Microbial interactions control décomposition

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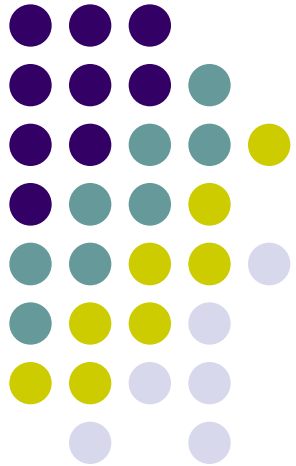
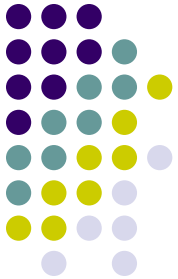


With the contribution of Maron, P.A., Aamor, A., Bdioui, N., Maire, V., Mary, B., Revaillot, S., Tardy, V. & Henault, C.

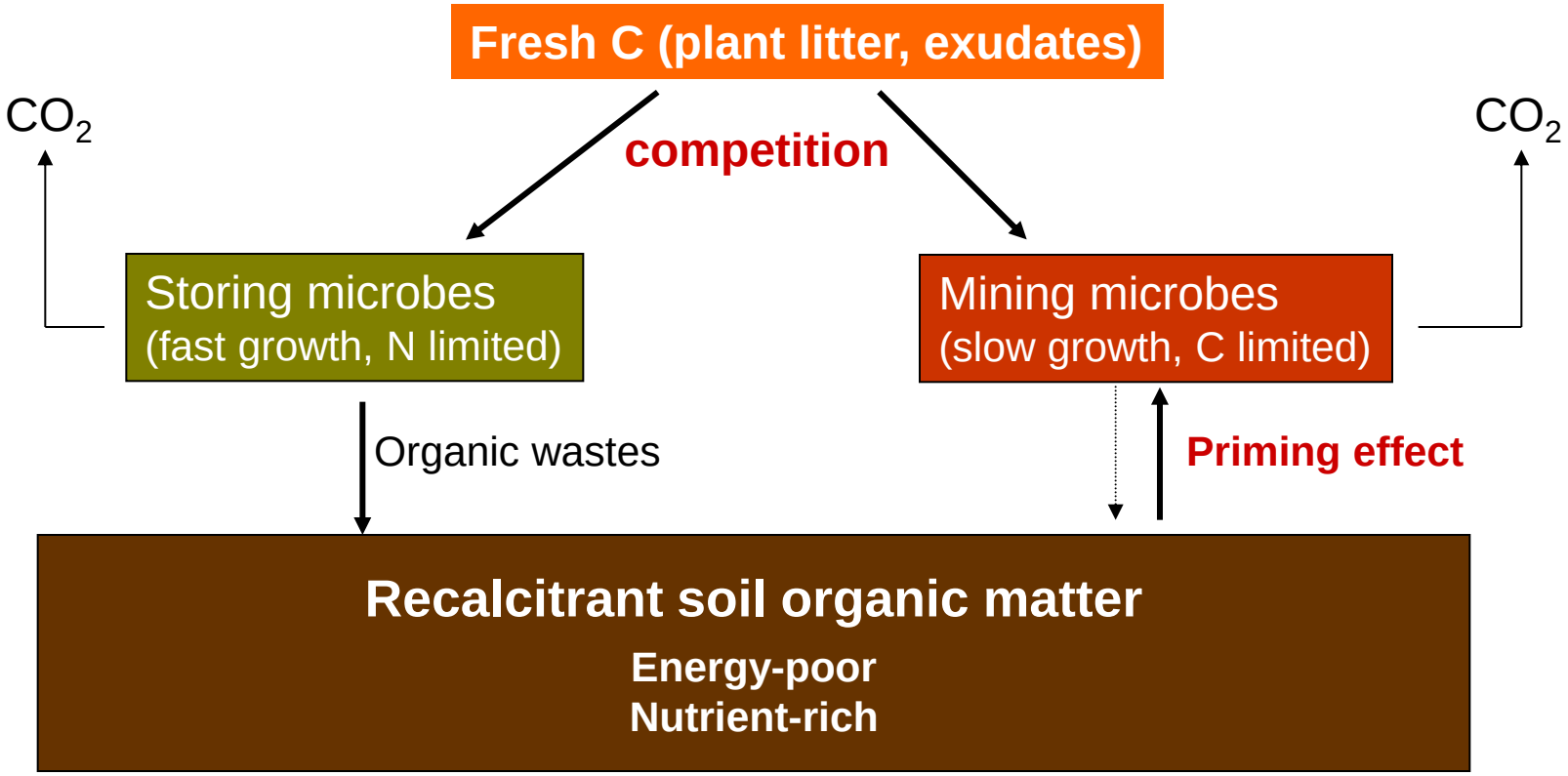
The reasons to reconsider current soil models



- Several phenomena remain unexplained by current models (e.g. Stability of deep C).
- Activity and size of microbial populations limit decomposition:
  - Less than 2-3% of SOM compounds are colonized by microbes.
  - The supply of fresh C stimulates microbial populations and SOM decomposition (priming effect).

Jenkinson et al., 1976; Paul and Clark, 1989; Broadbent, 1947; Bingeman et al., 1953; Wu et al., 1993; Liljeroth et al., 1994; Fontaine et al., 2007; Rasmussen et al., 2007; Kuzyakov et al., 2009

Alternative theory of SOC dynamics



Fontaine et al., Ecol Lett (2005)
Fontaine et al., Nature (2007)

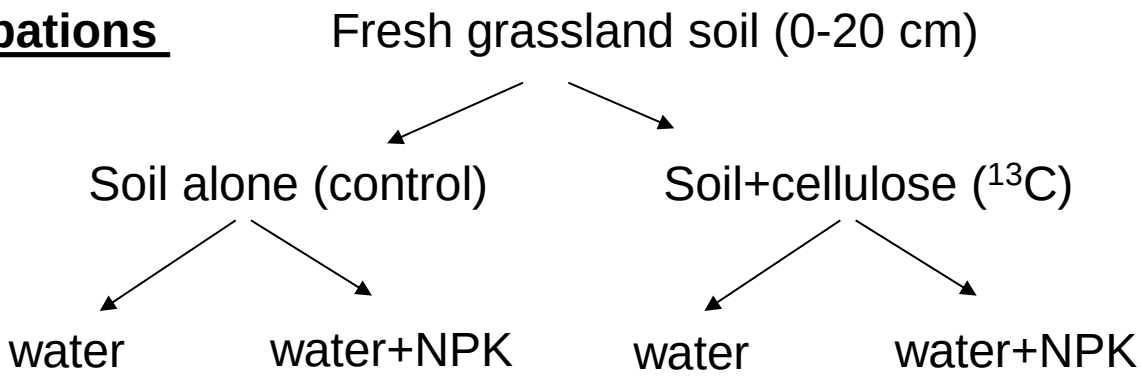
Objectives

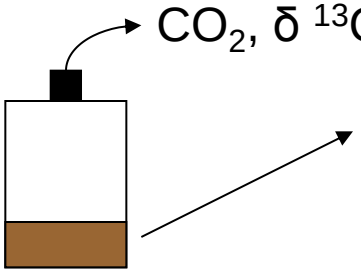
- The objectives of this study were:
  - identifying the microbial populations that control the priming and,
  - testing the theory of “the competition” by identifying different functions (storing/mining) among these populations.

An approach in two steps

- **Experiment 1**: identifying the microbial populations that control the priming effect.

Soil incubations



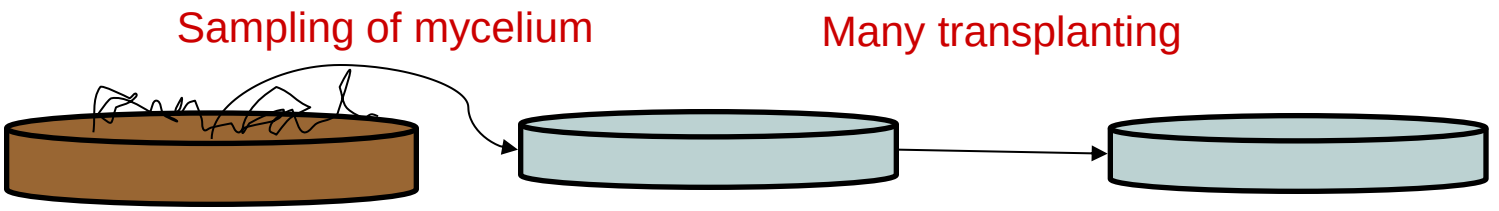


CO_2, δ ^{13}C (Priming measurement)

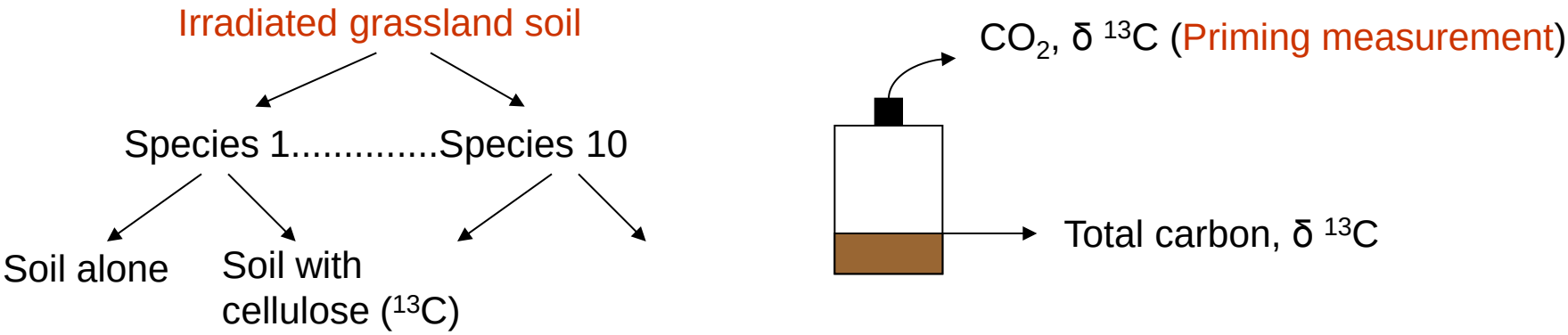
Microbial PLFA
Microbial DNA (B-ARISA and F-ARISA)
Molecular inventory of dominant fungi
(cloning and sequencing of 18S rDNA of fungi)

- **Experiment 2**: who does what?

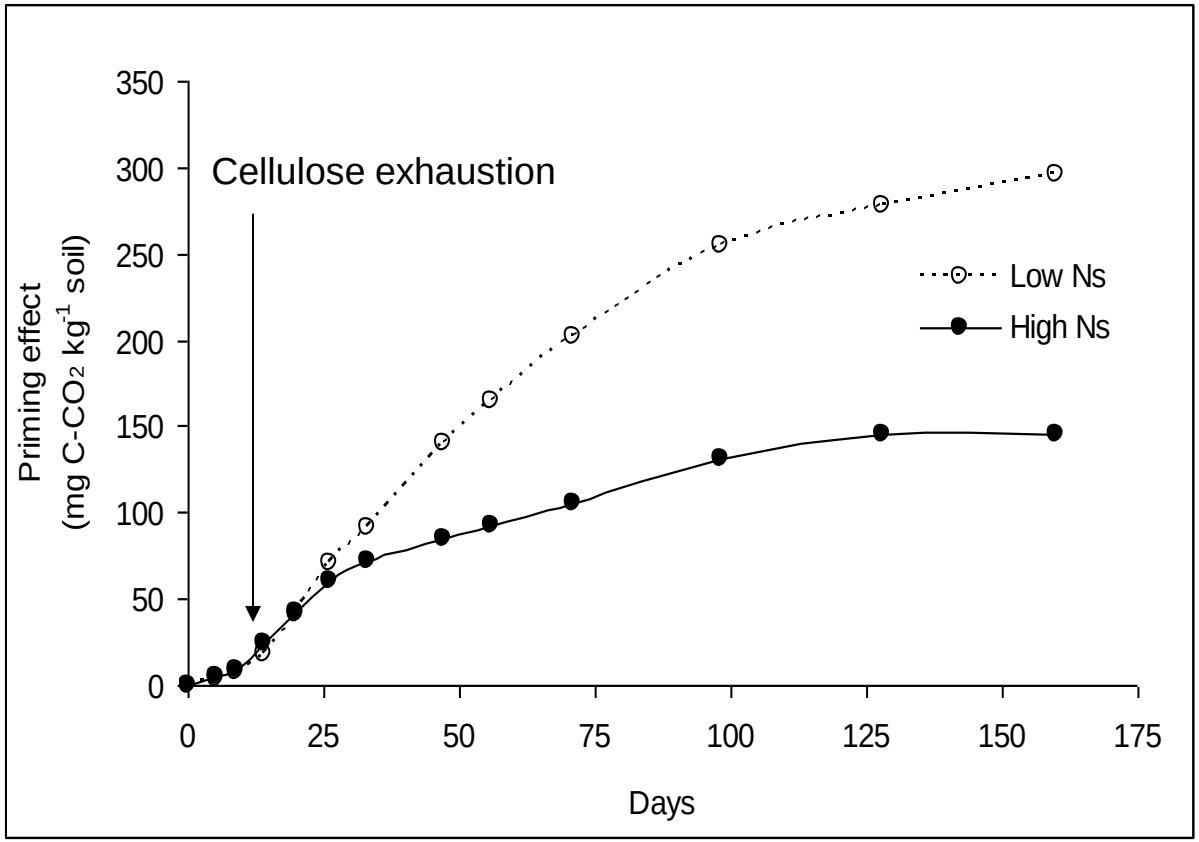
a/ Isolation and identification of cellulolytic fungi



b/ Re-inoculation of fungi to determine their role on SOC (storing/mining).



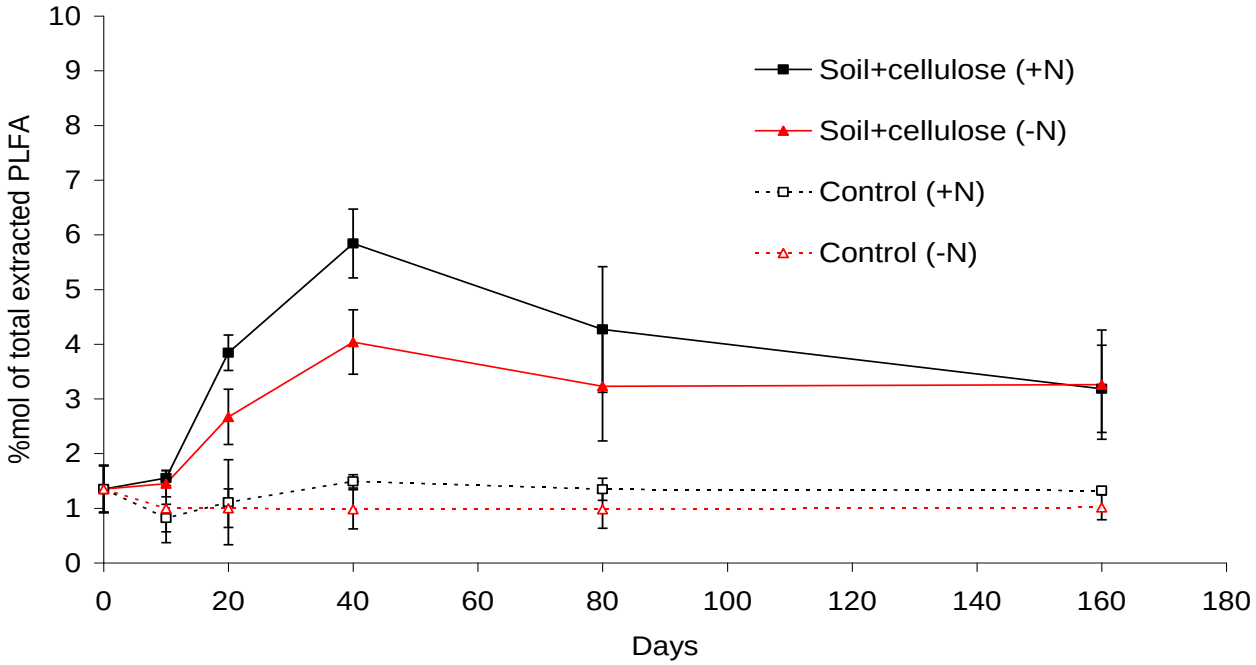
The supply of cellulose induced priming effects.



- ✓ **Cellulose decomposers mine SOC.**
- ✓ **This mining is 2 times higher in the low N treatment.**

Effects of cellulose on microbial community: PLFA method

Fungal biomarker **(18:2w6c)**



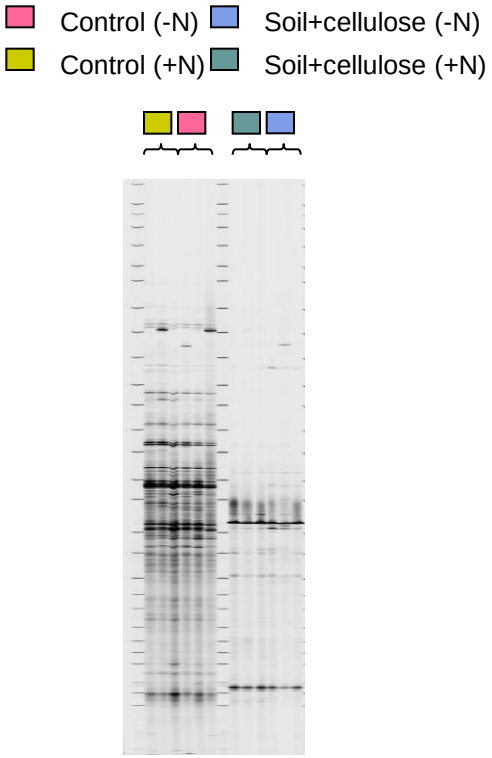
✓ **This suggest that fungi are key actors of cellulose decomposition and SOM mining.**

Effects of cellulose on microbial community: ARISA method

1./ The B-ARISA band profiles were not affected by the supply of cellulose.

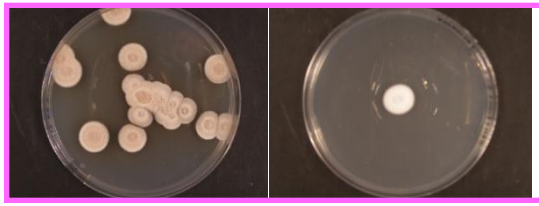
2./ The F-ARISA band profiles were strongly simplified by the supply of cellulose.

F-ARISA results for the day 40

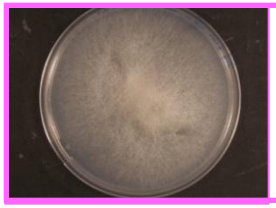


✓ This indicates that few different populations of fungi are involved in the priming.
✓The molecular inventory identified two major populations : *Geomyces pannarum, Humicola fuscoatra* (data not shown).

Isolation of 17 strains (6 genus)



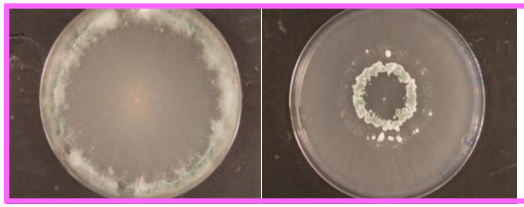
Geomyces pannorum



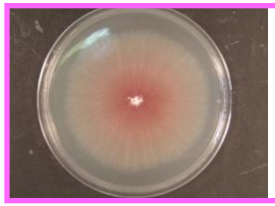
Mucor hiemalis

Humicola fuscoatra

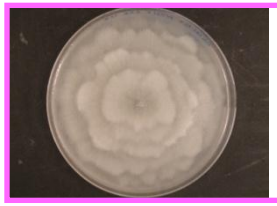
Bionectria ochroleuca



Trichoderma sp



Fusarium oxysporum



Unknown species

Isolated species have contrasted growth rates, from 2 mm d^{-1} for *Humicola fuscoatra* to 12 mm d^{-1} for *Trichoderma sp.*

Who is who?

Species	Priming effect	Quantity of soil ^{12}C (mg C kg^{-1})	
Trichoderma sp	No		Storing microbes
Mucor hiemalis	No		
Geomyces pannorum	No		
Humicola Fuscoatra	No		
Trichocladium asperum	No		
Zygomycete sp	No		
Fusarium oxysporum	Yes	62 ± 26	Mining microbes
Bionectria ochroleuca	Yes	89 ± 10	
Nectria lugdunensis	Yes	117 ± 23	
Zygorhynchus moelleri	Yes	140 ± 48	
Mixture of fungi	Yes	72 ± 20	

Preliminary results for 190 days of incubation

✓ This shows the existence of two distinct microbial functional groups (Mining and storing microbes).

Conclusions

- Fungi are the key actors of cellulose decomposition and SOM mining.
- We show the existence of two distinct microbial functional groups having opposed functions (Mining, storing) regarding to SOM.
- SOM dynamics are controlled by interactions between these two microbial groups.

Perspectives

- Several projects devoted to determine:
  - The roles of microbial interactions in the regulation of cycles in ecosystems (Soil as a bank, feedback buffering the impact of warming).
  - The impact of diversity loss in cultivated soils on these processes.
  - Molecular markers (DNA micro arrays) allowing to follow these key decomposers and the priming in ecosystems.

Funded projects: DIMIMOS et BIOMOS (french ANR agency), NitroEurop and Carbo-extreme.

What is the effect of cellulose supply on soil C storage?

	Nitrogen treatments	
	High N	Low N
New soil C (^{13}C)	232 ± 17	235 ± 21
Old soil C (^{12}C) lost by the priming effect	145 ± 16	296 ± 9
Soil C balance	**+87**	**-61**

in mg C kg^{-1} after the addition of 1000 mg cellulose.

✓ **Carbon input to soil may decrease soil C content because of the priming effect.**

✓ **The availability of nitrogen controls the direction of soil C change.**