Comparison of terrestrial and epiphytic plant communities of plantations (maritime pine, poplar) and subnatural forests

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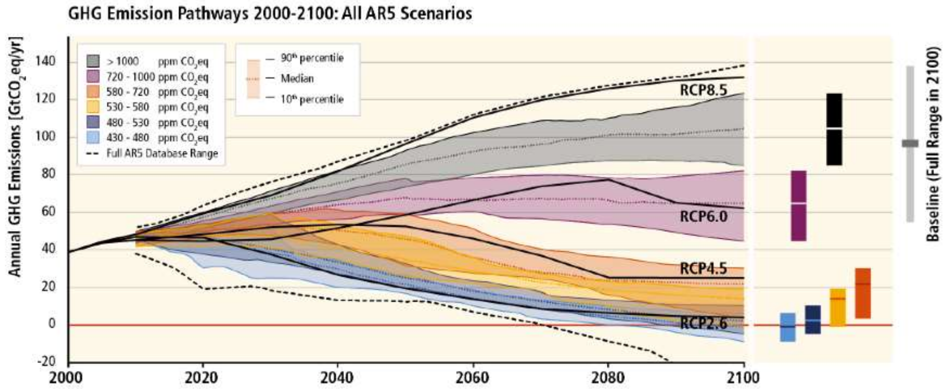
RÉPUBLIQUE FRANÇAISE
Liberté
Égalité
Fraternité

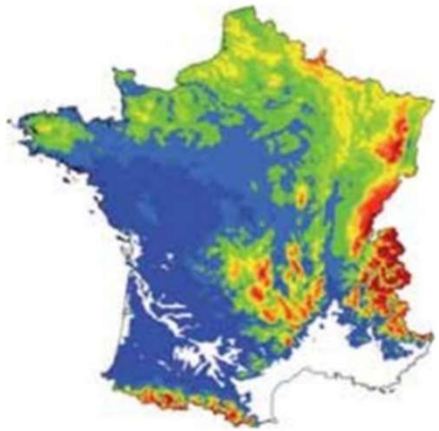
INRAE

Context

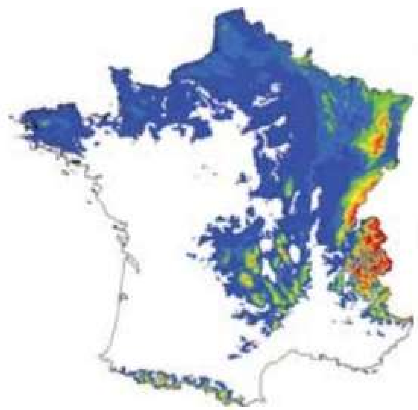


- Global changes:
  - climat
  - new parasites and diseases
  - fire
  - increase in wild ungulate population

⇒ mortality of some tree species
⇒ regeneration failure



Fagus sylvatica (2007)



Fagus sylvatica (2100)

Probability of presence

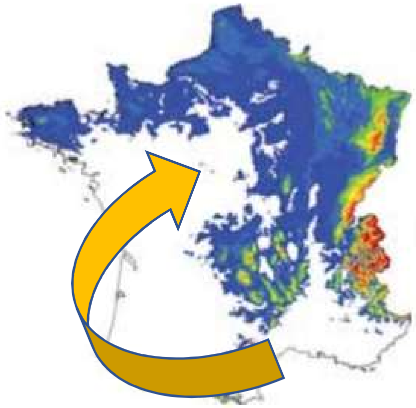
Badeau et al., 2007

Context

However, the goal of the forester = to restore the forest ecosystem

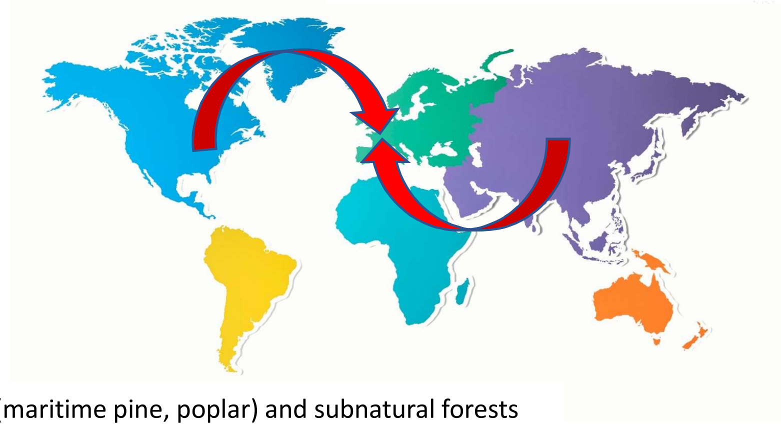
⇒ Assisted migration

Crossing biogeographic region without geographical barrier



⇒ introduction of exotic species

Crossing geophysical barrier (ocean, mountain)



Pinus pinaster and hypotheses about associated diversity

Historical, ecological and biological characteristics	Effects on associated diversity
Autochtonous in the south of France	☺ Species-time hypothesis => long time, long coevolution Assisted migration over a distance of only 400 km
Low Leaf Area Index (LAI)	☺ Favorable for chlorophyllous plants species
Acidic litter	☹ Limiting factor for some species
Rugose bark	☺ Favorable for establishment of epiphytic species
Exfoliating bark	☹ Disfavorable for establishment of epiphytic species
Acidic bark - pH 3-4 (Kuusinen,1996)	☹ Limiting factor for some epiphytic species


Exfoliating bark


Low Leaf Area Index (LAI)

Natural distribution ranges (Euforgen)

Hybrid Poplars and hypotheses about associated diversity

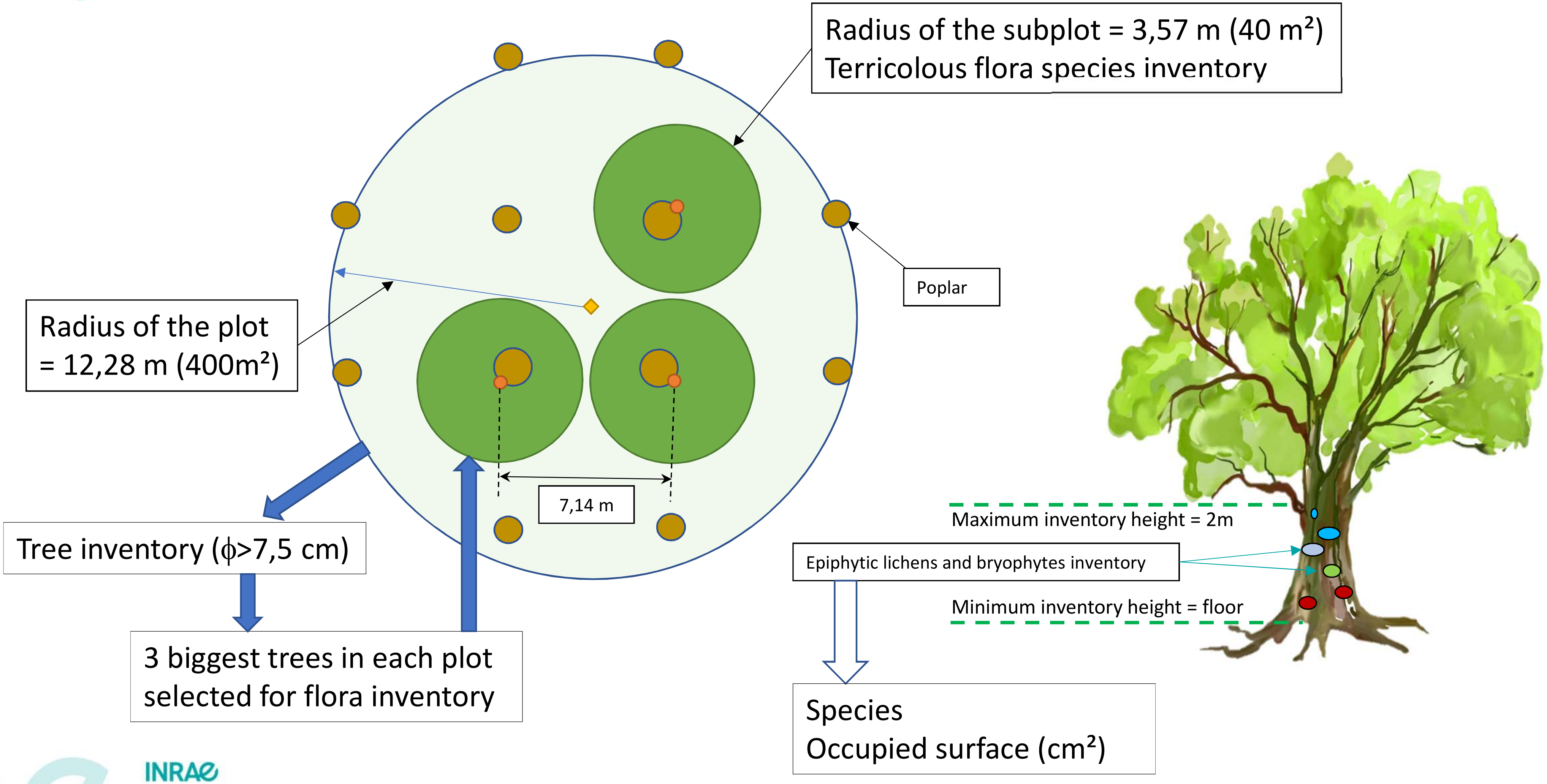
Historical, ecological and biological characteristics	Effects on associated diversity
Exotic about one or two hybrid parental species	☹ Species-time hypothesis => short time, short coevolution
Autochtonous parental species (Populus nigra)	☺ "Phylogenetic distance hypothesis" Enhanced associated diversity with coevolution
Low Leaf Area Index (LAI)	☺ Favorable for chlorophyllous plants species
Litter with high pH	☺ Favorable for richness species
Non exfoliating bark	☺ Favorable for establishment of epiphytic species
High bark pH (Kuusinen, 1996)	☹ ☺ Limiting factor for some lichen species, positive for bryophytes
Smooth bark	☹ Disfavorable for establishment of epiphytic species

Smooth bark

Low Leaf Area Index (LAI)

Natural distribution ranges of Populus nigra (Euforgen)

Material and methods



Material and methods - sample stratification

		Age class				
Tree species	Stand type	1	2	3	4	5
Pinus pinaster (introduced)	Acidiphilous	0-12 years	13-25 years	26-37 years	38-50 years	>50 years
Hardwood (autochtonous)	Acidiphilous	0-38 years	39-75 years	76-113 years	114-150 years	>150 years
Populus (introduced)	Alluvial	0-5 years	6-10 years	11-15 years	16-20 years	>20 years
Hardwood (autochtonous)	Alluvial	0 - 45 years	46 - 90 years	91 – 135 years	136 – 180 years	>180 years

In the case of plantations the age is generally known precisely, but in the case of natural regeneration the age is known approximately and the Gdom (basal surface area of the 3 dominant trees in the plot) is used as an approximate value.

Material and methods - statistics

Tree-level alpha diversity is determined by Bayesian models :

a, b, β, c and ea constants are calculated with the R package runMCMCbtadjust (Gosselin, 2024):

$$\text{Log}(\text{mean}(SR_i) = a + b\ \text{Ess}_i + \beta \log(\text{Surf\_releve}_i) + c\ \text{secteur}_i + ea\ \text{placette}_i$$

- b Ess$_i$: Fixed to -1 (exotic) or 1 (autochtonous)
- β: Fixed between 0 and 1
- Surf_releve$_i$: Prospected trunk or soil surface (Scaled value)
- secteur$_i$: Bourgueil, Levroux, Orléans, Romorantin, Vierzon
- ea placette$_i$: random effect

Symbols of Significance :

*   p<0.05

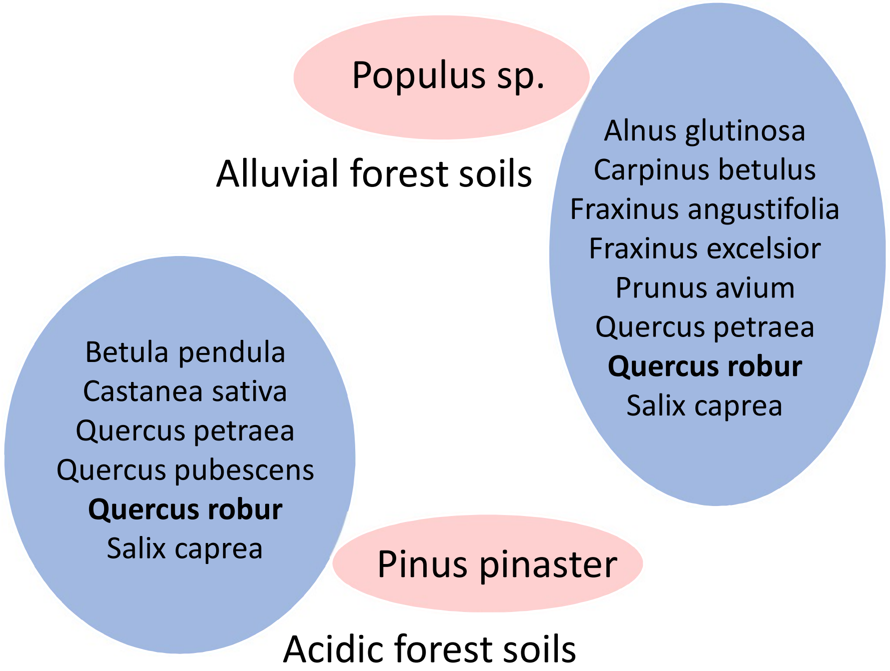
**   p<0.01

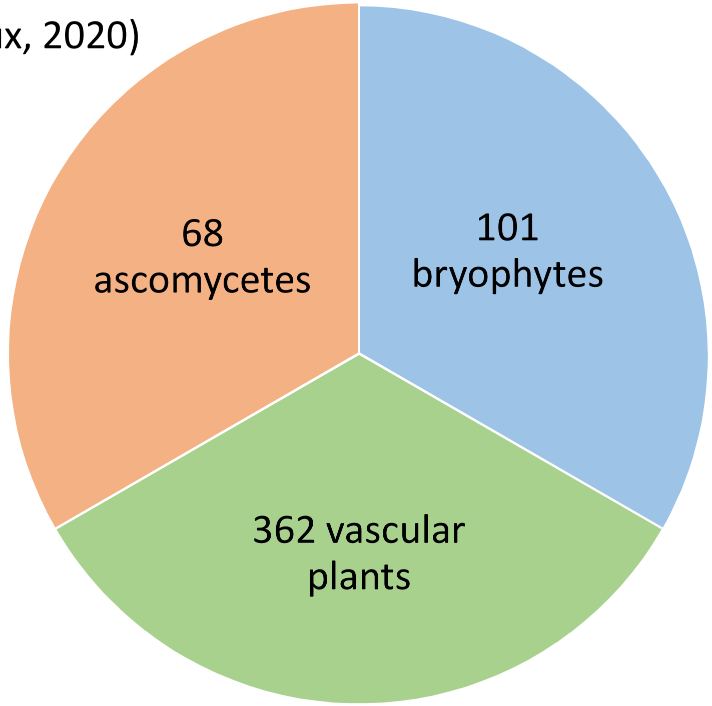
*** p<0.005

Plot-level gamma diversity is determined by Rarefaction and extrapolation curves, iNEXT, Chao, A. et al. 2014

Overall results (in situ)

- Near than 10000 plants recorded on or at the foot of 336 trees on 112 plots
- 531 different taxa inventoried
- 48 rare species recorded (Inpn 2024; Roux, 2020)





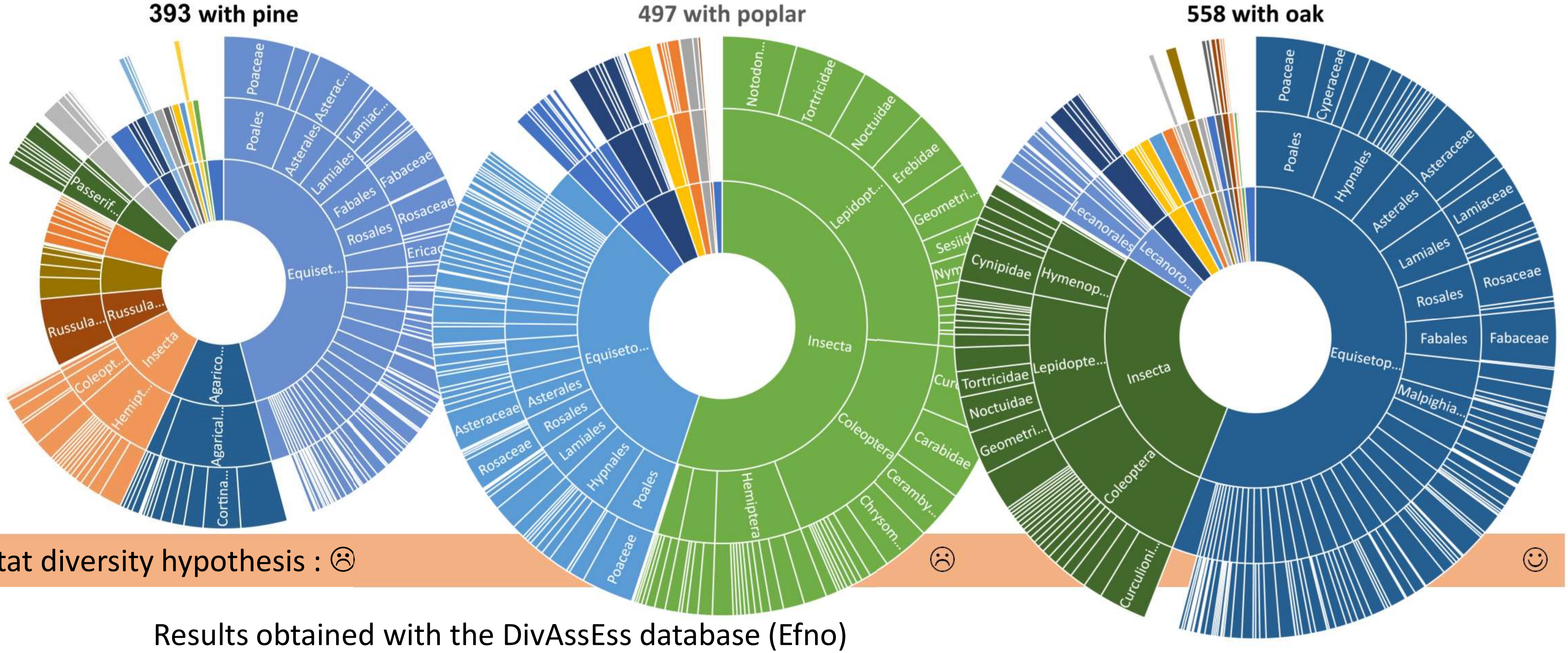
Rare species inventoried during this research project

Group	Species	Status	Tree species associated
Bryophytes	Sematophyllum substrumulosum	New species discovered in the region	PINUPINA
Bryophytes	Sphagnum platyphyllum	New species discovered in the region	PINUPINA
Vascular	Rubus ferriararum	New species discovered in the region	PINUPINA and QUERPETR
Vascular	Agrostis curtisii	Regional red list	PINUPINA
Vascular	Carex strigosa	Regional red list	FRAXEXCE
Vascular	Juncus squarrosus	Regional red list	PINUPINA
Vascular	Simethis mattiazzii	Regional red list	PINUPINA
Bryophytes	Orthotrichum pumilum	Provisional regional red list	FRAXEXCE
Bryophytes	Scleropodium cespitans	Provisional regional red list	FRAXEXCE
Bryophytes	Zygodon conoideus	Provisional regional red list	QUERPETR

9 other species are classified as "Znieff determinants", including:
4 associated with **FRAXEXCE** (Carex pendula, Cornus mas, Primula elatior and Viola canina)
3 associated with **POPUSP** (Carex tomentosa, Juncus subnodulosus and Lathyrus nissolia)
2 associated with **QUERROBU** (Cornus mas, Phyteuma spicatum)
1 associated with **PINUPINA** and **BETUPEND** (Erica scoparia)

Gamma species richness according to scientific literature

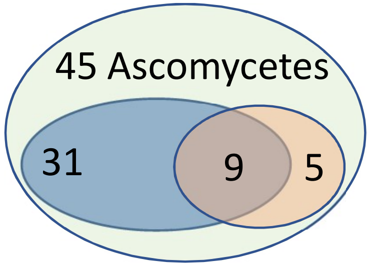
Species currently recorded in the Centre-Val de Loire region and known to be associated with tree species



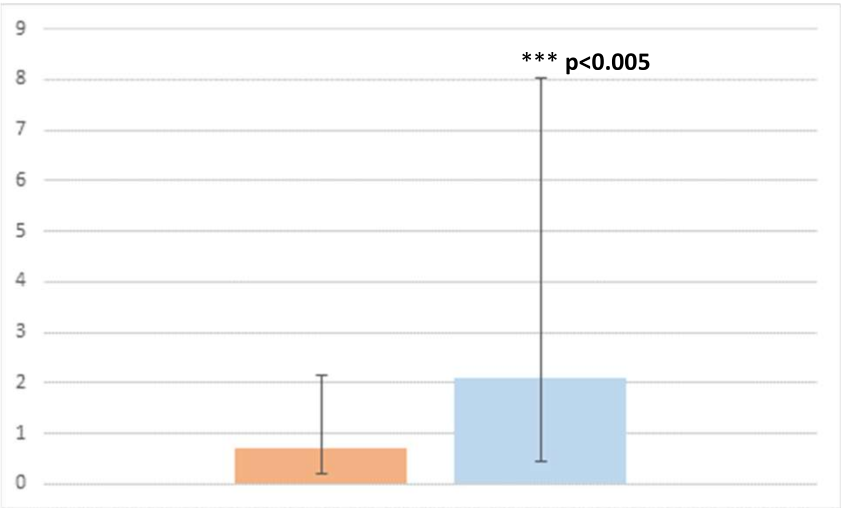
Results obtained with the DivAssEss database (Efno)

Woodlands made up of exotic tree species have potentially lower associated diversity but are not deserts.

Epiphytic Ascomycetes Species richness Alpha/Gamma on Maritime pine (Red) and Hardwood on acidic soils (blue)

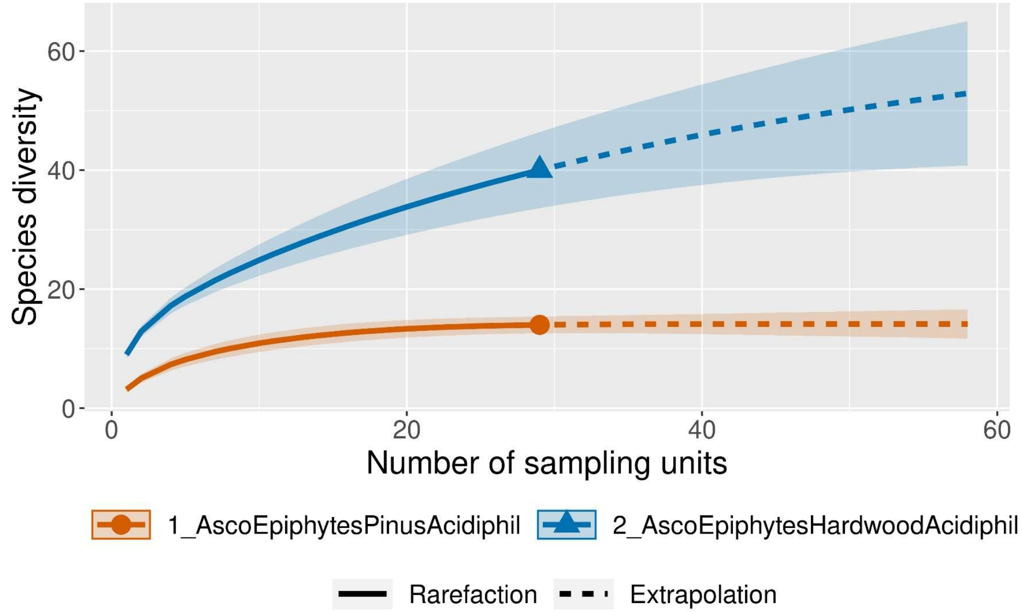


Alpha species richness



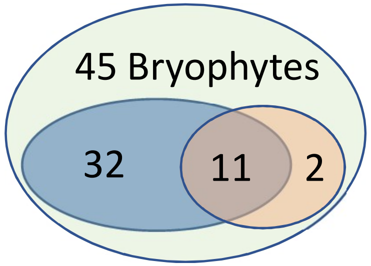
Simulation for trees with a diameter of 41,5 cm (median value on acidic soil)

Gamma species richness

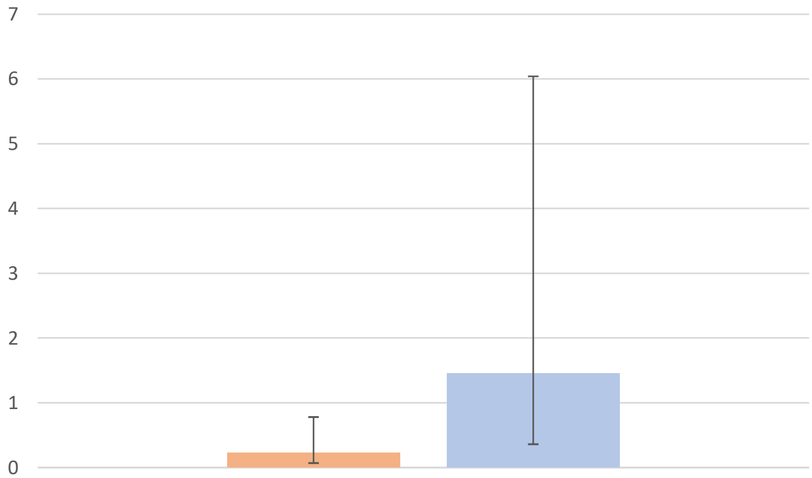


Alpha epiphytic ascomycete species richness is significatively lower on maritime pine at tree level.
Gamma epiphytic ascomycete species richness is significatively lower on maritime pine at plot level.

Epiphytic Bryophytes Species richness Alpha/Gamma on Maritime pine (Red) and Hardwood on acidic soils (blue)

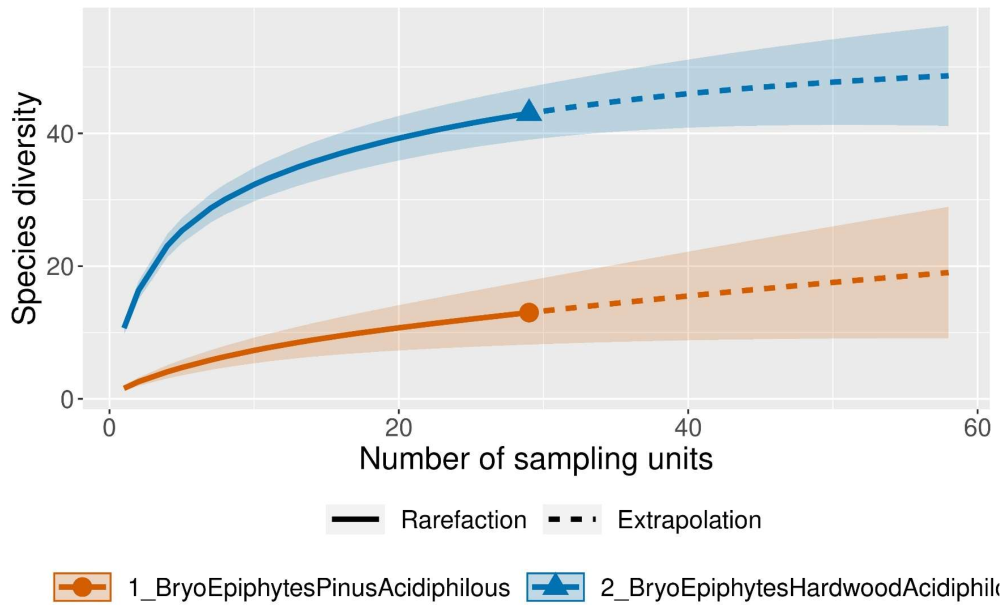


Alpha species richness



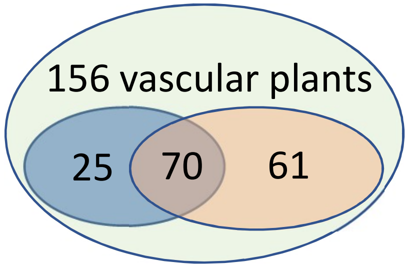
Simulation for trees with a diameter of 41,5 cm (median value on acidic soil)

Gamma species richness

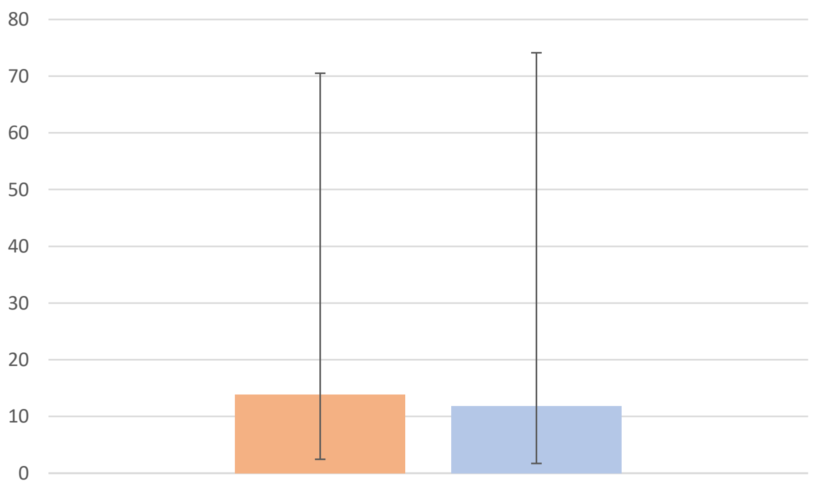


Alpha epiphytic bryophyte species richness is significatively lower on maritime pine at tree level.
Gamma epiphytic bryophyte species richness is significatively lower on maritime pine at plot level.

Terricolous vascular species richness Alpha/Gamma under Maritime pine (Red) and Hardwood on acidic soil (blue)

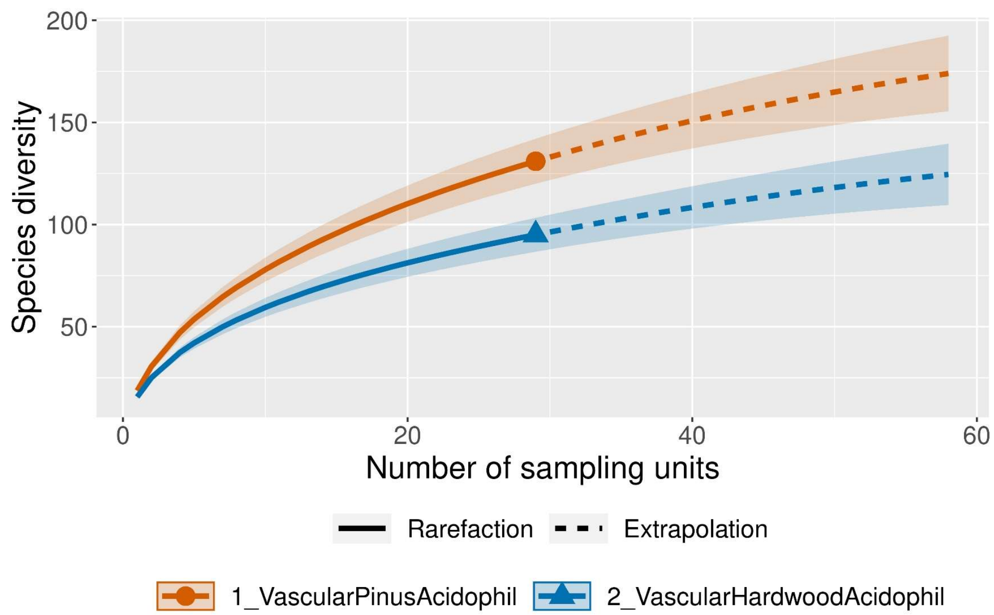


Alpha species richness



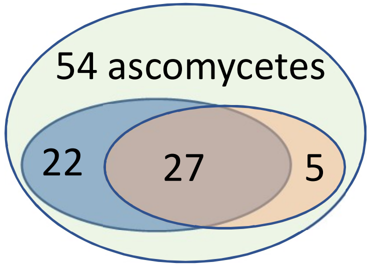
Simulation for trees with a diameter of 41,5 cm (median value on acidic soil)

Gamma species richness

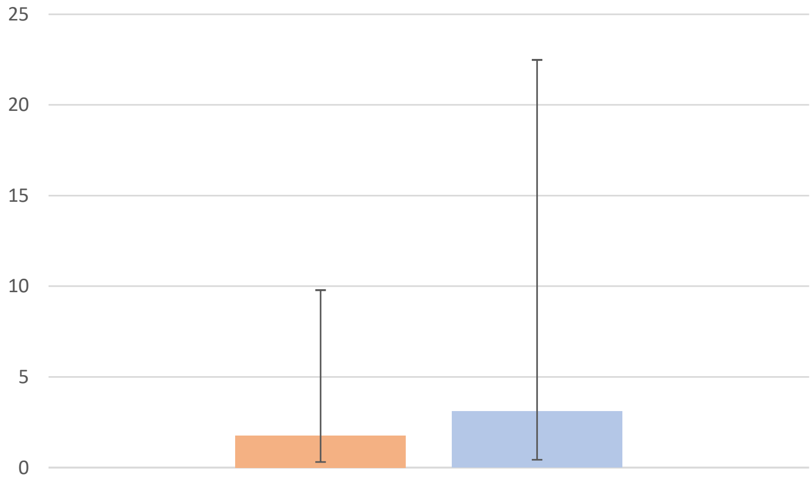


Alpha vascular terricolous species richness is not significatively different between Maritime pine and Hardwood on acidic soil. Gamma vascular terricolous species richness is significatively higher under maritime pine.

Epiphytic Ascomycetes Species richness Alpha/Gamma on poplar (Red) and Hardwood on alluvial soil (blue)

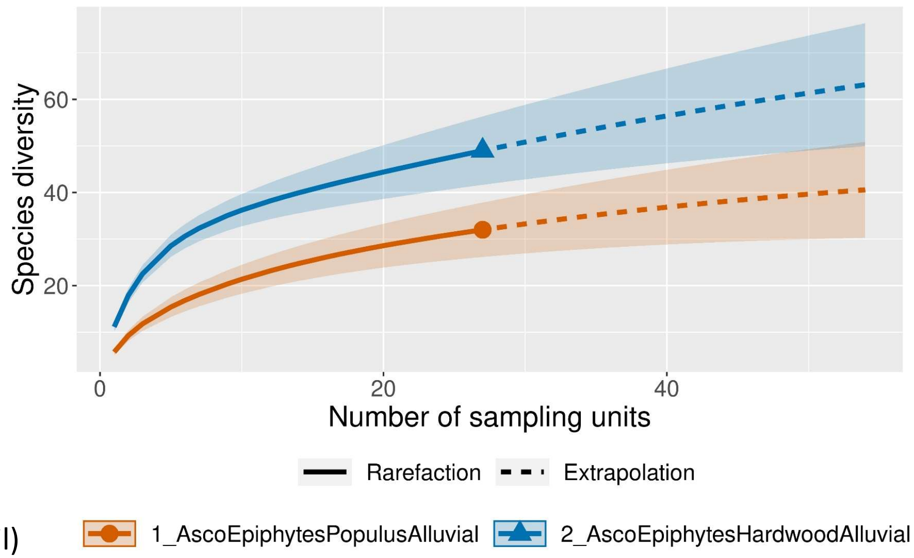


Alpha species richness



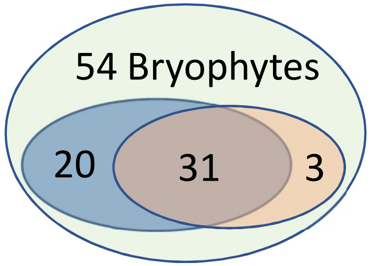
Simulation for trees with a diameter of 33.7 cm (median value on alluvial soil)

Gamma species richness

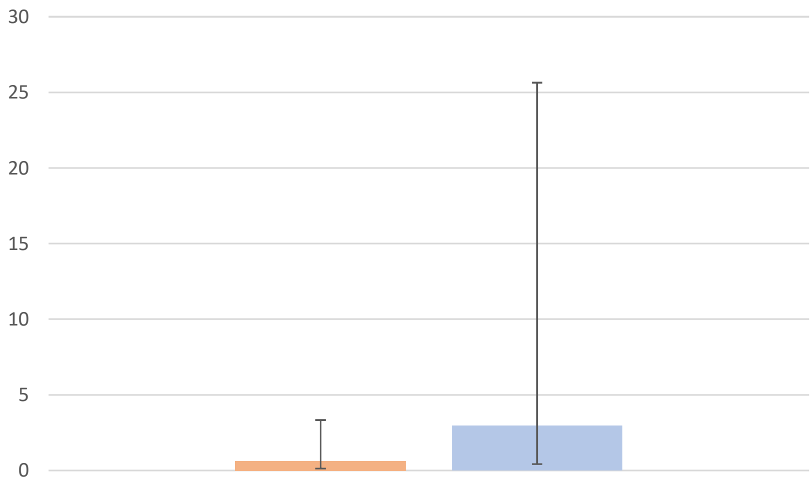


Alpha and Gamma ascomycetes epiphytic species richness are significatively lower on poplar

Epiphytic Bryophytes Species richness Alpha/Gamma on Poplar (Red) and Hardwood on alluvial soil (blue)

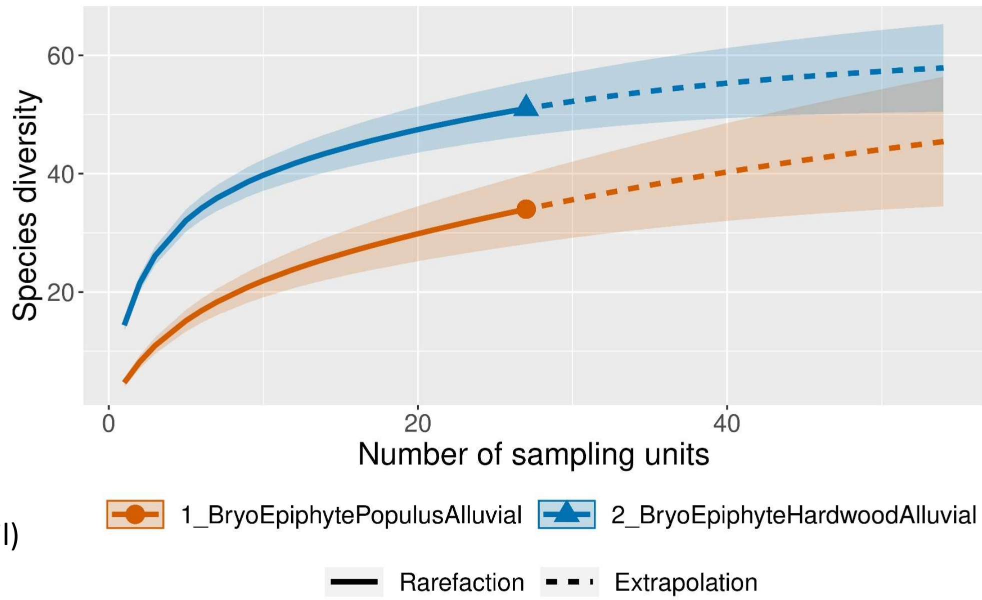


Alpha species richness



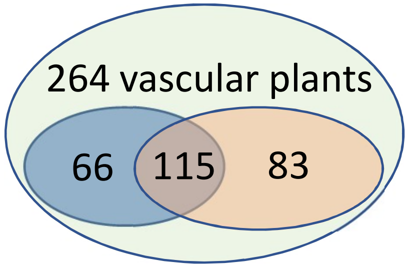
Simulation for trees with a diameter of 33.7 cm (median value on alluvial soil)

Gamma species richness

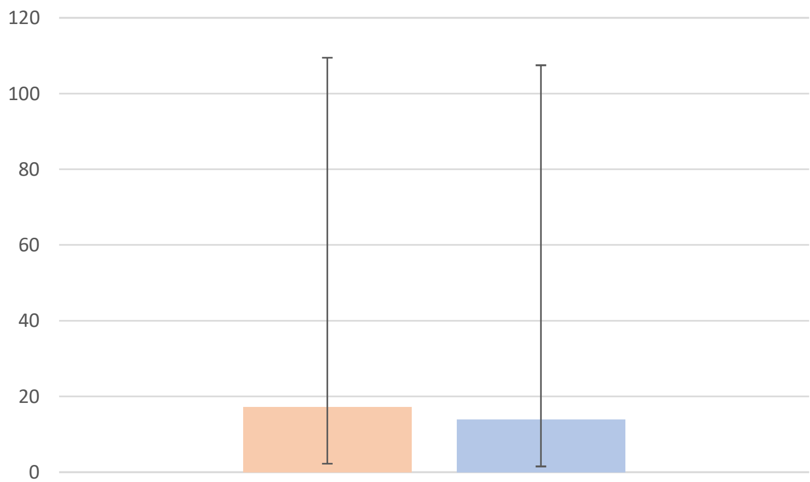


Alpha and Gamma bryophytes epiphytic species richness are significatively lower on poplar. However, extrapolation of gamma species richness appears to predict a non-significant difference at large spatial scales.

Terricolous vascular species richness Alpha/Gamma under Poplar (Red) and Hardwood on alluvial soil (blue)

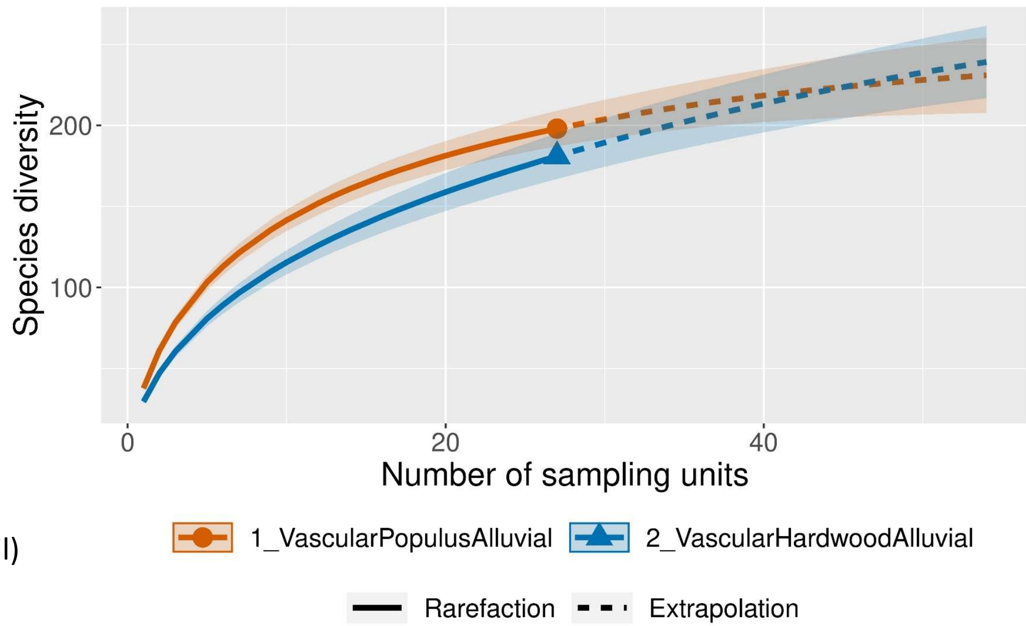


Alpha species richness



Simulation for trees with a diameter of 33.7 cm (median value on alluvial soil)

Gamma species richness



Alpha richness in terricolous plant vascular species is not significantly different between poplar and native hardwoods. Gamma richness is significantly higher under poplar for a limited number of plots. But at large spatial scales it becomes not significantly different.

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