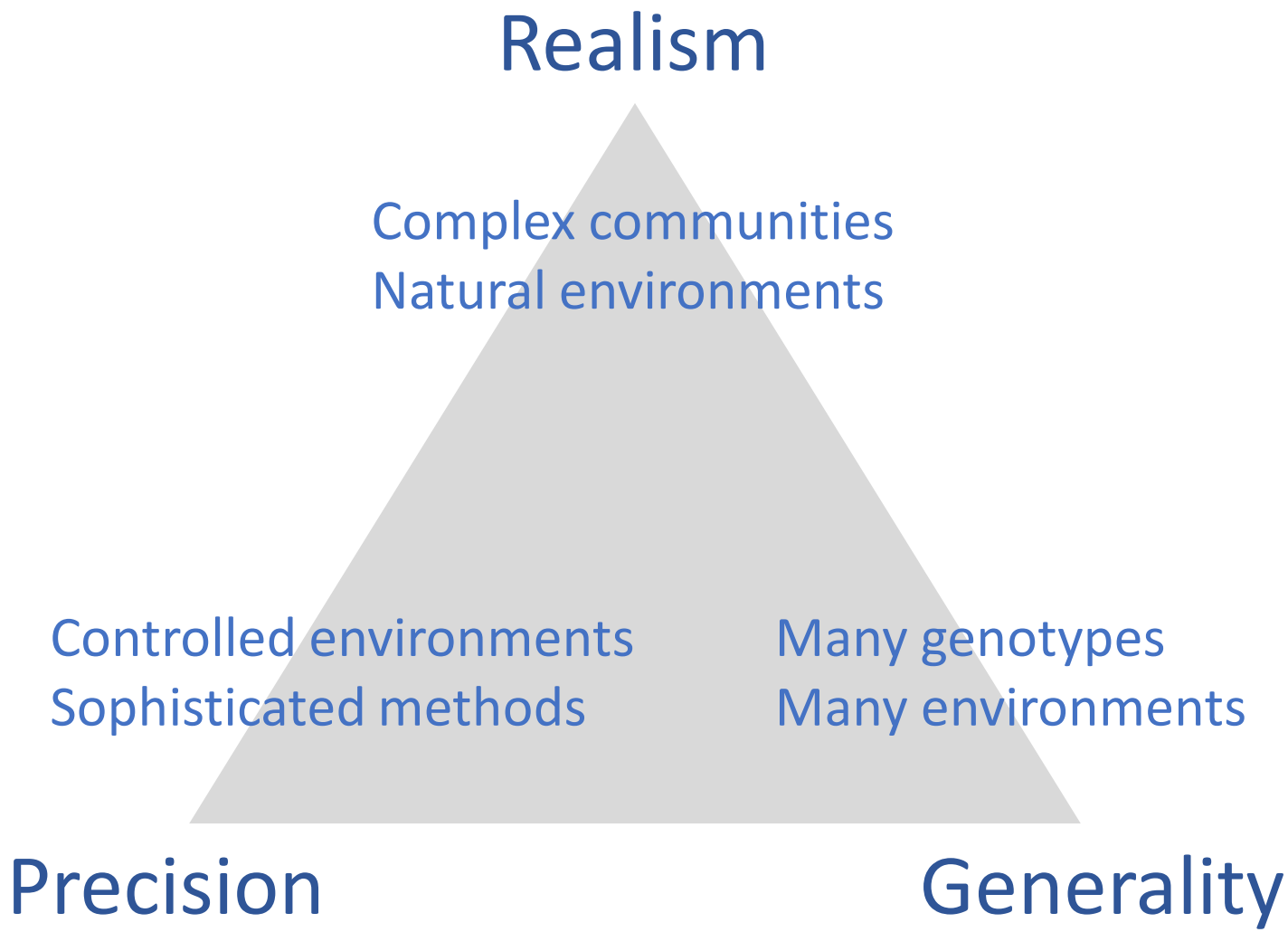
Genotype x environment (G x E)

Microbe x environment (M x E)

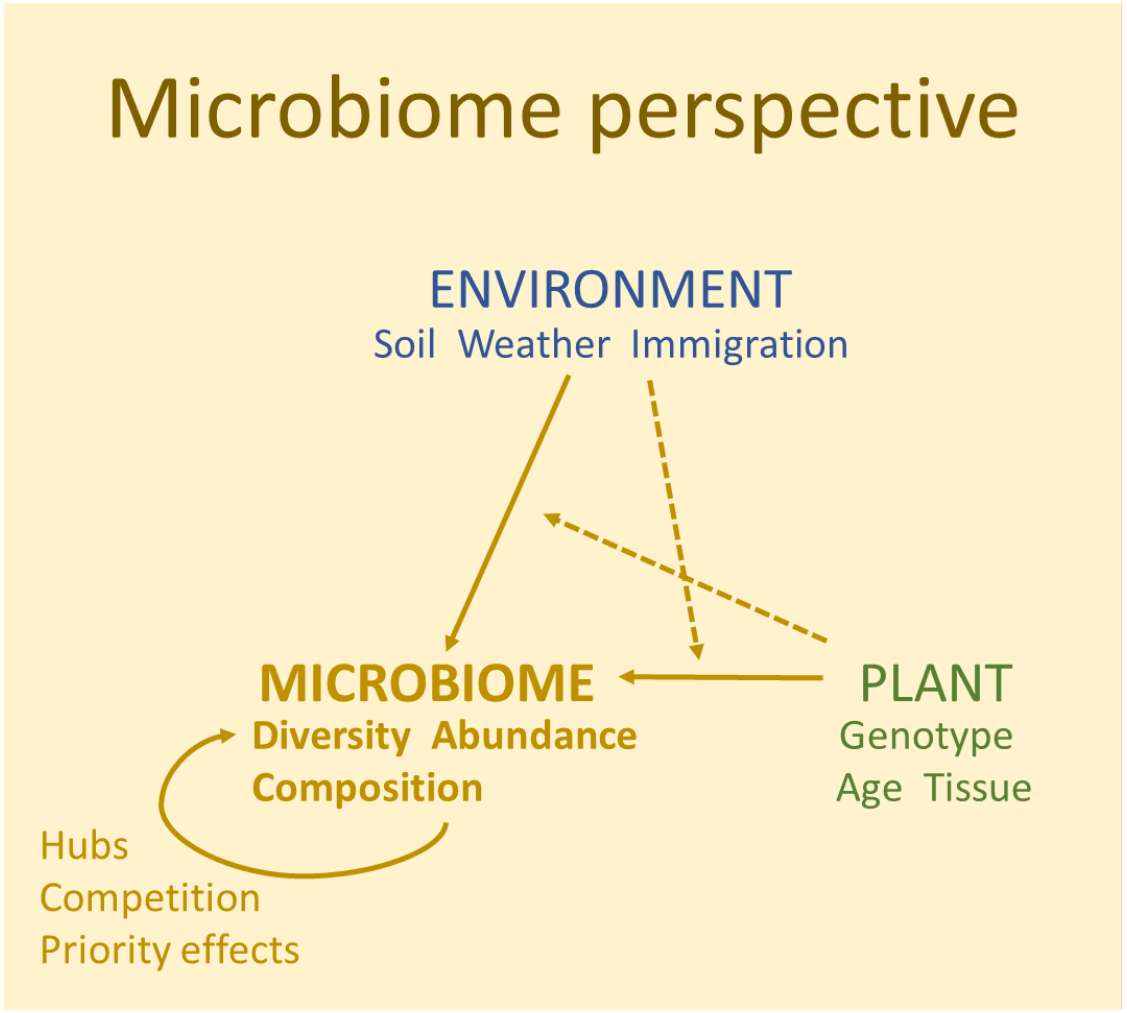
G x M x E

G x M x M x E

…

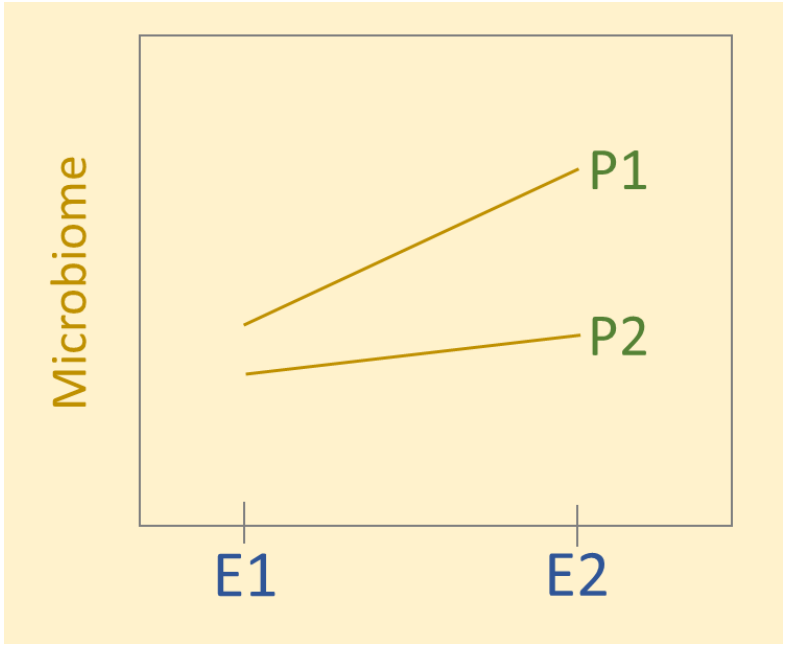

Realism
Complex communities
Natural environments
Controlled environments
Sophisticated methods
Many genotypes
Many environments
Precision
Generality

Two types of ecological plant-microbiome studies

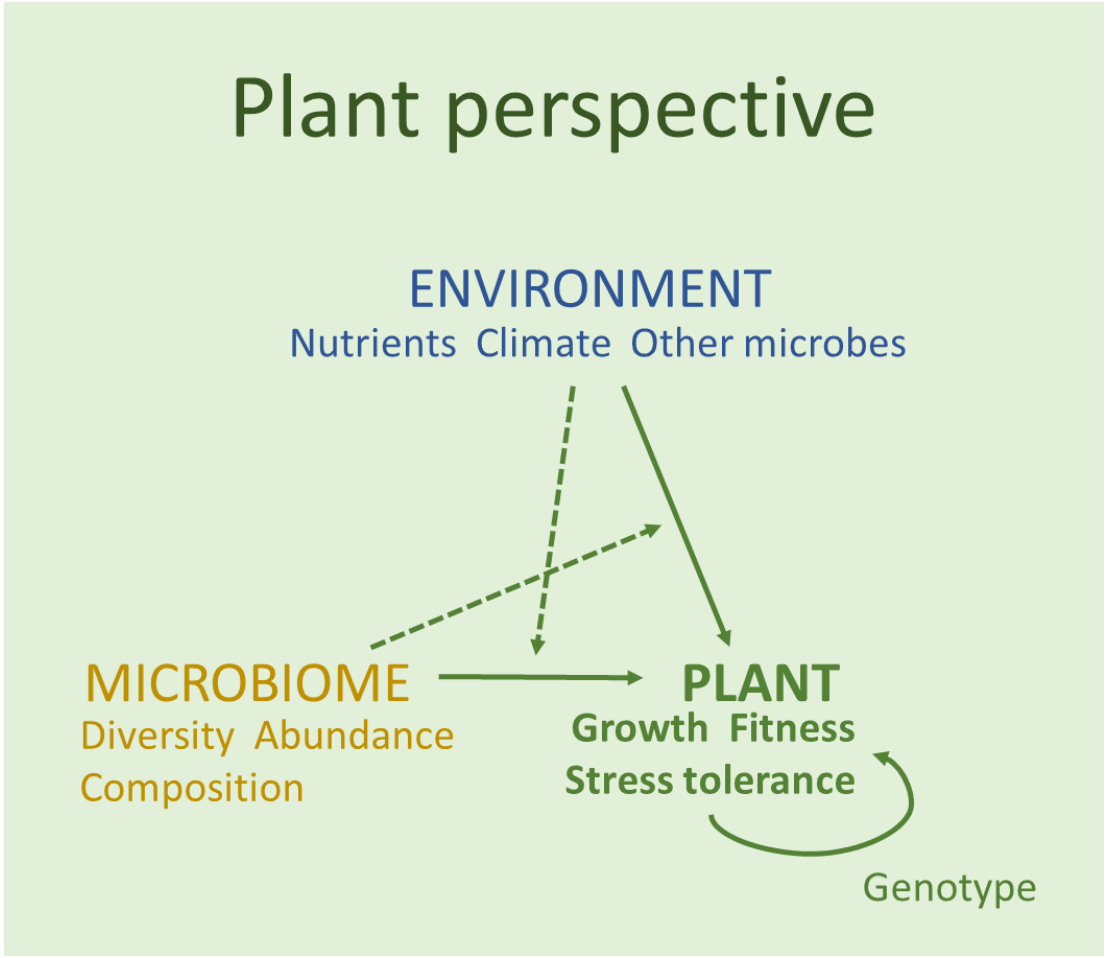


Microbiome is dependant variable

Often analysis of sequencing data

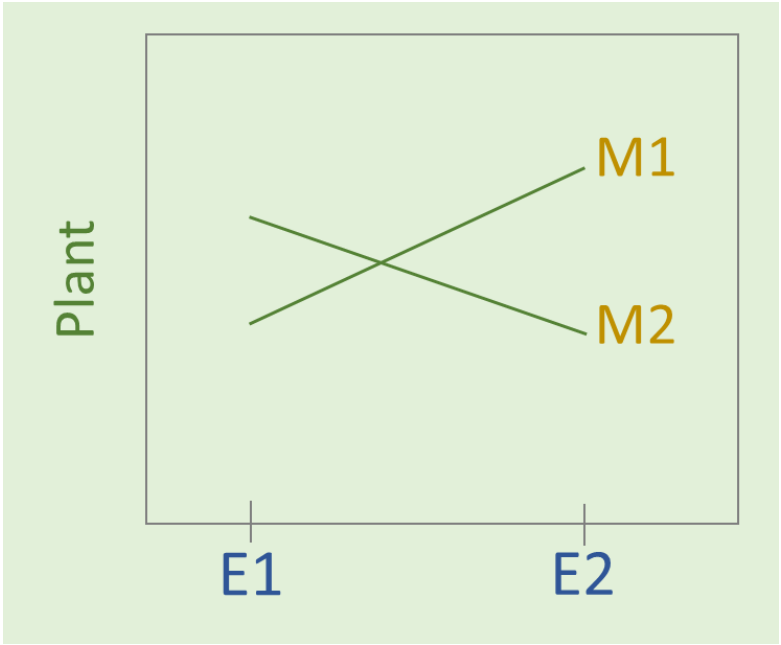


Two types of ecological plant-microbiome studies

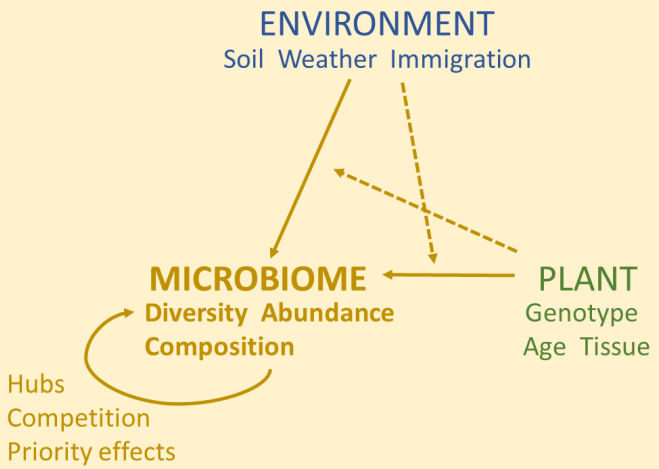


Plant is dependant variable

Analysis of plant fitness/physiology



Microbiome perspective



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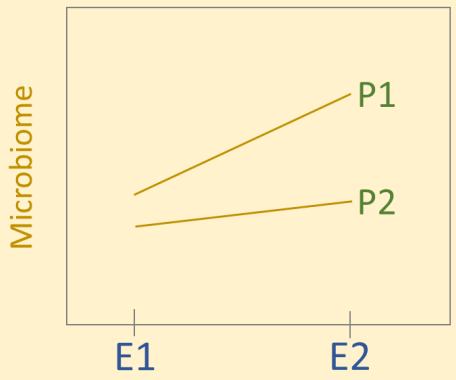
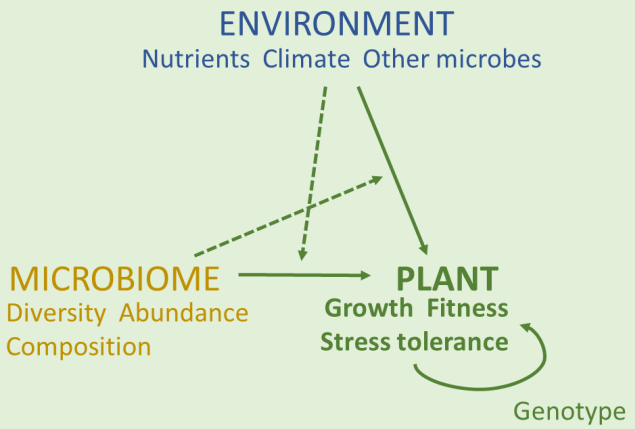
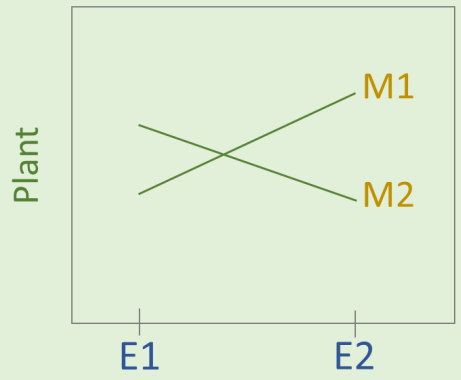


Plant perspective



D



Jung et al. (2021) Understanding plant microbiomes requires a genotype x environment framework. *Am J Bot*

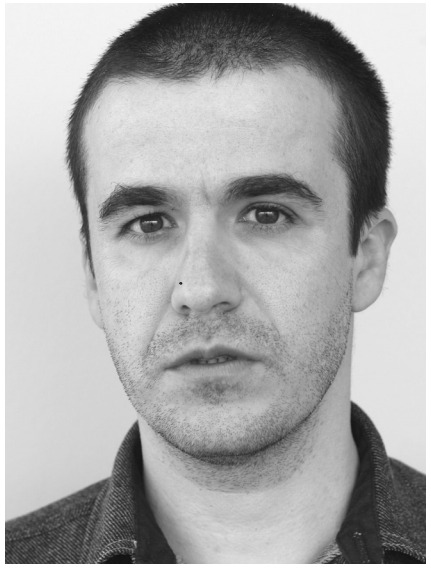
Goals of this workshop

- Think about ecological perspectives
- Learn some computational & statistical methods
- Get to know each other and have fun

Who are we?

Maryam

Eric



Madalin

Jun-Hee

Oliver

And who are you?

5 October

08:30 Room open, with coffee & croissants

09:00 **Welcome & introduction**
What are ecological plant-microbiome studies?
Getting to know each other

10:00 **Amplicon sequencing data**
Setting up OTU/ASV tables/metadata.
Evaluating data quality.
Jupyter/Google colabs notebooks
Short intro to R

12:30 Lunch

13:30 **Analyzing microbial community data I**
R packages for microbiome analyses; normalizing data
Simple stats: comparing samples, diversity metrics, etc.

15:30 Coffee & cake

16:00 **Analyzing microbial community data II**
Analysing & visualising networks
Network statistics, hubs, etc.

18:00 End

19:30 Dinner at An An, Aixer Strasse 46 (Bus 13 to "Aixer Strasse)

6 October

08:30 Room open, with coffee & croissants

09:00 **Analyzing microbial community data III**
Network statistics, hubs, etc. continued
Using machine learning to understand microbial communities

12:00 Lunch

13:00 **Analyzing inoculation studies I**
Basic logic of GLM
Environmental influences
Plant species/genotype effects

15:00 Coffee & cake

15:30 **Analyzing inoculation studies II**
G x E interactions
Visualizing multifactorial results

17:00 Group work – connect with own project(s)

18:00 End

19:30 Dinner at Die Wurstküche, Am Lustnauer Tor 8 (Bus stop „Nonne

7 October

08:30 Room open, with coffee & croissants

09:00 Group work – connect with own project(s)

10:00 **Analyzing inoculation studies III**
Functional biodiversity
Analysing microbial diversity experiments

12:00 Farewell