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Plant interactions as biotic drivers of intraspecific variability in leaf litter traits and decomposability of a foundation tree species (*Quercus petraea*)

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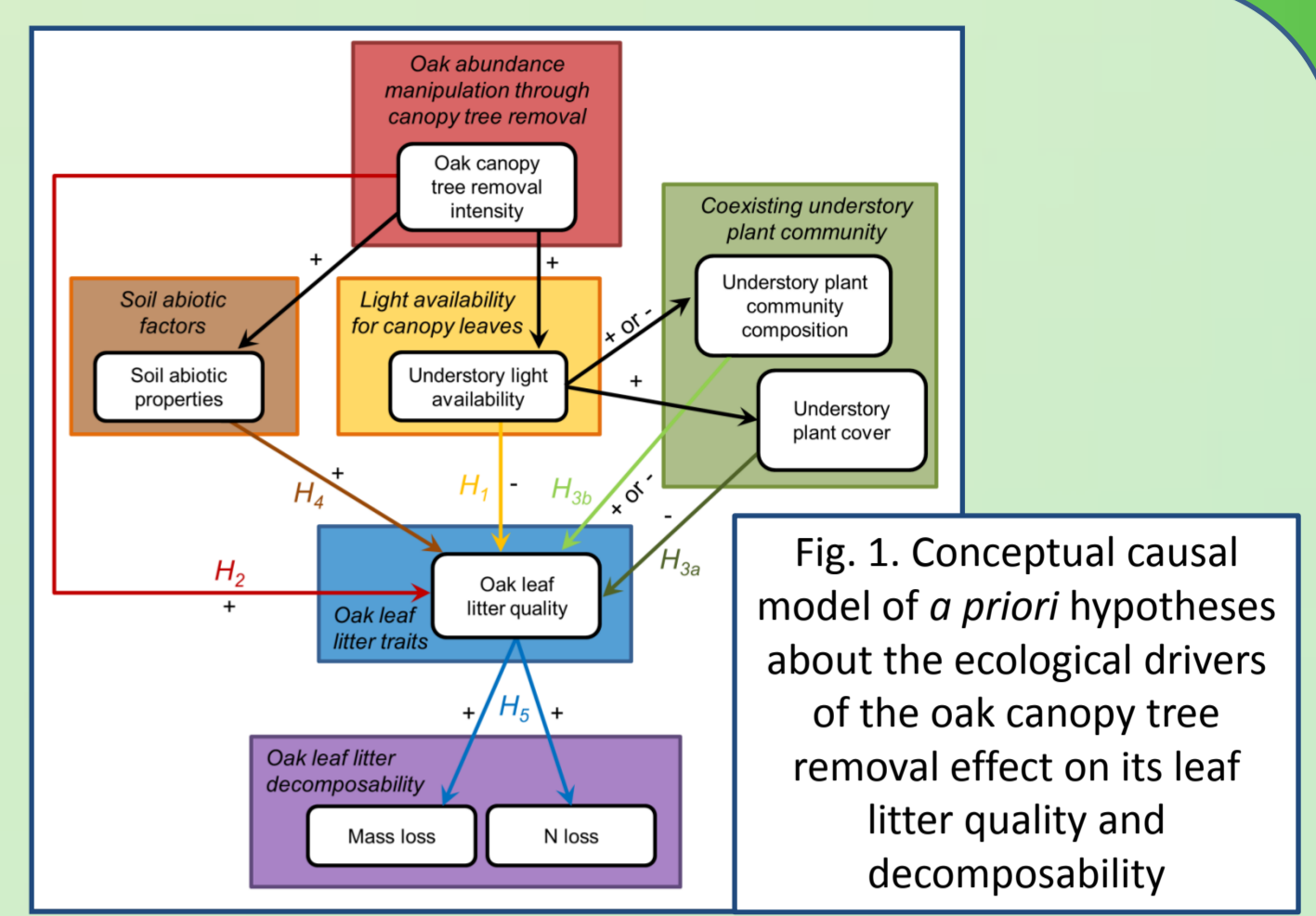
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Context & scientific issues

- **Leaf litter traits and decomposability** are increasingly recognized as an 'extended' phenotype affecting plant community dynamics and ecological processes through plant-litter-soil feedbacks.
- **Intraspecific trait variability** can be an important source of functional diversity. While the role of genetic variability and environmental conditions, *i.e.* mostly soil abiotic factors, as sources of intraspecific variation in leaf litter traits and decomposability has been explored, very few studies have focused on the effect of **biotic factors such as plant neighbor identity and abundance and plant-plant interactions**.
- **Removal experiments** can be useful tools to manipulate species abundance in real ecosystems and to study the effect of altering plant interactions. Hence, the **removal of oak canopy trees** can affect oak leaf litter quality by altering: competition for light among trees (H_1); competition for nutrients among trees (H_2); competition for nutrients between trees and coexisting understory plants (H_3), either related to abundance changes (H_{3a}) or shifts in species composition (H_{3b}) of understory plants; soil abiotic properties alterations (H_4).

Aim of the study: to assess how plant interactions control intraspecific variation in oak leaf litter traits and decomposability



Material & methods

Study sites & treatments:

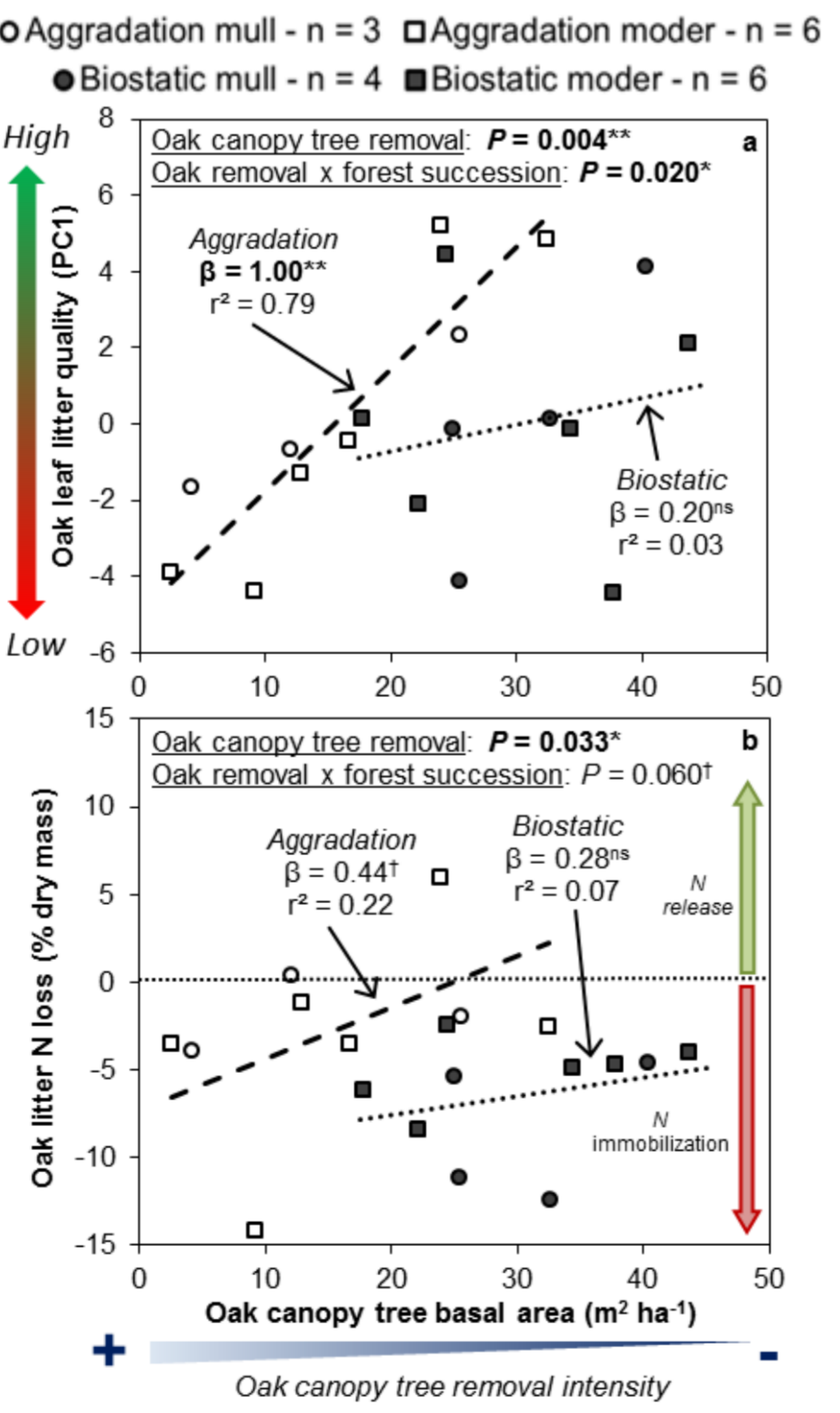
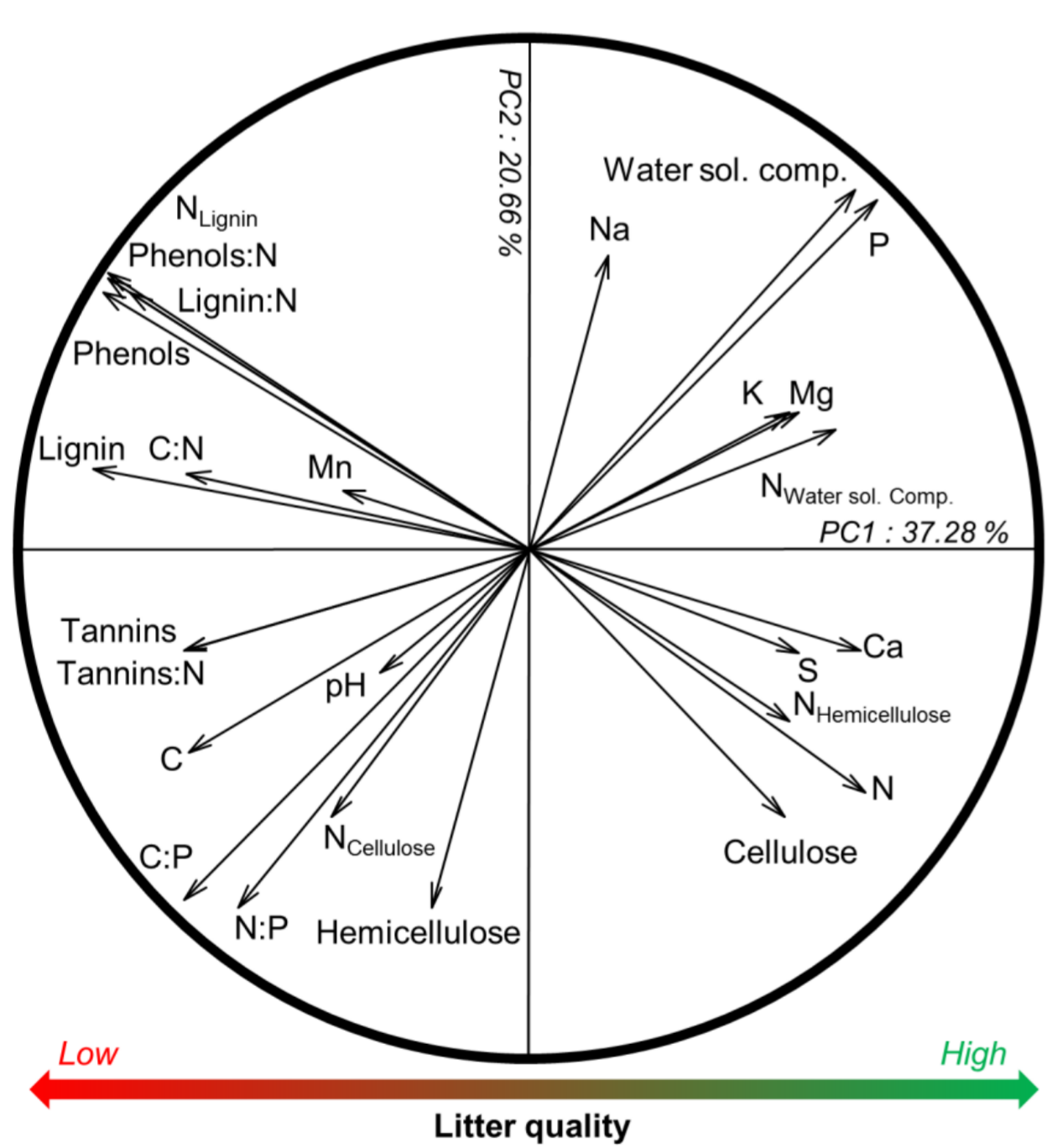
- **Experimental manipulation of oak abundance** through the removal of oak canopy trees using silvicultural-thinning regimes of contrasting intensity (Fig. 2)
- 5 Forest sites located throughout northern France on **contrasted pedoclimatic contexts** (Fig. 3):
 - Oceanic to continental temperate climate
 - Very acidic (moder) to slightly acidic (mull) soil conditions
- Utilization of two complementary **experimental networks**:
 - The Scientific Interest Group - French national cooperative for data on forest growth - oak group (GIS-Coop)
 - The oak network of the Forest and Wood Resource Laboratory (LERFoB)
- 19 sessile oak (*Quercus petraea*) stands studied covering a wide gradient of:
 - **Oak abundance** → 3 to 44 m²·ha⁻¹ (oak canopy tree basal area used as a proxy)
 - **Forest successional stage** → 18 to 171 years old stands
 - ✓ **Aggradation** stage (< 90-year-old) → intense tree height growth and plant competition
 - ✓ **Biostatic** stage (>90-year-old) → maturity of trees



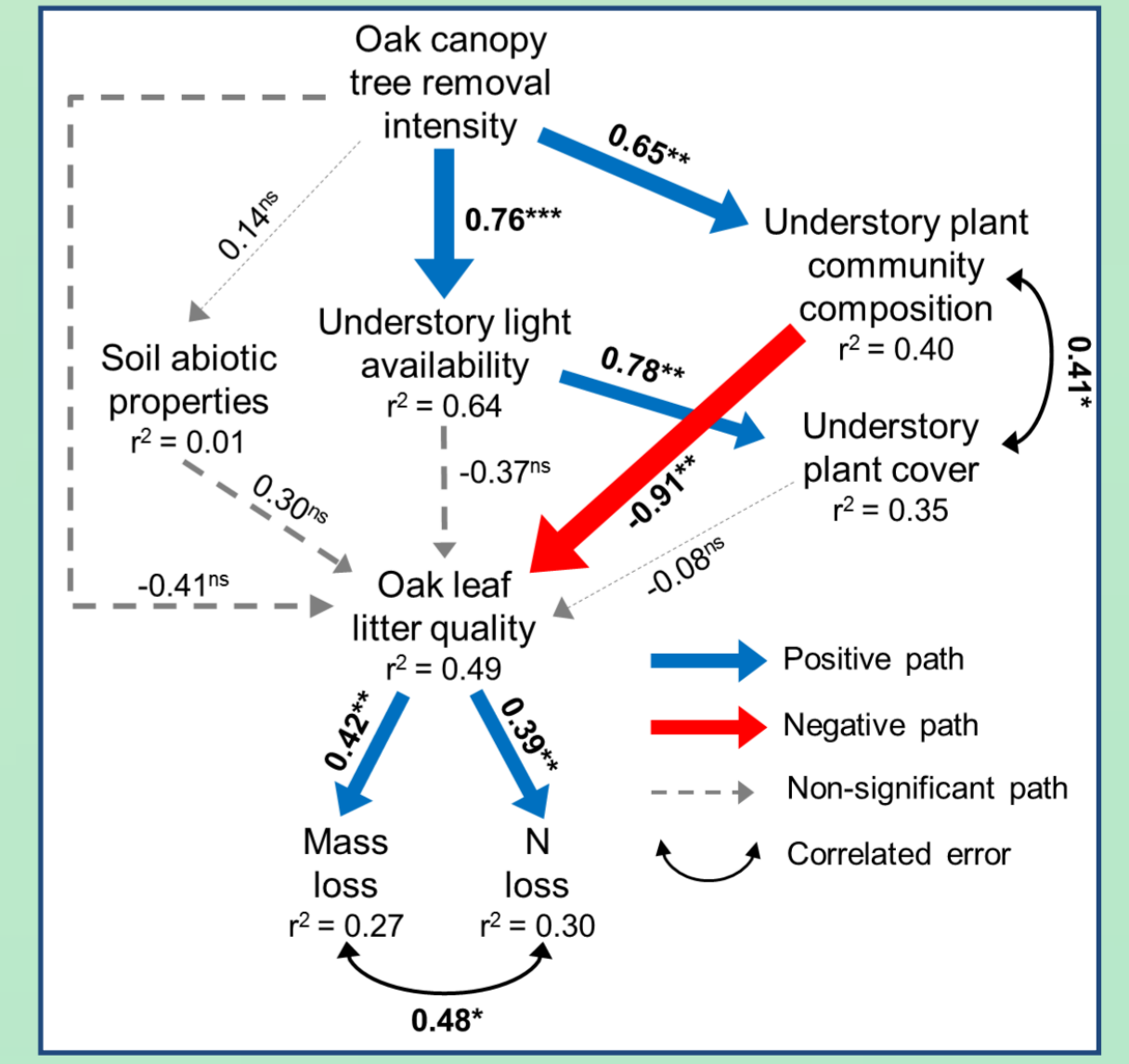
Oak leaf litter sampling and analyses:

- Sampling by **litter traps** (Fig. 4)
- A large set of 26 **litter chemical and biochemical traits** to characterize oak leaf litter quality
- Decomposability of oak leaf litter determined using **standardized *ex situ* decomposition bioassays** (Fig. 5)

Results & discussion



- Oak leaf litter quality strongly declined with tree removal in early forest successional stage, which had important negative consequences for litter decomposability
 - Litter became poorer in nutrients such as N and Mg and richer in secondary metabolites such as total phenolics, condensed tannins and lignin (Fig 6, 7a)
 - Importantly, litter N loss switched from N release to N immobilization (Fig 7b)
- Variance partitioning indicated that oak abundance explained as much variation in oak leaf litter traits as oak age and twice as much as soil abiotic factors
 - This underlines that biotic factors can be more important sources of intraspecific variation in tree leaf litter traits than more commonly recognized soil abiotic factors



- The decline of oak leaf litter quality induced by tree removal was most likely driven by a shift in understory plant community composition (H_{3b} , Fig. 8)
 - This could be due to an increased competition with a more abundant and faster-growing understory plant community with an higher leaf N content
 - We propose that this plasticity of leaf litter traits could be an adaptive strategy of ectomycorrhizal tree species consisting in 'short-circuiting' the N cycling through plant-litter-soil feedbacks in order to preserve their pre-empted nutrient pool of the capture by competing understory plants in the context of treefall gaps.

Conclusions & broader implications

- Our large-scale, multi-site study involving long-term oak canopy tree removal provides clear experimental evidence that **biotic factors such as plant-plant interactions can be strong drivers of plasticity in leaf litter traits**, with important consequences for litter decomposability.
- This finding contributes to the emerging view that **phenotypic plasticity** is fundamentally related to biotic interactions for sessile organisms, especially for long-lived and large plant species such as trees.
 - Taking this source of functional diversity into account could help us to better understand plant community dynamics and ecological processes in terrestrial ecosystems.

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