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Interconnecting Forests, Science and People

IUFRO FOREST ENVIRONMENT DIV 8 CONFERENCE 2023

Impact of five tree species conversion modalities on fungi soil biodiversity as monitored by DNA-metabarcoding in temperate forests

Vincent Moulin, Robinson Ribemont, Fabrice Bureau, Lucas Poullard, Michaël Aubert and Lucie Vincenot

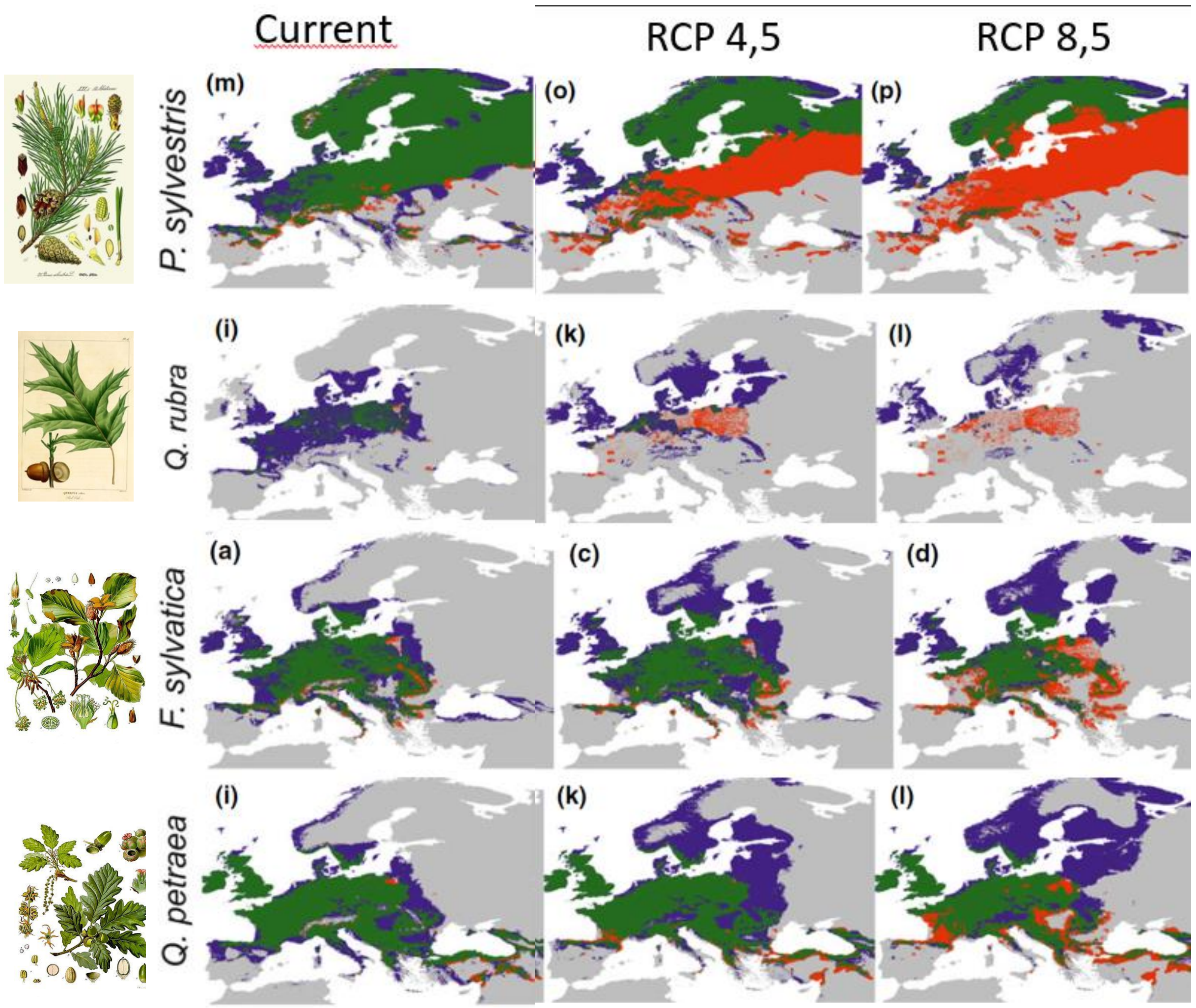
EcoDiv Laboratory,
Rouen Normandy University/INRAE
France

UNIVERSITÉ DE ROUEN NORMANDIE
INRAE la science pour la vie, l'humain, la terre
ECODIV
497 NBISE

Funders:
RÉGION NORMANDIE
l'Europe s'engage en France

Host organisation:
UNIVERSIDADE DE ÉVORA

Projected potential tree species distribution



Potential range expansion

Statu quo

Potential range contraction

Fig2: Projected potential tree species distribution in 2060-2080 from (Dyderski et al., 2018)

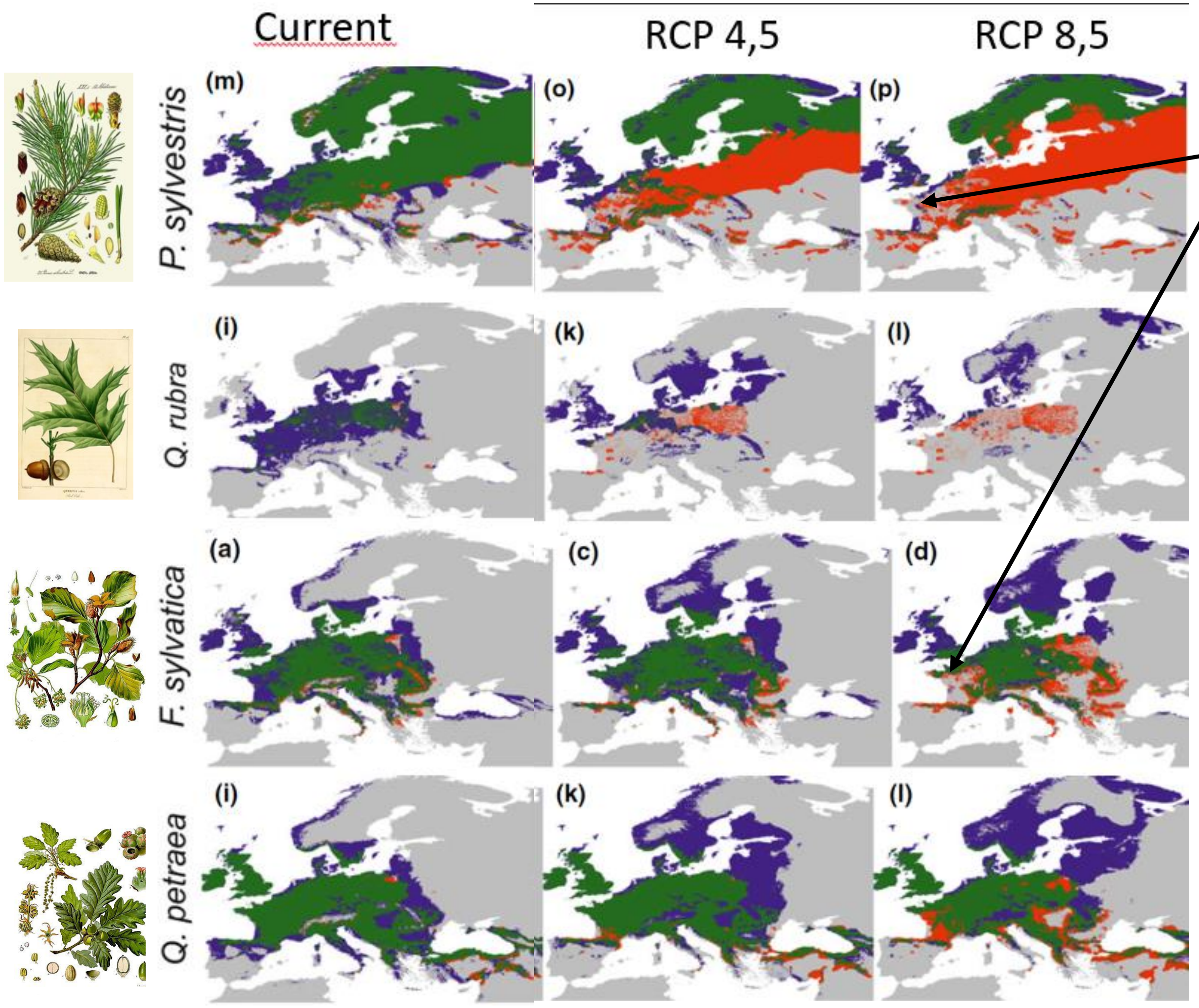
Projected potential tree species distribution

Winner potential species at the **European scale**:

A. alba, ***F. sylvatica***, *F. excelsior*, *Q. robur*,
and ***Q. petraea***

Loser species at the **European scale**:

B. pendula, *L. decidua*, *P. abies*, ***P. sylvestris***, *P. menziesii*, ***Q. rubra***, and *R. pseudoacacia*



Normandy is located at the distribution frontier for *Fagus sylvatica* and *Pinus sylvestris* distribution.

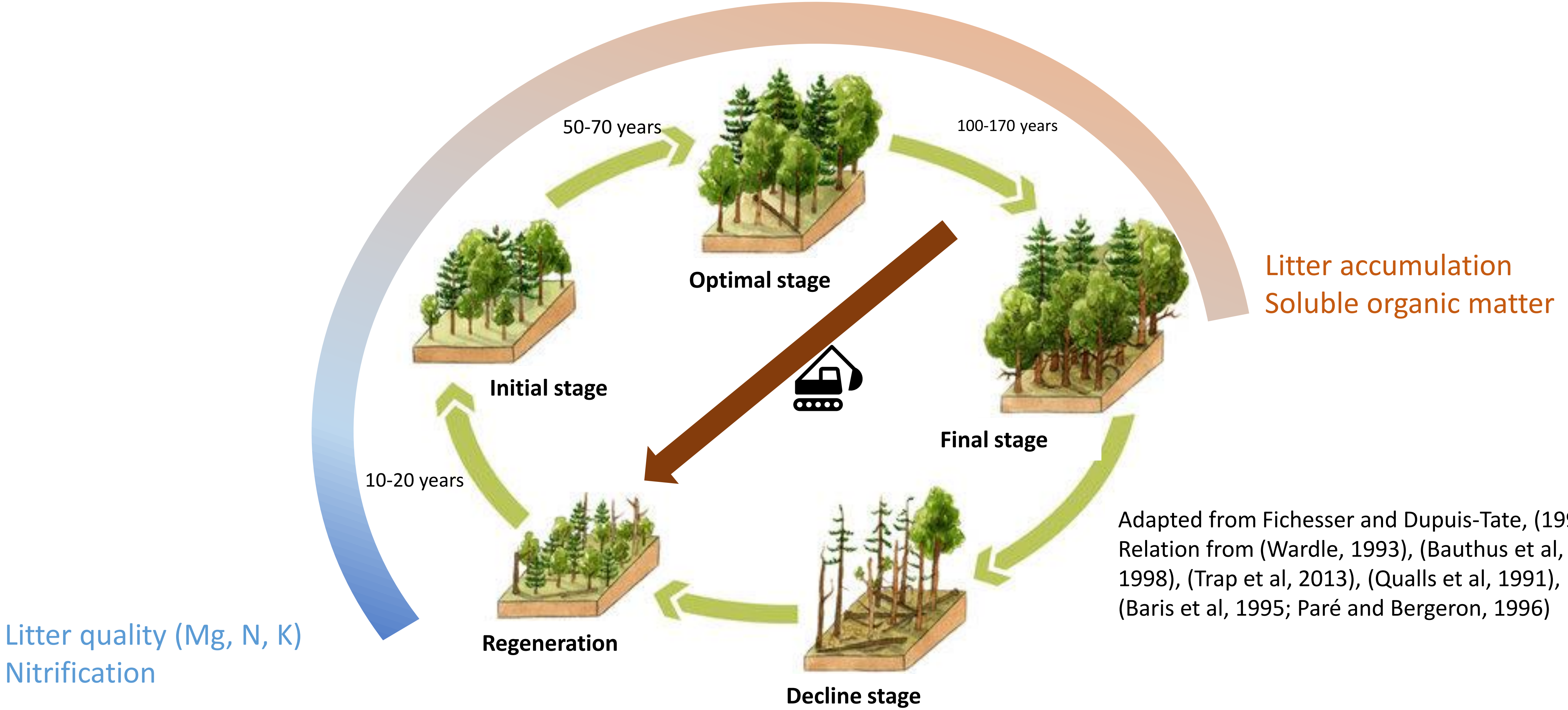
Potential range expansion

Statu quo

Potential range contraction

Fig2: Projected potential tree species distribution in 2060-2080 from (Dyderski et al., 2018)

The theoretical impacts of tree species conversion: 1. Sylvigenetic cycle interruption by rejuvenation



Adapted from Fichesser and Dupuis-Tate, (1996)
Relation from (Wardle, 1993), (Bauthus et al, 1998), (Trap et al, 2013), (Qualls et al, 1991), (Baris et al, 1995; Paré and Bergeron, 1996)

The theoretical impacts of tree species conversion : 2. The tree specie's effect

Inspired from (Elllison et al, 2005)

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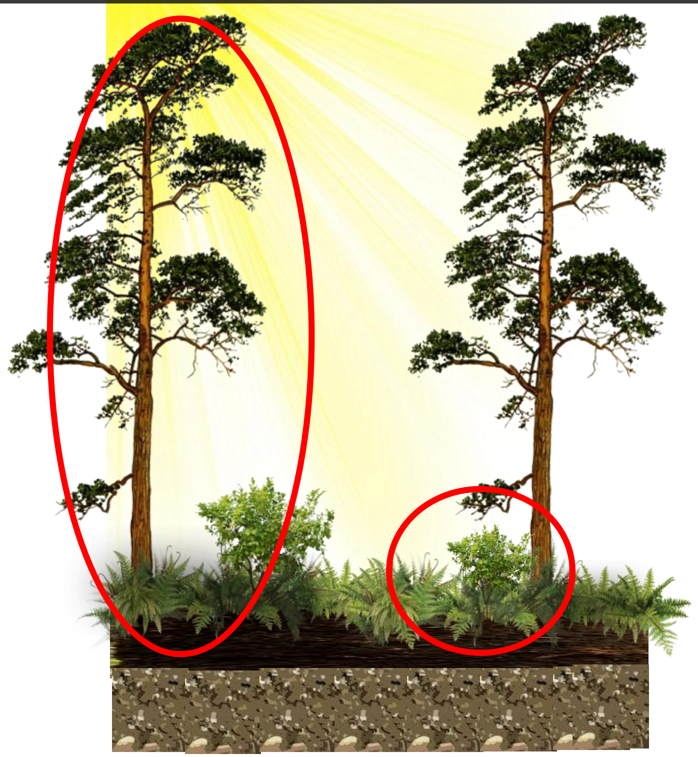
The theoretical impacts of tree species conversion : 2. The tree specie's effect

Tree diversity
Shrub diversity
Basal area



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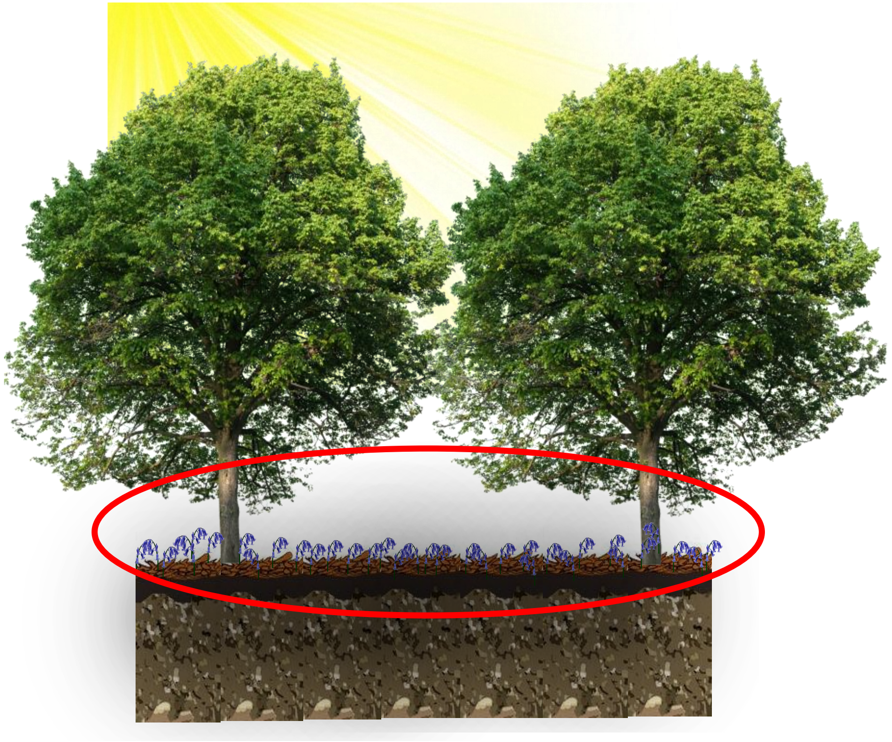
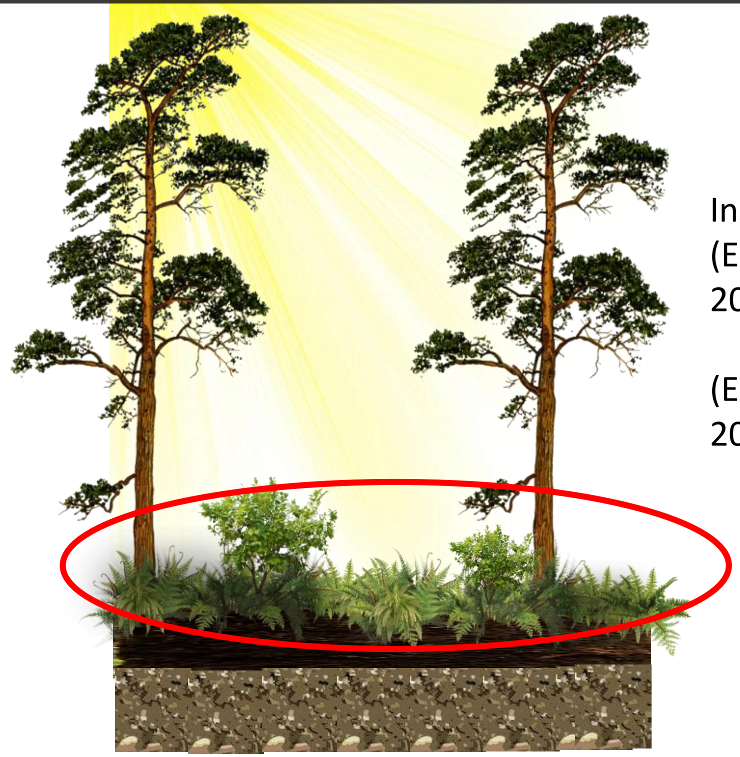


Tree diversity
Shrub diversity
Basal area

Understorey light



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The theoretical impacts of tree species conversion : 2. The tree specie's effect

Tree diversity
Shrub diversity
Basal area

Understorey light

Herbaceous diversity
Moss diversity

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Tree diversity
Shrub diversity

Understorey light

Herbaceous diversity
Moss diversity

Humus form
Soil ph
Root density
Soil nutrients availability
Soil humidity

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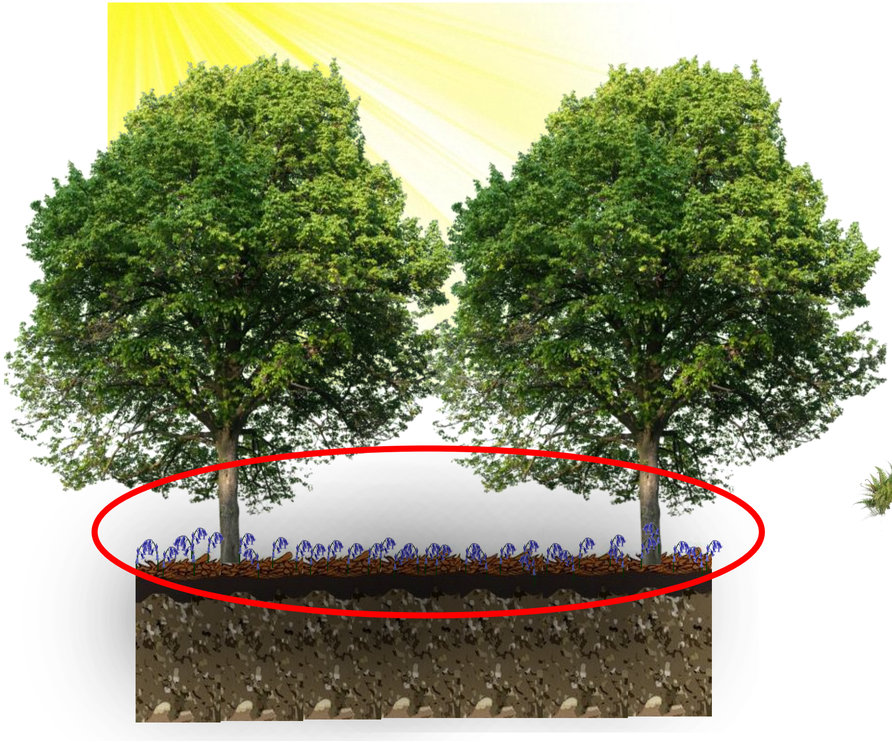
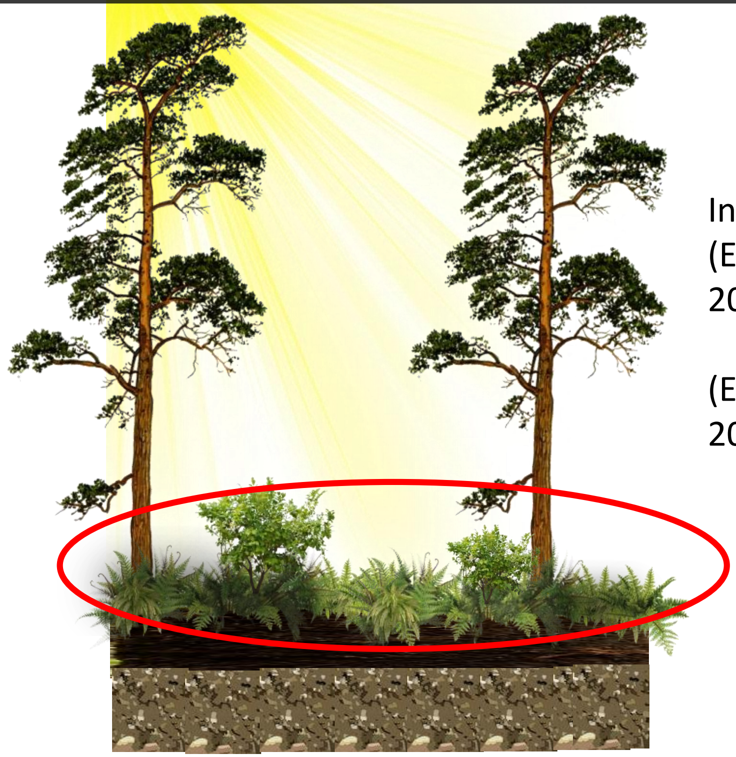


Tree diversity
Shrub diversity

Understorey light

Herbaceous diversity
Moss diversity

Humus type
Soil ph
Root density
Soil nutrients availability
Soil humidity



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Tree species effect is more studied for differences between broadleaf and resinous.

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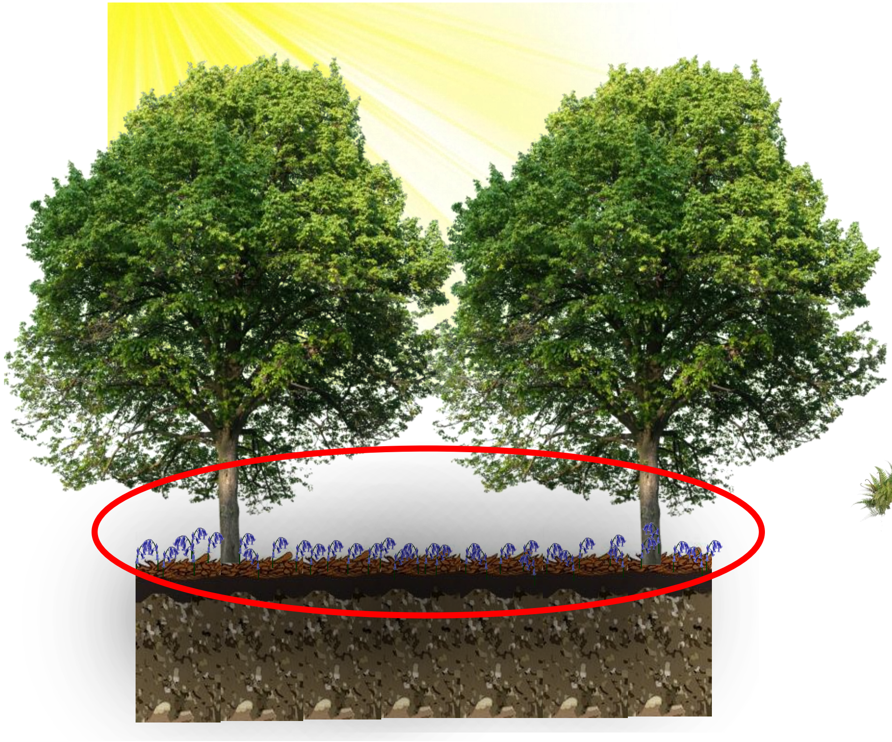

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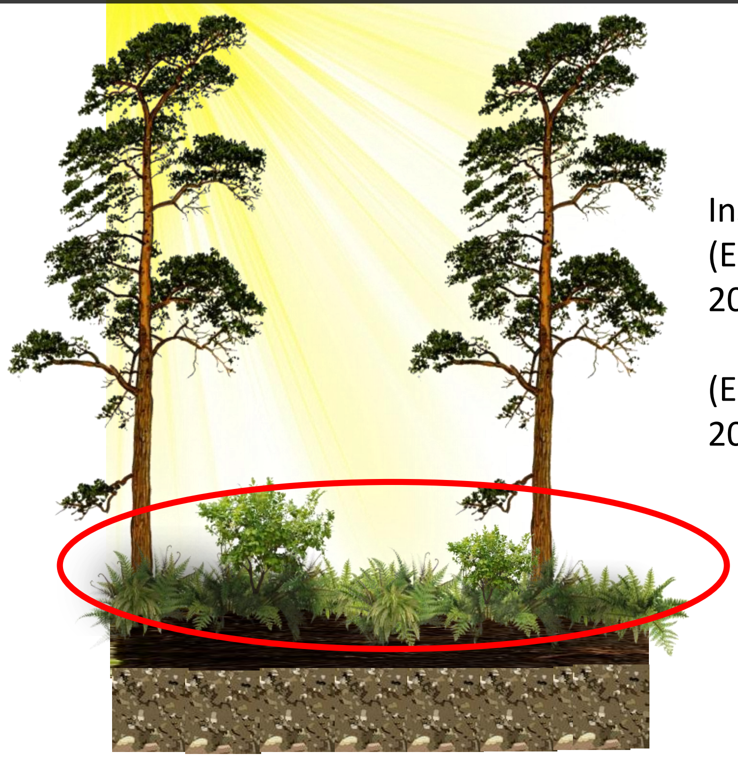

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Few studies are studying the differences inside a category.

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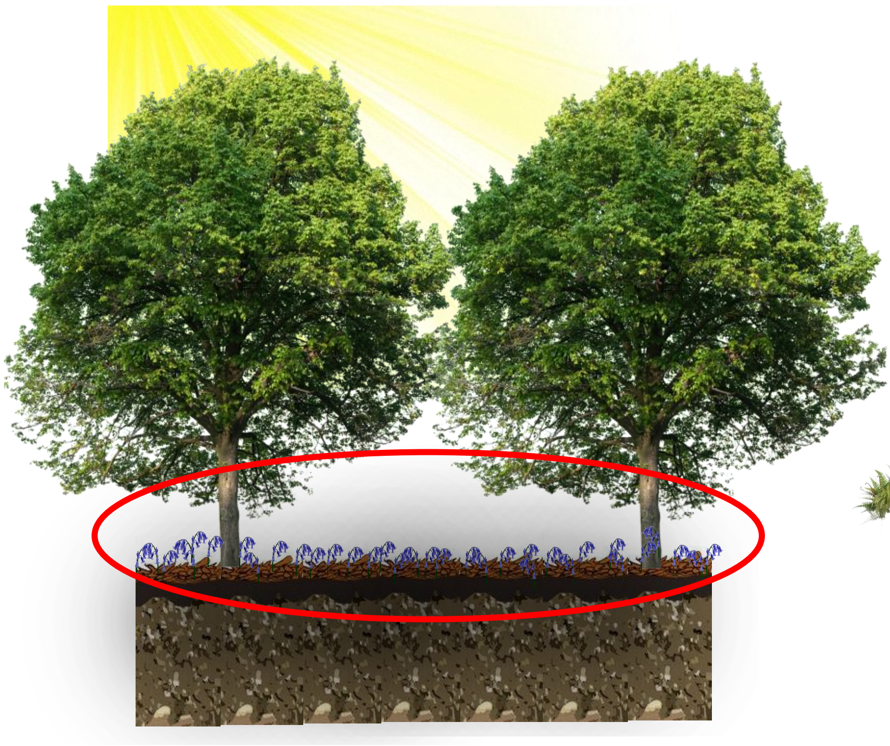

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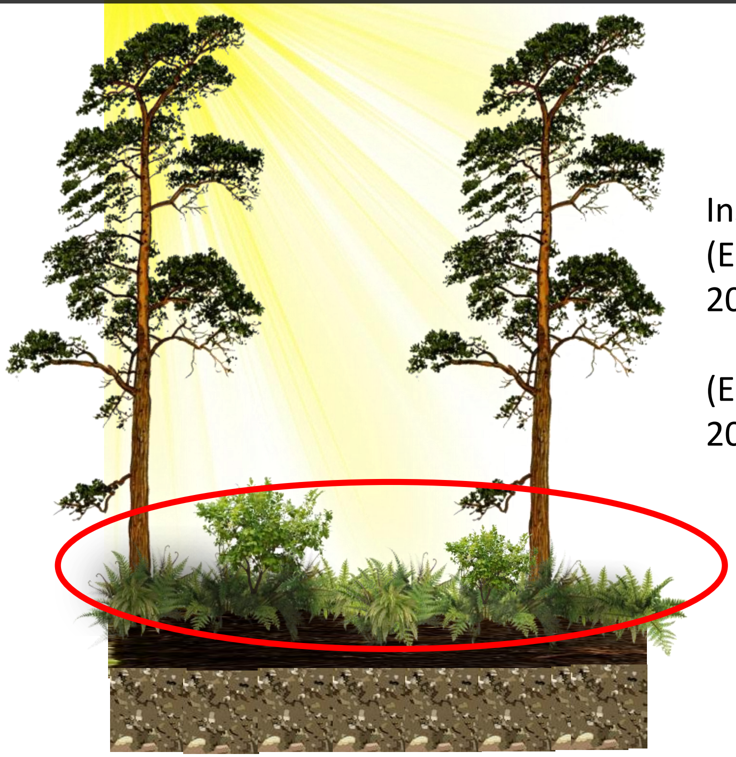

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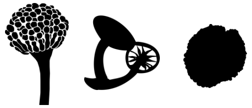
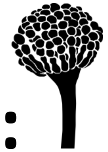
Tree species effect is more studied for differences between broadleaf and resinous.
Few studies are studying the differences inside a category.
And fewer for the impact on fungi.



Soil fungi biodiversity and their functions:

- **Studied soil fungi phyla:**

Ascomycota:  Include saprotrophs, necrotrophic and biotrophic parasites of plants and animals, symbionts (lichens, endosymbionts and ectomycorrhiza).

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Basidiomycota  Include saprotrophs, symbionts (ectomycorrhiza), necrotrophic and biotrophic parasites of plant and fungi.

Soil fungi biodiversity and their functions:

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Basidiomycota  Include saprotrophs, symbionts (ectomycorrhiza), necrotrophic and biotrophic parasites of plant and fungi.

Mortierellomycota  Their relative abundance decreases with P (Li X. et al, 2021). *Mortierella sp.* can transform phosphorus from insoluble to soluble form. (Osorio et al, 2013).

stoniness

Experimental design: Conversion from aged *Fagus sylvatica*

Soils:

Ancient alluvial terraces of the Seine

Oligotroph soils with sand alluvial material. Variable stoniness

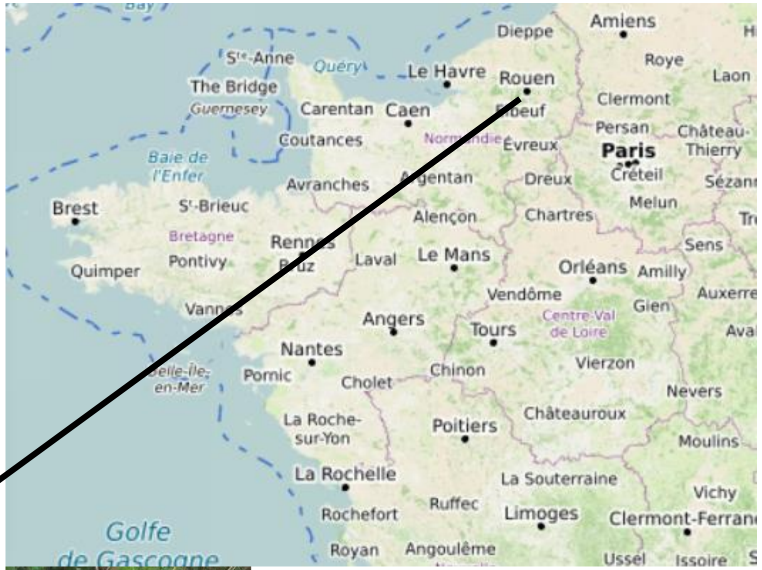
stoniness

Experimental design: Conversion from aged *Fagus sylvatica*

$\bar{x}$ = 134 years

N=8

Fagus sylvatica



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Fagus sylvatica

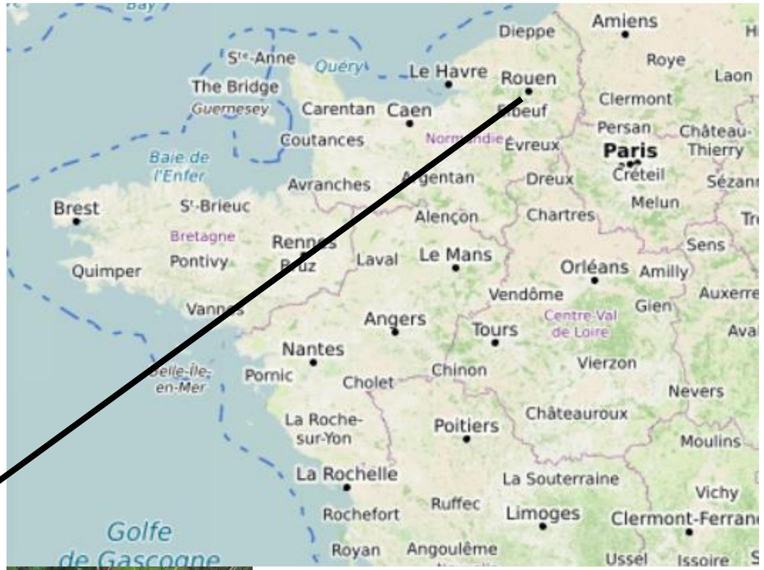
N=6

$\bar{x}$ = 134 years

N=8

Fagus sylvatica

Rejuvenation effect



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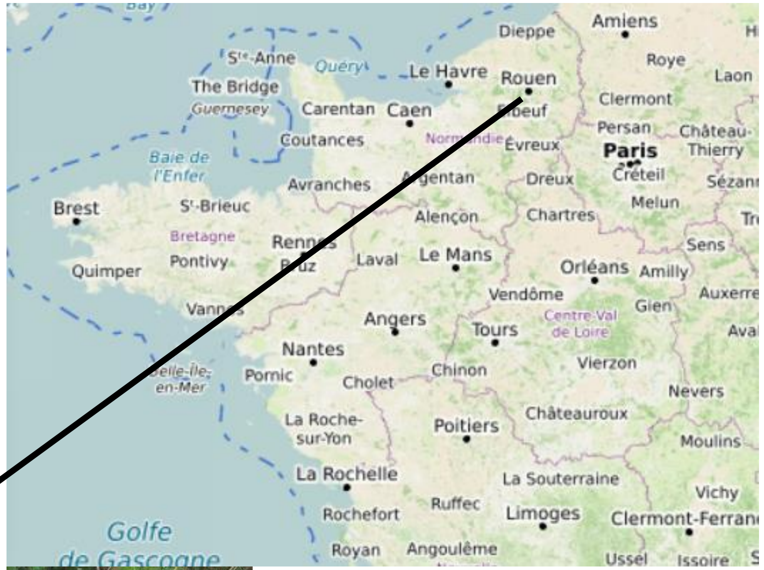
Fagus sylvatica

$\bar{x}$ = 25 years

N=8

Quercus petraea

Tree specie effect



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Fagus sylvatica

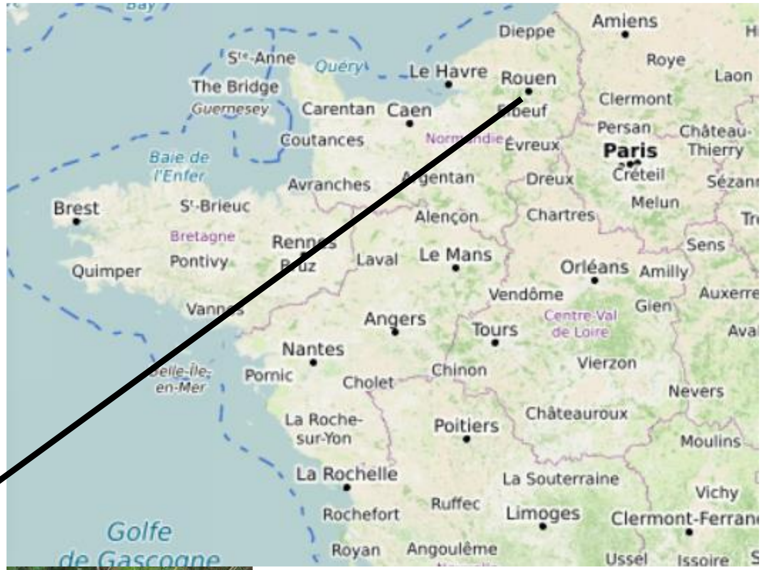
$\bar{x}$ = 25 years

N=8

Quercus petraea

N=3

Quercus petraea unevenaged management



Soils:
Ancient alluvial terraces of the Seine
Oligotroph soils with sand alluvial material. Variable stoniness

Experimental design : Conversion from aged *Pinus sylvestris*

Soils:

Ancient alluvial terraces of the Seine

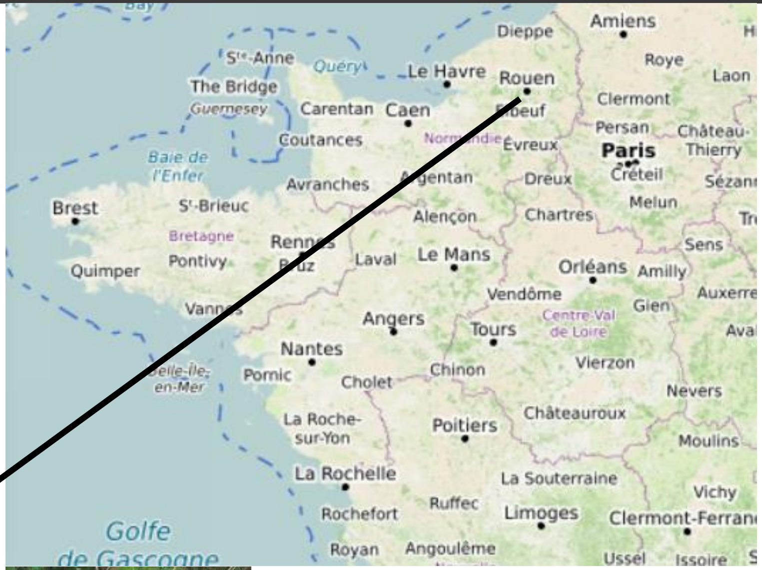
Oligotroph soils with sand alluvial material. Variable stoniness

Experimental design : Conversion from aged *Pinus sylvestris*

$\bar{x}$ =97 years

N=11

Pinus silvestris



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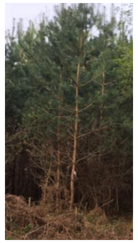
N=11

Pinus silvestris

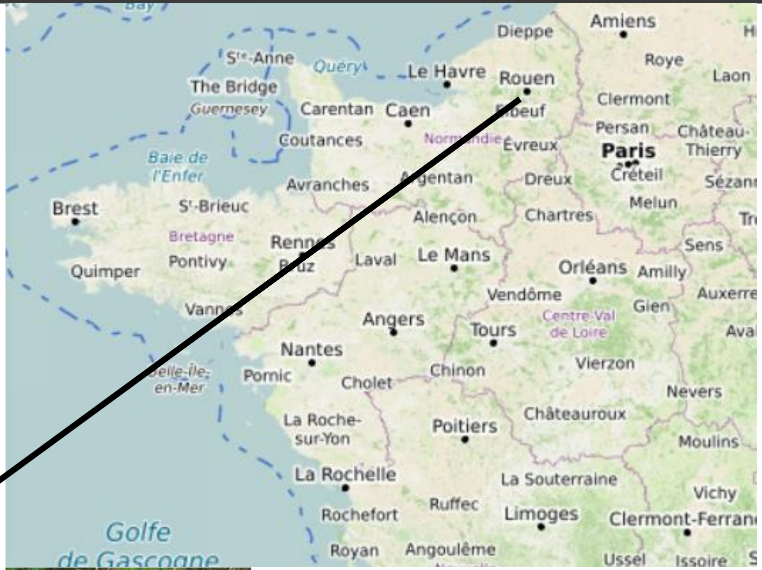
Rejuvenation effect

$\bar{x}$ =26 years



Pinus silvestris

N=12



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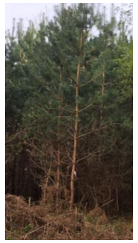
$\bar{x}$ =29 years

Quercus rubra

N=6

$\bar{x}$ =26 years



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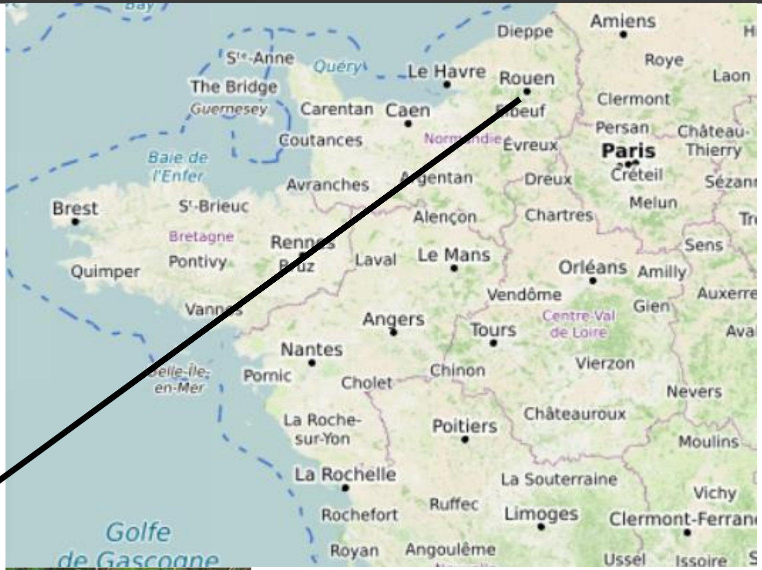
N=12



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Oligotroph soils with sand alluvial material. Variable stoniness

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Tree species effect

$\bar{x}$ =97 years

N=11

Pinus silvestris

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Pinus nigra var. *corsicana*

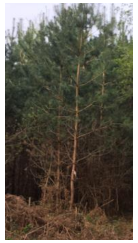
N=12

$\bar{x}$ =29 years

Quercus rubra

N=6

$\bar{x}$ =26 years



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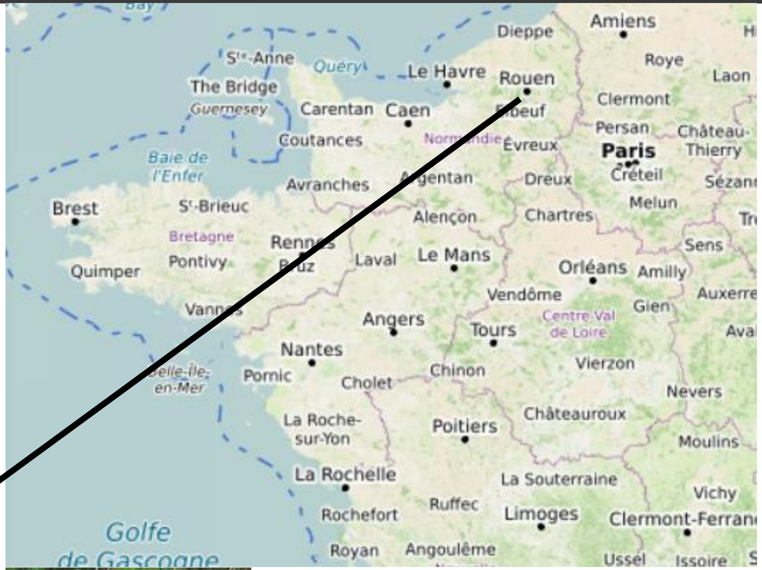
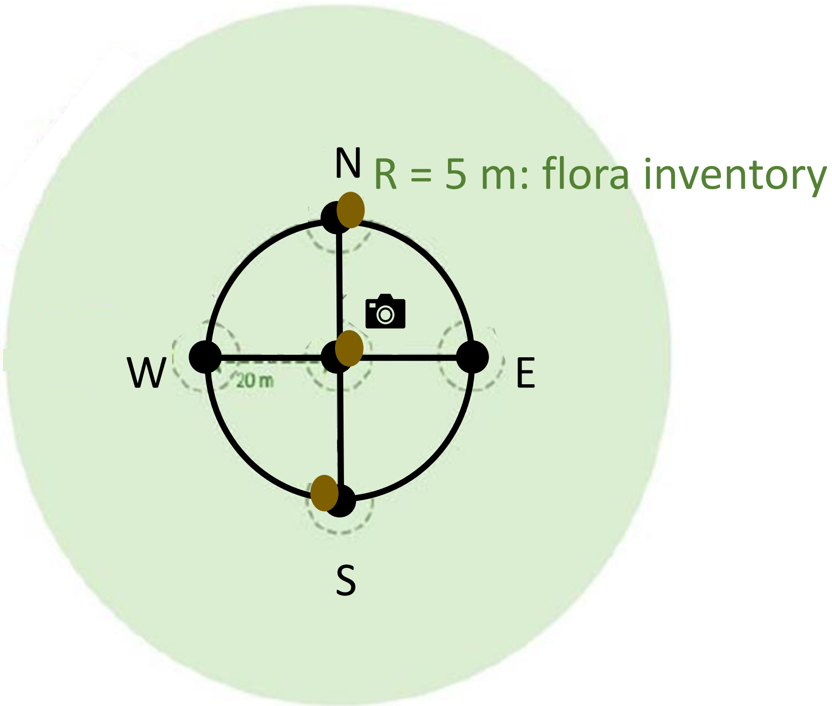


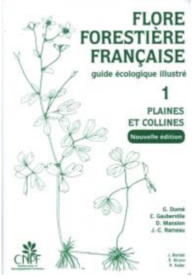
Soils:

Ancient alluvial terraces of the Seine

Oligotroph soils with sand alluvial material. Variable stoniness

The monitored data



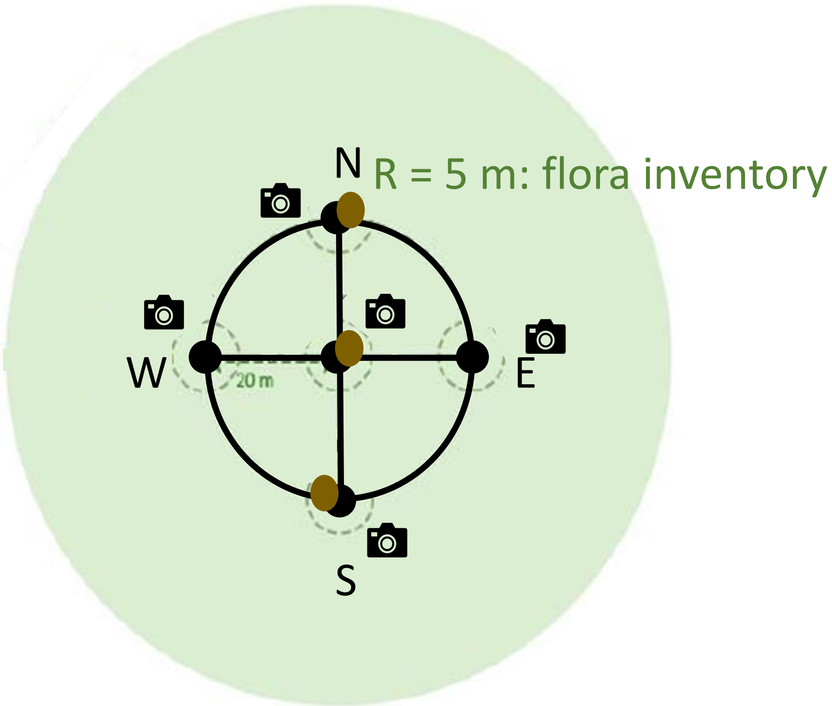


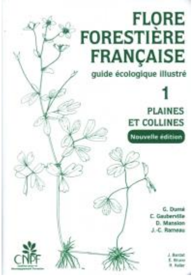
Phytosociological inventory

5*78,5m²

Stratification according to Lacoste et Salonon (1969).

The monitored data





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Fisheye photography

Treatment with hemispheR (Chianucci and Macek, 2023)

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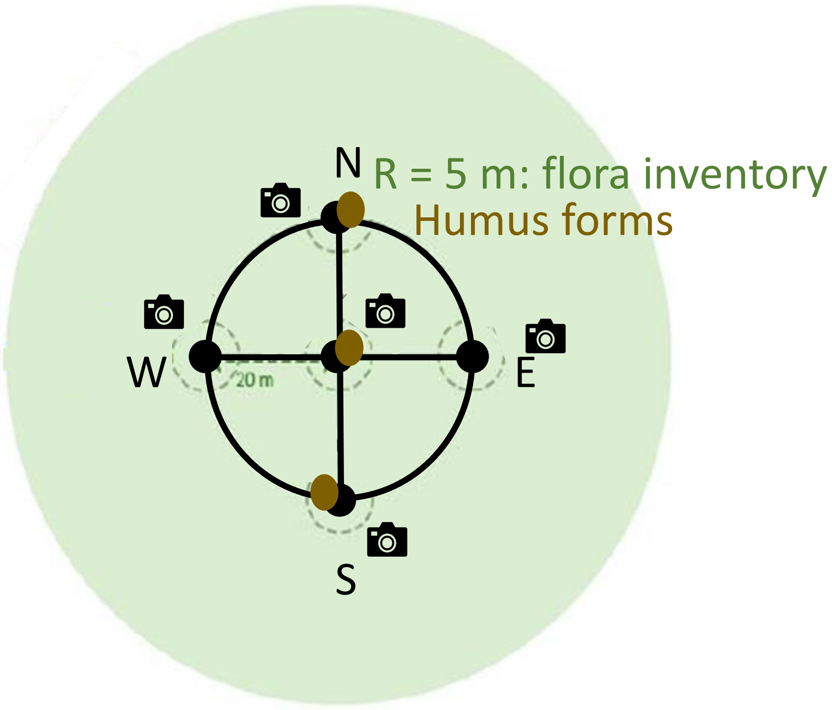
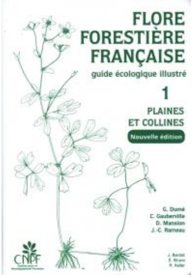


Soil/litter parameters

Fine humus form
(17 parameters)
Indicator values from baseflor
(Julve,2021)



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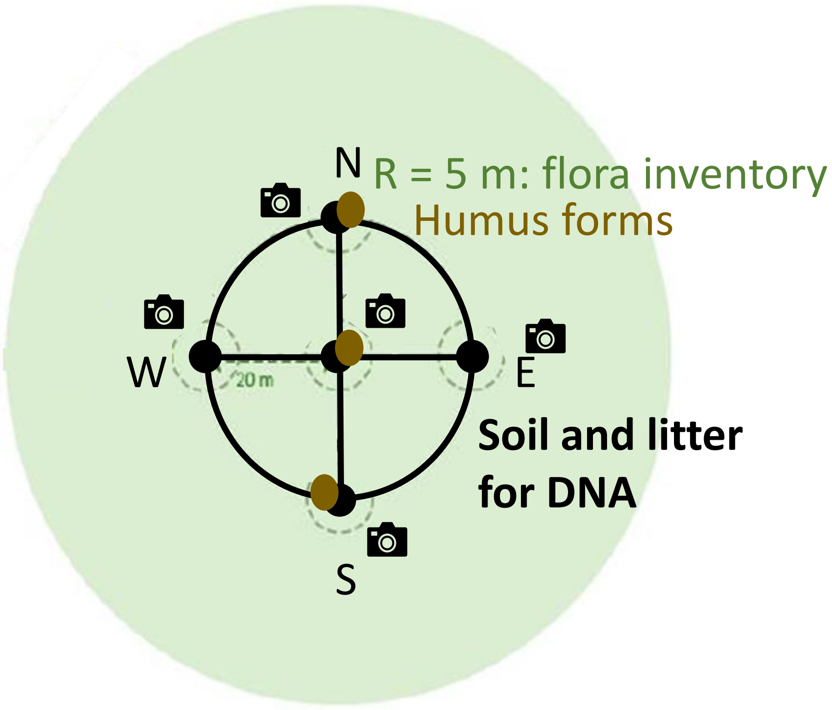

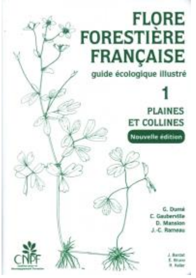

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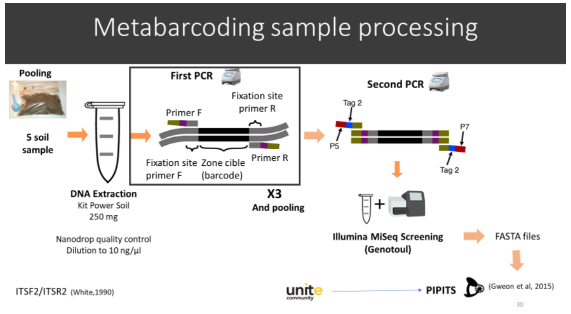


Soil DNA sampling

18 cm*18 cm

Litter + soil 0-10 cm

ITSF2/ ITSR2 (White, 1990)

Hypothesis

H1: Rejuvenation decreases fungal richness.

$\bar{x}$ = 134 years

N=8

Fagus sylvatica

$\bar{x}$ = 29 years

Fagus sylvatica

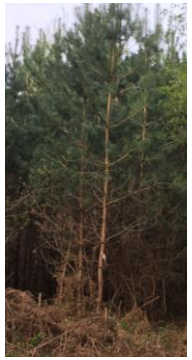
N=6

$\bar{x}$ =97 years

Pinus silvestris

N=11

$\bar{x}$ =26 years



Pinus silvestris

N=12

Hypothesis

H2: The change in dominant tree species impacts fungal richness

N=8

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Fagus sylvatica

$\bar{x}$= 25 years

Quercus petraea

N=8

$\bar{x}$ =28 years

N=12

Pinus nigra var. *corsicana*

$\bar{x}$ =97 years

N=11

Pinus silvestris

$\bar{x}$ =29 years

N=6

Quercus rubra

Hypothesis

H3: Fungal richness depends of biotic and abiotic variables that are modified by the main tree specie or the rejuvenation explaining the differences observed

Tree diversity
Shrub diversity

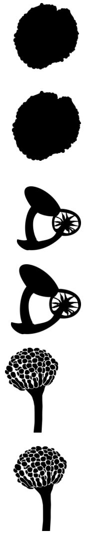
Understorey light

Herbaceous diversity
Moss diversity

Humus form
Soil ph
Root density
Soil nutrients availability
Soil humidity

Results on Fungal taxa richness

<u>Statistical summary of the mean test (Permanova) realized on the diferent fungal phyla richness</u>



Variable	p-value
Soil Mortierelomycota richness	0,25
Litter Mortierelomycota richness	0,61
Soil Basidiomycota richness	0,053 .
Litter Basidiomycota richness	0,12
Soil Ascomycota richness	0,88
Litter Ascomycota richness	0,46

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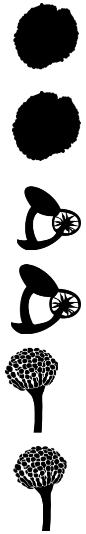

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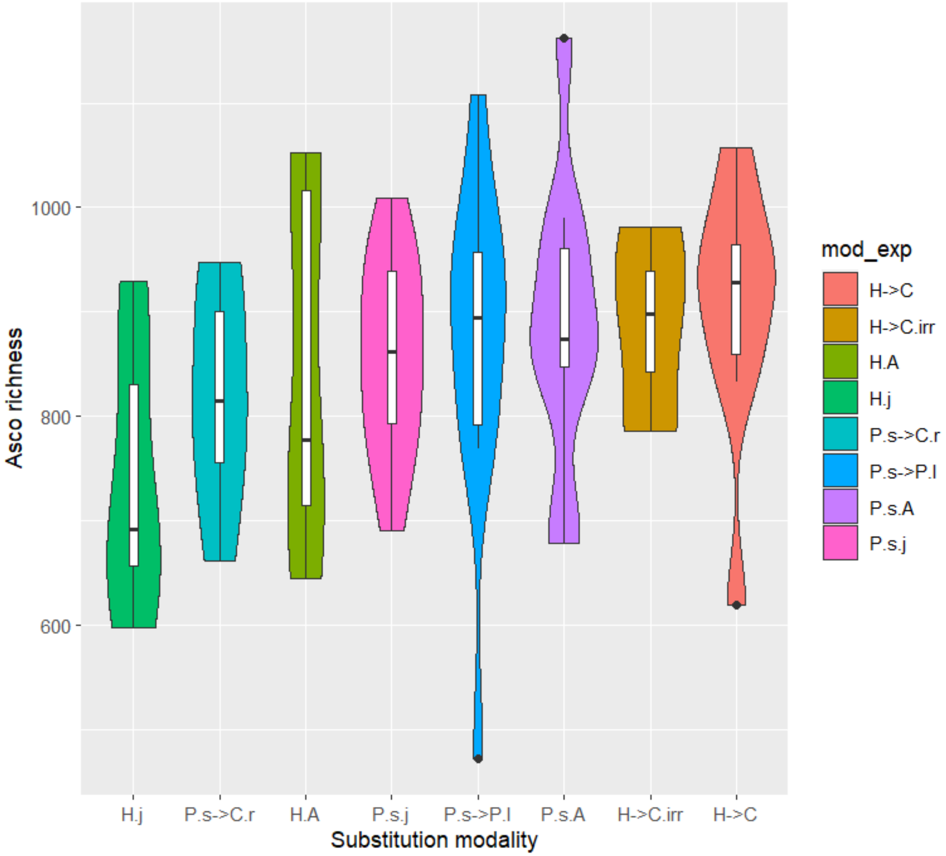
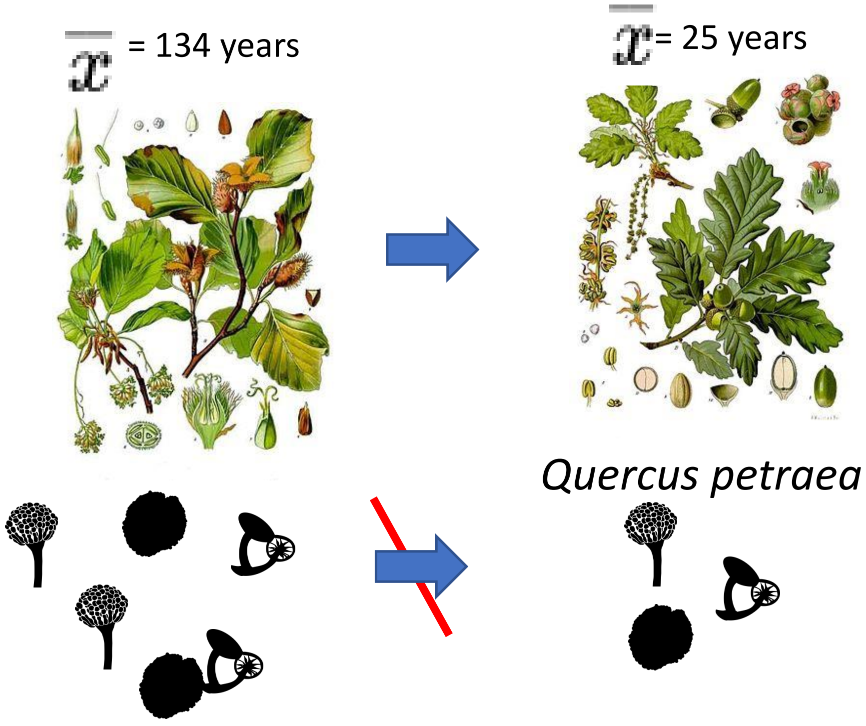
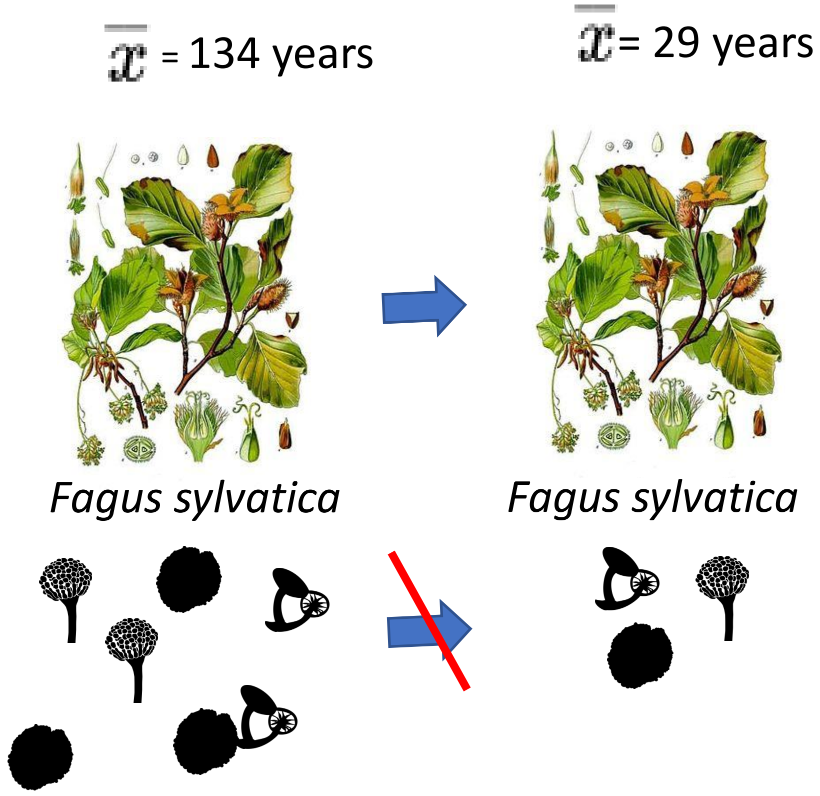


First conclusion

Surprising result

We reject H1 and H2





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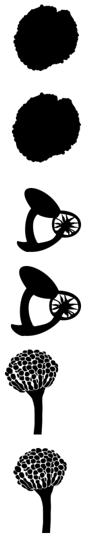

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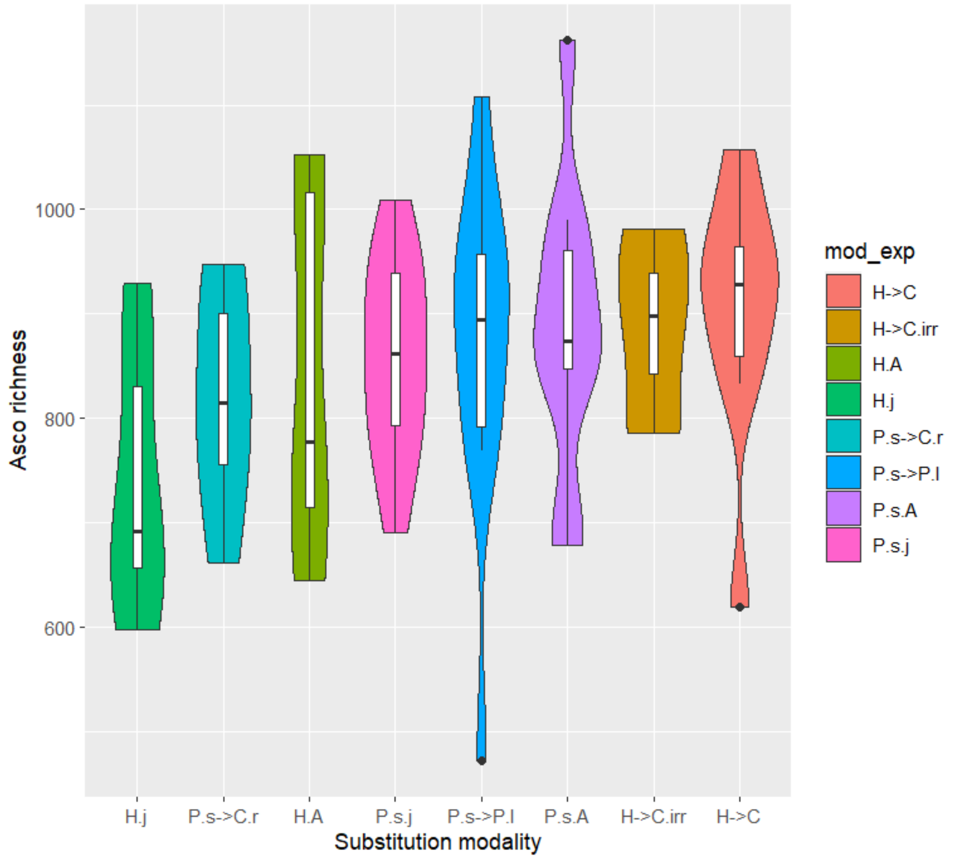


Intra substitution modality variability is very hight…

New hypothesis

H3 unlikely because of high variation in one conversion modality.

H4: Abiotic and biotic variable apart from conversion modality can explain variation in fungal richness.

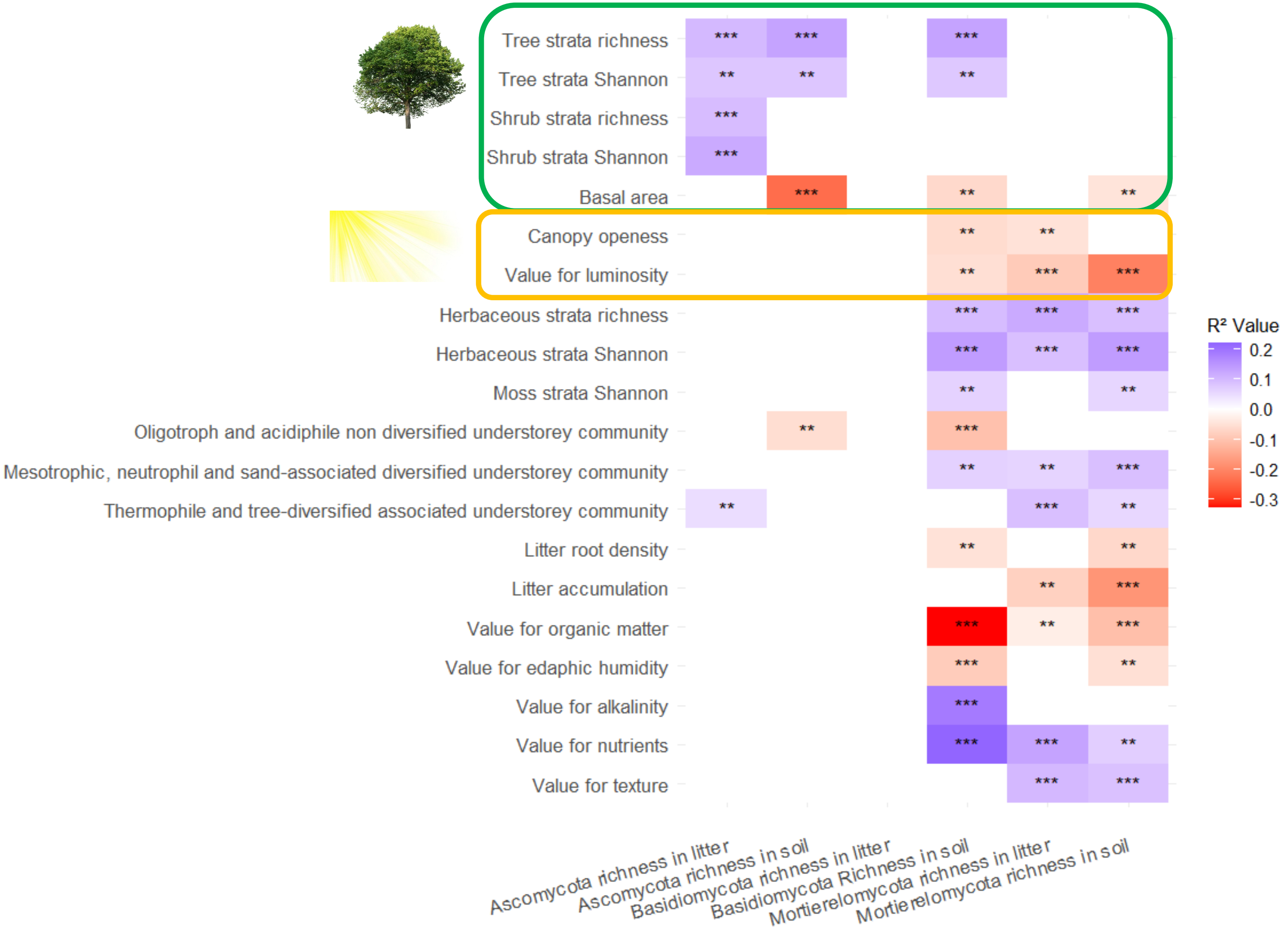
Results on Fungal taxa richness

We will analyze this figure by type of variable:

Variables from the woody strata

Correlation matrix between the significative variable(in linear model Richness~f(variable)) and the Fungal richness (warning include also no linear correlation)

Results on Fungal taxa richness



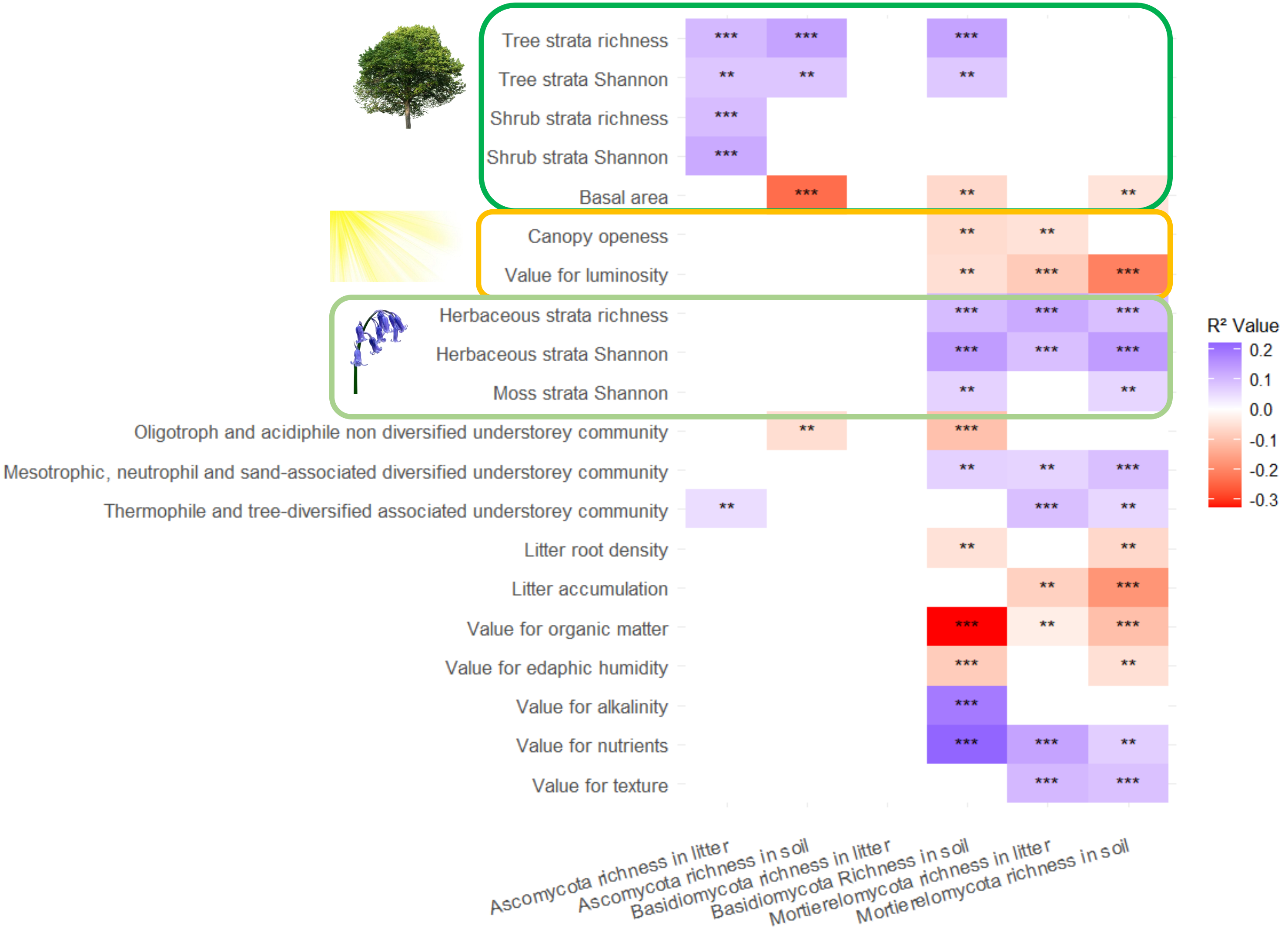
We will analyze this figure by type of variable:

Variables from the woody strata

Light variables

Correlation matrix between the significative variable(in linear model Richness~f(variable)) and the Fungal richness (warning include also no linear correlation)

Results on Fungal taxa richness



We will analyze this figure by type of variable:

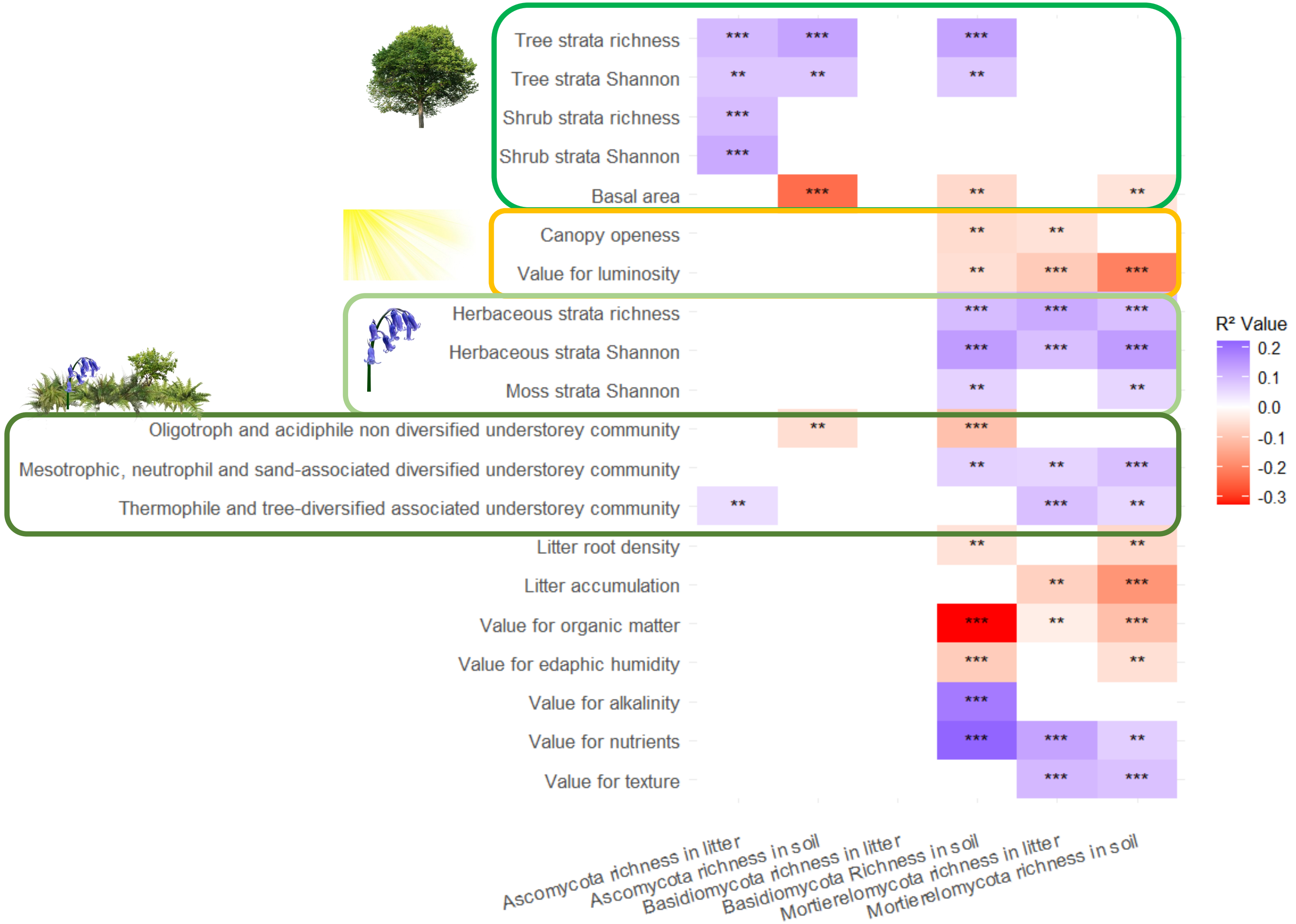
Variables from the woody strata

Light variables

Understorey plant alpha diversity

Correlation matrix between the significative variable(in linear model Richness~f(variable)) and the Fungal richness (warning include also no linear correlation)

Results on Fungal taxa richness



Correlation matrix between the significative variable(in linear model Richness~f(variable)) and the Fungal richness (warning include also no linear correlation)

We will analyze this figure by type of variable:

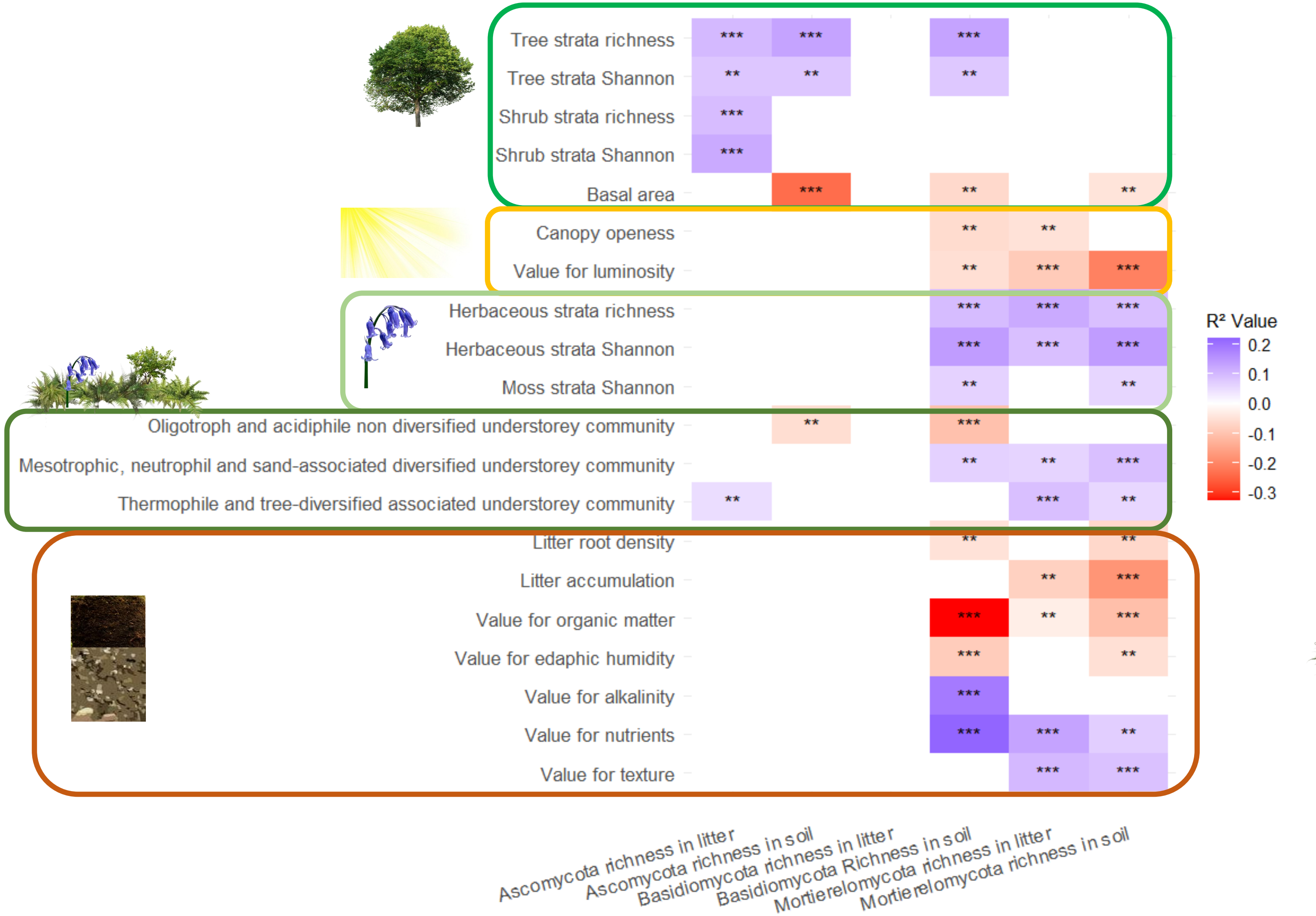

Variables from the woody strata

Light variables


Understorey plant alpha diversity


Plant community

Results on Fungal taxa richness



We will analyze this figure by type of variable:

Variables from the woody strata

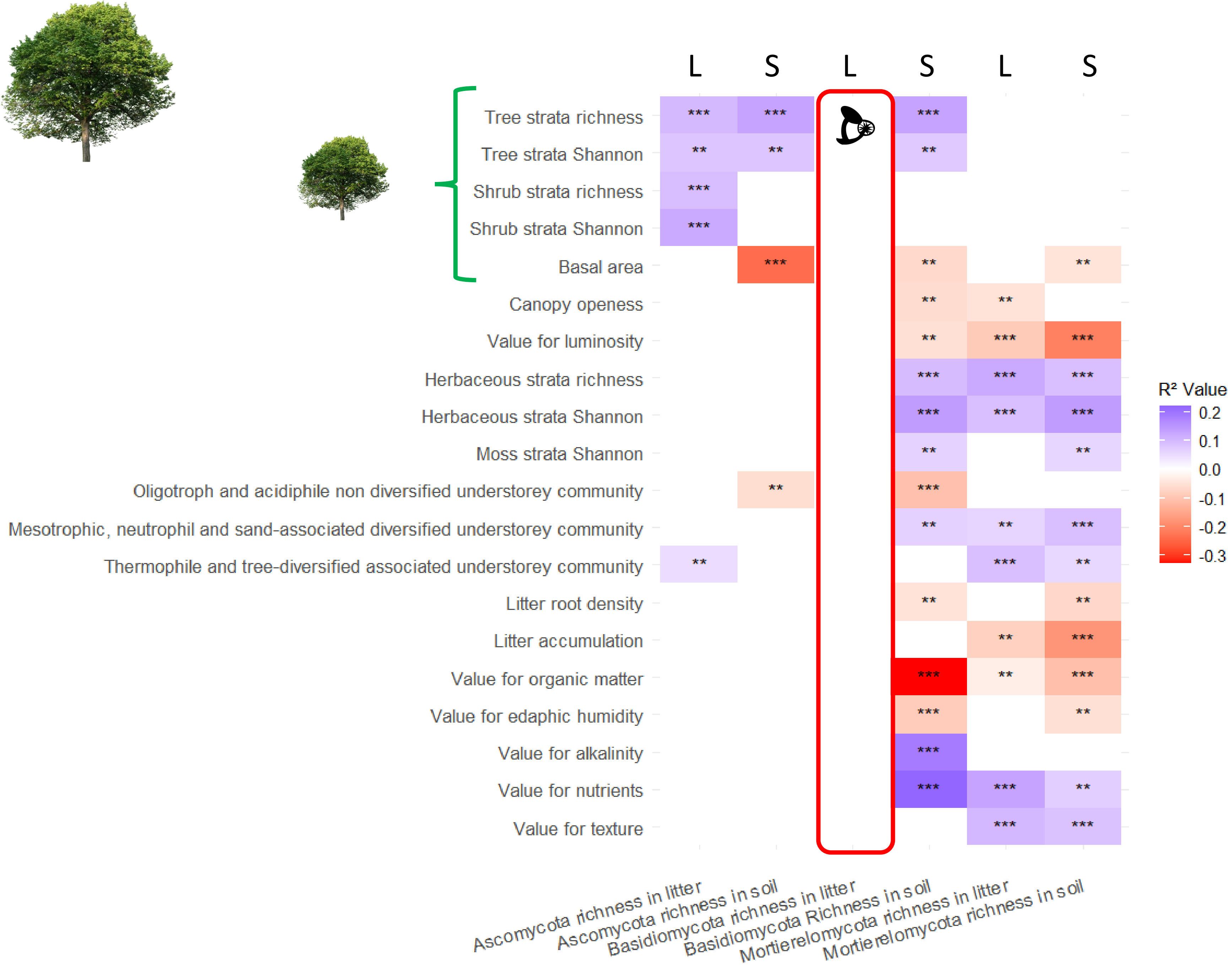
Light variables

Understorey plant alpha diversity

Plant community

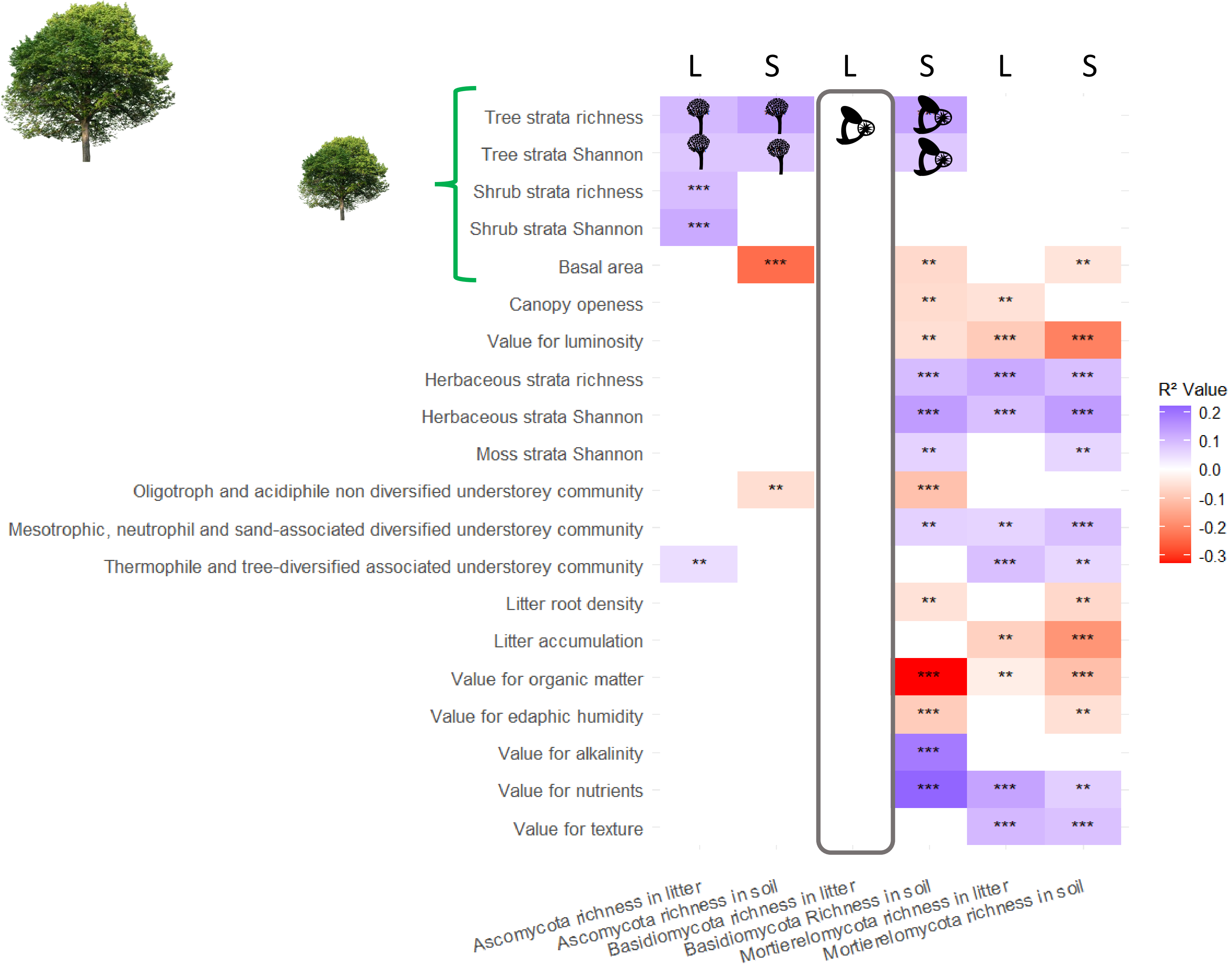
Edaphic variables

Correlation matrix between the significative variable(in linear model Richness~f(variable)) and the Fungal richness (warning include also no linear correlation)



Basidiomycota richness in litter → NS

Correlation matrix between the significative variable(in linear model Richness~f(variable)) and the Fungal richness (warning include also no linear correlation)

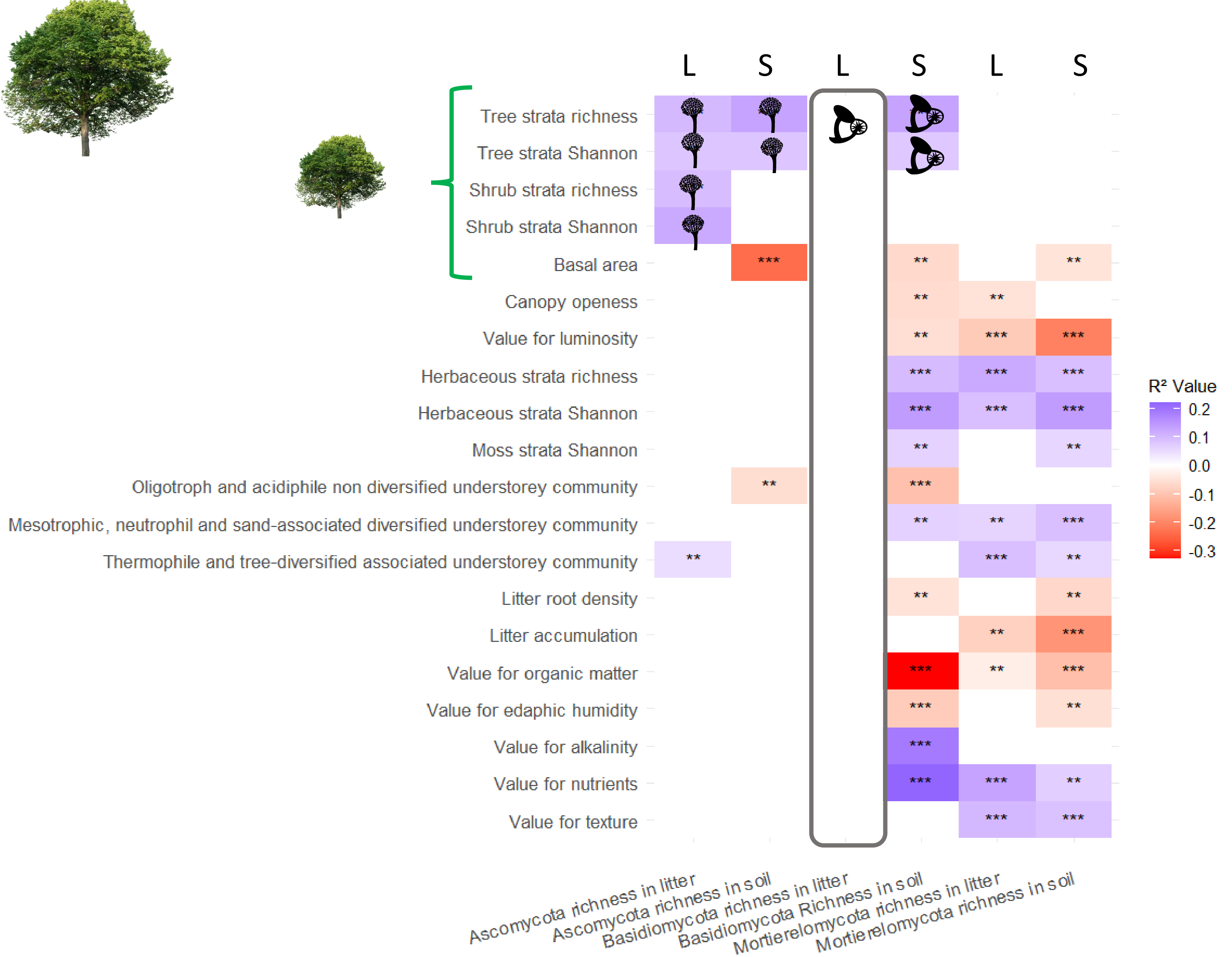


Ascomycota richness and Basidiomycota richness in soil→ + with Tree alpha diversity

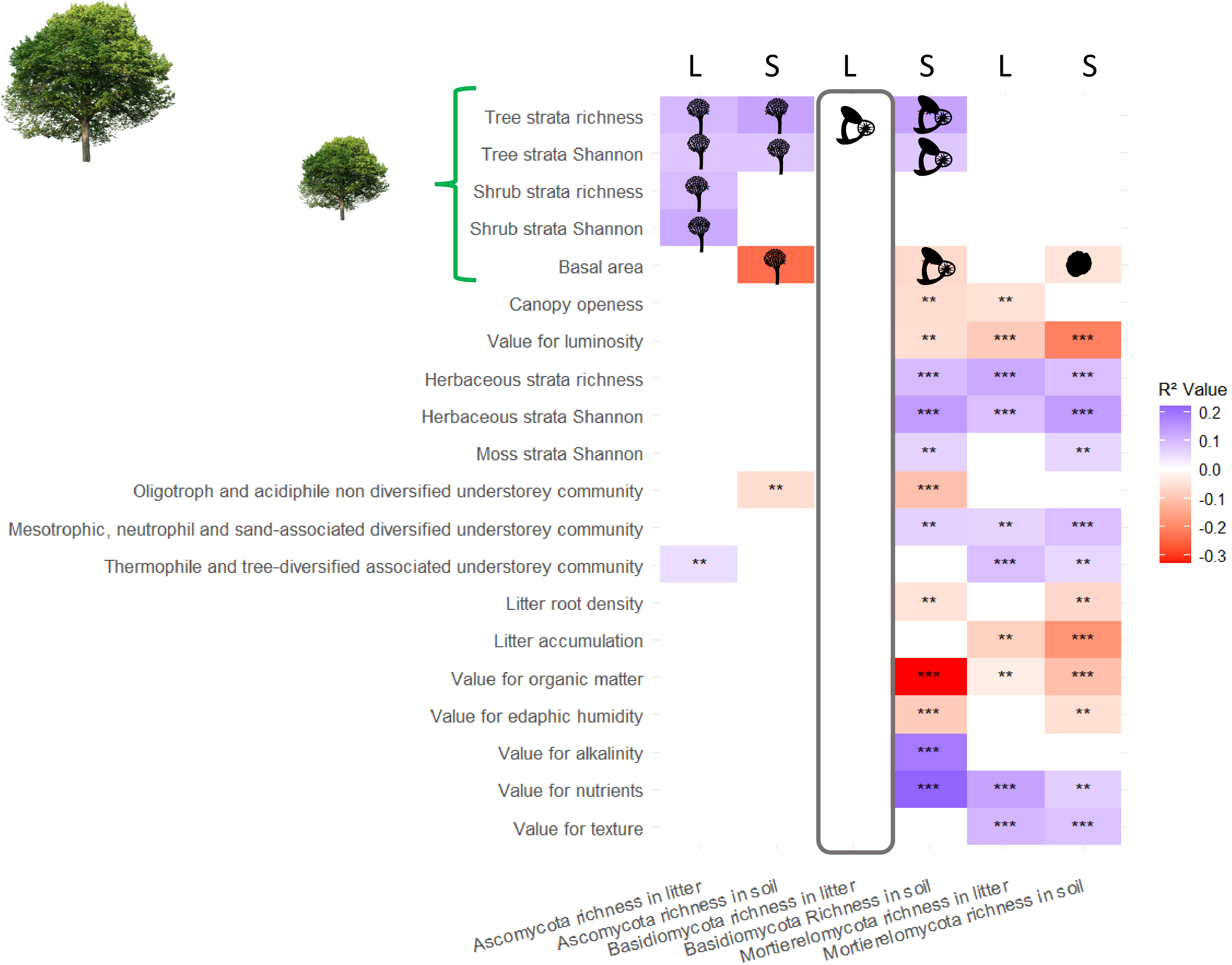
Mortierellomycota richness→ NS with Tree alpha diversity

Correlation matrix between the significative variable(in linear model Richness~f(variable)) and the Fungal richness (warning include also no linear correlation)

Ascomycota richness → + with Shrub alpha diversity



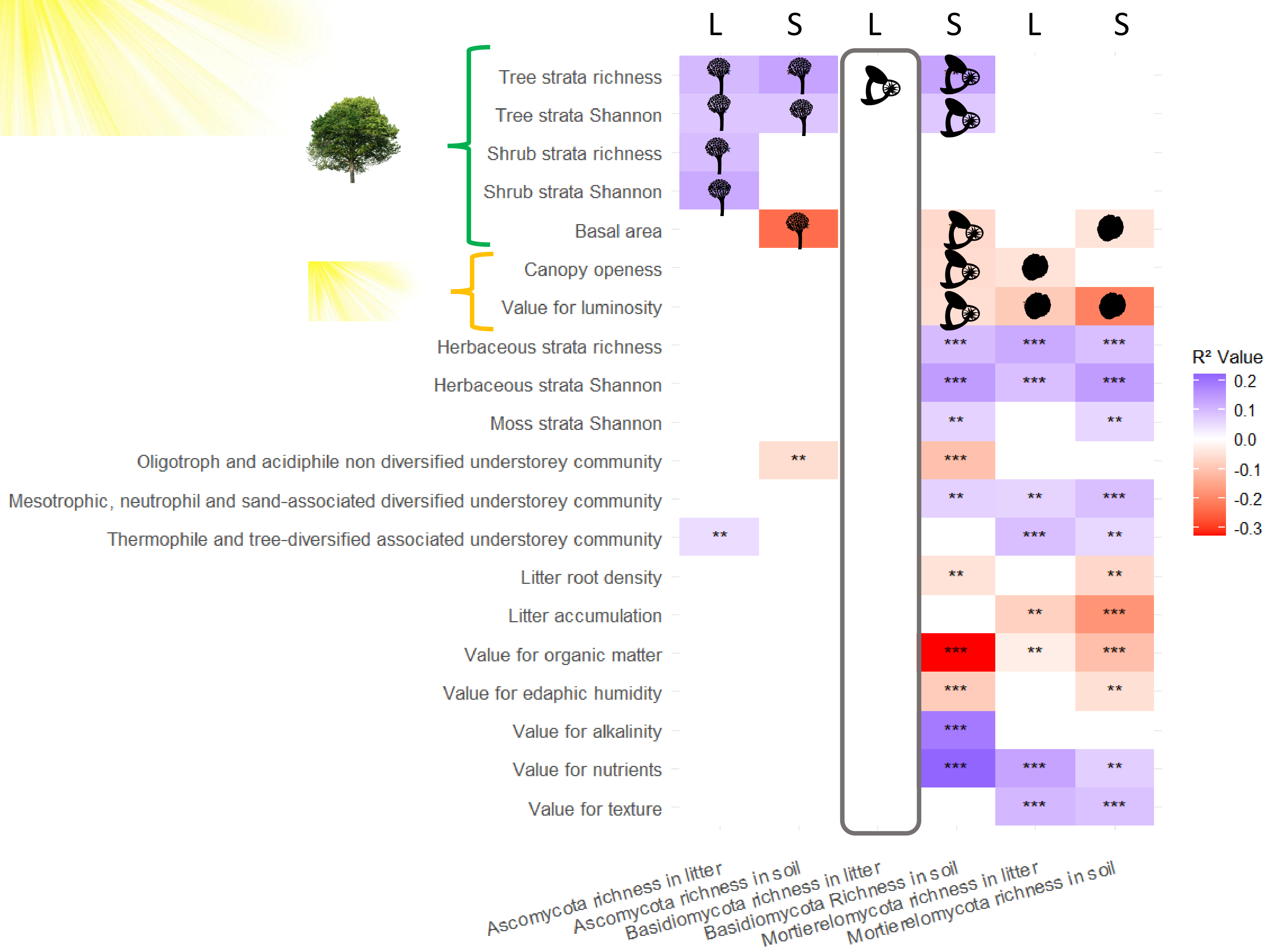
Correlation matrix between the significative variable(in linear model Richness~f(variable)) and the Fungal richness (warning include also no linear correlation)



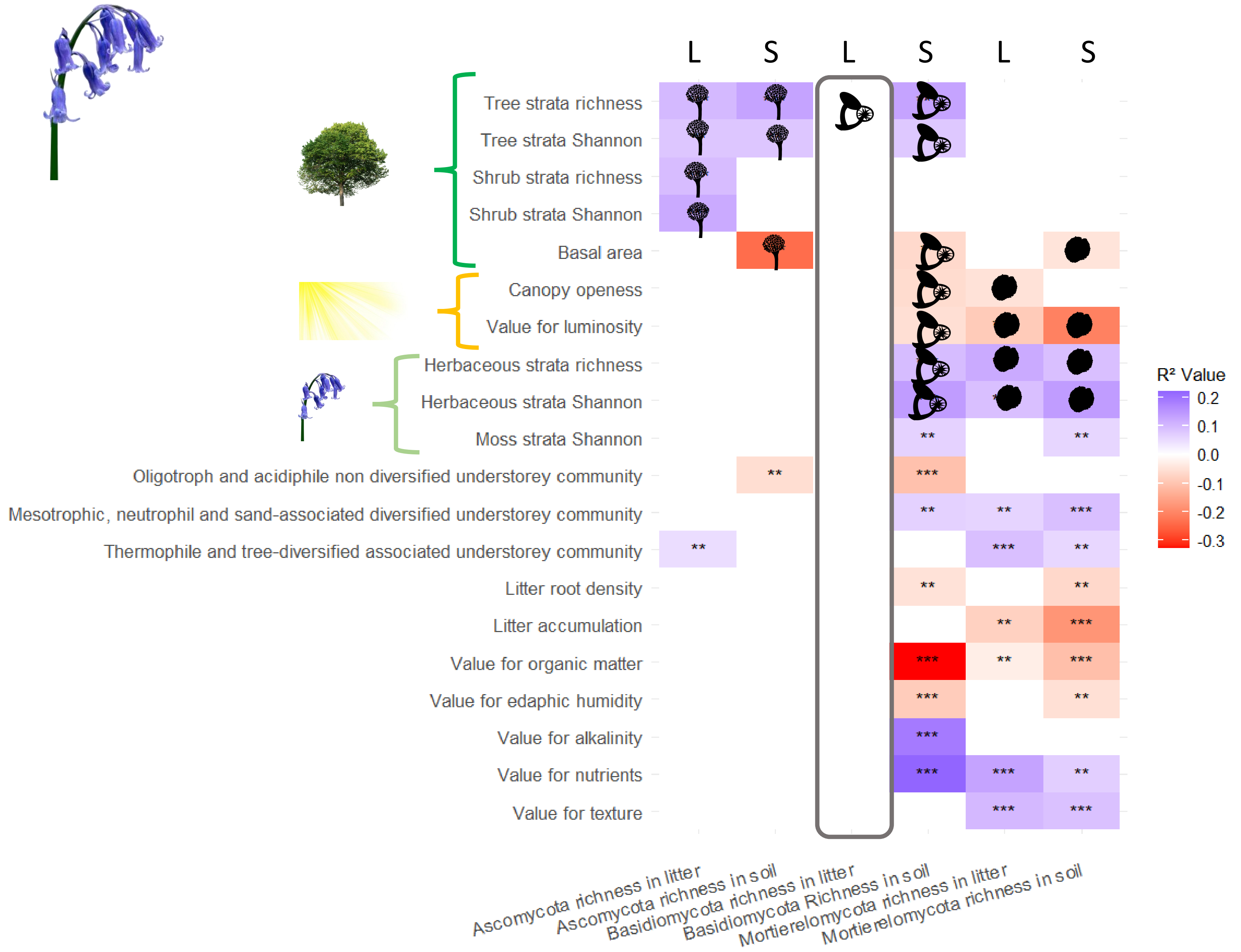
All Fungi richness → - with Tree basal area

Correlation matrix between the significative variable(in linear model Richness~f(variable)) and the Fungal richness (warning include also no linear correlation)

Basidiomycota richness in soil and Mortierellomycota richness → - with light



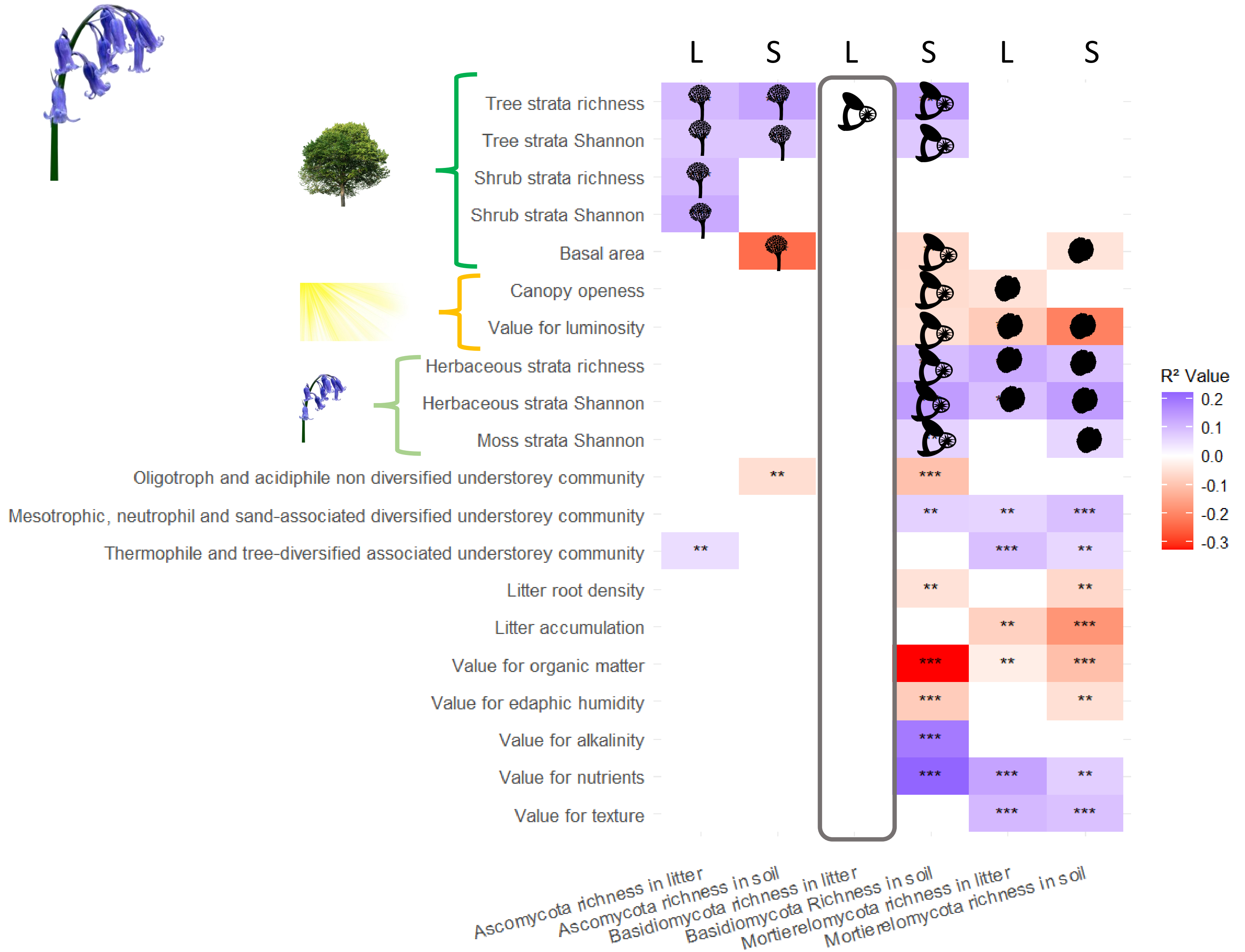
Correlation matrix between the significative variable(in linear model Richness~f(variable)) and the Fungal richness (warning include also no linear correlation)



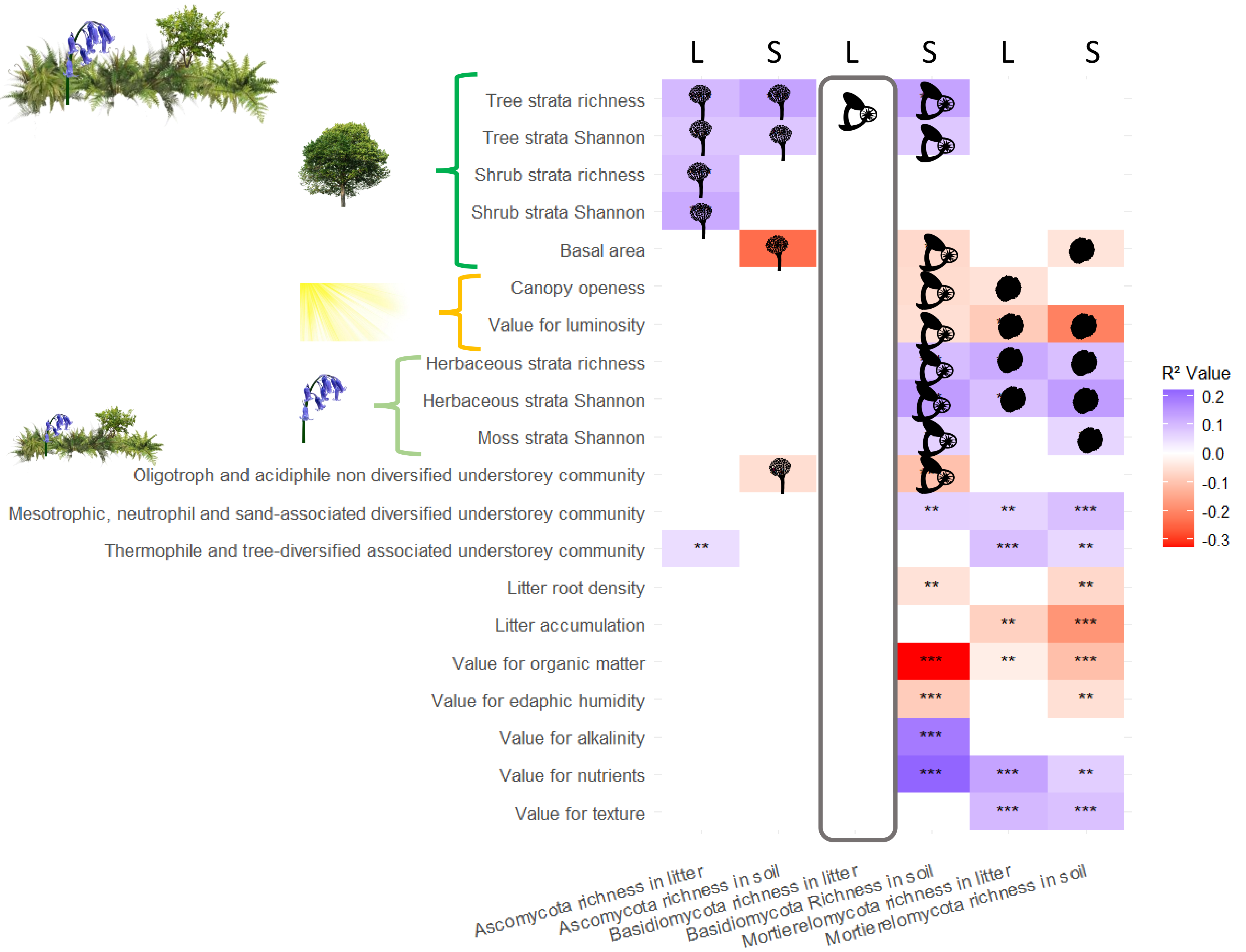
Basidiomycota richness in soil and Mortierellomycota richness → + with Herbaceous richness

Correlation matrix between the significative variable(in linear model Richness~f(variable)) and the Fungal richness (warning include also no linear correlation)

Basidiomycota and Mortierellomycota richness in soil → + with Moss richness

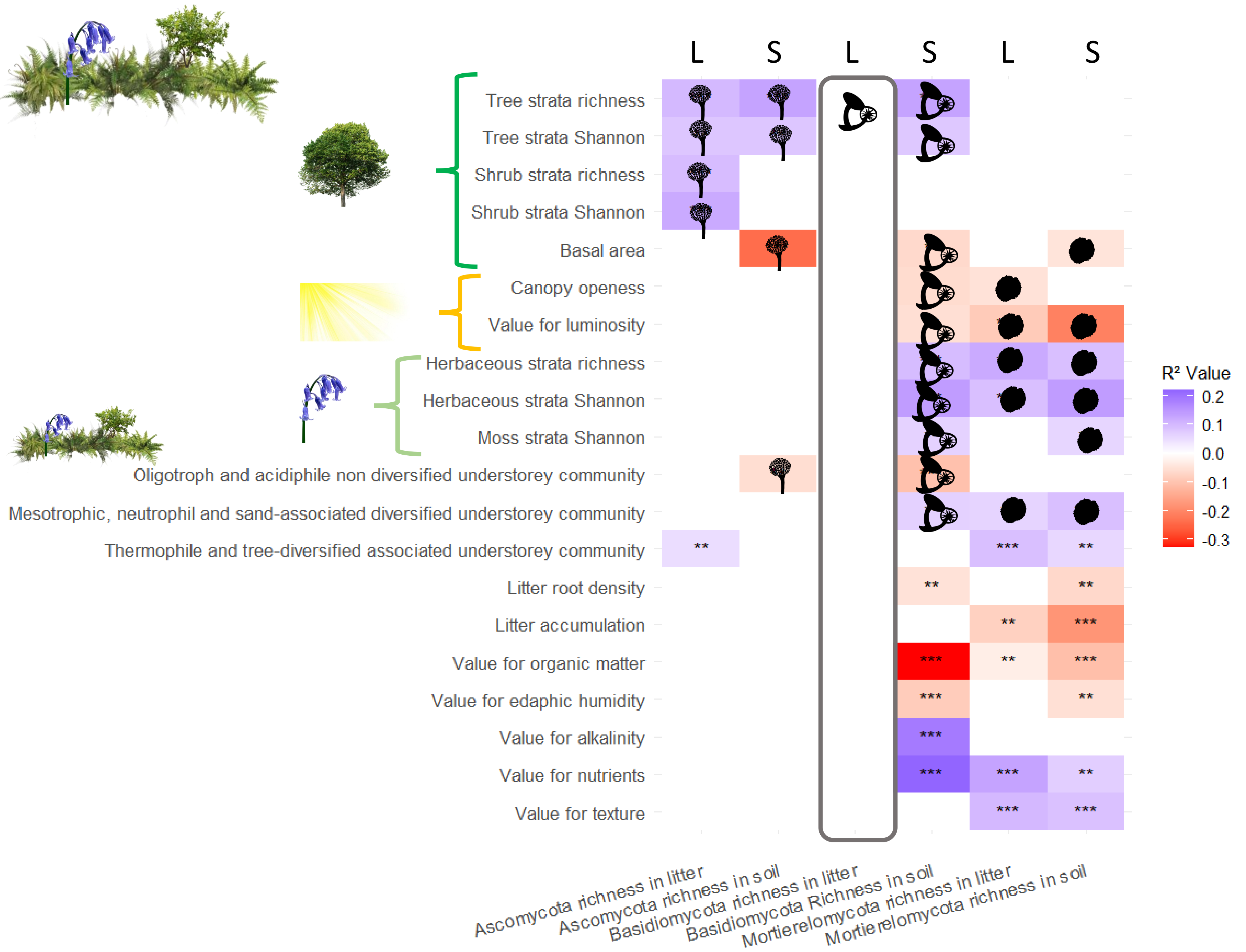


Correlation matrix between the significative variable(in linear model Richness~f(variable)) and the Fungal richness (warning include also no linear correlation)



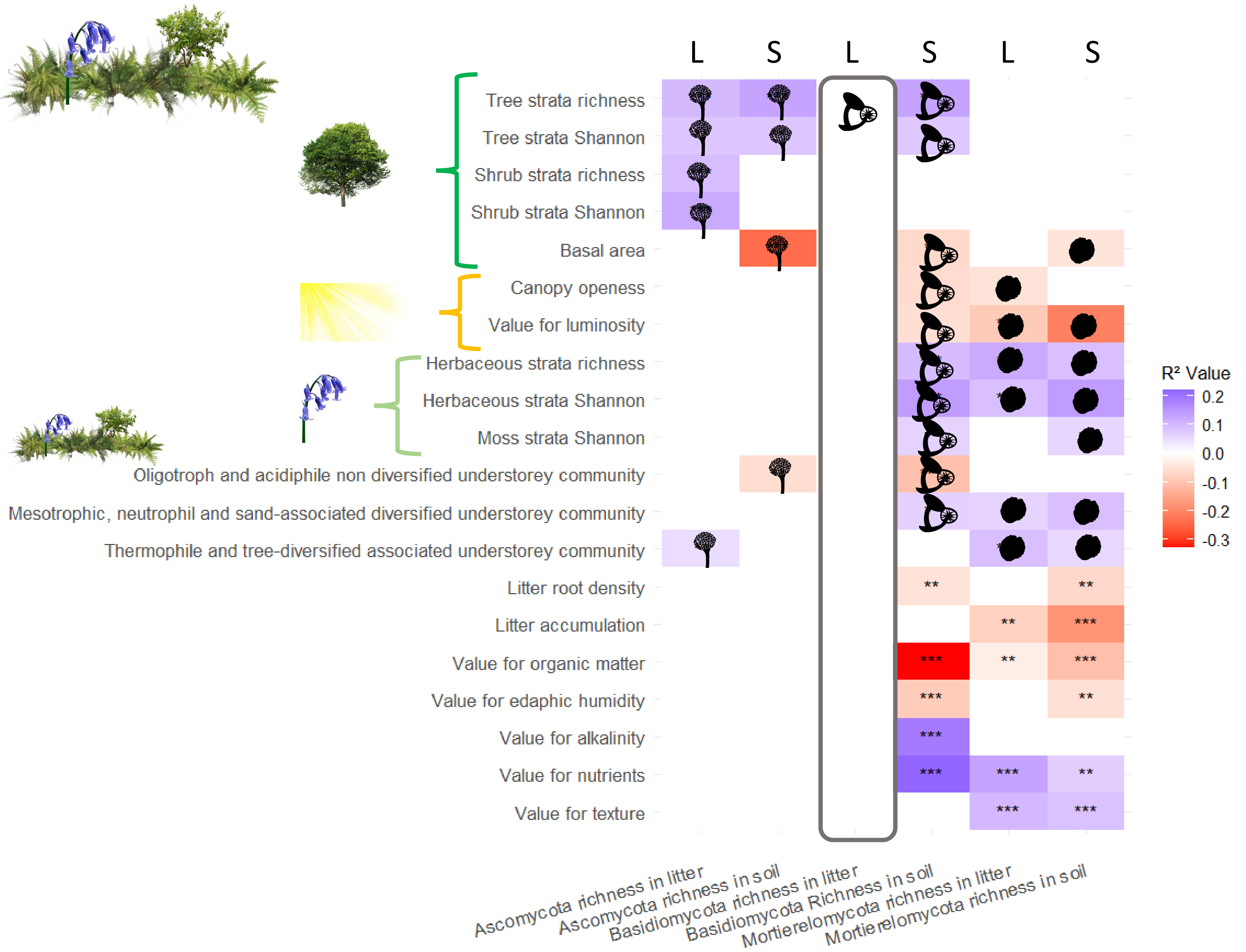
Ascomycota and Basidiomycota richness in soil → - with oligotrophic and acidiphile non diverse community

Correlation matrix between the significative variable(in linear model Richness~f(variable)) and the Fungal richness (warning include also no linear correlation)



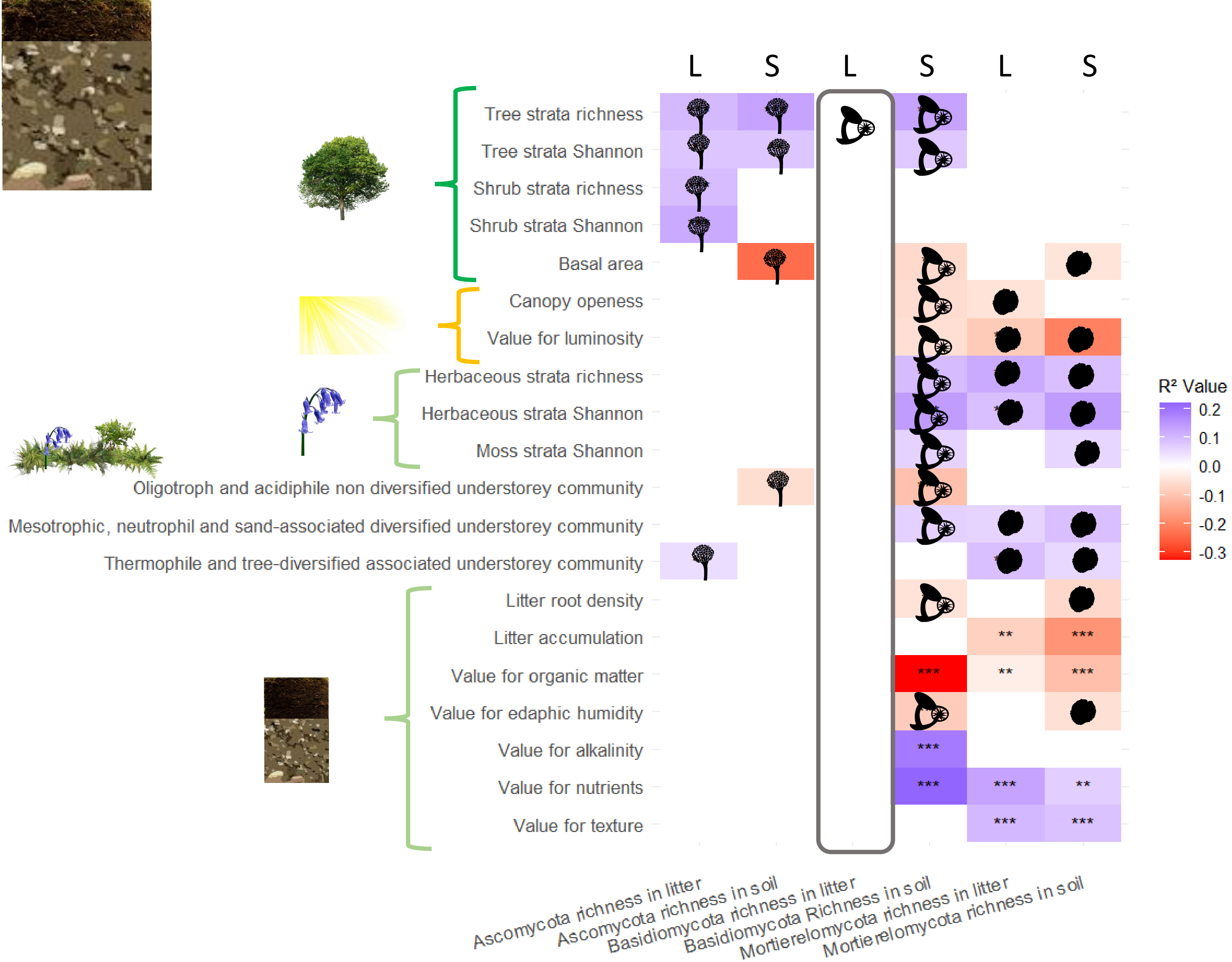
Basidiomycota richness in soil and Mortierellomycota →+ with mesotrophic, neutrophil and sand associated understorey community

Correlation matrix between the significative variable(in linear model Richness~f(variable)) and the Fungal richness (warning include also no linear correlation)



Ascomycota richness in litter and Mortierellomycota richness →+ with thermophile and tree-diversified associated understorey community

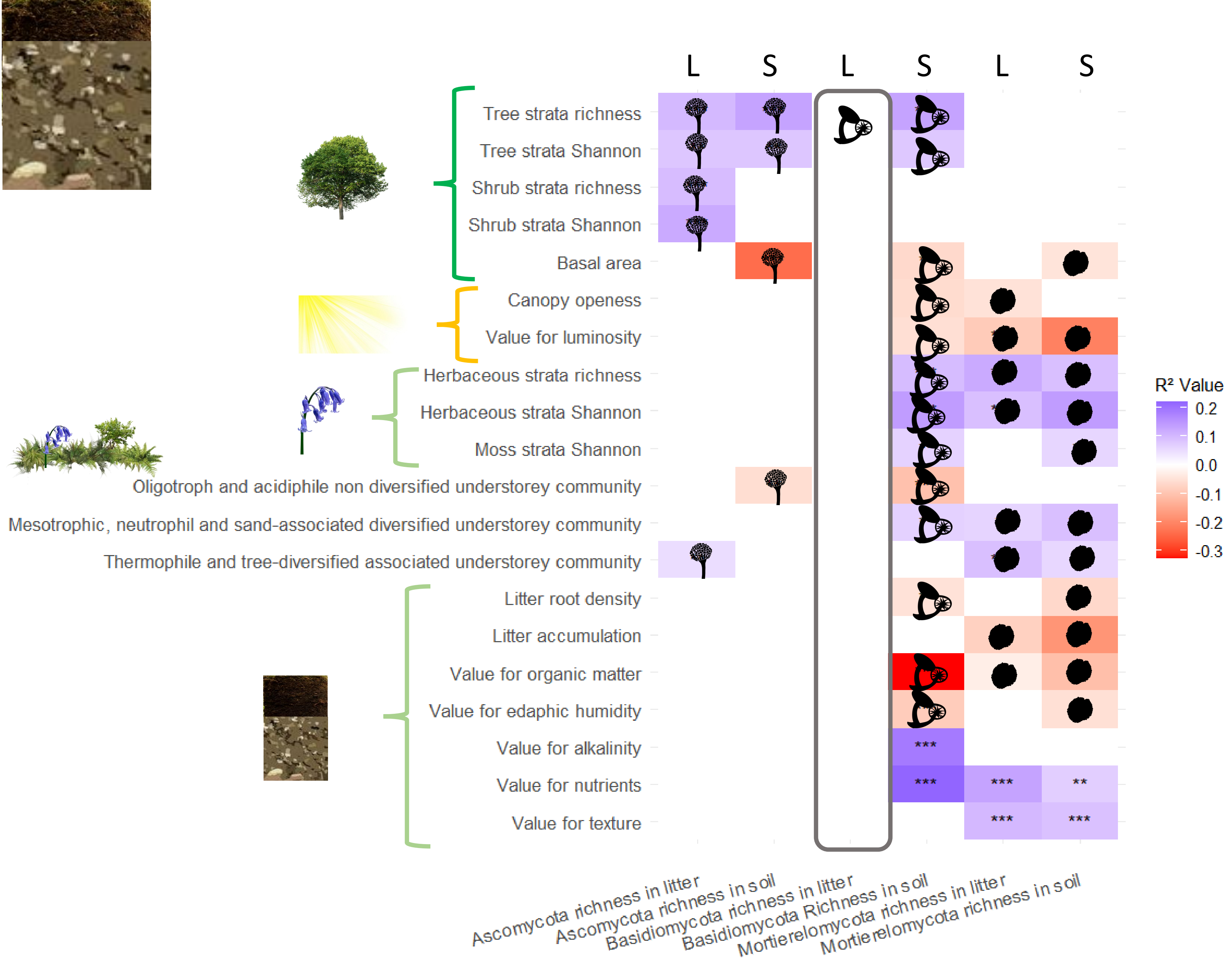
Correlation matrix between the significative variable(in linear model Richness~f(variable)) and the Fungal richness (warning include also no linear correlation)



Ascomycota richness → N.S with edaphic variables

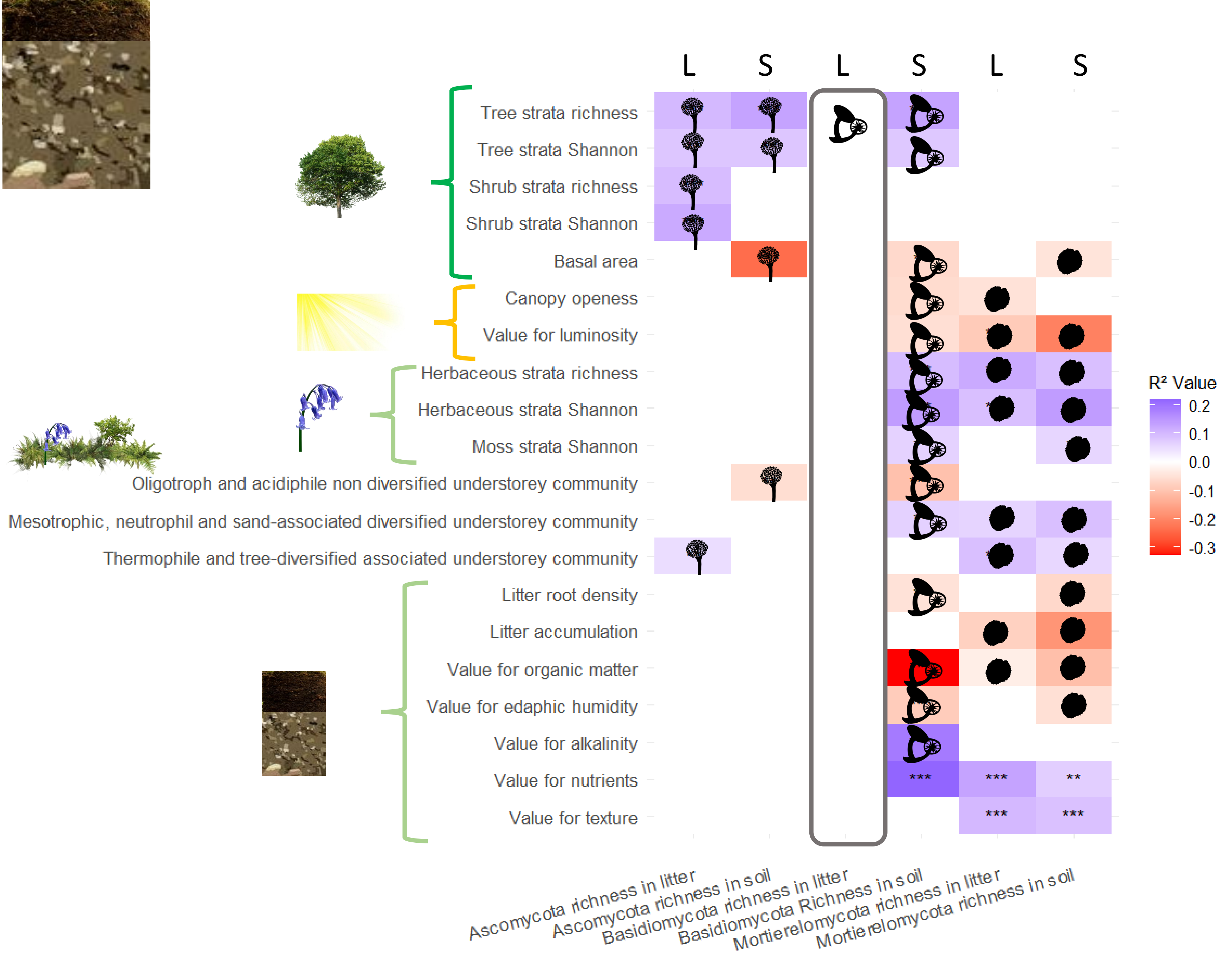
Basidiomycota and Mortierellomycota richness in soil → - with root density and edaphic humidity

Correlation matrix between the significative variable(in linear model Richness~f(variable)) and the Fungal richness (warning include also no linear correlation)



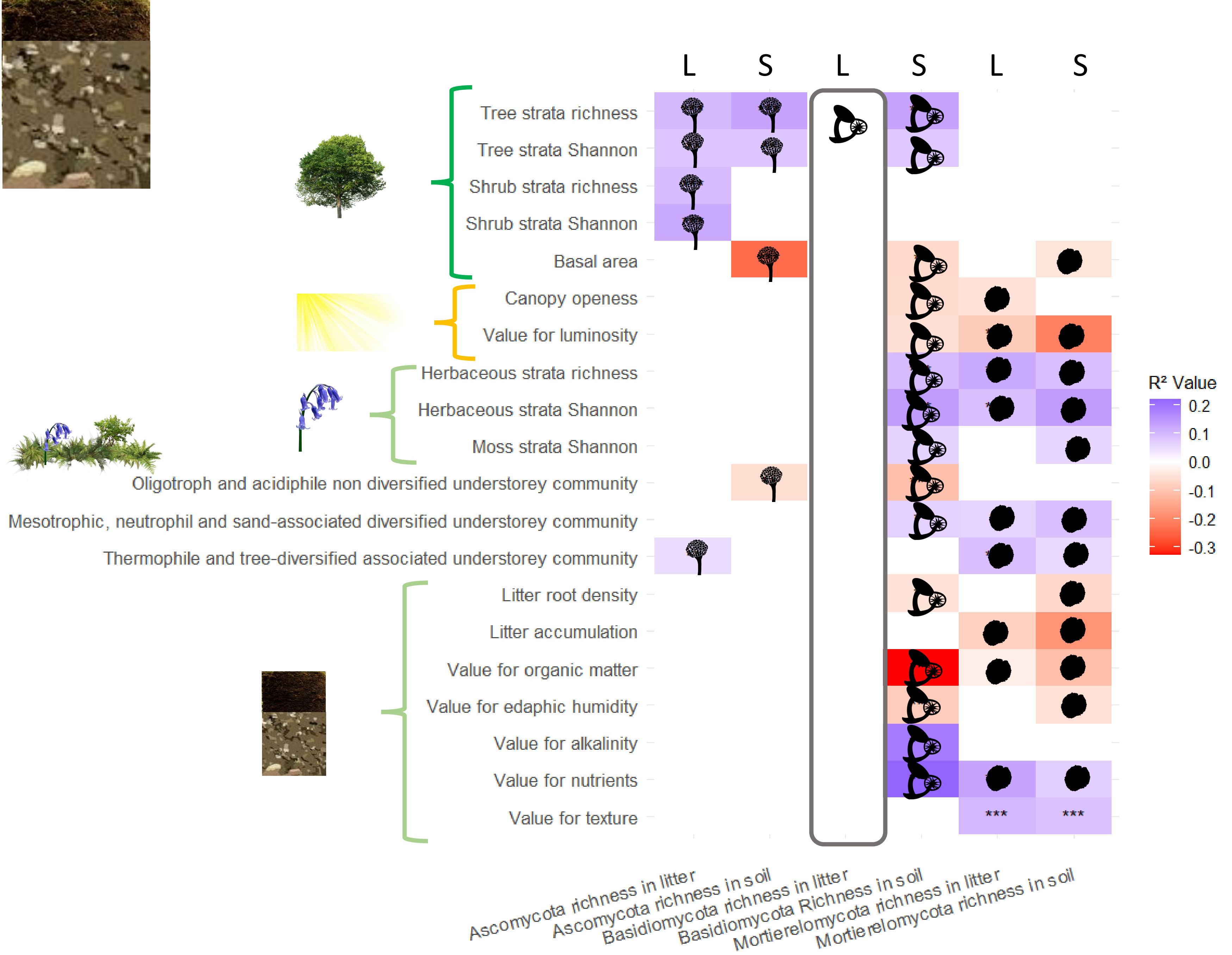
Basidiomycota in soil and Mortierellomycota richness → - with O.M accumulation

Correlation matrix between the significative variable(in linear model Richness~f(variable)) and the Fungal richness (warning include also no linear correlation)



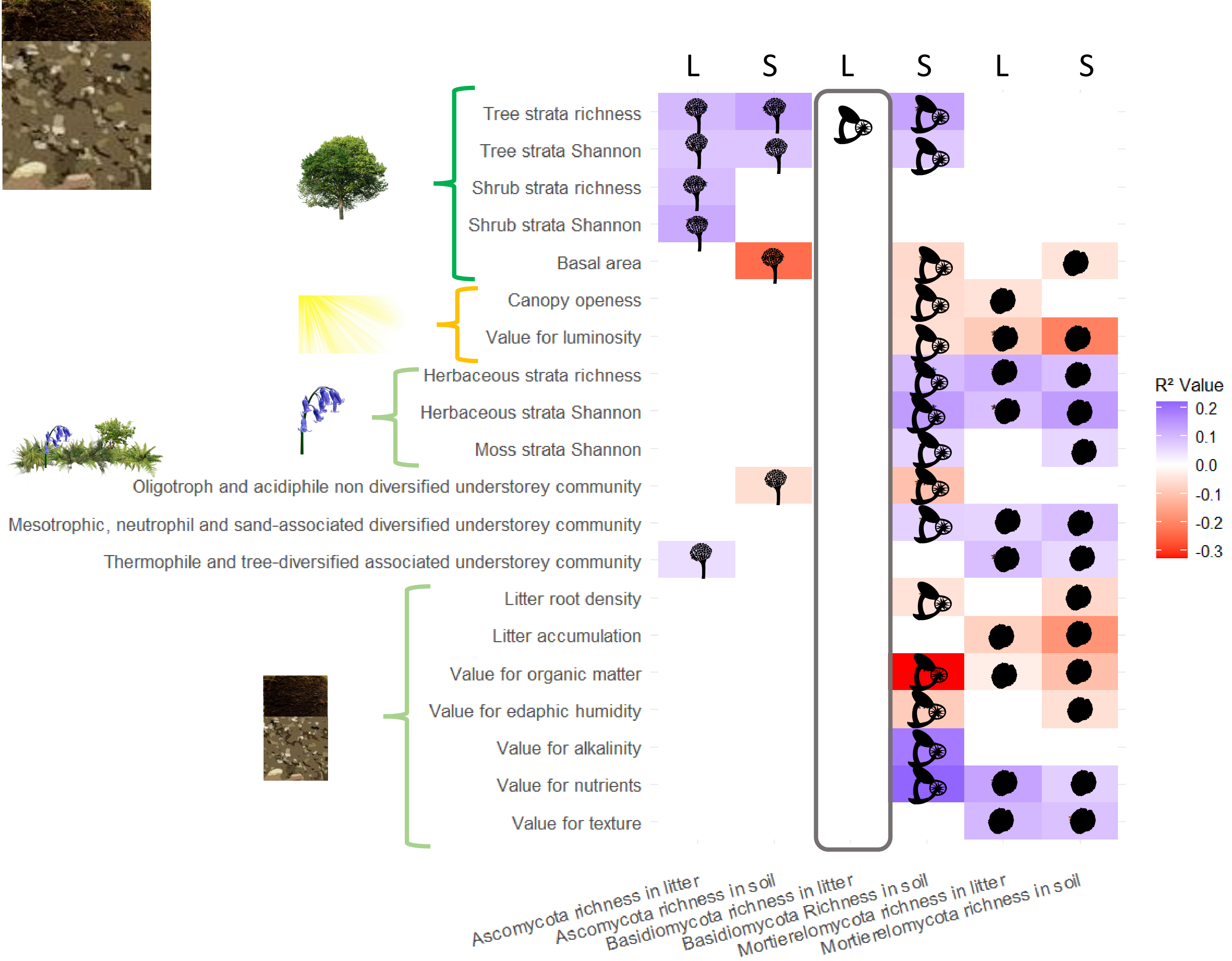
Basidiomycota in soil → + with hight ph

Correlation matrix between the significative variable(in linear model Richness~f(variable)) and the Fungal richness (warning include also no linear correlation)



Basidiomycota in soil and Mortierellomycota → + with nutrients

Correlation matrix between the significative variable(in linear model Richness~f(variable)) and the Fungal richness (warning include also no linear correlation)

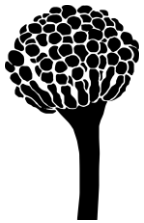


Mortierellomycota richness
→ + with sand texture

Correlation matrix between the significative variable(in linear model Richness~f(variable)) and the Fungal richness (warning include also no linear correlation)

Conclusion/Discussion

- The three phyla richness doesn't react to the same variable groups.



Conclusion/Discussion

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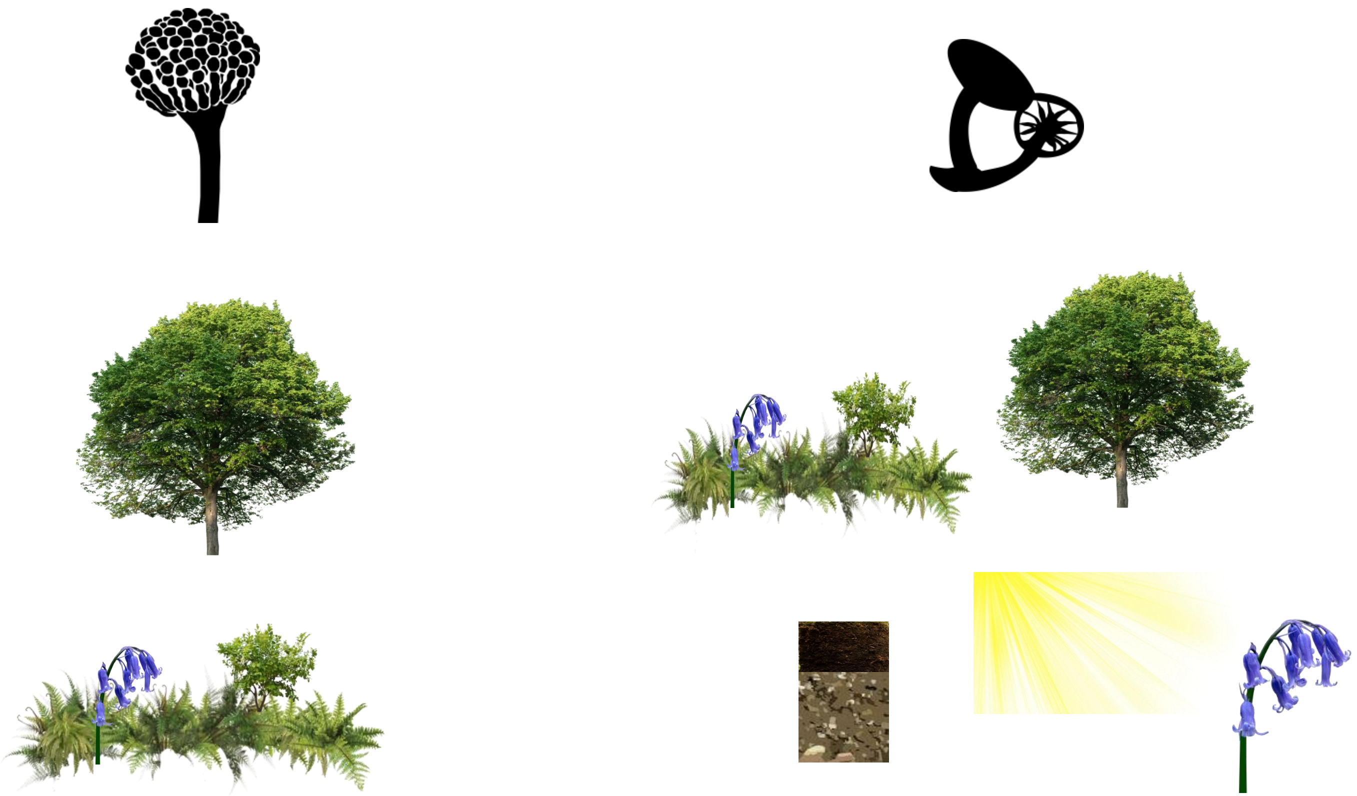
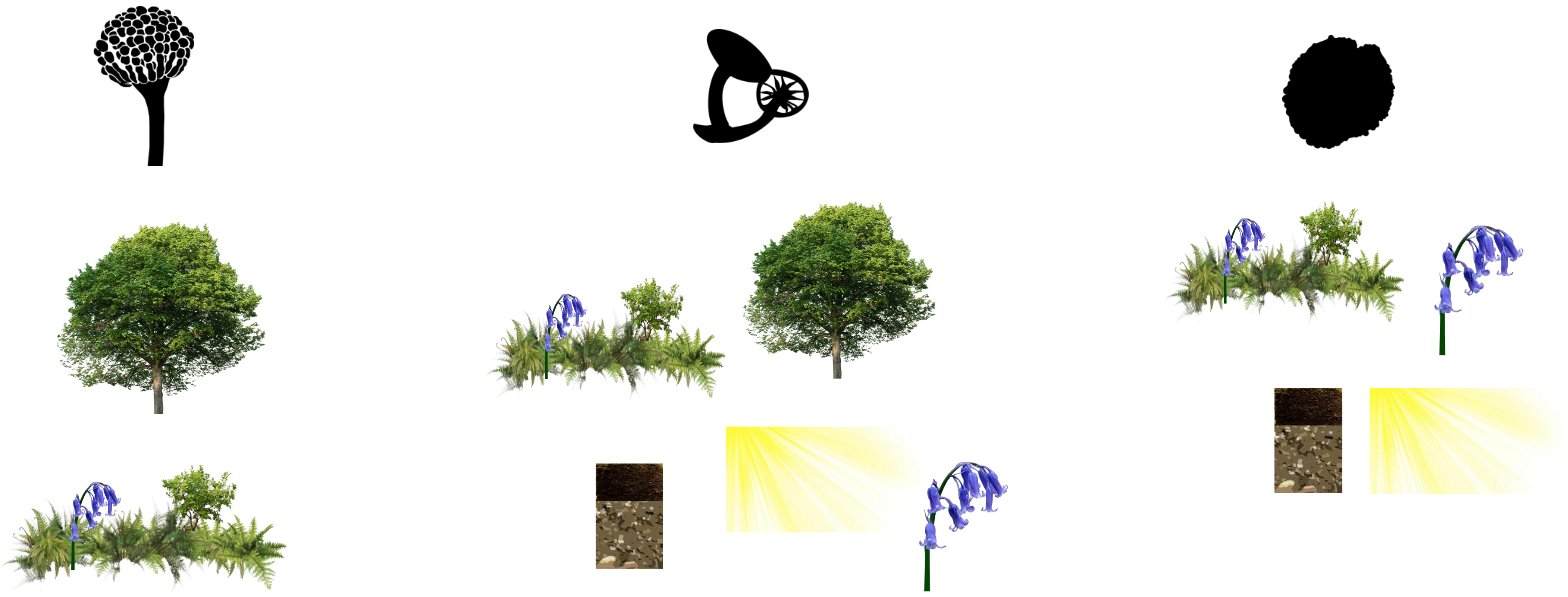


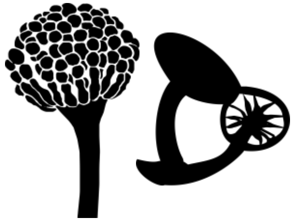
Conclusion/Discussion

- The three phyla richness doesn't react to the same variables.

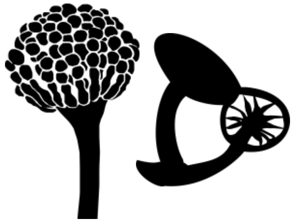


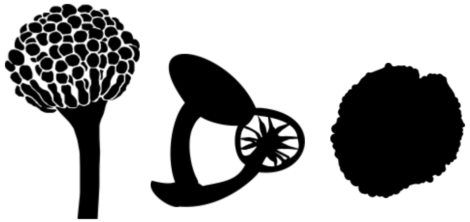
Advices for foresters

+  Diversity

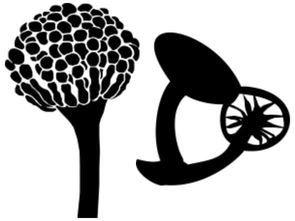
+  Richness

Advices for foresters

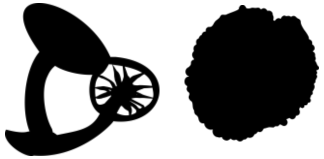
+  Diversity → +  Richness

-  Basal area → +  Richness

Advices for foresters

\+  Diversity → +  Richness

\-  Basal area → +  Richness

\+  Diversity → +  Richness

Advices for foresters

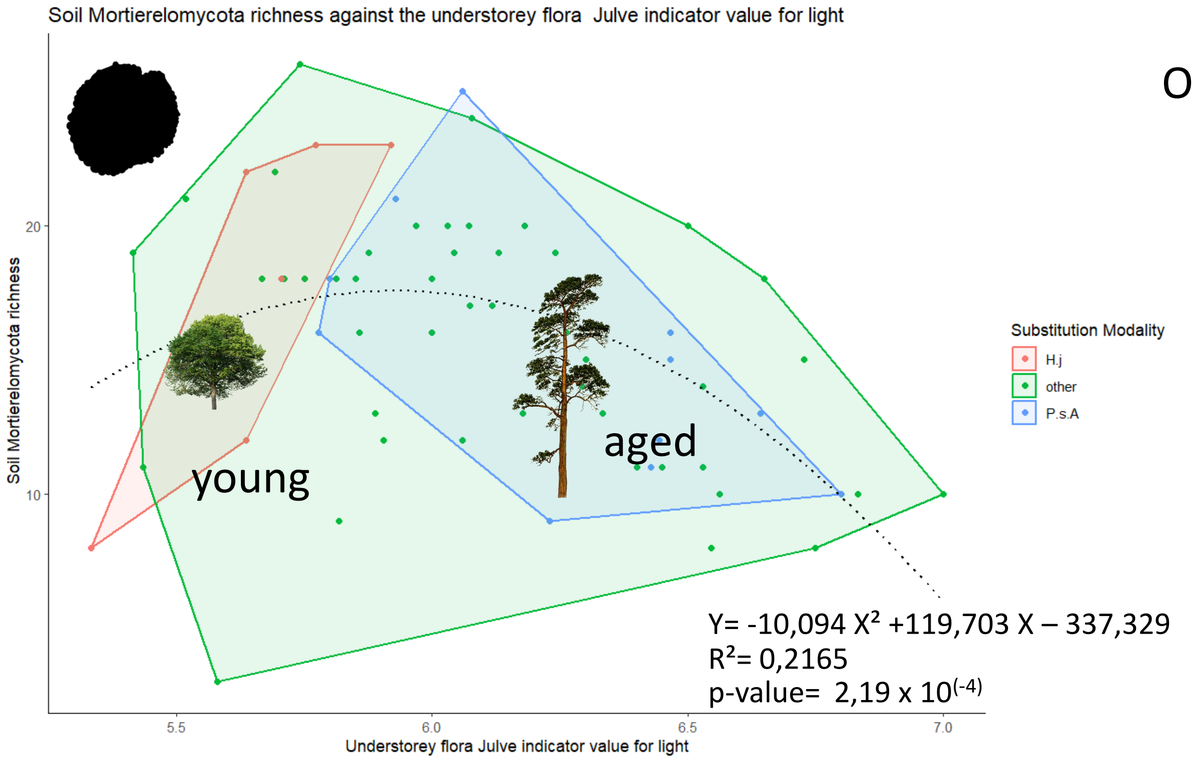
- → +  Richness

Advices for foresters

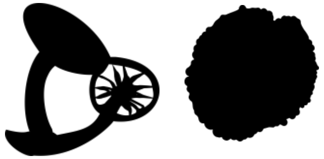
-

+  Richness

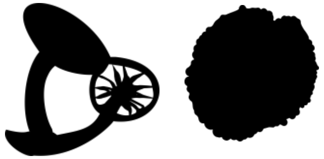
Optimum at IV=6 or **10000 lux**

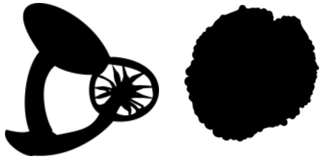


Advices for foresters

+  Soils nutrients → +  Richness

Advices for foresters

\+  Soils nutrients → +  Richness

\-  Litter accumulation → +  Richness

\+  ph → +  Richness

Thank you for your attention

Scan this QR to find the Ecodiv lab team and my thesis advisors…

Dr. Lucie Vincenot

Pr. Michaël Aubert

and this QR to find my Researchgate profil in order to:

- Follow the publications of the FUSEE project
- Contact me to discussion or question
- Or futur collaboration. I will support my thesis before 09/2024.

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Some photography illustrating the diferent atmosphere in our forest plot

Young Laricio pine modality

Aged beech modality

Some photography illustrating the diferent atmosphere in our forest plot

Young sessile oak modality

Young red oak modality

Some photography illustrating the diferent atmosphere in our forest plot

Young sessile oak modality

Young red oak modality

Some photography illustrating the diferent atmosphere in our forest plot

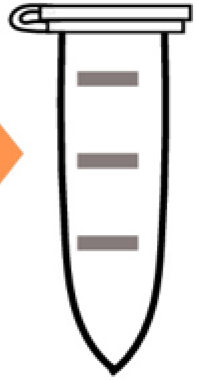
(Very) Young Scot pine modality

Young beech modality in spring

Metabarcoding sample processing

Pooling

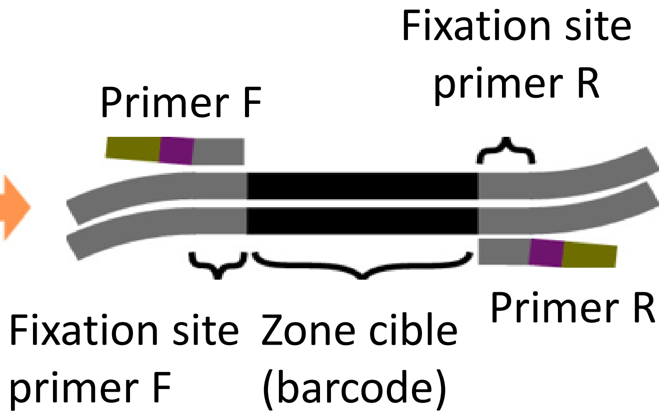
5 soil sample



DNA Extraction
Kit Power Soil
250 mg

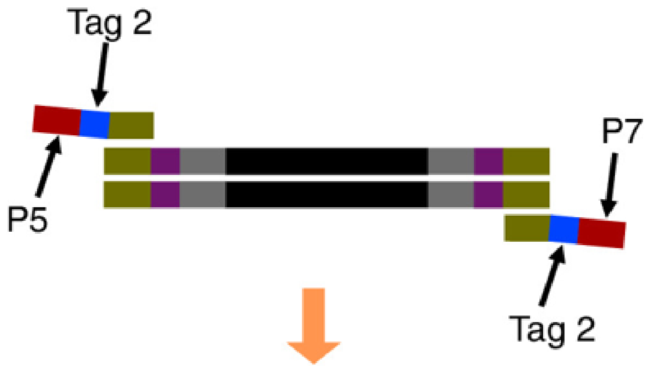
Nanodrop quality control
Dilution to 10 ng/µl

First PCR



X3
And pooling

Second PCR



Illumina MiSeq Screening (Genotoul)

FASTA files

unite community → **PIPITS** (Gweon et al, 2015)

ITSF2/ITSR2 (White,1990)