## Optimizing the interaction of micro-organisms and plants



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### The cell metabolism







### Nutrition in soil









#### 5 yrs-old *Pinus* seedling (1958)





#### **MYCORRHIZAS**



#### A dual organ between roots and fungi in 90% of land plants



### ENDOMYCORRHIZAS



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**MYC** - *Plant Archives* (2016), 16, 365

MYC +





#### *Science* (2011), 333, 880



 $0 \mu M P 35 \mu M P$ 

*Science* (2011), 333, 880



0 mM 25 mM

*Science* (2011), 333, 880



[phosphates] added on Trifolium subterraneum, mmol/kg









### Protection

Limestome (Ca<sup>2+</sup>) tolerance in *Eucalyptus globulus*, mycorrhizal or not.



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(0.6 Kb)





*Rhizophagus intraradices* mycorrhizal protection

against the root pathogenic nematode *Xiphinema index* 

on Vitis amurensis

Plant Cell Physiol. (2006), 47, 154

(0.6 Kb)





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Non+ Glomusmycorrh.margarita





Severity of attack (% leaf damaged)



Non+ Glomusmycorrh.margarita





#### **Protection against** *Botrytis cinerea*



Non+ Glomusmycorrh.margarita

*Pin II* pathogenesis-related protease expression



# CSIC CEZ

#### Protection against Botrytis cinerea



Priming : establishment of mycorrhizae (or even of rhizosphere microbiotes) systemically allows for an efficient activation of defenses upon attack

Non+ Glomusmycorrh.margarita

**Effectors** ?



[phosphates] added on *Trifolium subterraneum*, mmol/kg

### Leaf interactions

### **PROTECTIVE ENDOPHYTES**



A neglected foliar hyperdiversity...

Up to 100 fungal species per leaf in the tropics

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A neglected foliar hyperdiversity...

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10<sup>8</sup> bacteria per gram of leaf



















# ... the free-radical detoxication hypothesis















#### **SECONDARY METABOLITES PRODUCTION**







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Mentha piperita New Phytologist (2003), 158, 579

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### Reproduction



#### Sambucus nigra

(elder)







#### METHYLOBACTERIA (PPFM) IN SEEDS



### **Endophytes** of plants and seeds tissues (feeding on pectin demethylation)

#### METHYLOBACTERIA (PPFM) IN SEEDS

Germination of soja (Glycine max) seeds

Treatment	Germination (%)
PPFM-enriched	65 %
Heated (no more PPFM)	$20 \ \%$
Heated + added PPFM	50 %
Heated + added cytokinines	50 %

Holland, Rec Res Dev Plant Physiol, 1997



#### **VEGETATIVE TRANSMISSION**



Stoloniferous *Glechoma hederacea* 



*Microbiome* (2018), 6, 79

#### **VEGETATIVE TRANSMISSION**

0

Mothers





1<sup>rl</sup> daughters

2<sup>nd</sup> daughters

#### Stoloniferous *Glechoma hederacea*

*Microbiome* (2018), 6, 79

#### **VEGETATIVE TRANSMISSION**





#### Stoloniferous *Glechoma hederacea*

Random < heritability of microbial assemblage :

Bacteria : p<0.001 Fungi : p<0.001

*Microbiome* (2018), 6, 79





Plant is a holobiont with:

Bacteria Fungi Archaea



# ... and we never used this for plant nutrition, nor protection.



Plant is a holobiont with:

Bacteria Fungi Archaea Thank you for listening !

For more :

see my book on microbiota download all my team's papers by searching for 'Selosse ISYEB'

