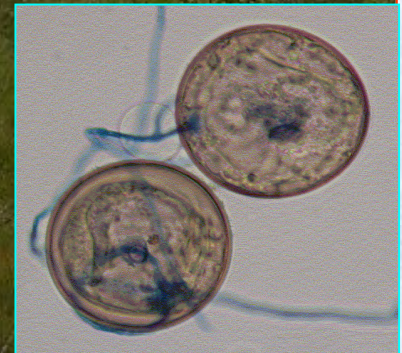
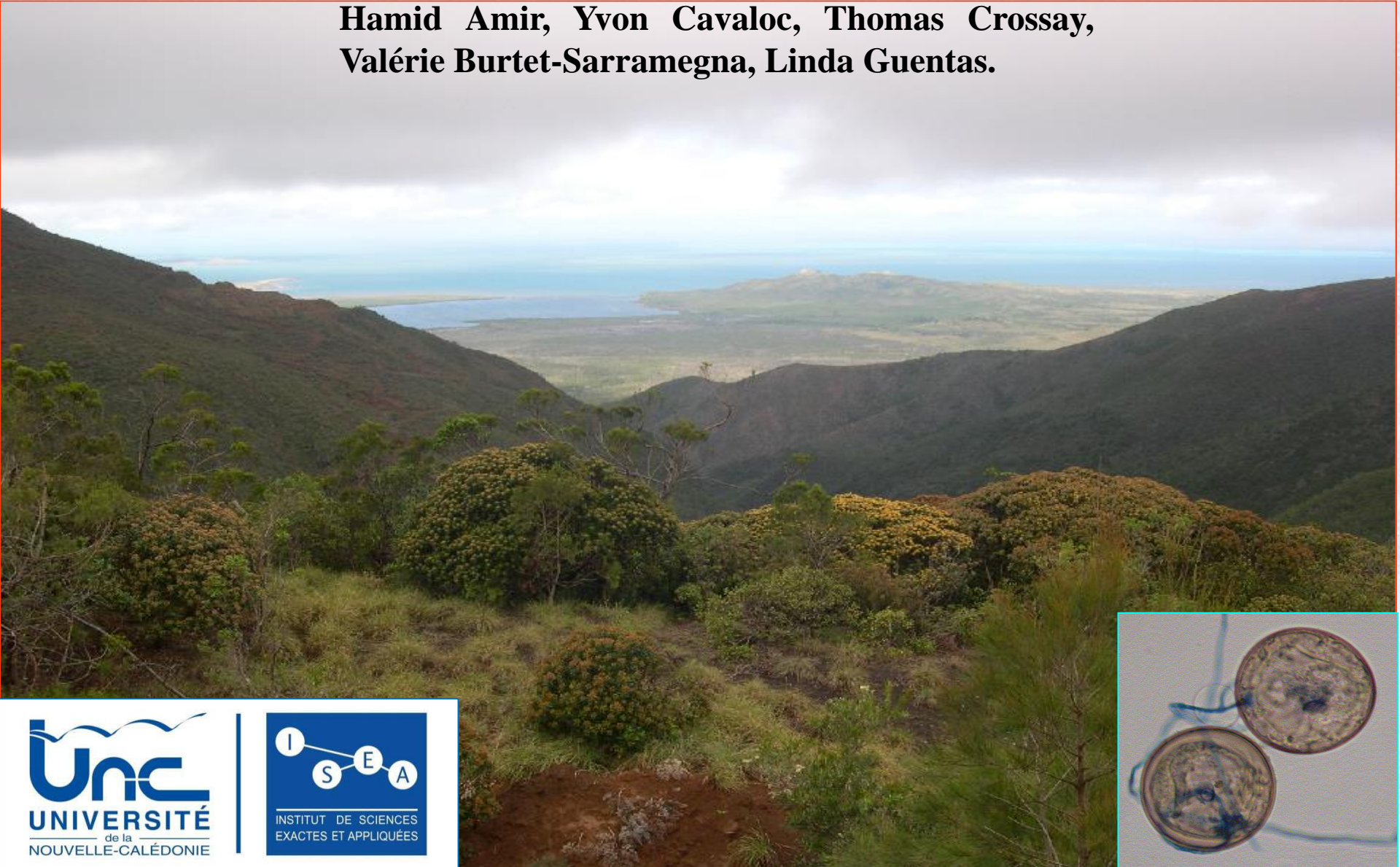
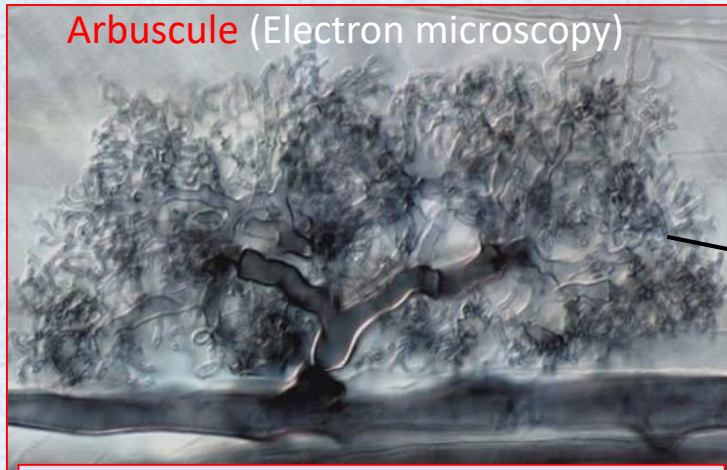


# Importance and roles of arbuscular mycorrhizal fungi in New Caledonian ultramafic soils

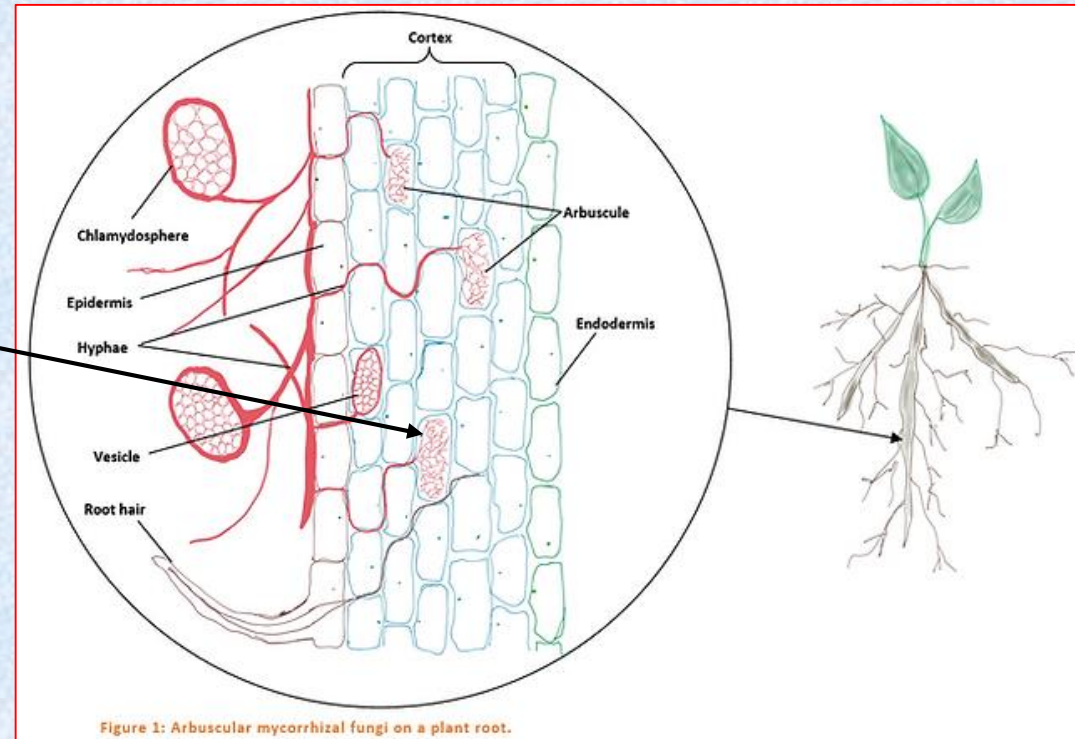
Hamid Amir, Yvon Cavaloc, Thomas Crossay,  
Valérie Burtet-Sarramegna, Linda Guentas.



Arbuscular mycorrhizal fungi (AMF): microscopic fungi (Glomeromycetes); produce one of the most frequent plant-microbe mutualistic symbiosis (80% of vascular plants); several important roles in ecosystems.



*Arbuscule : exchange interface between the fungus and the plant in root cortex*



Studies on AMF in New Caledonia mostly published in the last two decades.

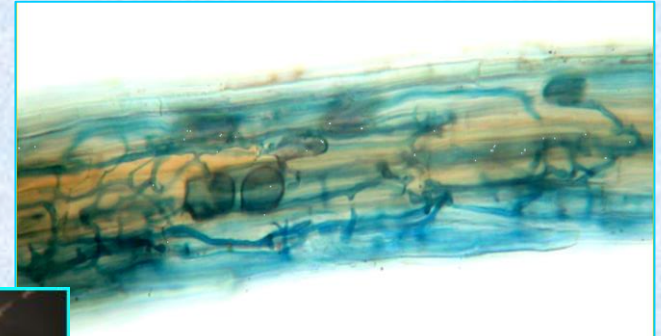
Here some examples summarising these studies

# 1- Abundance / importance of AMF in NC ultramafic ecosystems

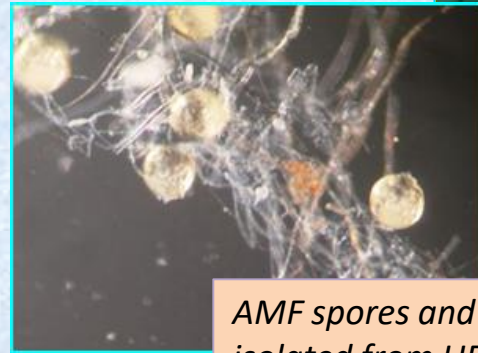
- **More than 95%** of the plant species analysed found **arbuscular mycorrhizal**

- AMF spores (conservation and propagation): in these soils varies between 1 to 200/g soil depending on vegetation density.

- **Cyperaceae family** generally considered as non-mycorrhizal : found **functionally mycorrhizal** in ultramafic maquis.



*Root colonization by AMF in NC maquis plant species*



*AMF spores and mycelium isolated from UF soil*

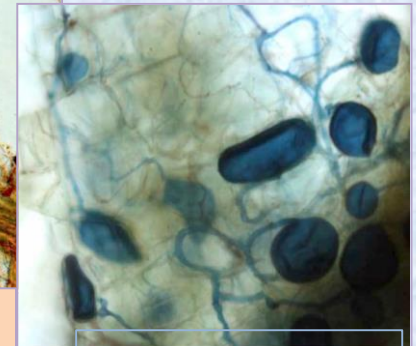
*(Amir and Pineau, 1997; Perrier et al. 2006; Amir and Ducouso 2010)*



*Tetraria comosa*

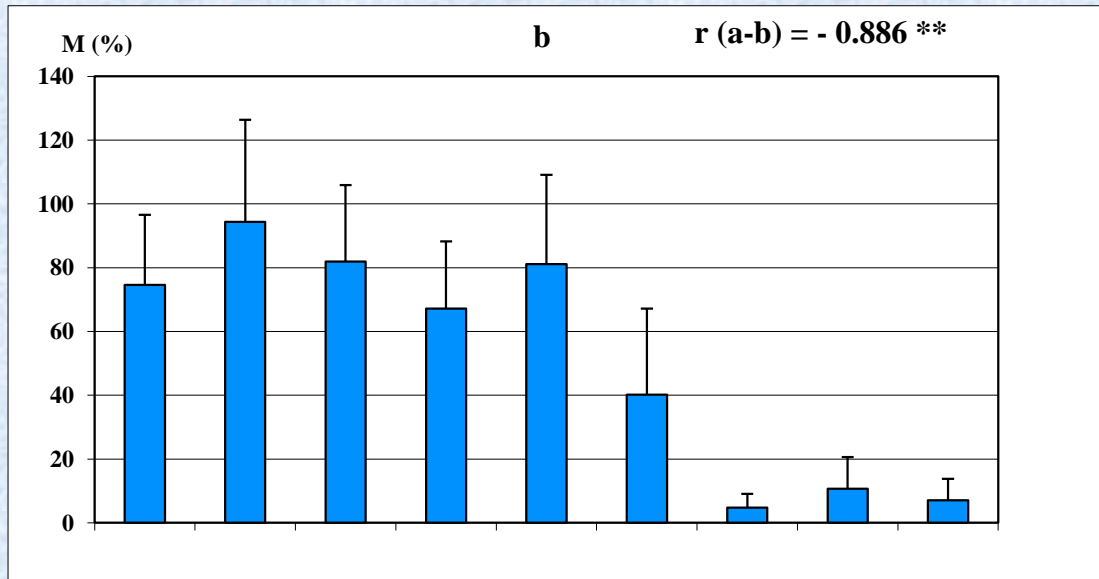
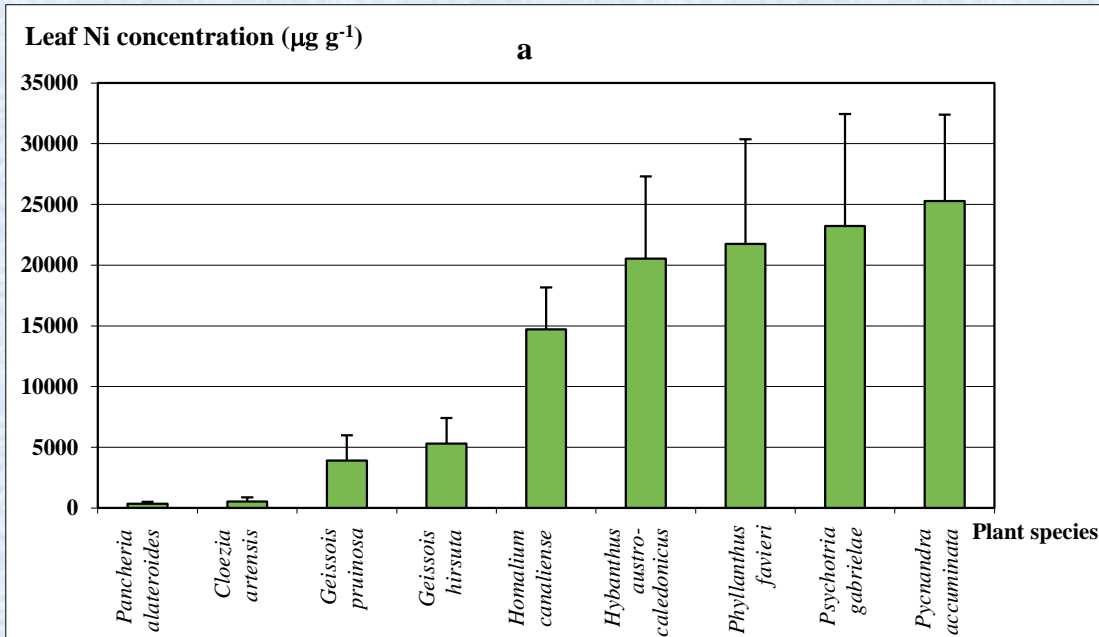


*Dauciform roots of Tetraria comosa (Cyperaceae) with AMF vesicles, and detailed view*



*(Lagrange et al. 2011; Lagrange et al. 2013)*

## - Mycorrhizal status of Ni-hyperaccumulating plants :



Relationships between Leaf-Ni concentration and mycorrhizal colonization of 9 Ni-accumulator plants

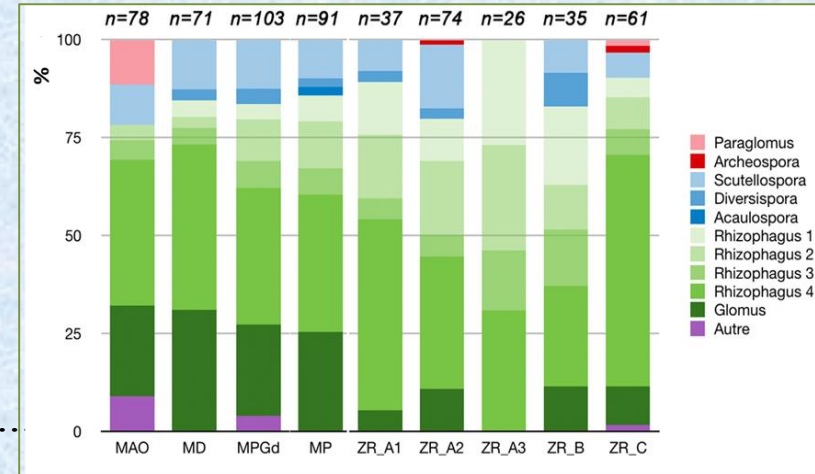
Negative correlation between Ni-concentration and mycorrhizal colonization + other studies

➔ the accumulation of Ni in roots inhibit mycorrhizal colonization

## 2- AMF diversity in NC ultramafic ecosystems

DNA sequencing in different projects allowed to compare UF and non-UF soils ; UF soils from different regions and ecosystems, showed that:

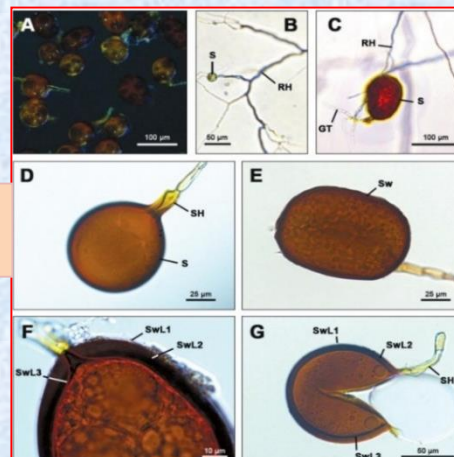
- AMF diversity **richness in UF soils similar to non-UF soils.**
- But qualitatively different for dominant genera:
  - \* **UF**: Glomeraceae highly dominant: *Glomus* + *Rhizophagus* (>60%); *Sclerocystis*; then *Diversispora*; *Archeospora*, *Claroideoglomus*...



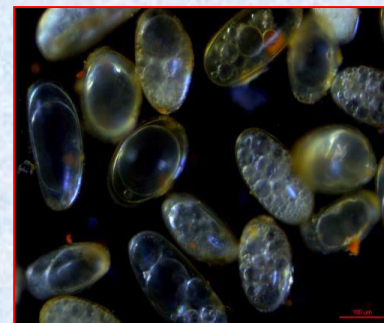
- \* **non-UF**: Less Glomeraceae (*Rhizophagus*, *Sclerocystis*) ; *Acaulospora* frequent ; then *Claroideoglomus*; *Funneliformis*...

High dominance of Glomeraceae (in green) in different UF soils

- Originality of UF AMF community species: five new species published; several others to be published.



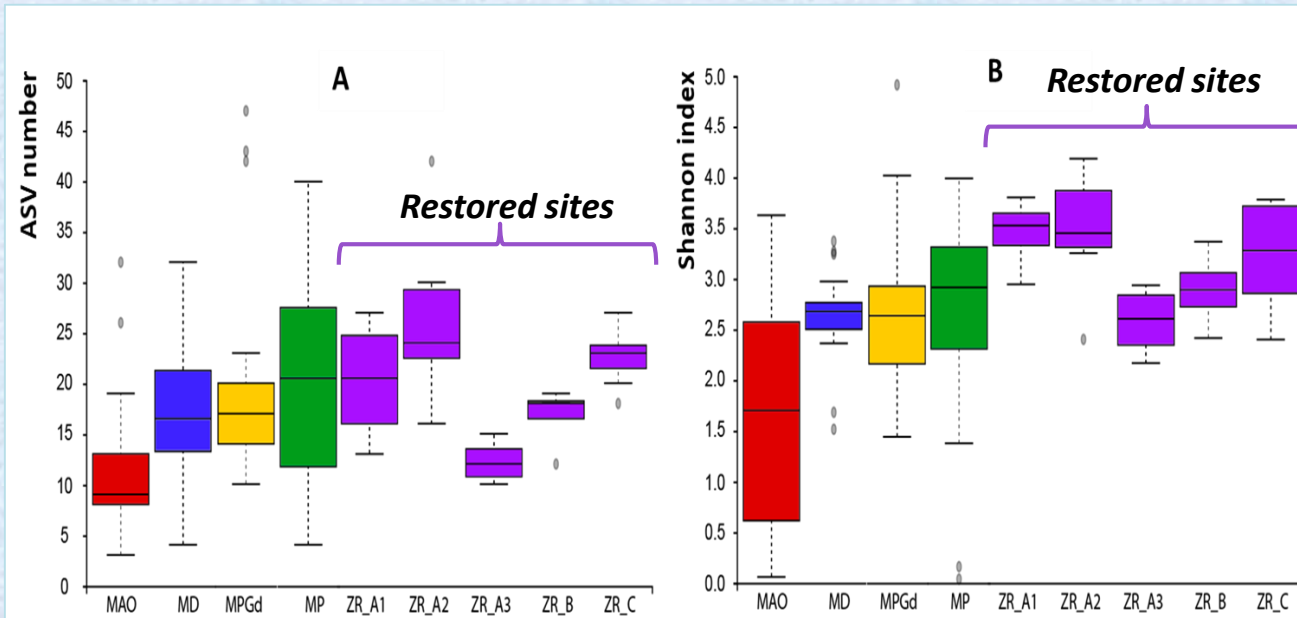
*Rhizophagus neocaledonicus* (Crossay et al. 2018).



Spores de *Scutellospora ovalis* (Crossay et al. 2018).

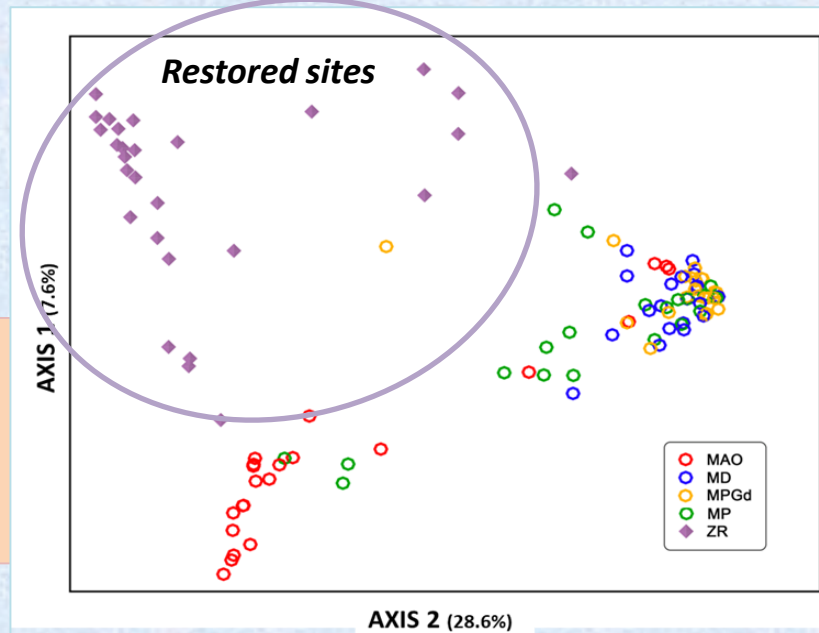
(Gensous 2014; Amir et al. 2015; Cavaloc et al. 2019)

- Analysis of AMF communities in restored ecosystems without topsoil : quantitatively similar to nearby non-degraded ecosystems, but **qualitatively different**.



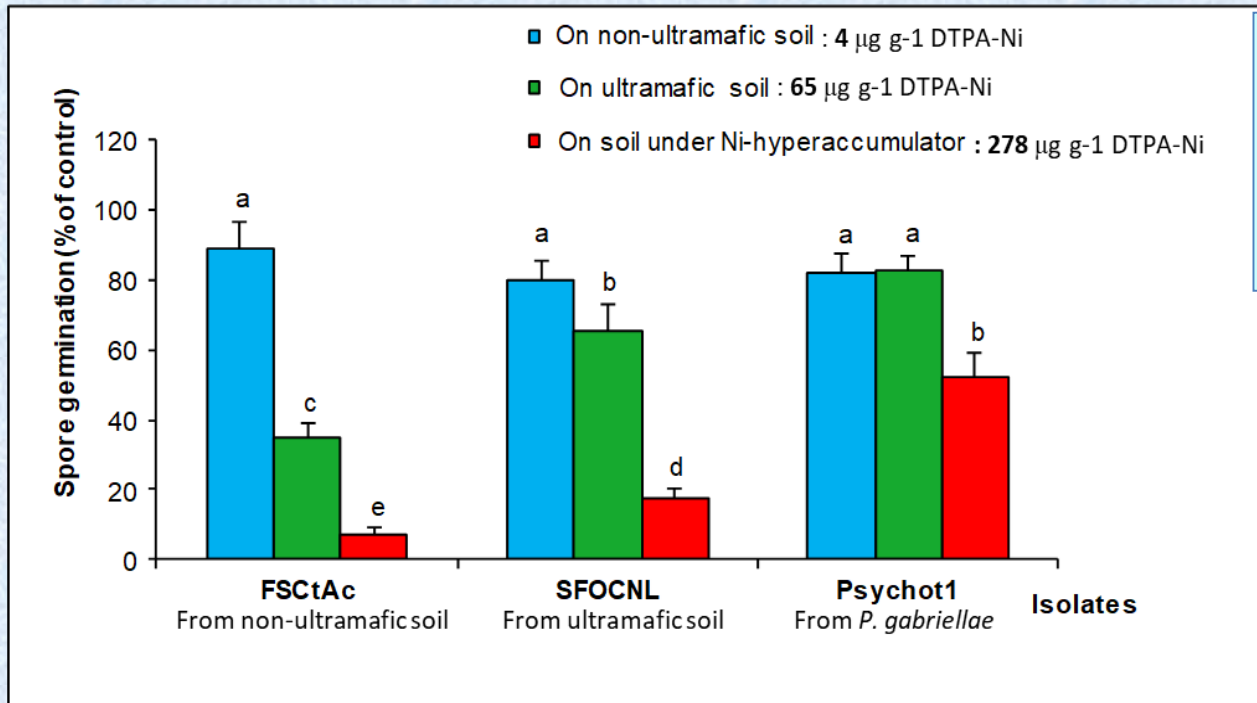
AMF diversity in soils of 5 restored sites (ZR) and 4 nearby reference natural ecosystems (MAO to MP). (A) ASV numbers, and (B) Shannon index

Non-metric multidimensional scaling analysis (NMDS) based on Bray-Curtis dissimilarity index for AMF communities in soils of 5 restored sites (ZR) and 4 nearby reference natural ecosystems (MAO to MP).



### 3- Adaptation of AMF to UF soils

- Experiments clearly showed **high adaptation of native AMF to UF soils**:



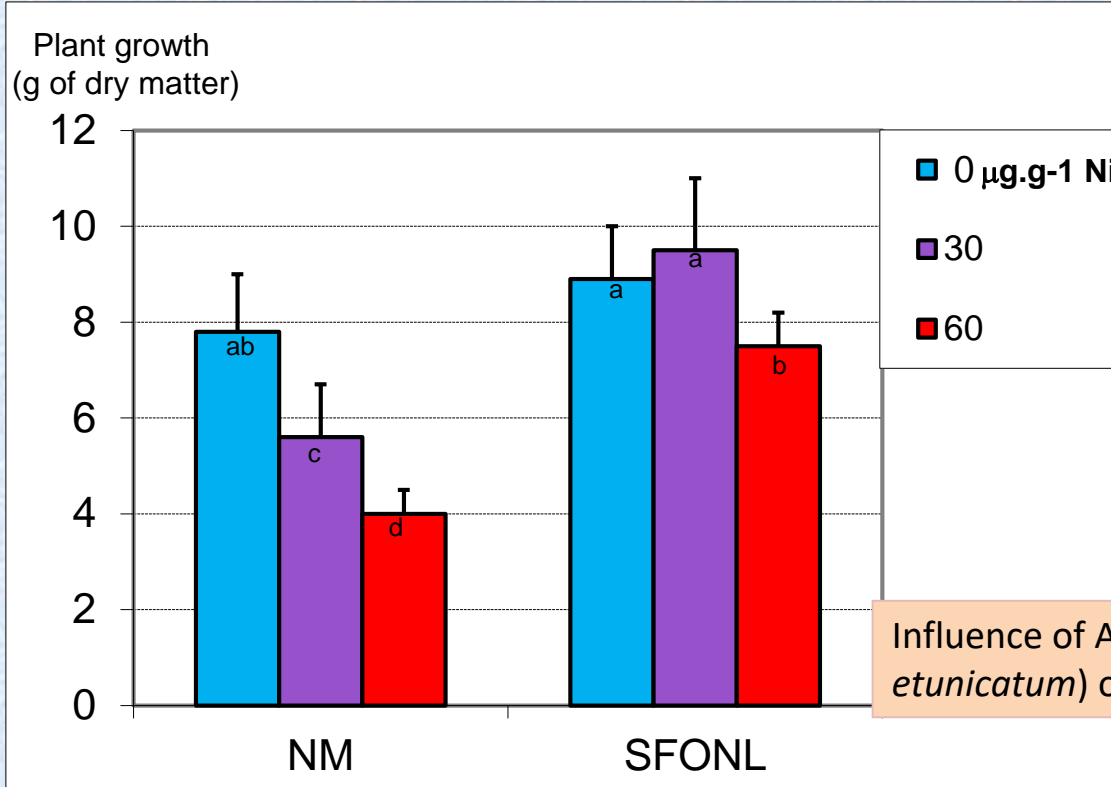
*Influence of different soils on spore germination of three AMF isolates from New Caledonian ultramafic and non-ultramafic soils*



- **AMF isolates from ultramafic soils more tolerant to Ni than non-ultramafic ones.**
- **AMF isolates from roots of *P. gabriellae* more tolerant to Ni than the two others.**

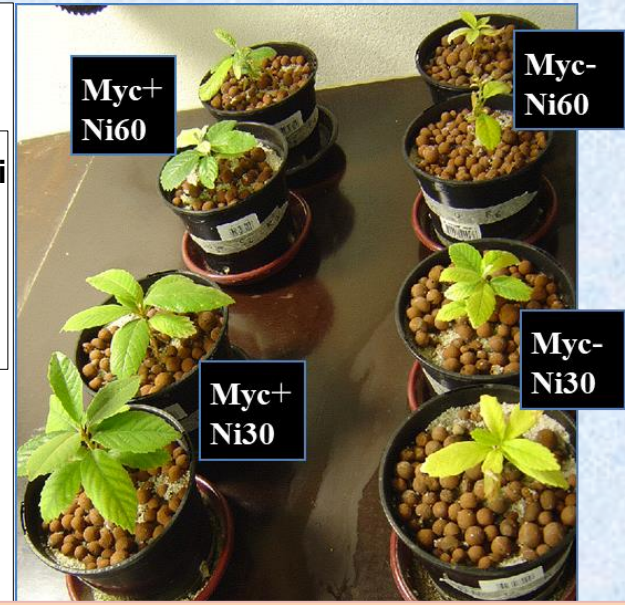
# 4- Effects of AMF on plant growth and adaptation to UF soils

- AMF increase metal tolerance of native plant species:



Influence of AMF isolate SFONL (*Claroideoglossum etunicatum*) on tolerance to Ni of *Alphitonia neocaledonica*

(Amir et al. 2013)



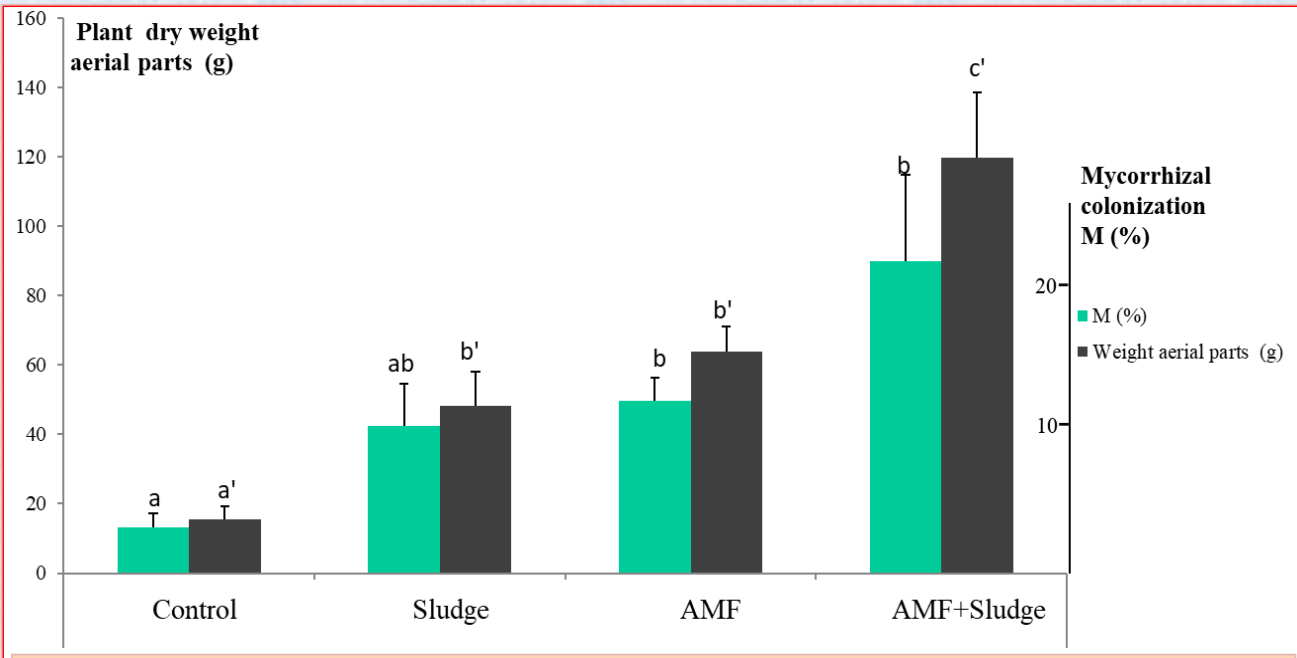
- AMF increase mineral nutrition and growth of UF plant species:

Influence of AMF isolate PSB1 (*Claroideoglossum etunicatum*) on *Metrosideros laurifolia* growth





- **Field experiments demonstrated the high benefit effects of AMF on plant growth and adaptation to UF soils:**



Relation between dry weight and mycorrhizal colonization (AMF) of *M. laurifolia*, at the end of the experiment in Goro; here combined with sewage sludge.

**Increase of:**

- P, N, K and Ca uptake
- Ca/Mg ratio

**Reduction of:**

- Mn, Co and Ni translocation



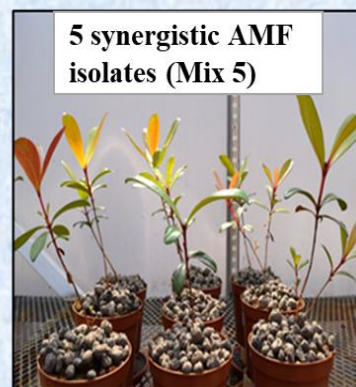
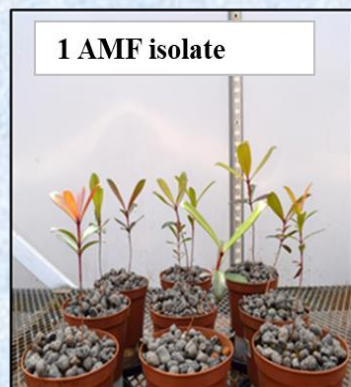
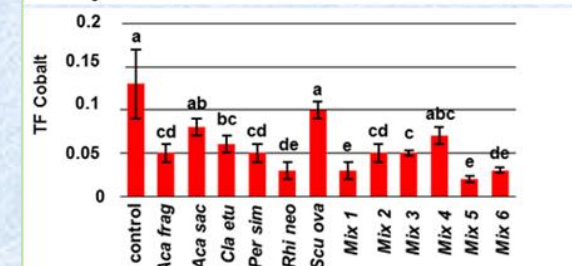
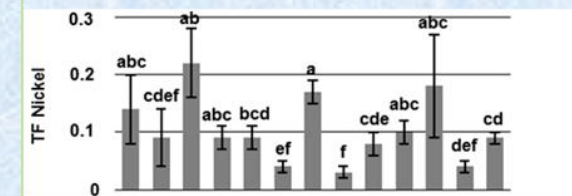
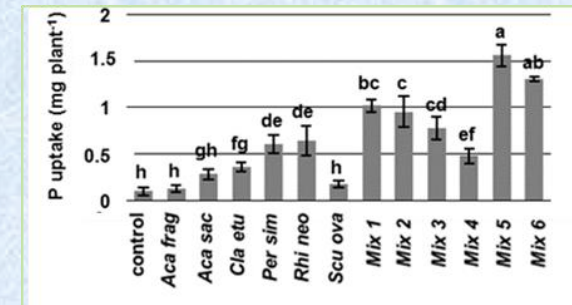
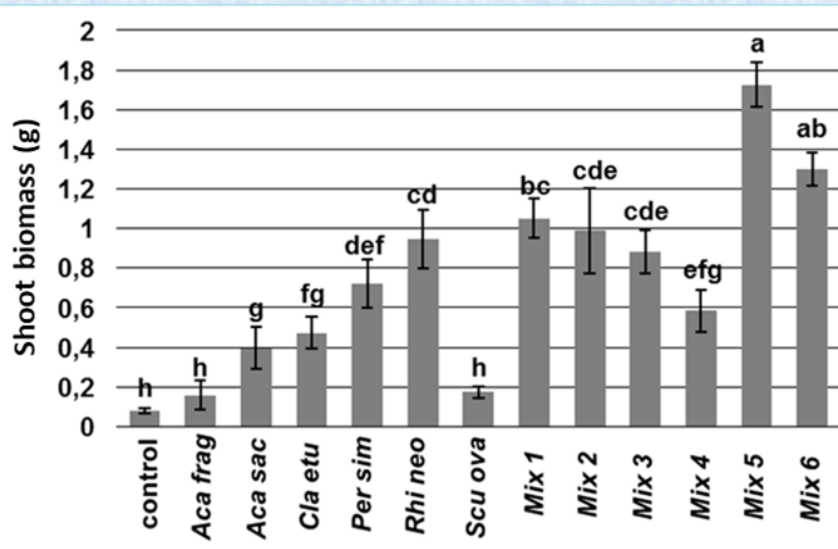
## - Study on synergy effects of different AMF species:

Positive effects of AM symbiosis greatly increased by using mix of AMF isolates phylogenetically distant (different families), with complementary eco-physiological features, showing the role of functional diversity.

Differed in :  
mycorrhizal  
colonization capacity,  
sporulation, effects on  
plant mineral  
nutrition, effect on  
metal translocation

Mix 5 =

*Rhizophagus neocaledonicus*  
+ *Scutelospora ovalis*  
+ *Pervetustus simplex*  
+ *Claroideoglomus etunicatum*  
+ *Acaulospora saccata*



*Metrosideros laurifolia*

(Crossay et al. 2019)

## 5- Commercial production of efficient native AMF

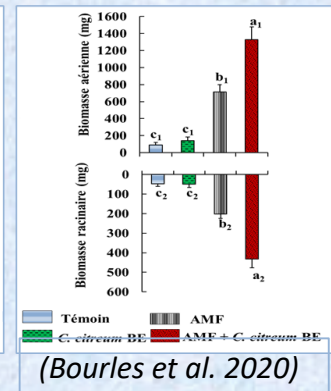
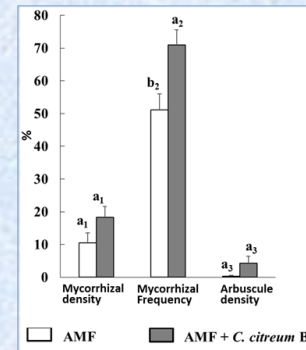
Aura Pacifica a biotechnological company recruited PhD student from ISEA-UNC and worked in partnership to produce and commercialize at large scale an AMF mixed inoculum based on Crossay et al. (2019)



**Commercial AMF inoculum  
produced by AURA Pacifica,  
in partenariat with iSEA, UNC**

# Conclusion

- Our studies on AMF in UF soils showed the importance of this symbiosis in extreme conditions, here characterized by at least 3 types of stresses: mineral deficiency, metal toxicity and water stress.
- AMF communities are quantitatively important, diversified and original.
- Their effects on plants are determinant to cope with the three stresses.
- importance to manage this symbiosis for ecological restoration of degraded UF soils
- Ongoing studies aim to reinforce the investigations on complementary effects of AMF and bacteria, particularly on mycorrhiza helper bacteria (MHB).



(Bourles et al. 2020)

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Thank you for listening