II. Deep insight into plant habitats

Sugar Beet

<u>The seed microbiome project (ACIB)</u>
Christin Zachow, Henry Müller
Ralf Tilcher (KWS SAAT AG)

acib austrian centre of industrial biotechnology

KWS

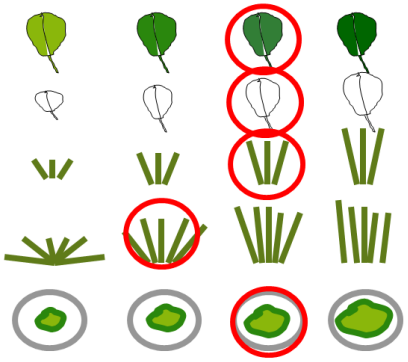
biotenzz Gesellschaft für Biotechnologie mbH

Cultivar-specific microbiomes

Experimental design

- **Genetic pool of sugar beet cultivars which are *Rhizoctonia*-tolerant and -susceptible from different origins.**
- **Analysed categories:**

○ **Cultivar***

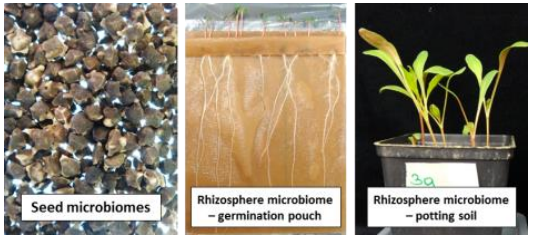


○ ***Rhizoctonia solani* response**

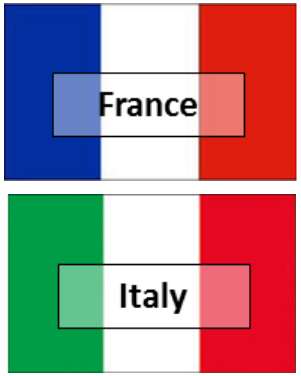
Tolerant

Susceptible

○ **Habitat**



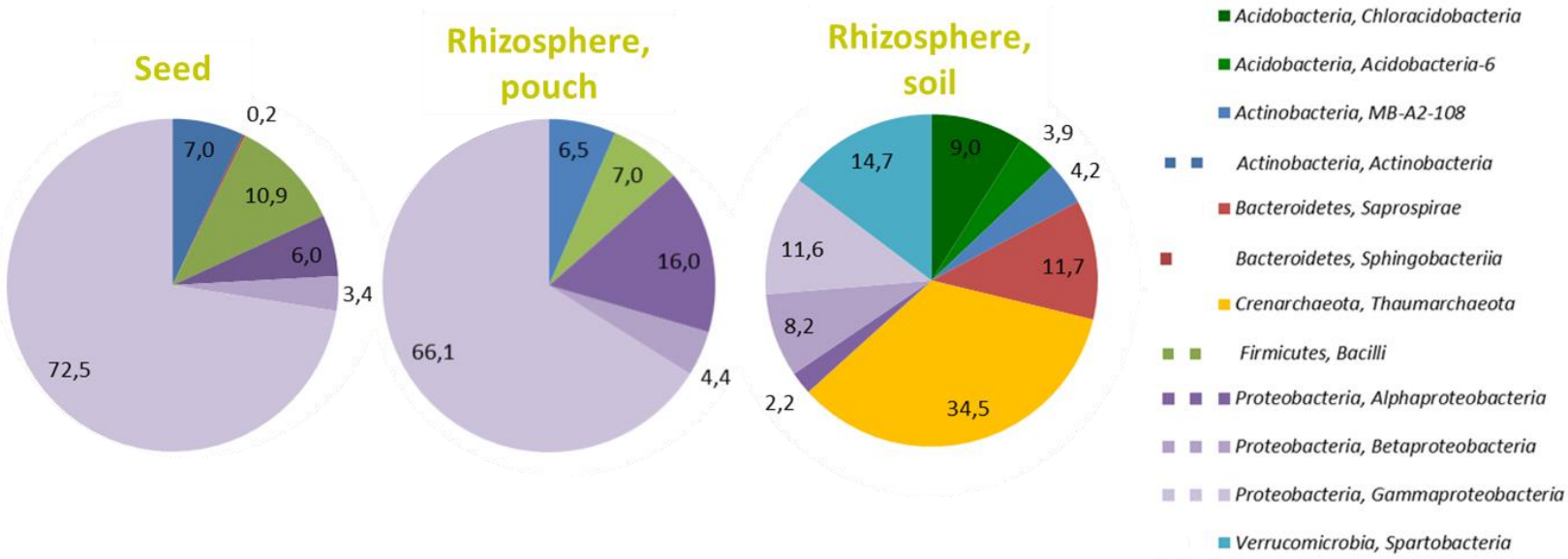
○ **Origin**

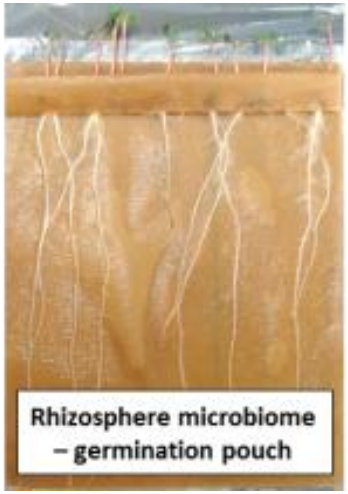


***provided by KWS SAAT SE**

Cultivar-specific microbiomes

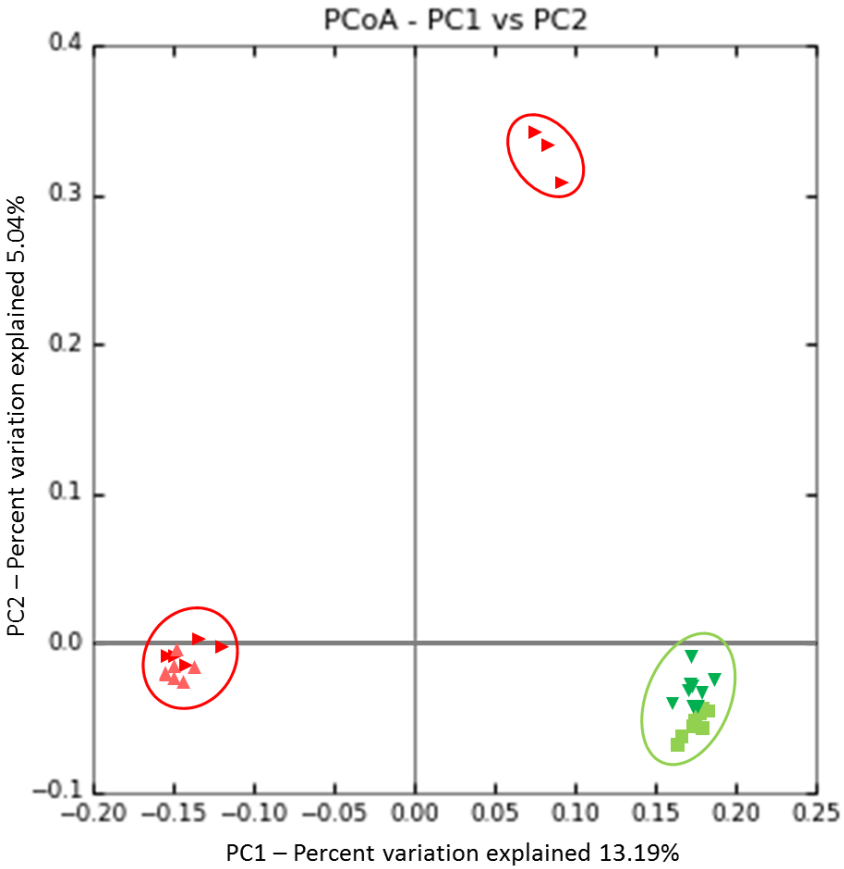
Taxonomic composition of dominant OTUs (> 0.1%)



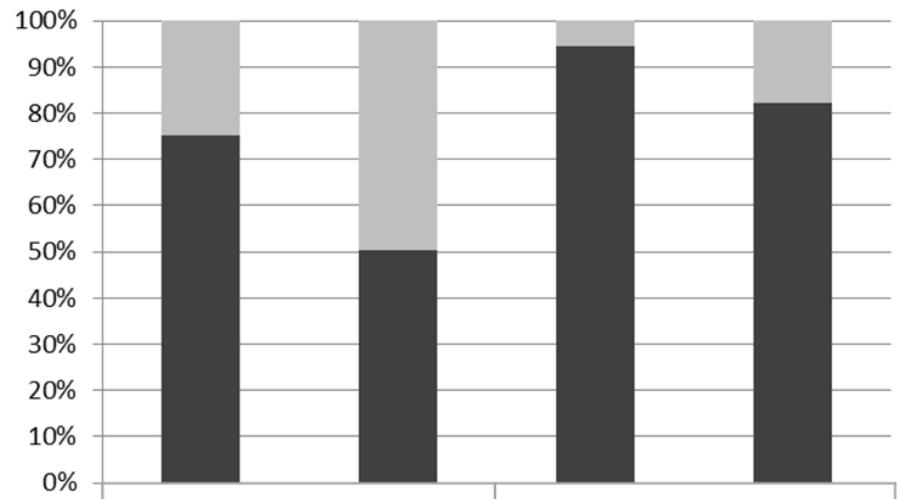


Cultivar-specific microbiomes

Rhizosphere microbiome: eco-/genotype specificity



Resistance
Susceptibility



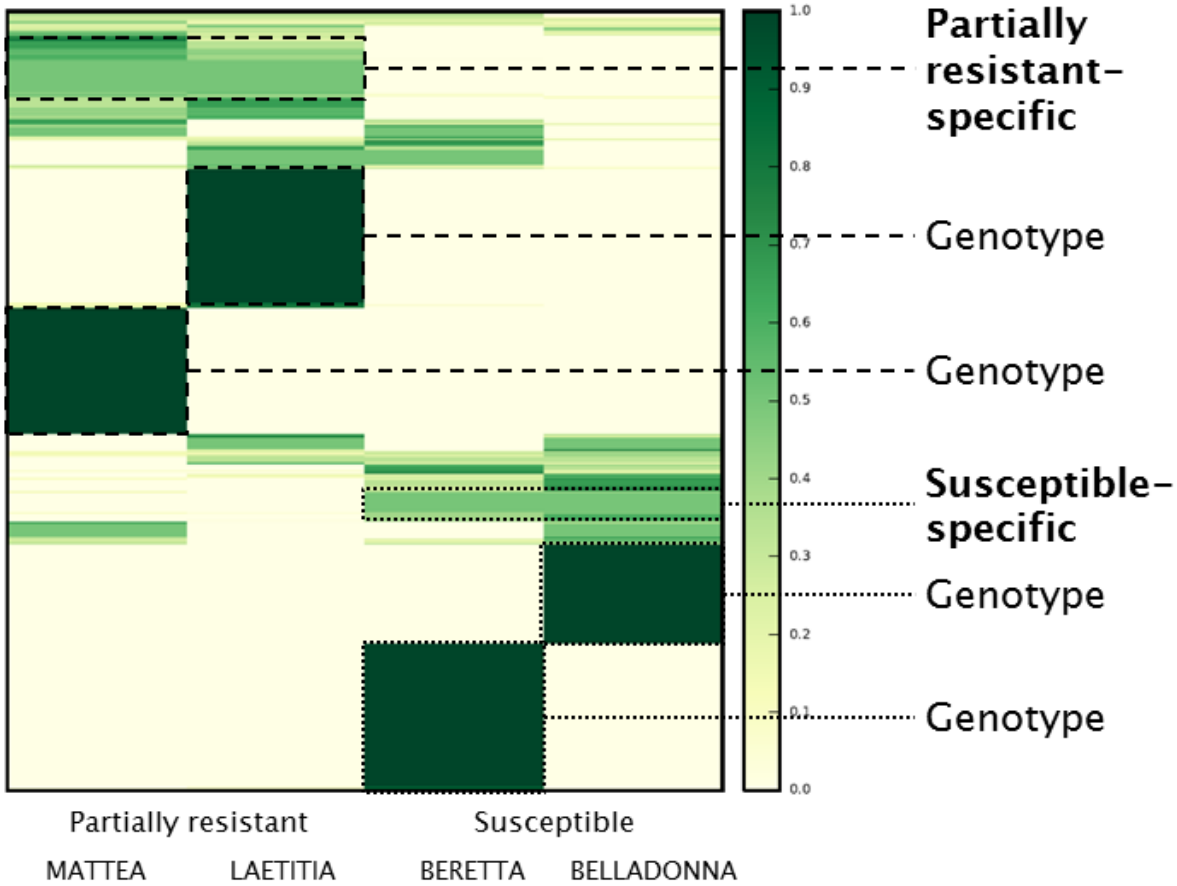
	OTU		Reads	
	Seed	R-soil	Seed	R-soil
Total #	110,042	164,668	3,665,330	4,826,193
Shared #	82,872	82,872	3,462,743	3,962,749
Shared %	75.3	50.3	94.5	82.1

Unique
Shared

Normalized unweighted UniFrac 2D PCoA plots - Rhizosphere

Cultivar-specific microbiomes

Rhizosphere microbiome: eco-/genotype specificity



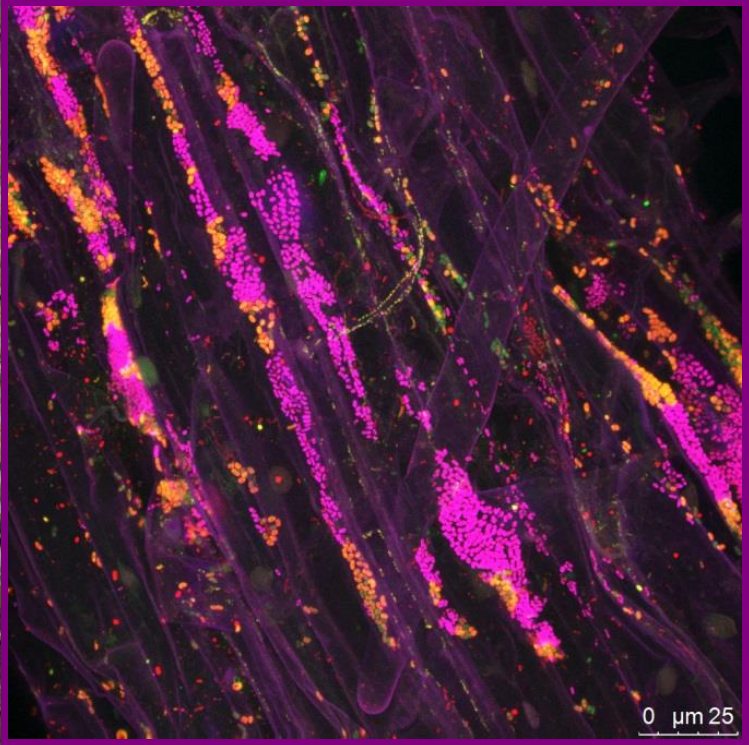
R. solani **effect only visible in the rhizosphere for different taxonomic levels (i.e.** ***Archaea, Enterobacteriales, Pseudomonas*****).**

CONCLUSION II

The microbiome is plant- and cultivar-specific and adapted to the conditions within the ecosystem.

III. Predictable biocontrol strategies

Lettuce



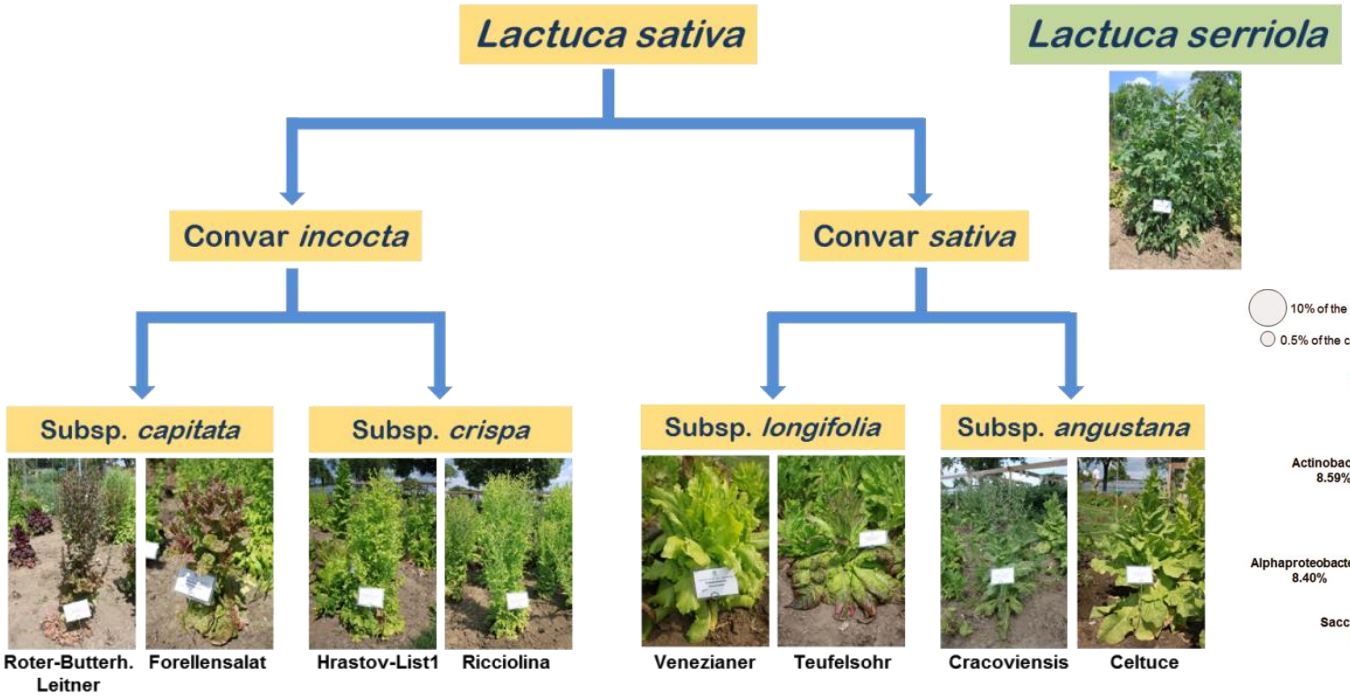
<u>The Lettuce project (EU)</u>

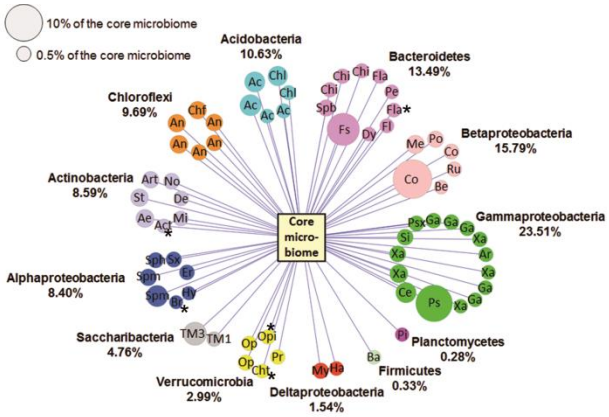
Armin Erlacher, Massimiliano Cardinale

Rita Grosch (IGZ)

Martin Grube (KFU Graz)

Lettuce: specificity and co-occurrence patterns

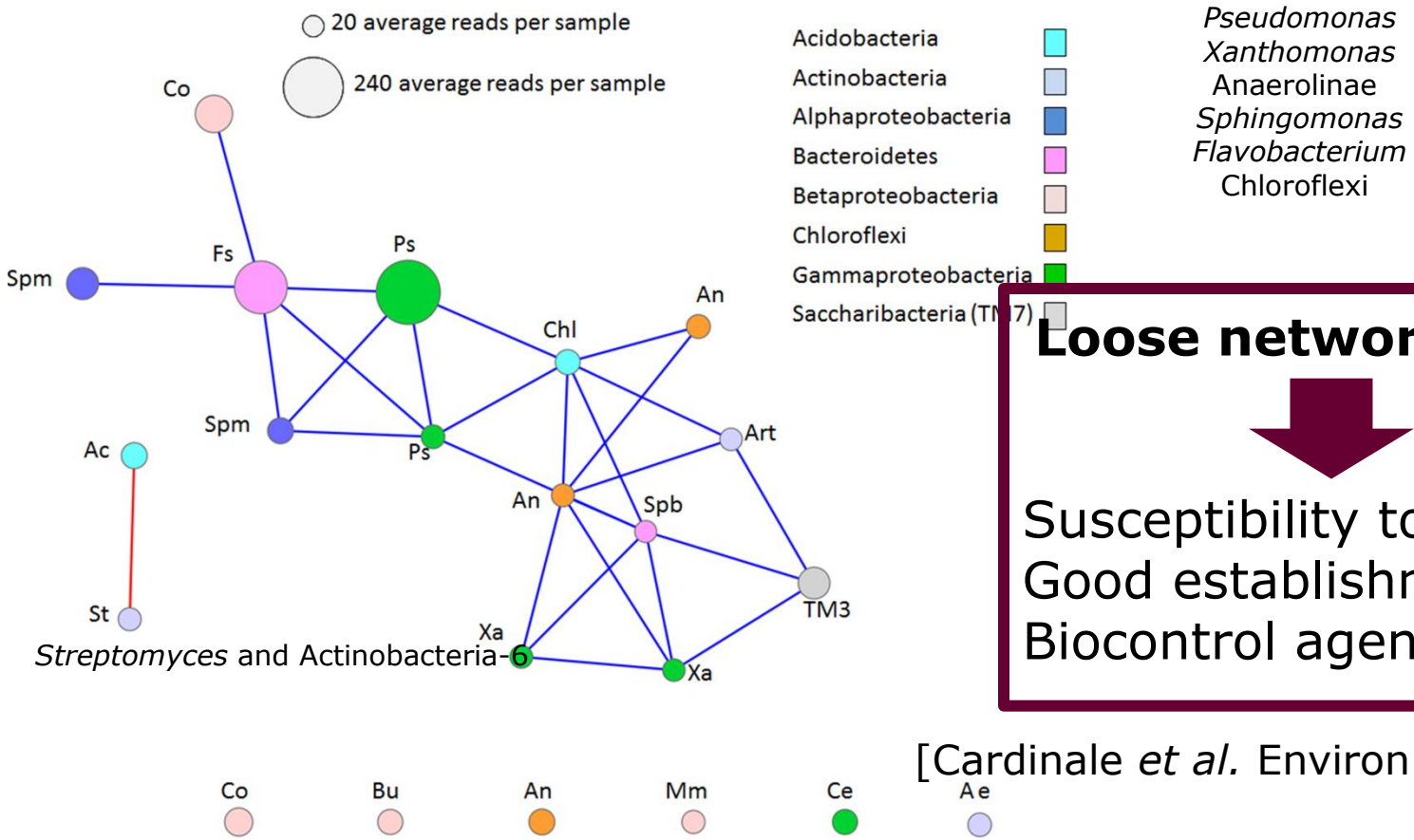




- significant differences at species and cultivar level
- 12.5% cultivar-specific bacteria; 49% core microbiome

Domestication lead to bacterial diversification in lettuce root system.

Lettuce: specificity and co-occurrence patterns



Loose network structure

Susceptibility to pathogens?
Good establishment of Biocontrol agents?

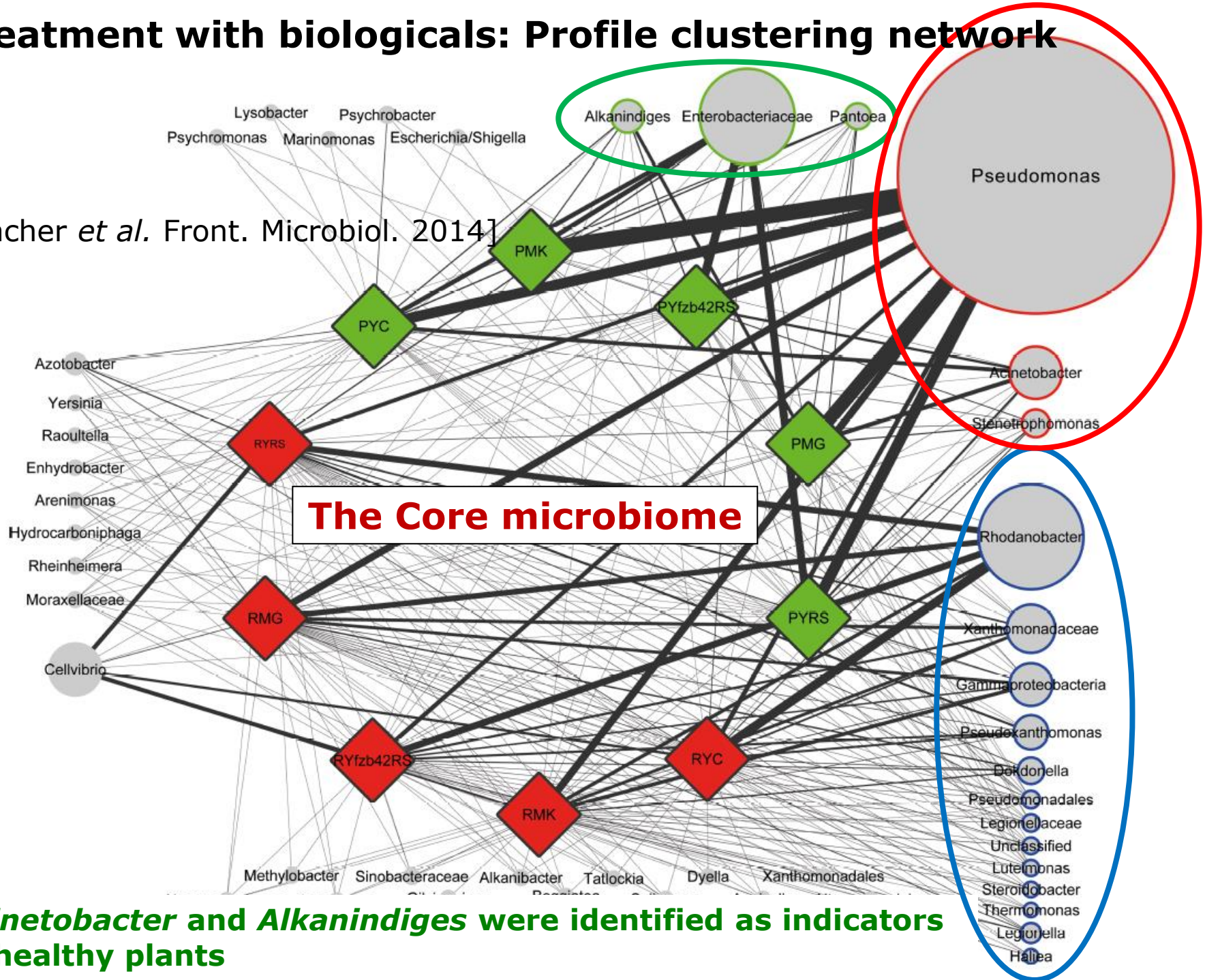
[Cardinale *et al.* Environ. Microbiol. 2014]

Spearman correlations between OTUs showed that co-occurrence prevailed over co-exclusion

- predominant taxa with positive interactions but not involved in
- highly correlated modules, low colonization resistance

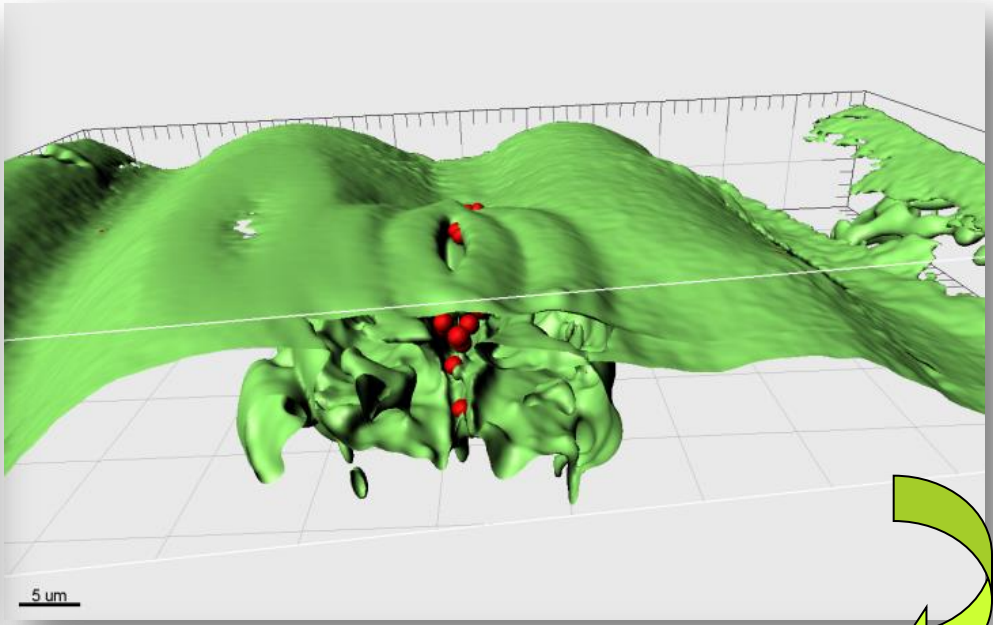
Treatment with biologicals: Profile clustering network

[Erlacher *et al.* Front. Microbiol. 2014]



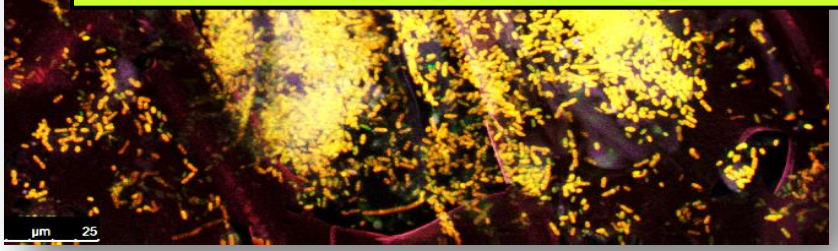
***Acinetobacter* and *Alkanindiges* were identified as indicators of healthy plants**

CONCLUSION III

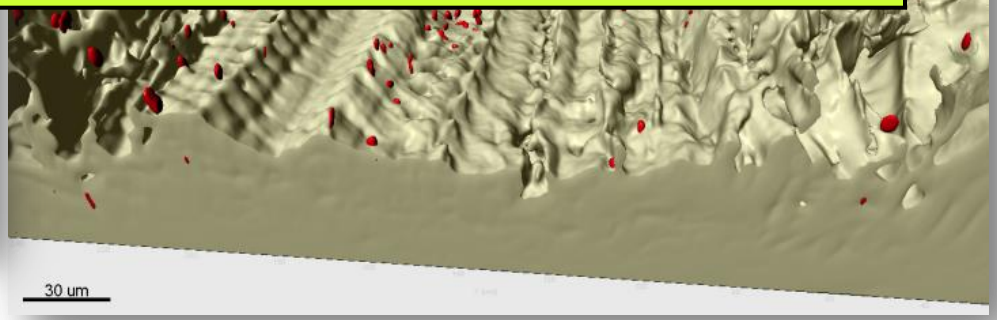


The structure of the microbiome network is important for plant health and disease.

Hypothesis: Natural vaccination by plant-associated bacteria.

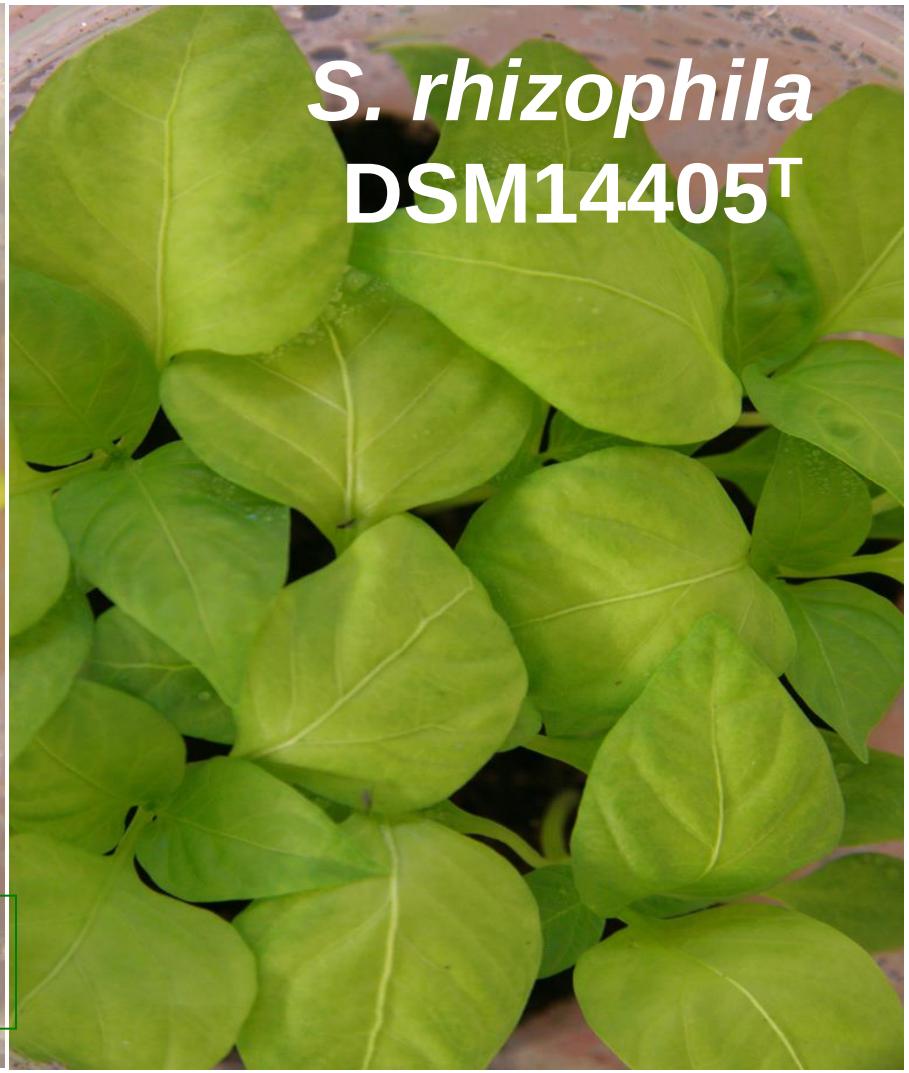


[Berg *et al.* Microb. Biotechnol. 2014]



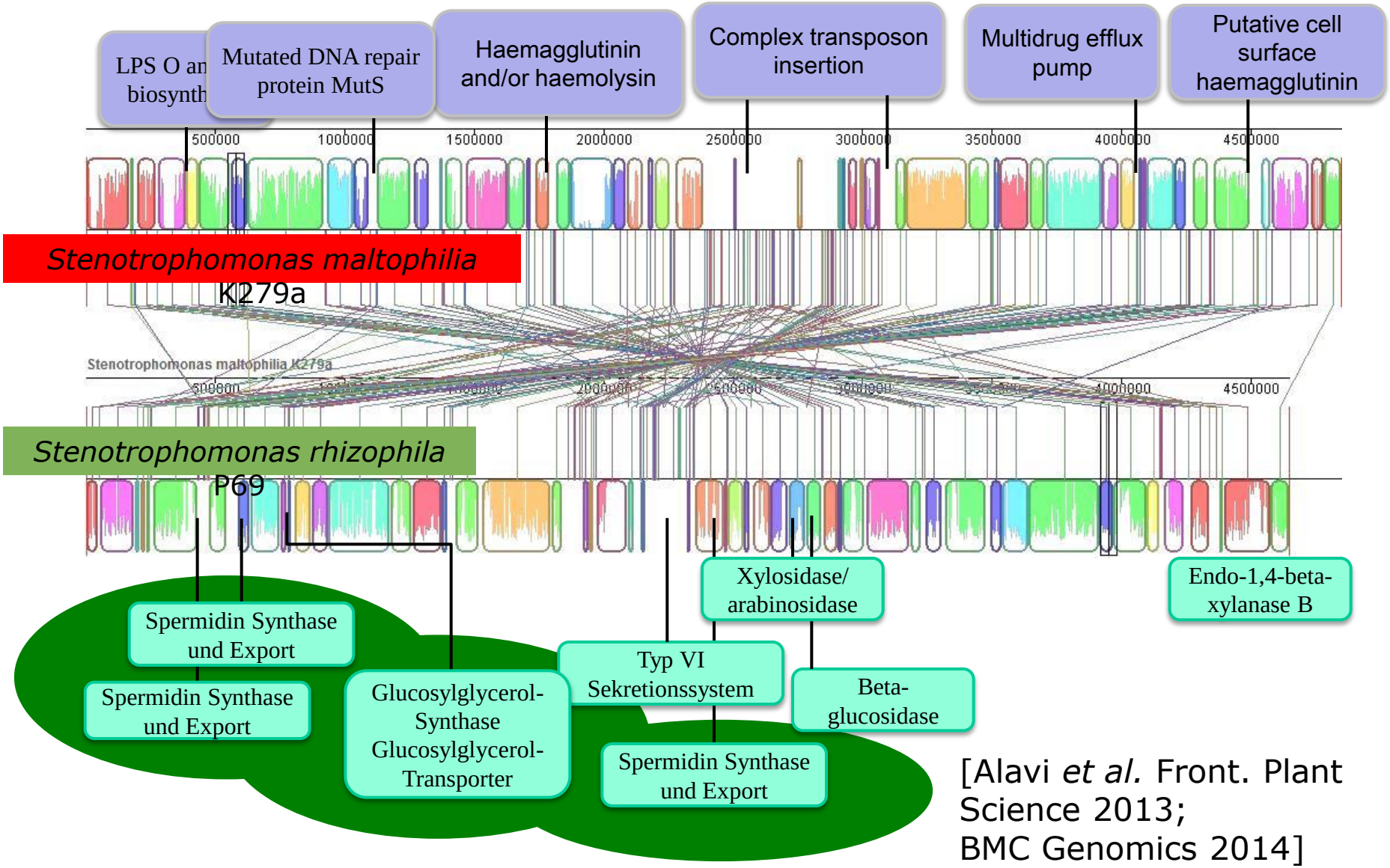
IV. Mode of action

Stenotrophomonas rhizophila



The *Stenotrophomonas* project (FWF)
Peyman Alavi, Henry Müller
Gabriele Alfano

Stenotrophomonas: genome comparison



[Alavi *et al.* Front. Plant Science 2013; BMC Genomics 2014]

***Identified as mode of action by transcriptomics**

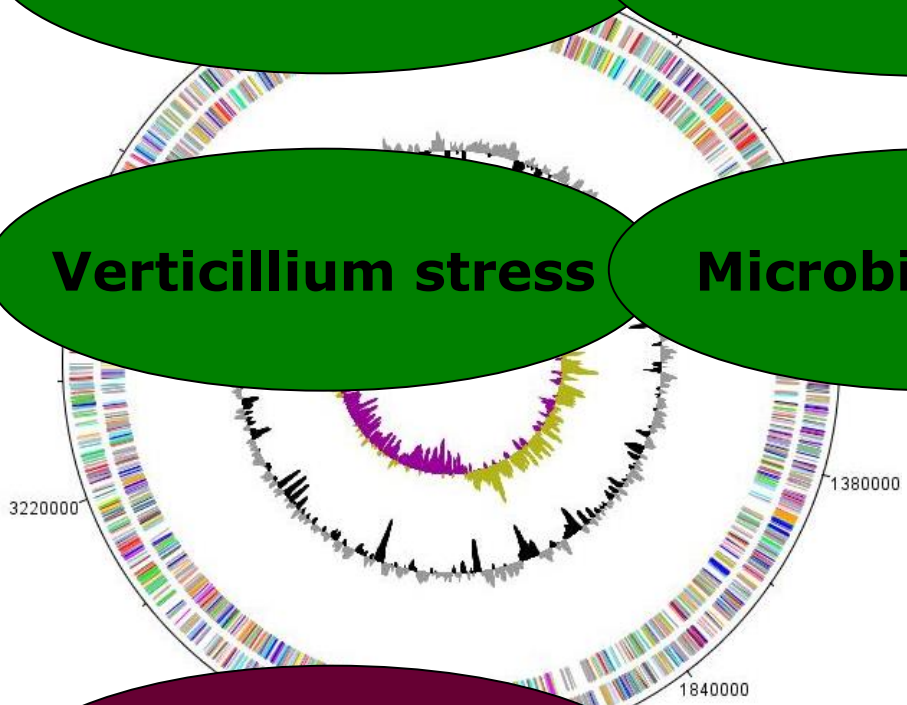
Stenotrophomonas: Mode of action

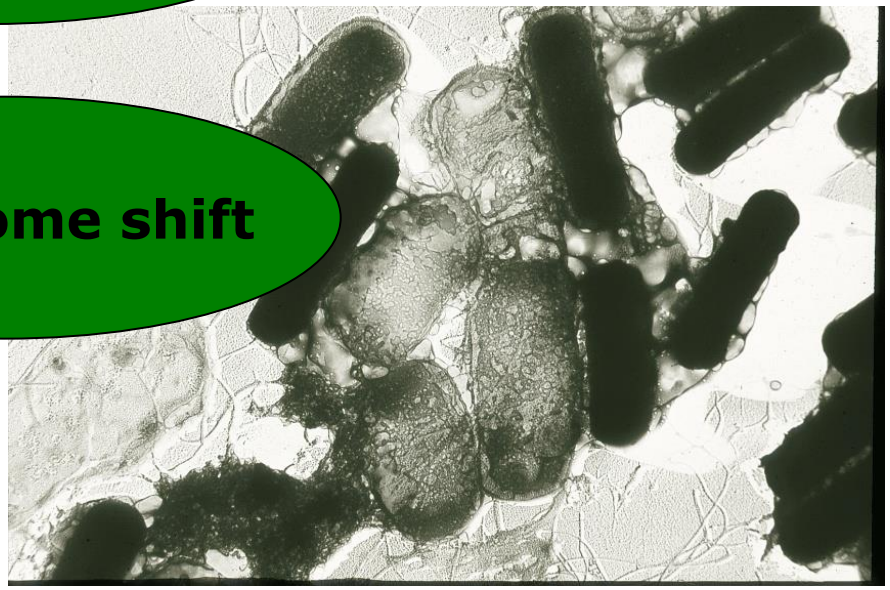
Root extracts

A-biotic stress

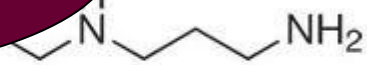
Verticillium stress

Microbiome shift

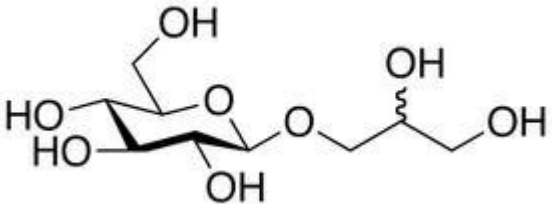




Suicide at 37°C



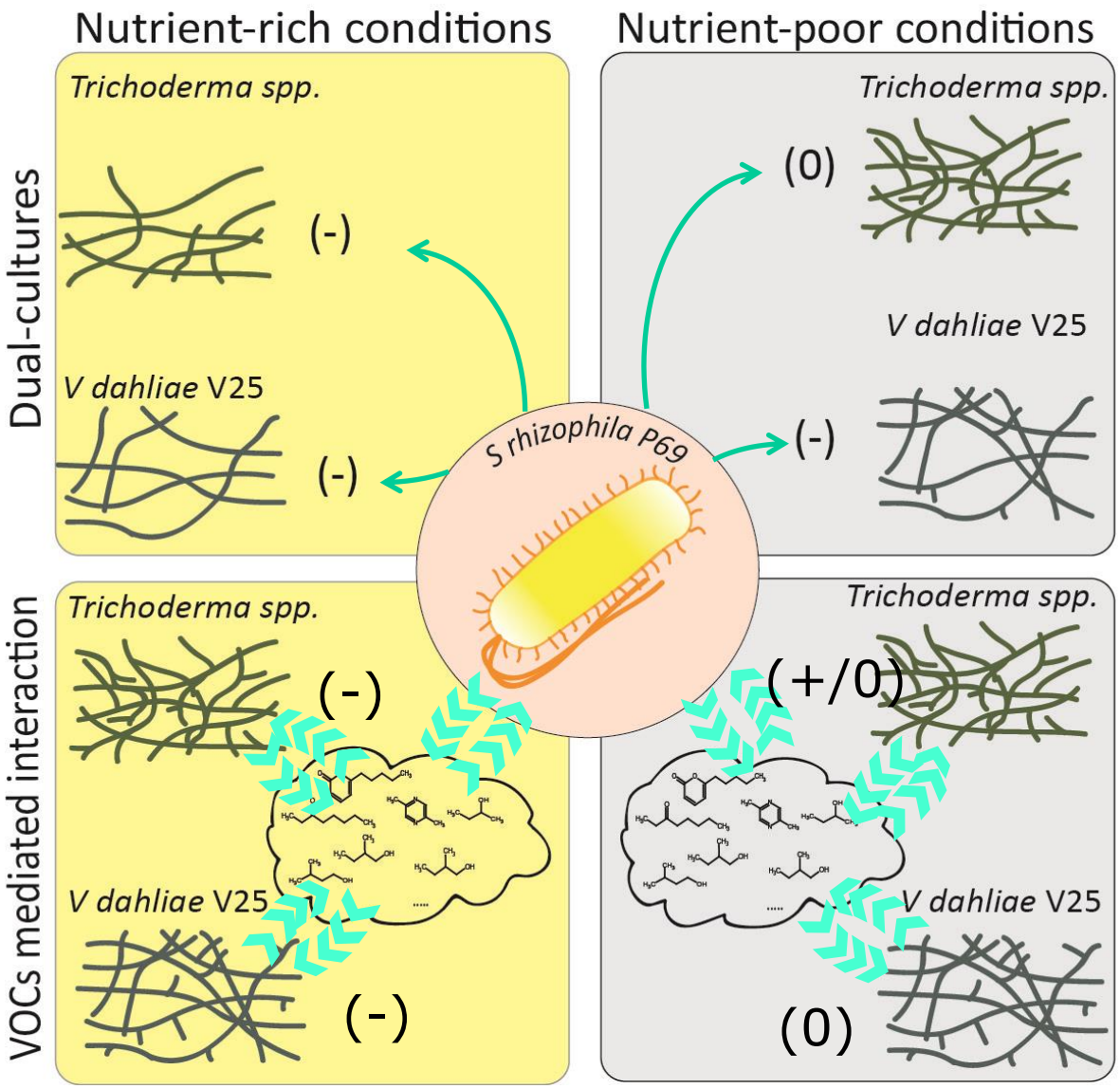
Spermidine



Glucosylglycerol

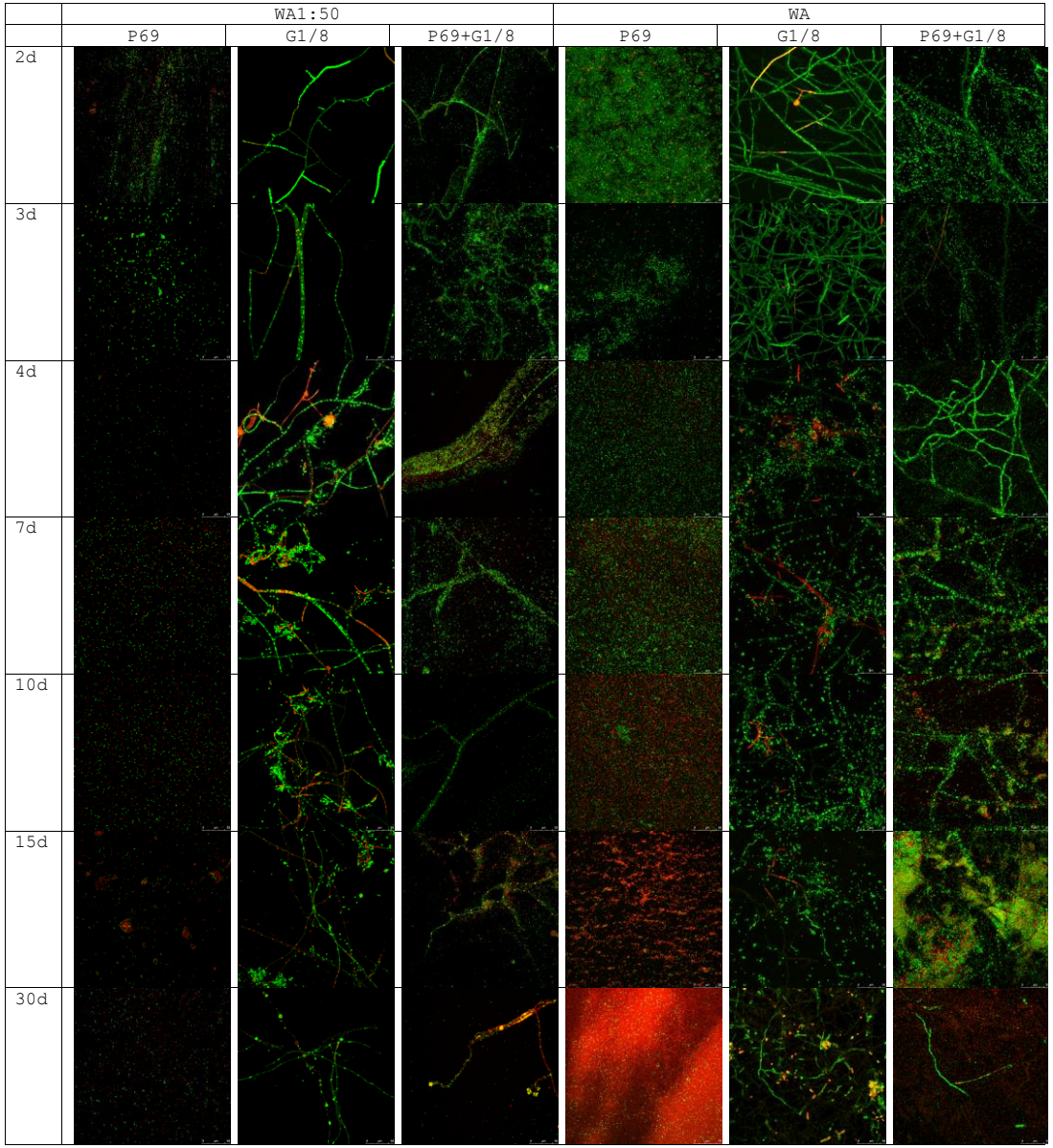
[Ryan *et al.* Nat. Microb. Rev. 2009; Schmidt *et al.* Biol. Fertil. Soils 2010; Alavi *et al.* Frontiers Microbiol. 2013, BMC Genomics 2014]

Stenotrophomonas: Mode of interaction



[Alfano *et al.* manuscript in preparation]

Stenotrophomonas: Specific interaction studies



In vitro Stenotrophomonas-Trichoderma interaction studies

WA1:50 = nutrient-poor conditions

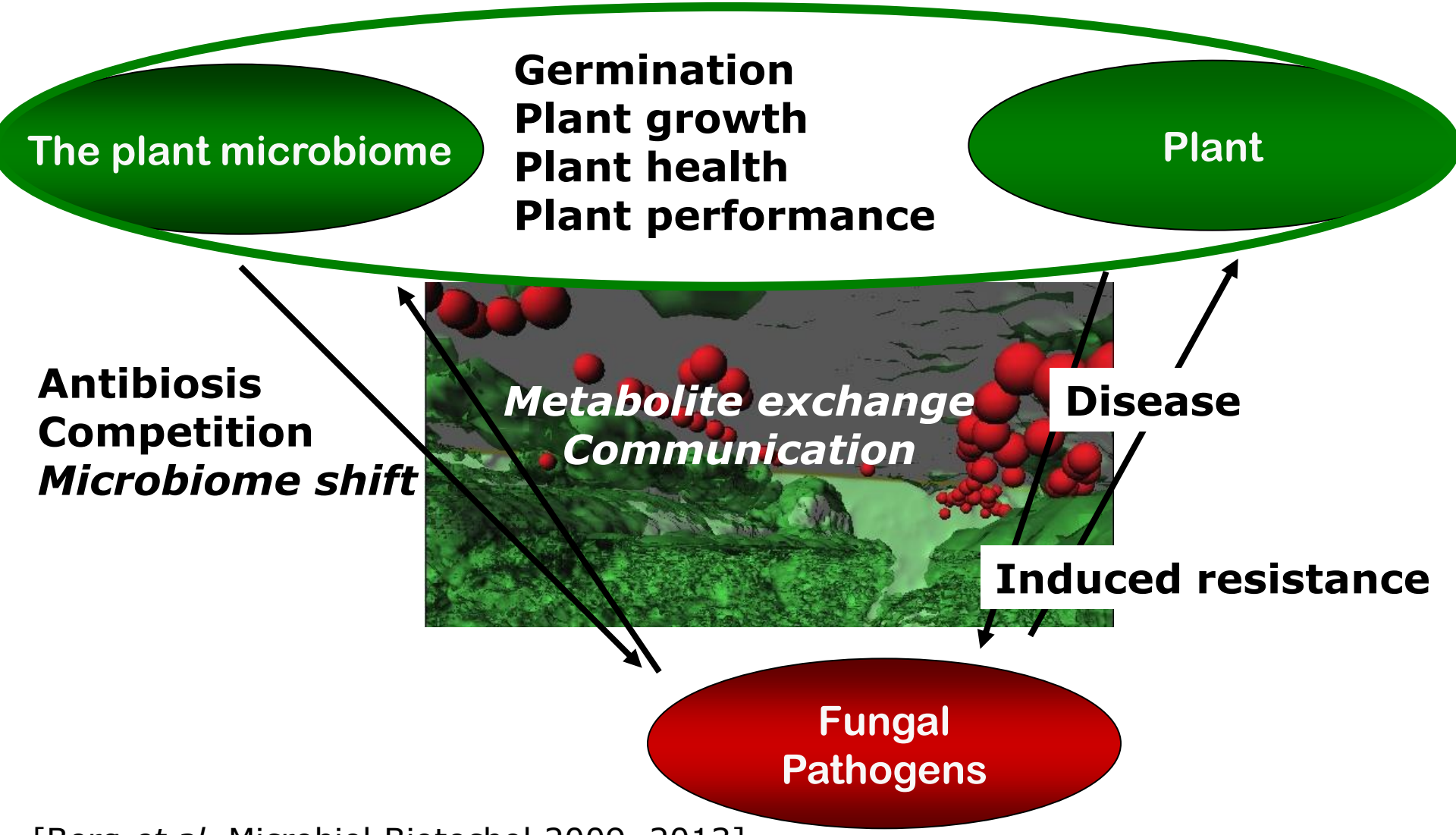
WA = nutrient-rich conditions

Live/Dead Staining:

living cells

dead cells

CONCLUSION IV



[Berg *et al.* Microbiol Biotechol 2009, 2013]

CONCLUSIONS: Biocontrol of root pathogens

1. **Deep insights reveal cultivar-specific microbiomes, which have to be considered for biocontrol strategies.**
2. **Theories of microbial ecology can be used to develop predictable, microbiome-assisted control.**
3. **Microbiome shifts are a novel mode of action.**
4. **Interactions are based on a broad range of metabolites (VOCs) and are triggered by nutrients.**
5. **Within microbiomes – Archaea, Bacteria and Fungi – interact.**
6. **Members of the microbiome can be transferred to other habitats, which offers an new potential for healthy food.**

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Uni Greifswald

Vision: Healthy food for our health

NAWI Graz
10 YEARS