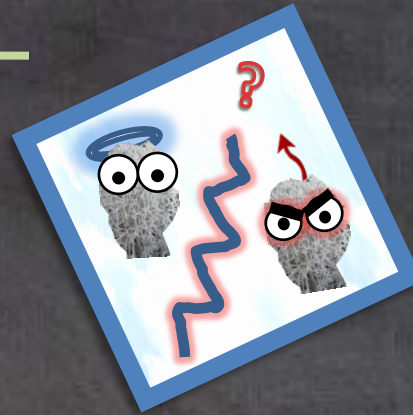


# Do lichens prevent pine stand reClosure in the boreal forest?

**Marine Pacé**

PhD student in  
environmental sciences

Nicole Fenton, David Paré,  
Yves Bergeron



# Introduction

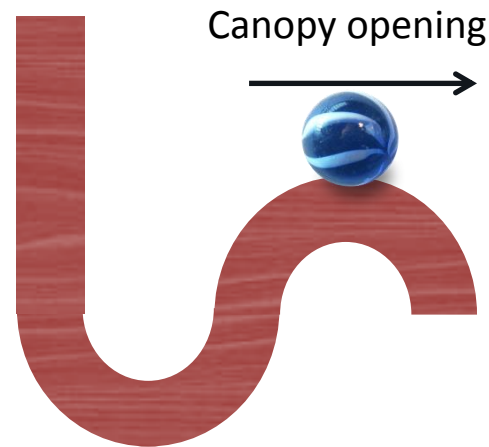
## Pine stands on sandy soil in the boreal forest





# Introduction

## Pine stands on sandy soil in the boreal forest



# Introduction

## Pine stands on sandy soil in the boreal forest



Canopy opening



Stable alternative  
state\*

Pine regeneration  
deficit



\* Jasinsky and Payette 2005



# Introduction

## Pine stands on sandy soil in the boreal forest



Canopy opening  
→

Stable alternative state

Pine regeneration deficit



# Introduction

## Pine stands on sandy soil in the boreal forest



Canopy opening



Stable alternative  
state

Pine regeneration  
deficit



Do lichens play a role in maintaining open lichen woodlands in the boreal forest?

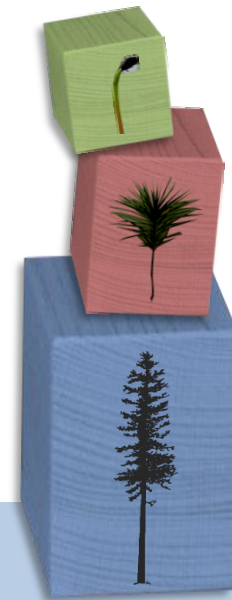


# Introduction

**Question :**




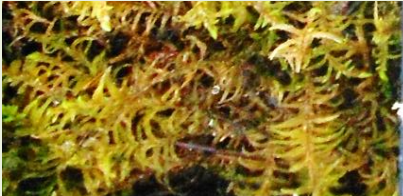

Do lichens affect jack pine germination  
and/or growth?

And if so, how?



# Experimental design







## Application of various treatments...

Tree	Ground cover	Fertilization
Jack pine	bare soil 	Control  VS Fertilized 
	Feather mosses 	
	Lichen 	



# Experimental design






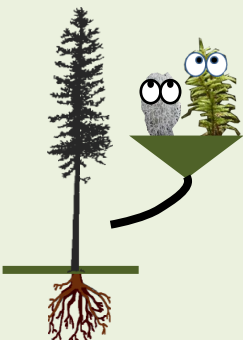
... at different stages of pine development

Stage of growth	Design	
Germination 	<i>Ex situ</i> *	
Seedling growth 	<i>Ex situ</i> *	
Young tree growth 	<i>In situ</i> <i>Ex situ</i> *	 

\* Substrate from the field

# Experimental design

... at different stages of pine development

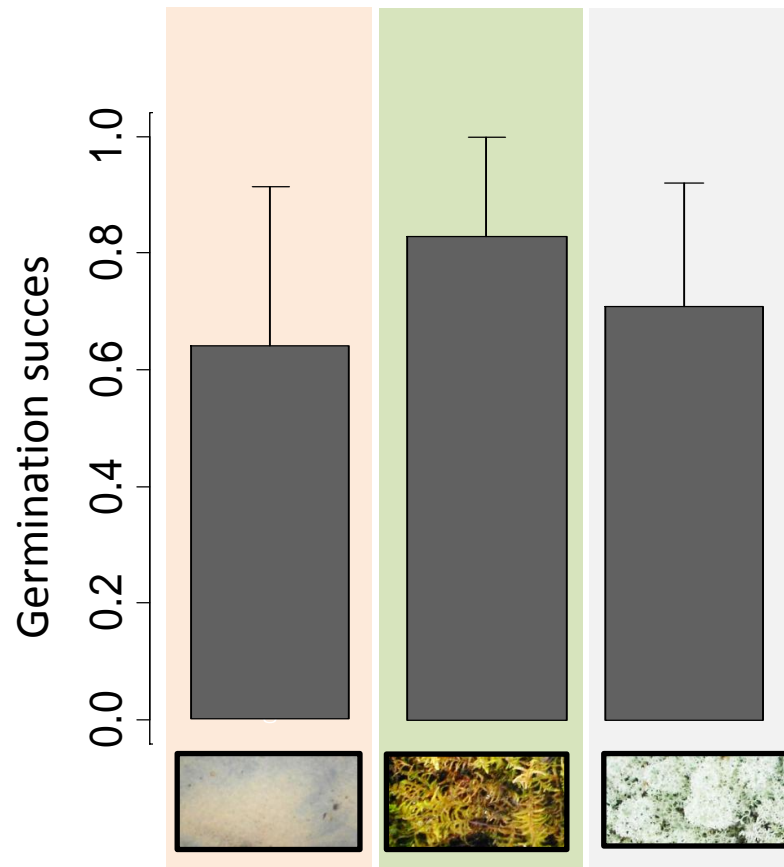
Stage of growth	Design	Treatment application
Germination 	<i>Ex situ</i> *	Direct exposition 
Seedling growth 	<i>Ex situ</i> *	
Young tree growth 	<i>In situ</i> <i>Ex situ</i> *	<div>Direct exposition </div> <div>Indirect exposition </div>

\* Substrate from the field



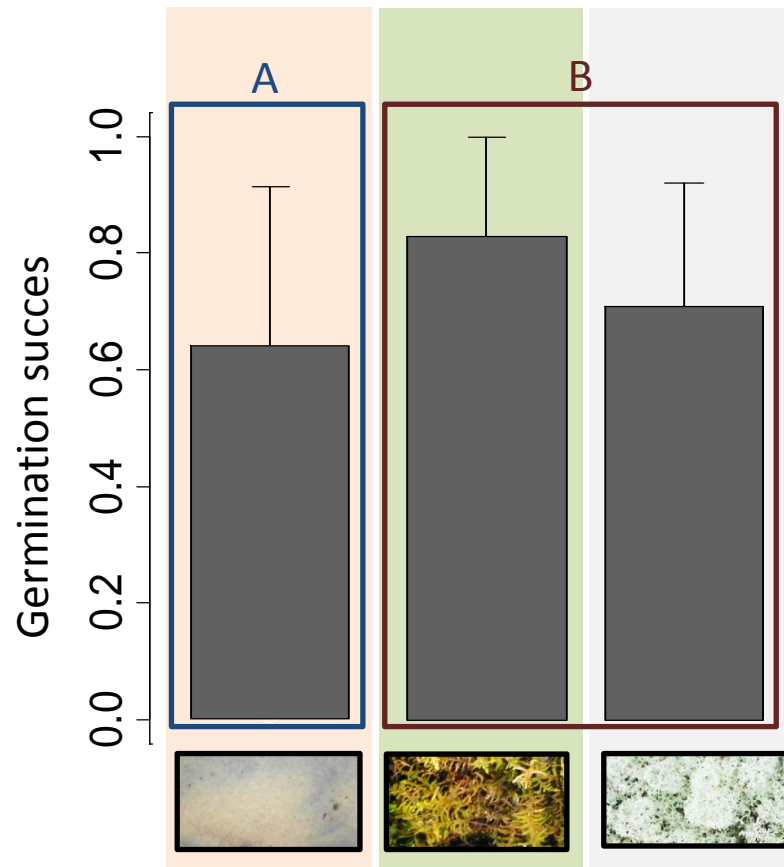
# Results

## Germination



# Results

## Germination



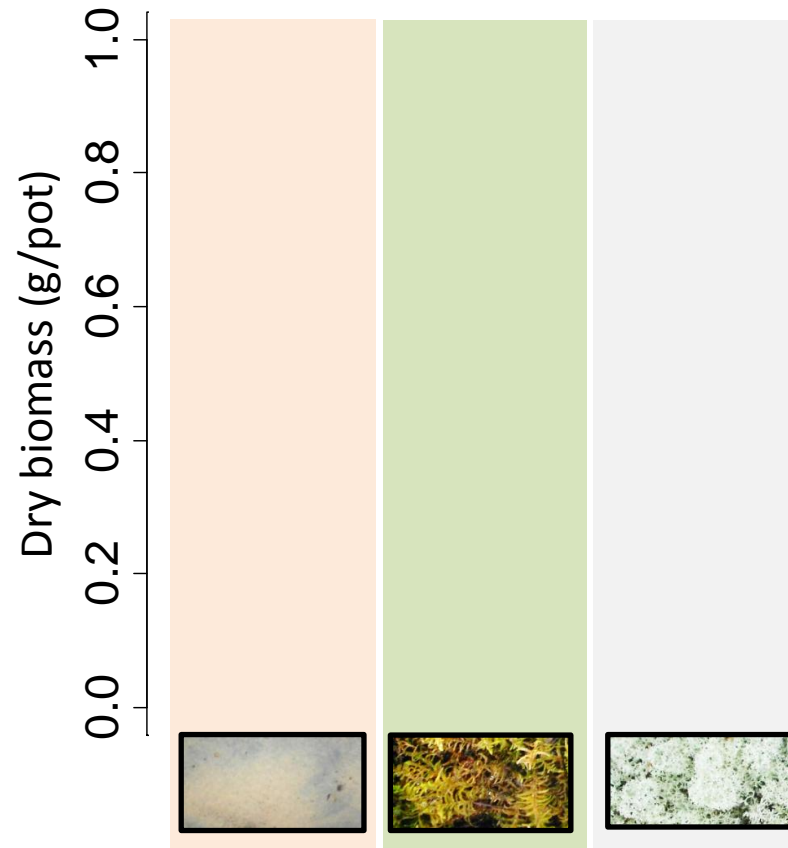
Positive effect of the ground cover





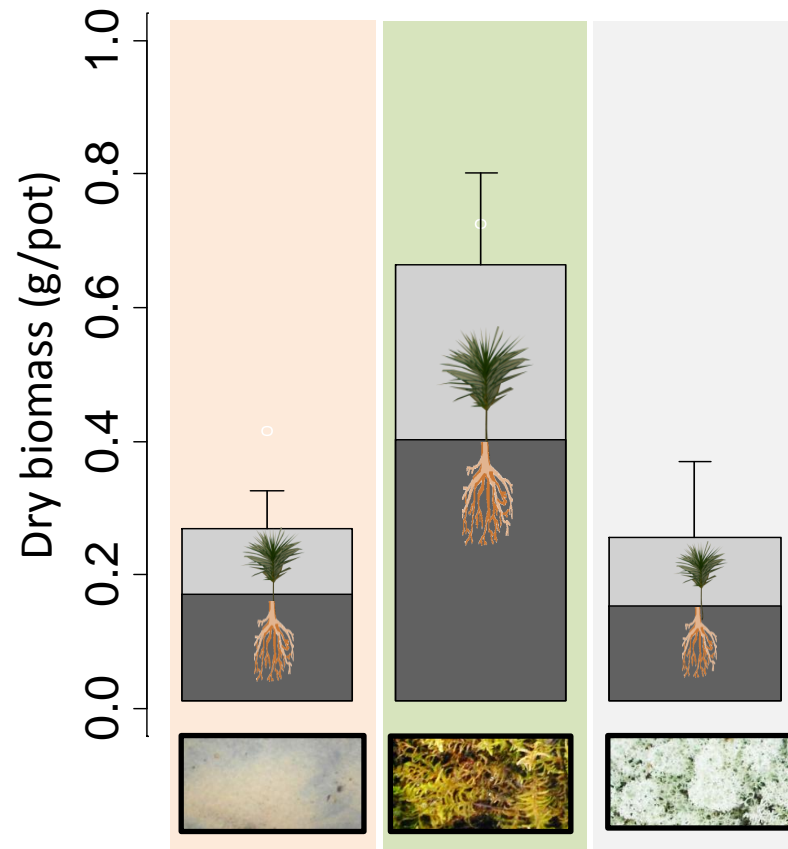
# Results

## Seedling growth



# Results

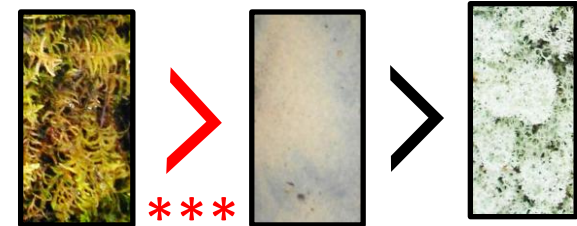
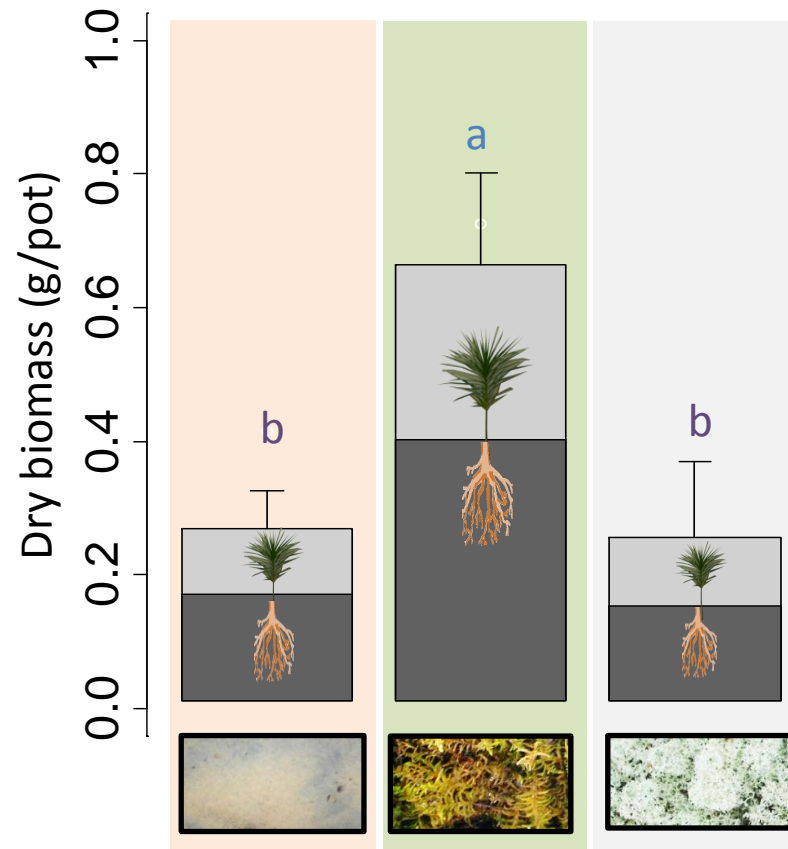
## Seedling growth





# Results

## Seedling growth

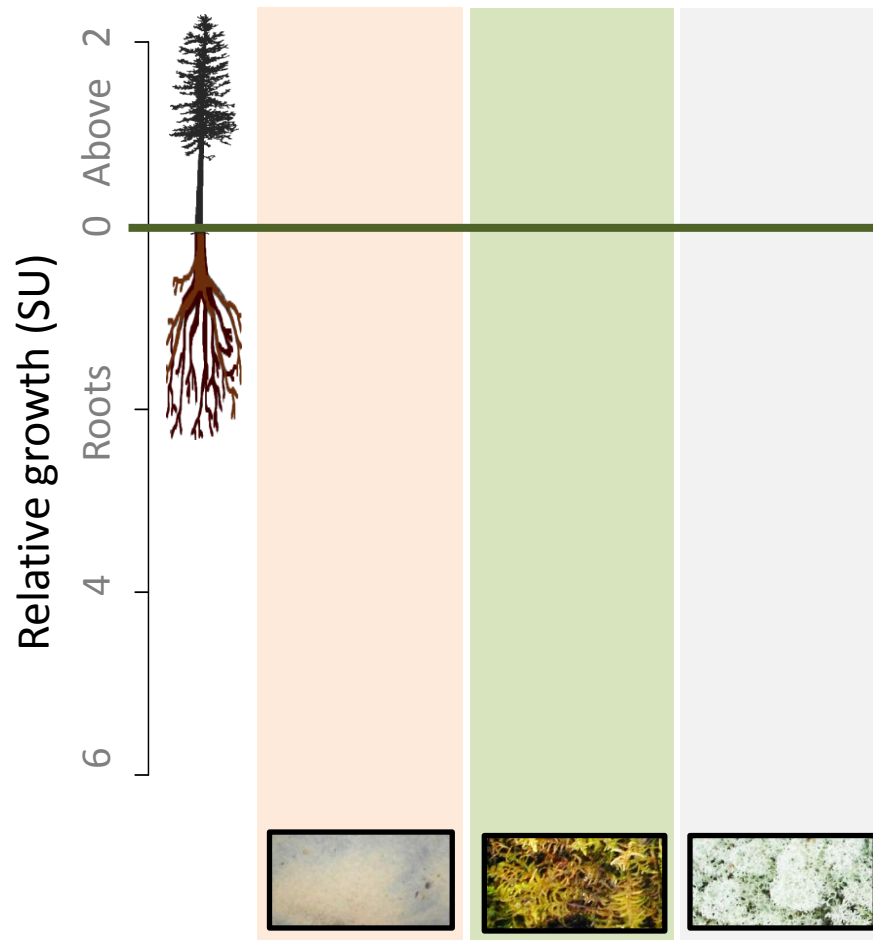


Positive effect of feather mosses



# Results

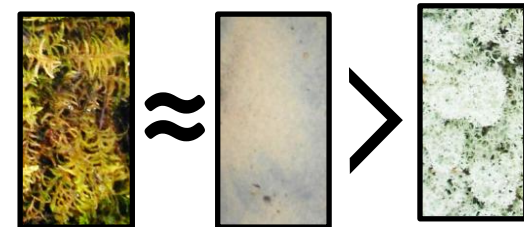
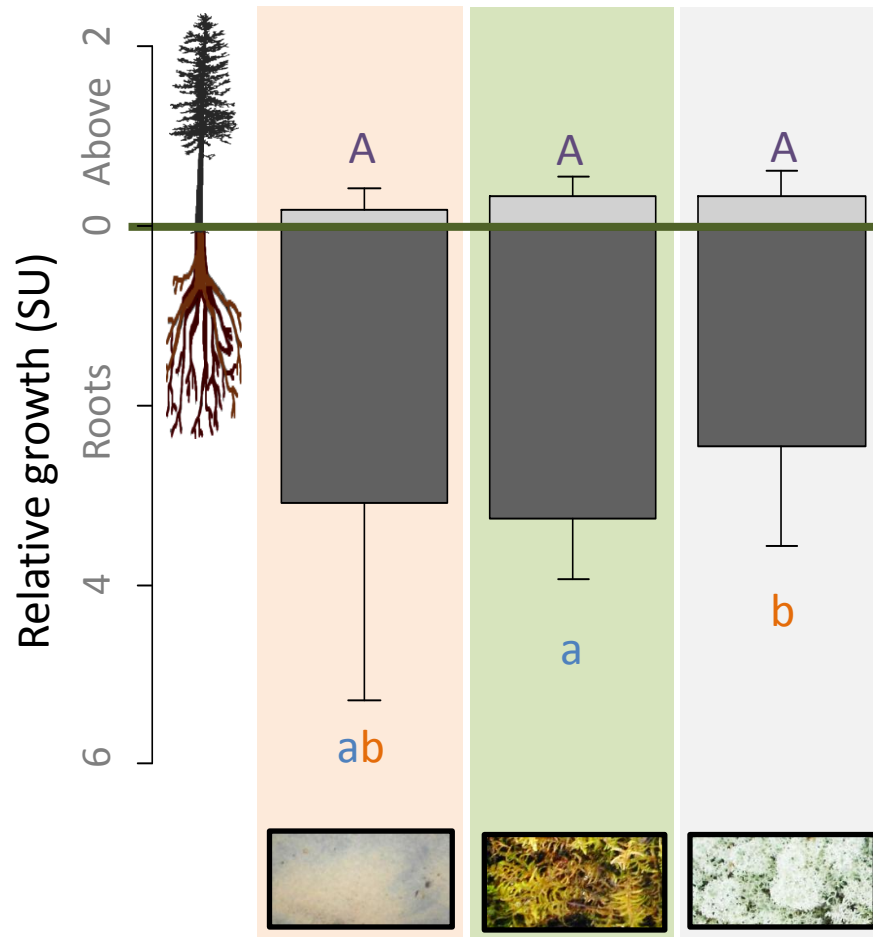
## Young tree growth *ex situ*





# Results

## Young tree growth *ex situ*

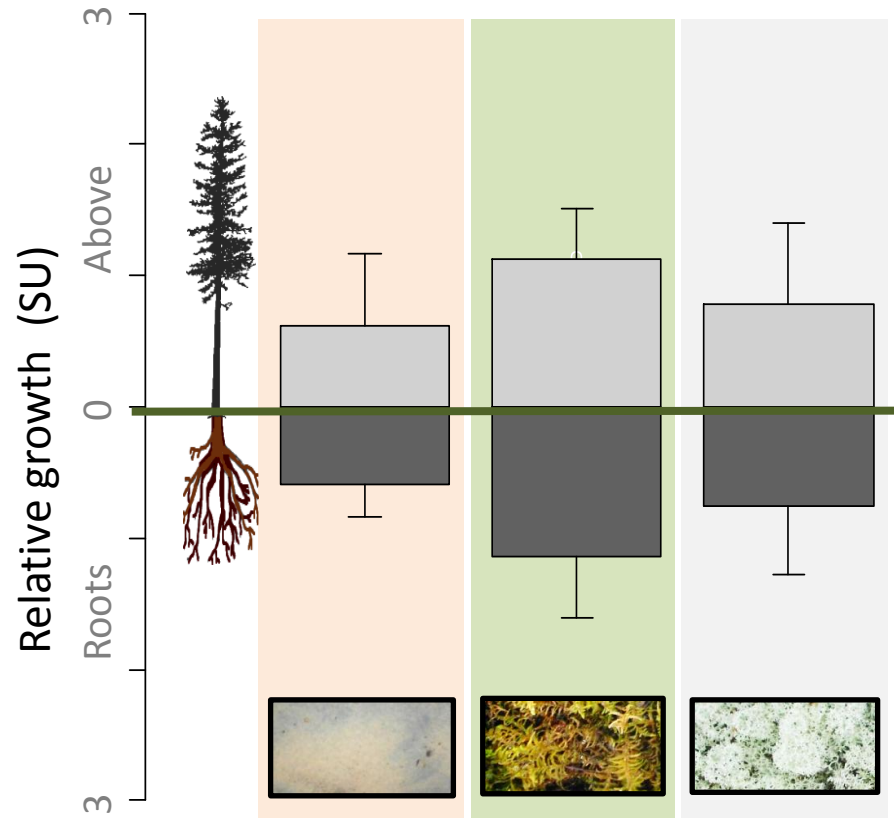


Negative effect of lichens on root growth



# Results

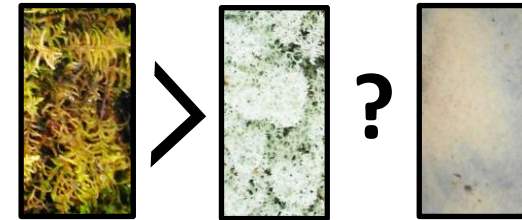
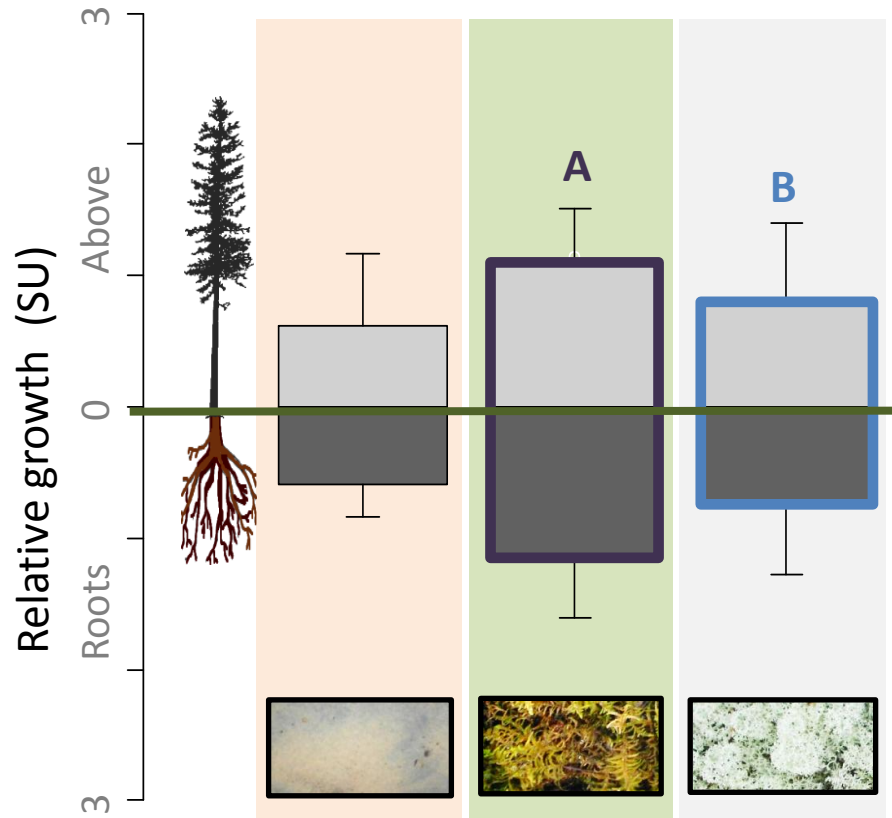
## Young tree growth *in situ*





# Results

## Young tree growth *in situ*

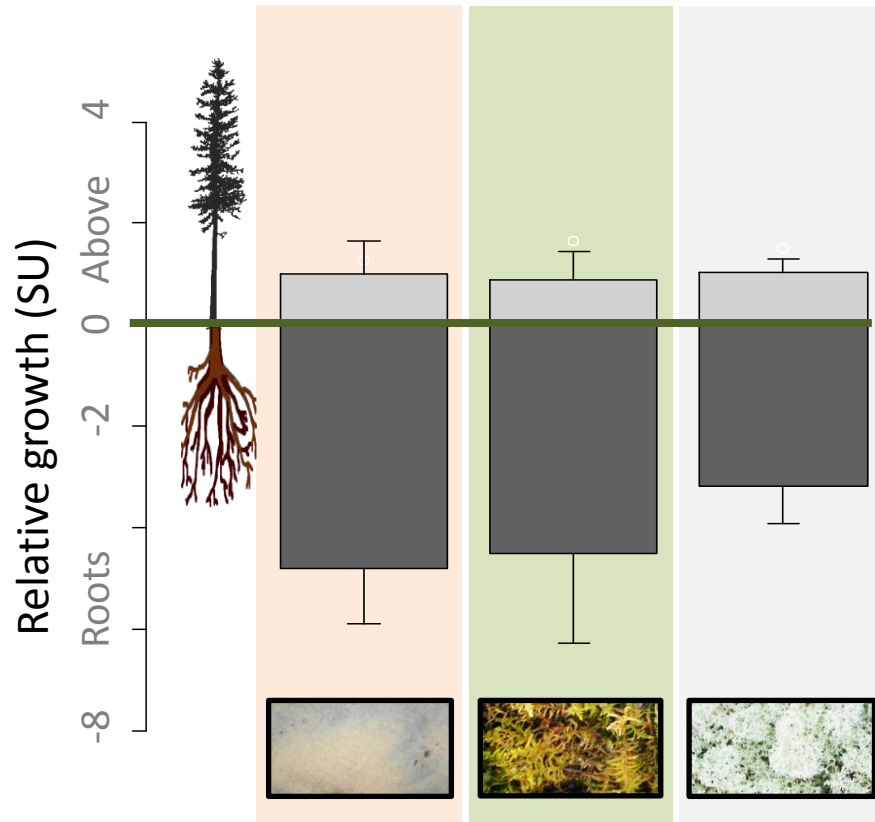


Negative effect of lichens on pine growth



# Results

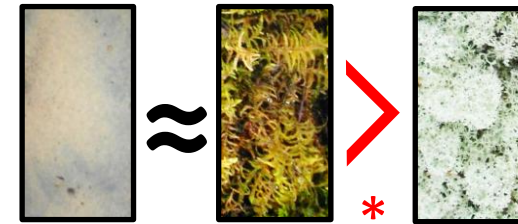
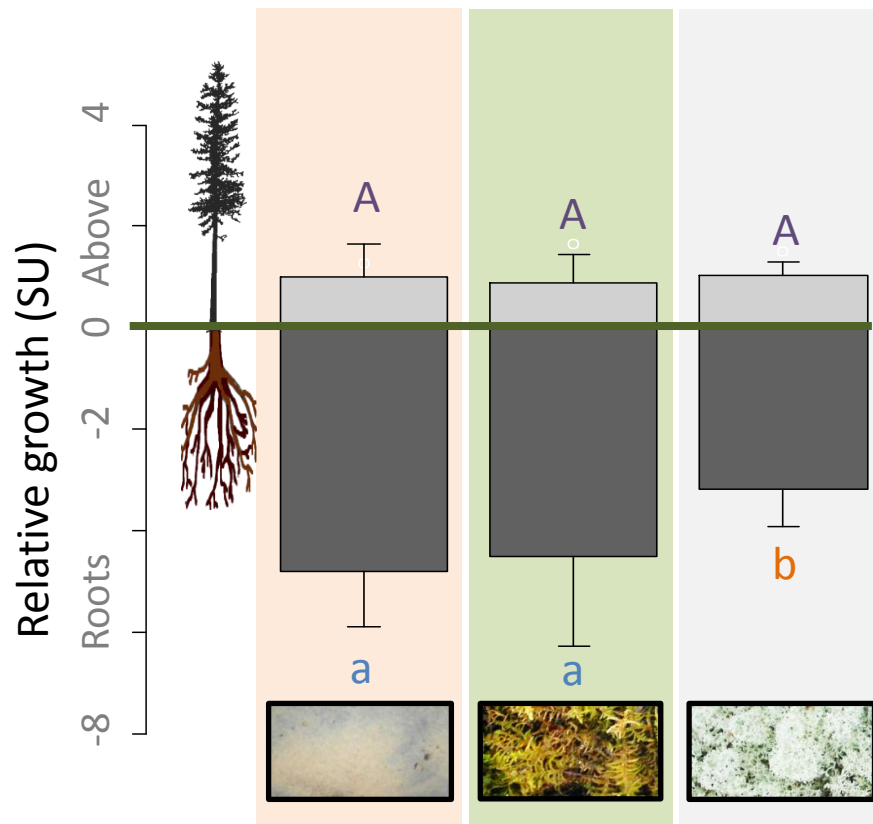
## Young tree growth *ex situ* – indirect exposition





# Results

## Young tree growth *ex situ* – indirect exposition

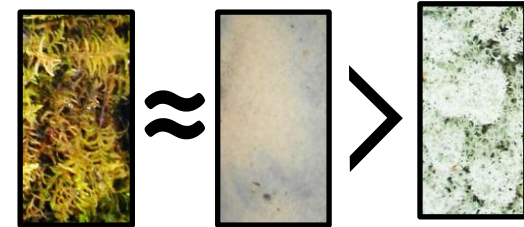
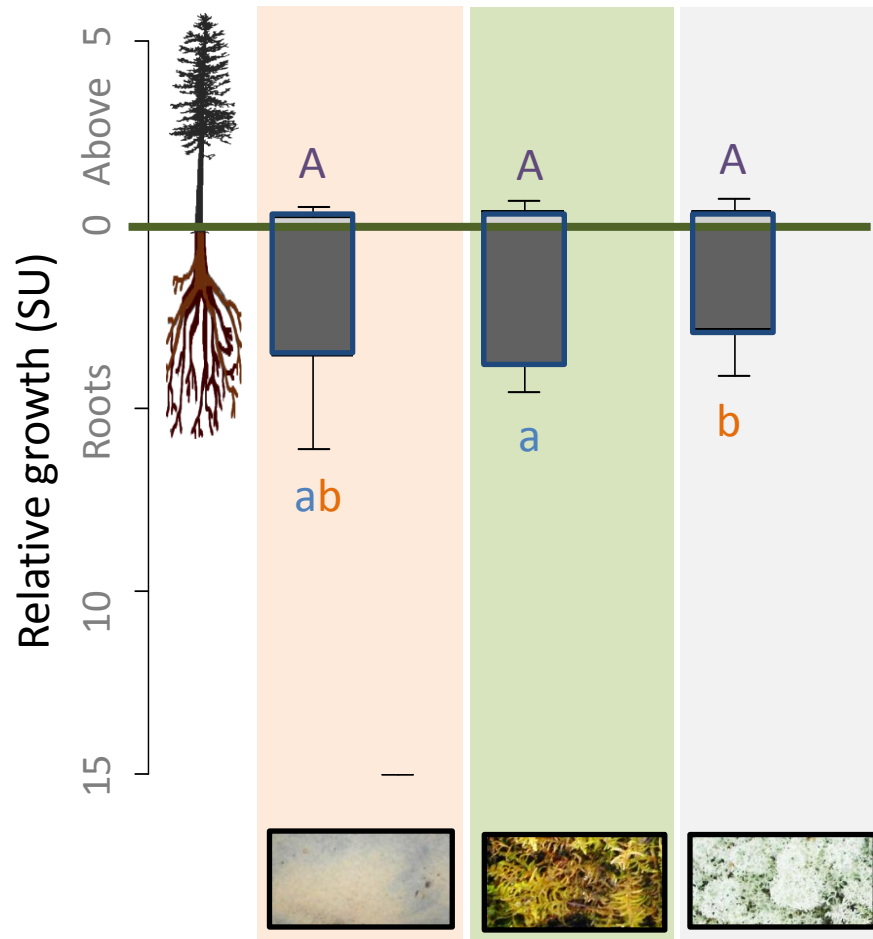


Negative effect of the lichen leachates on root growth



# Results

## Young tree growth *ex situ*



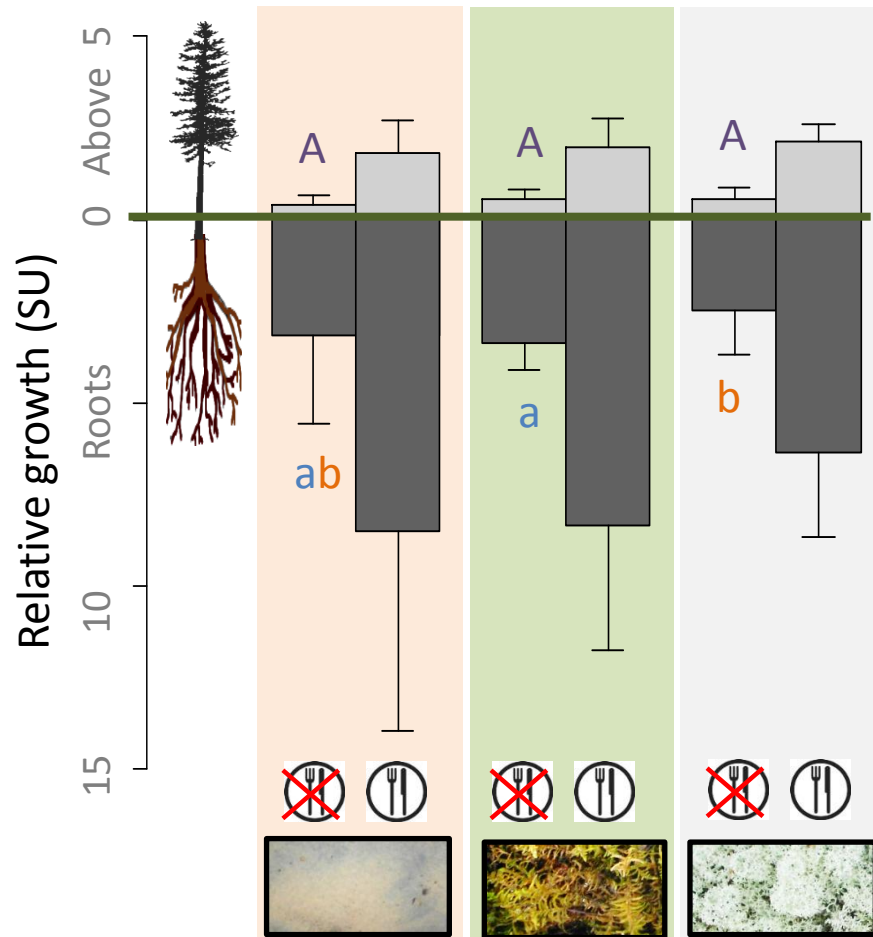
Negative effect of lichens on root growth





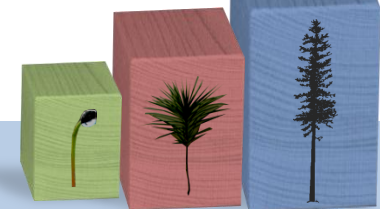
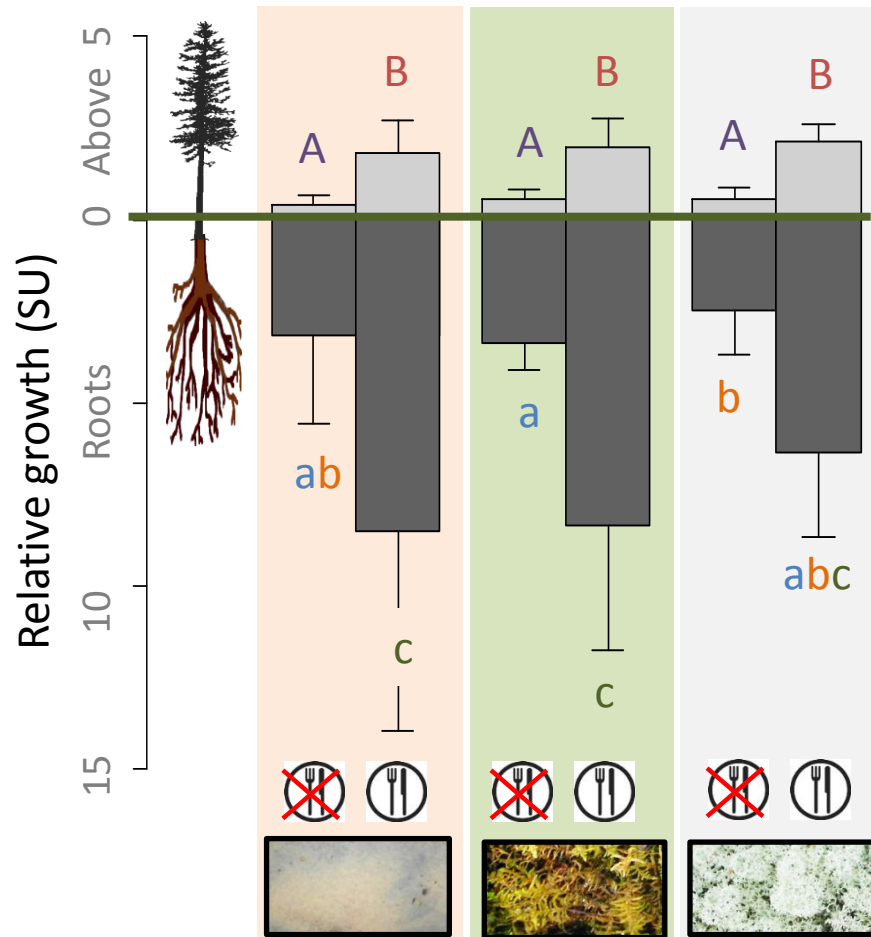
# Results

## Young tree growth *ex situ*



# Results

## Young tree growth *ex situ*

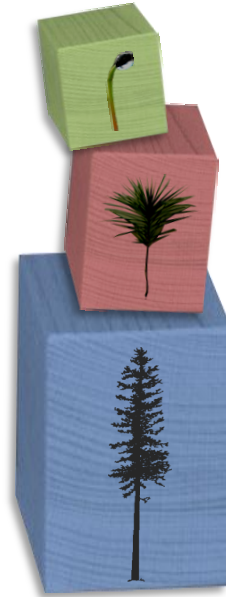


Positive effect of fertilisation regardless of the cover



# Results

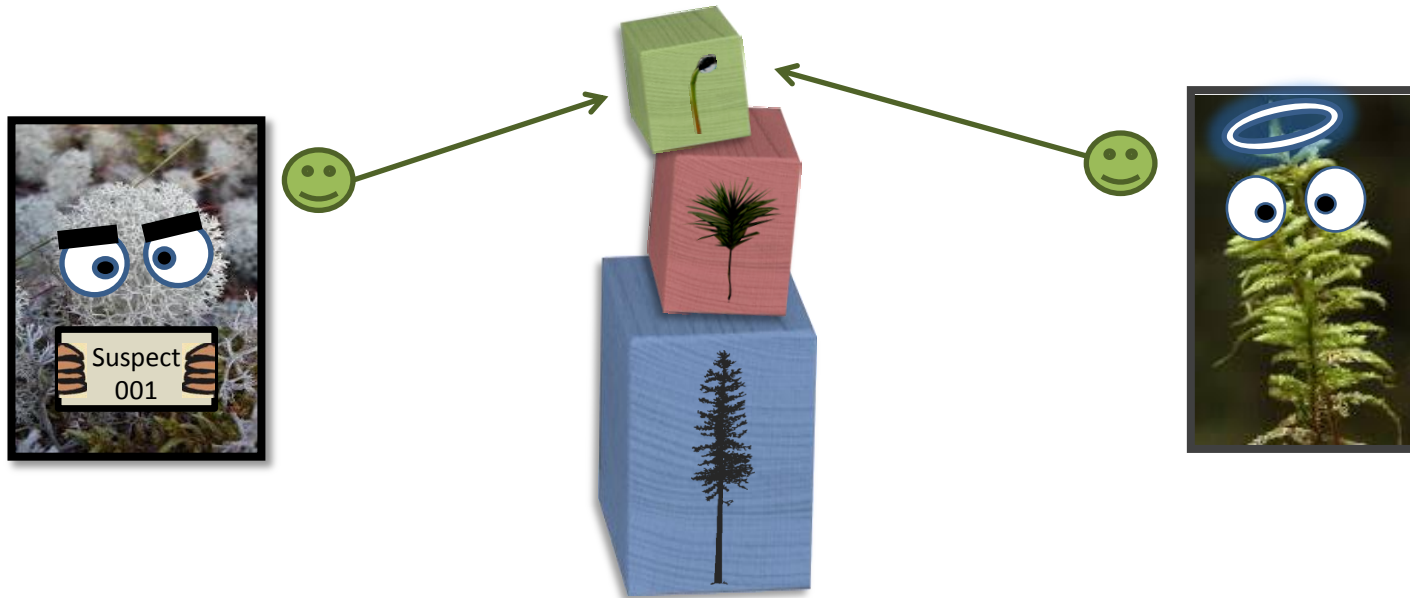
## Lichen and feather moss effects on pine growth\*



\* Reference = bare soil

# Results

## Lichen and feather moss effects on pine growth\*

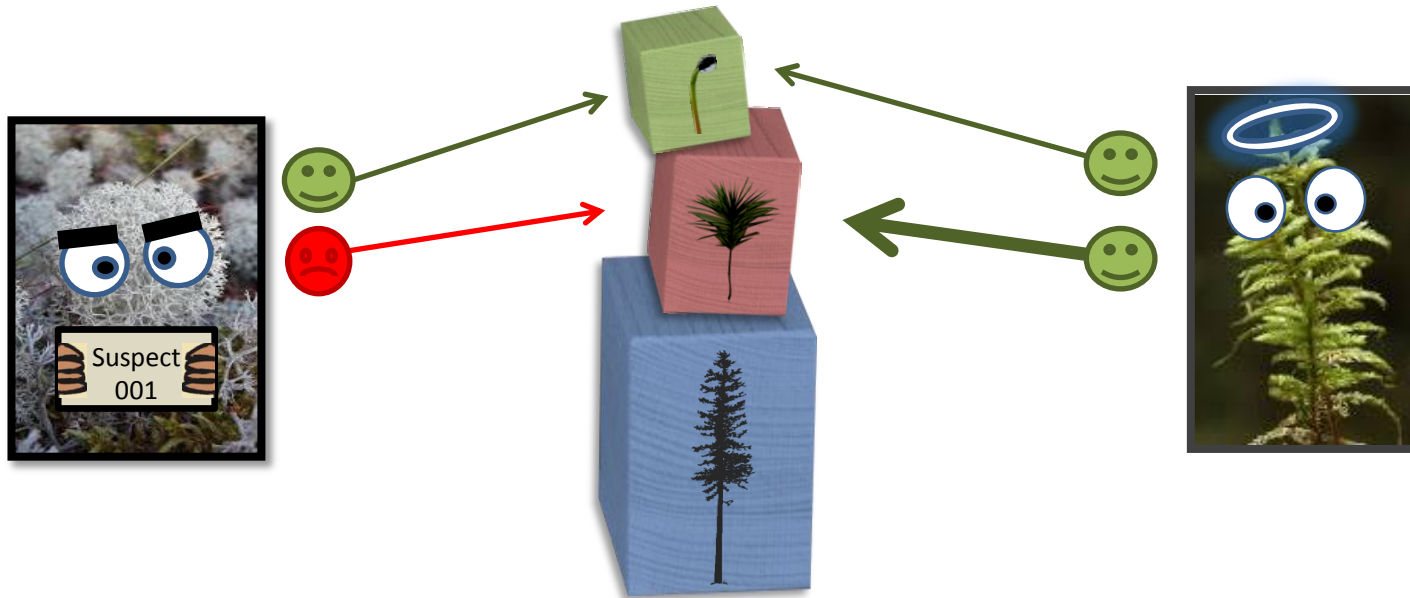


\* Reference = bare soil



# Results

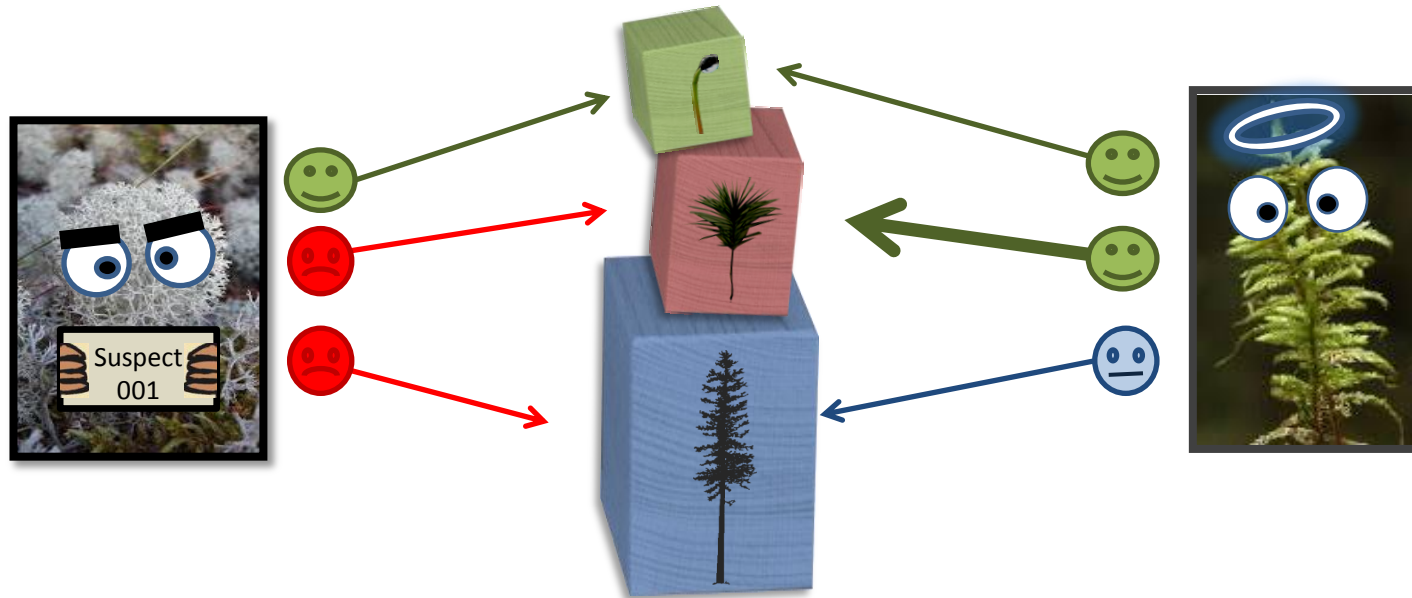
## Lichen and feather moss effects on pine growth\*



\* Reference = bare soil

# Results

## Lichen and feather moss effects on pine growth\*

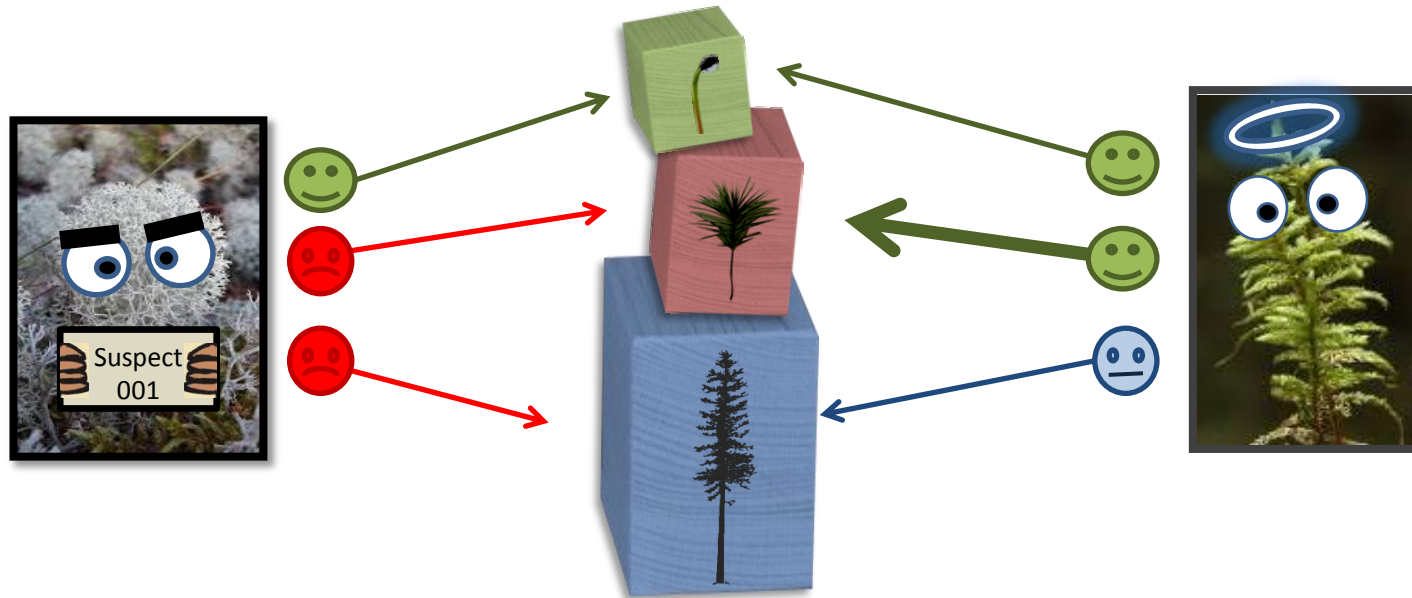


\* Reference = bare soil



# Results

## Lichen and feather moss effects on pine growth\*

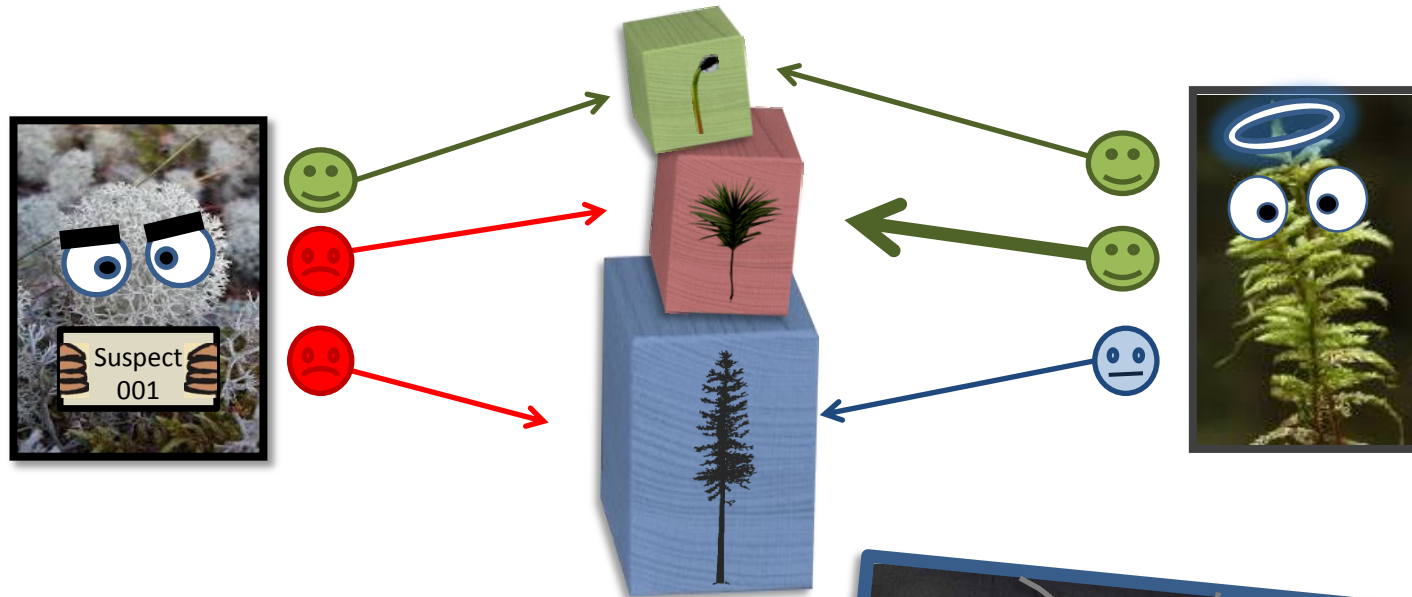


Lichen has a globally **negative effect** on pine growth:  
**some clues on is M.O.?**

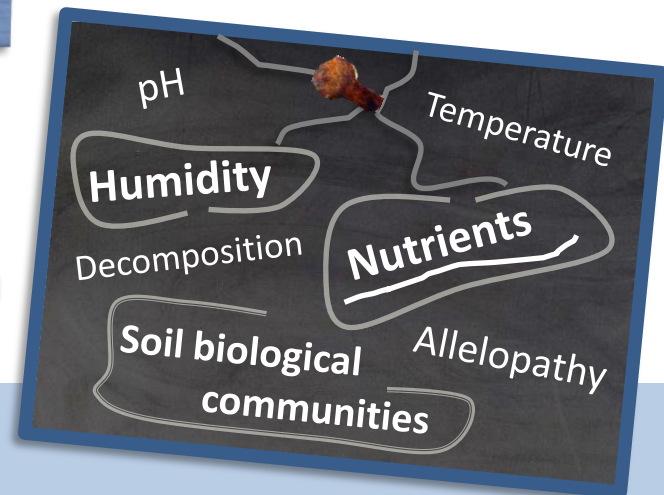
\* Reference = bare soil

# Results

## Lichen and feather moss effects on pine growth\*



Lichen has a globally **negative** effect on pine growth: some clues on is M.O.?

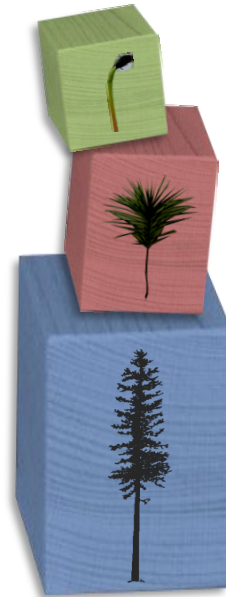


\* Reference = bare soil

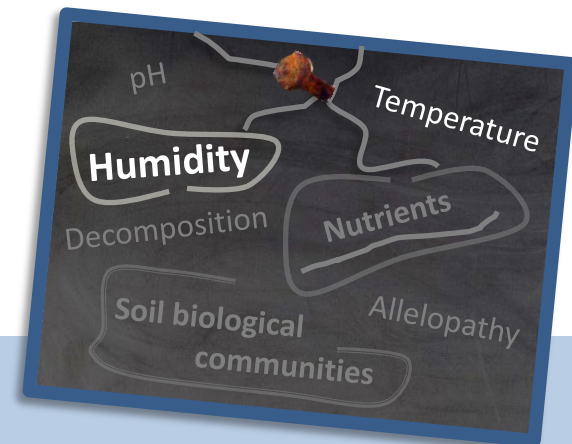


# Discussion

## Effect *via* soil moisture

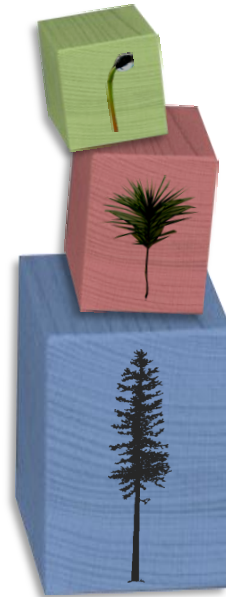


Higher moisture under lichens ...

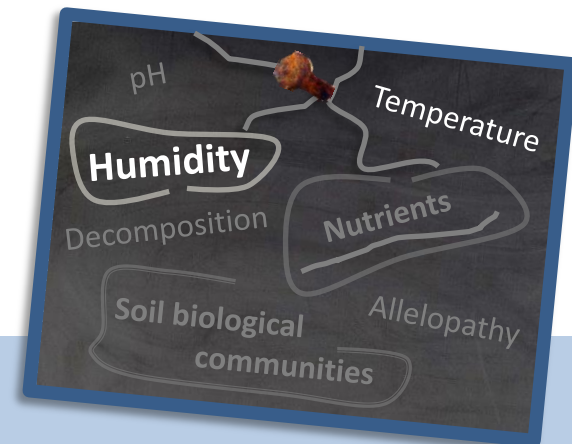


# Discussion

## Effect *via* soil moisture



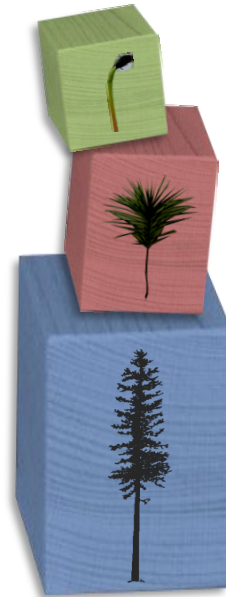
... Related to different rates of  
**evapotranspiration** ...



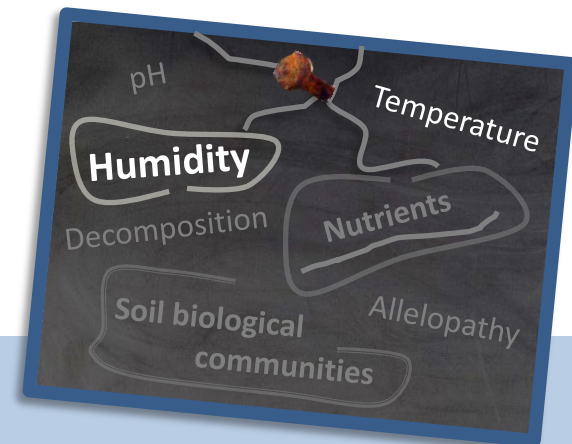


# Discussion

## Effect *via* soil moisture

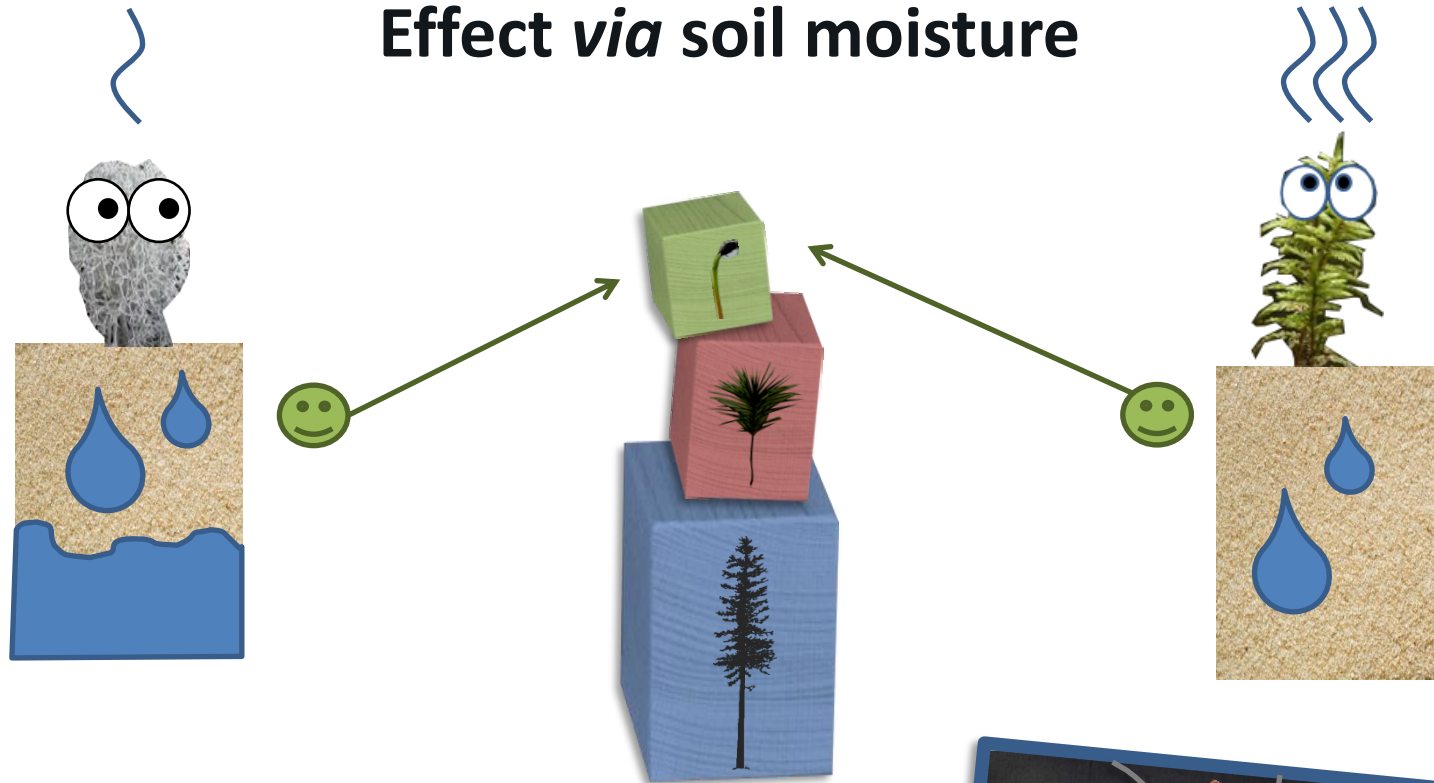


... But also to the emission by lichens of a **slimy substance** that reduced the drainage ...

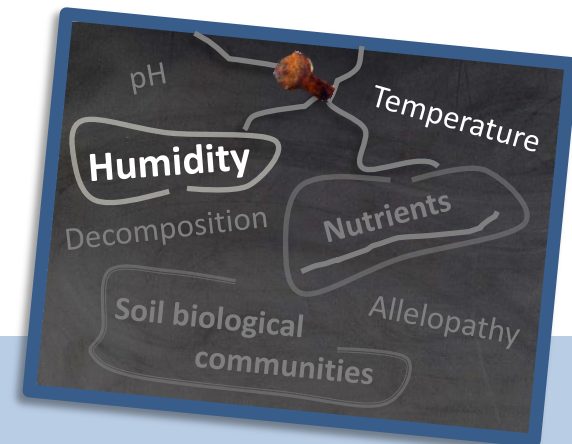


# Discussion

## Effect *via* soil moisture



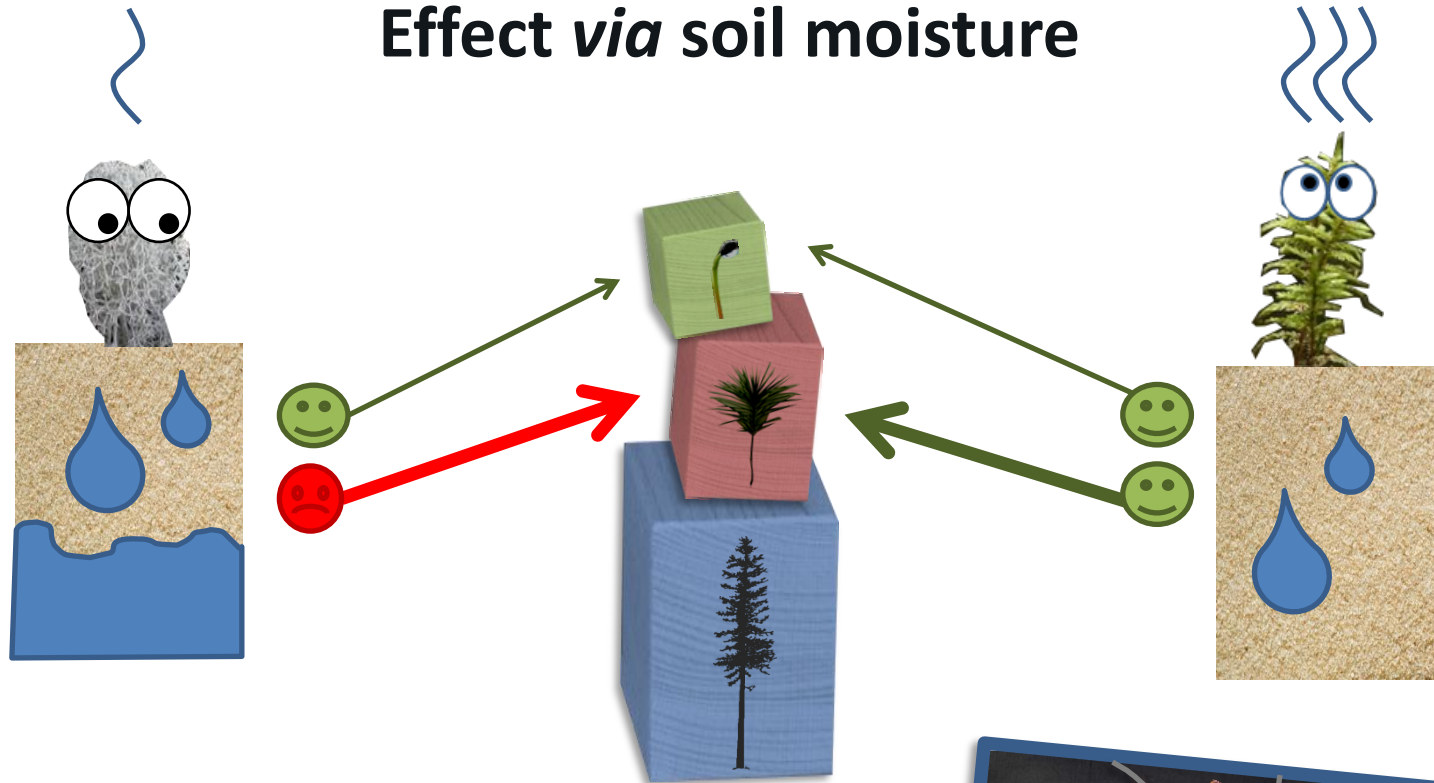
... **Contrasted effects** depending on the stage of pine development.





# Discussion

## Effect *via* soil moisture

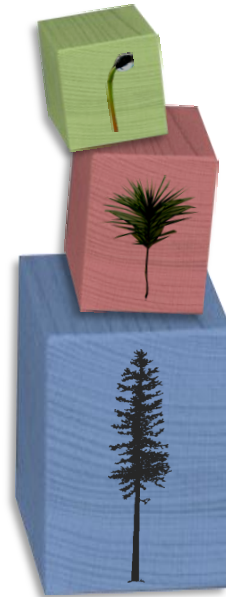


... **Contrasted effects** depending on the stage of pine development.

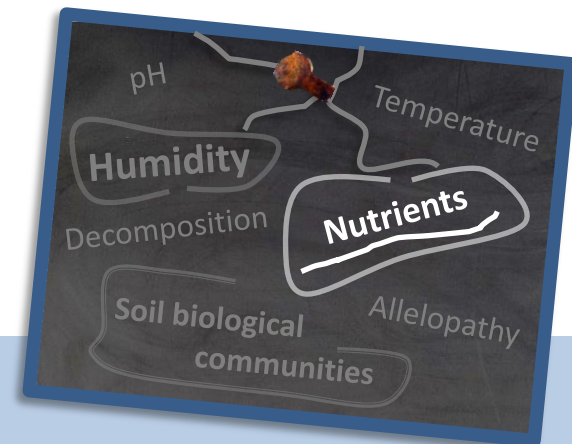


# Discussion

## Effect *via* soil nutrients



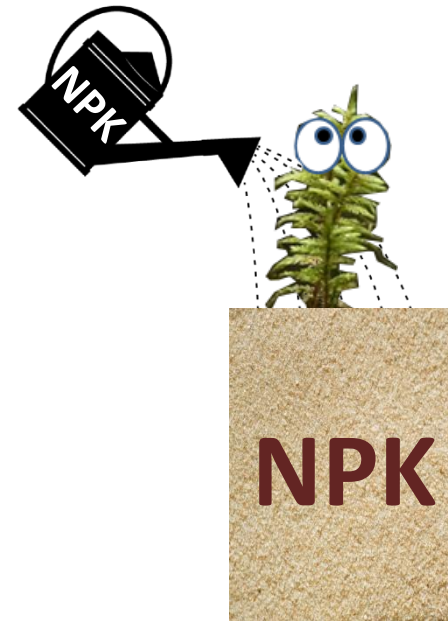
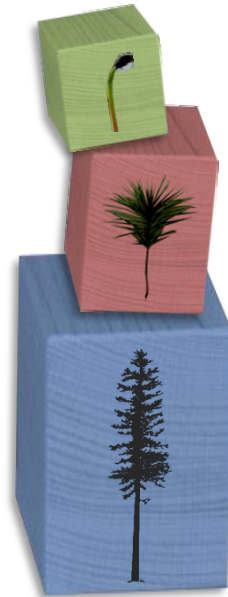
Overall **less soil nutrients** under lichens ...





# Discussion

## Soil nutrients

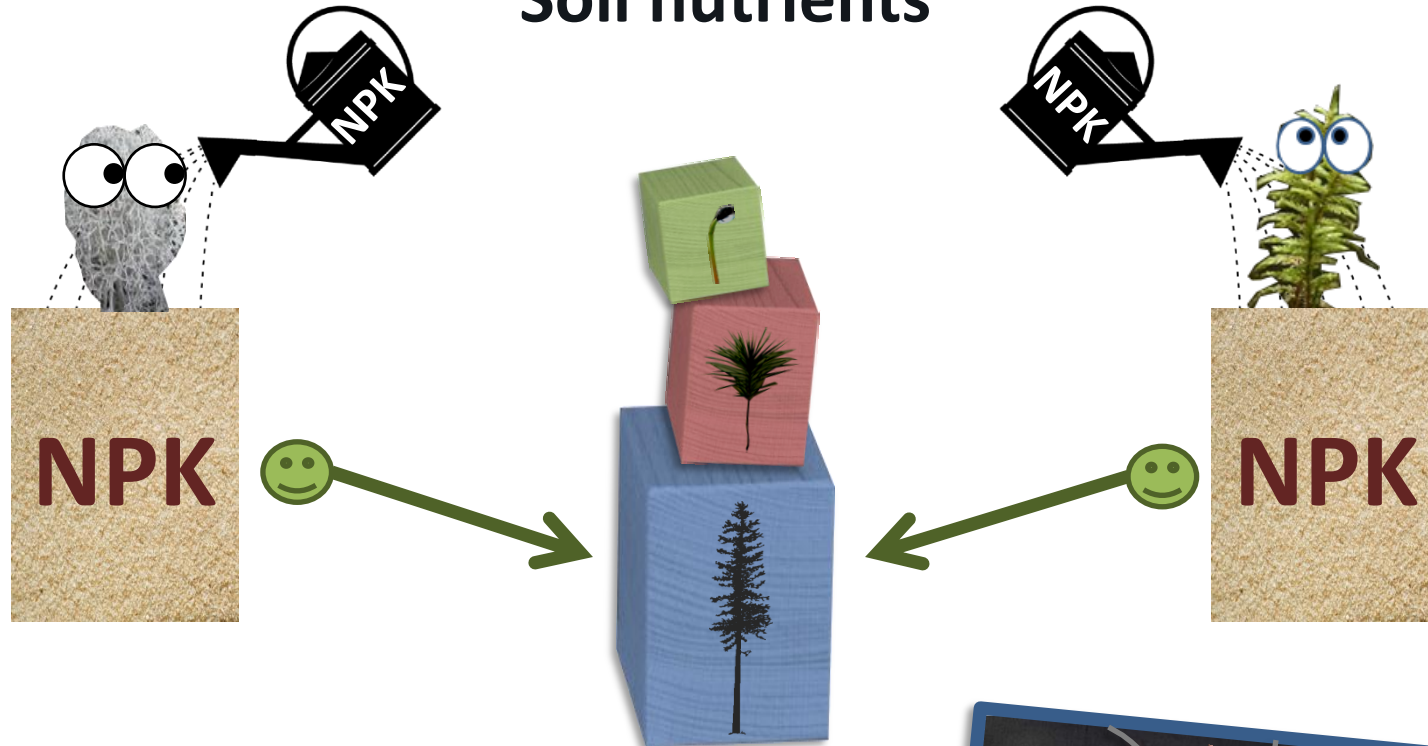


High fertilization = should **reduce the difference** between lichens and feather mosses

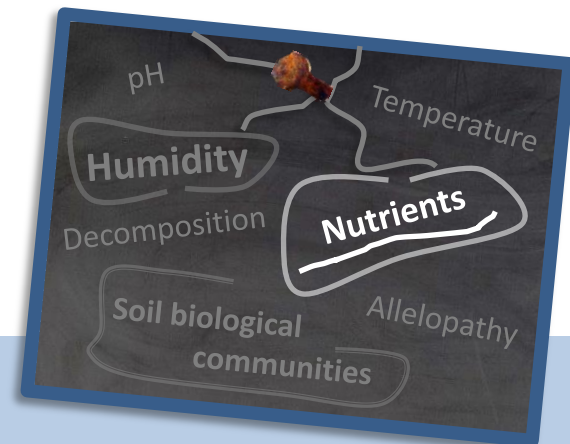


# Discussion

## Soil nutrients



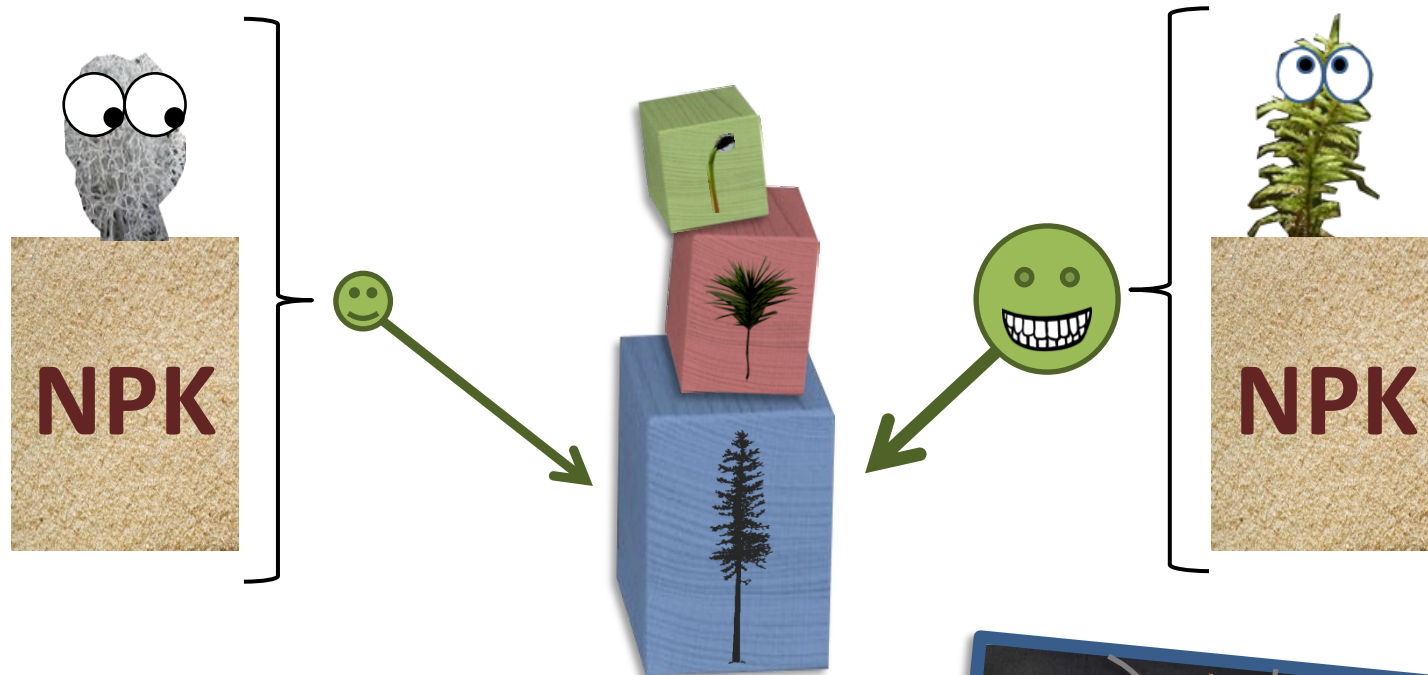
... However, the positive effect of fertilization is the same **regardless** of the ground cover ...



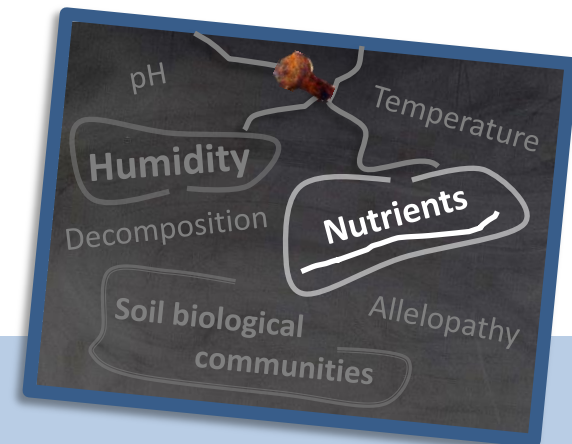


# Discussion

## Effect *via* soil nutrients

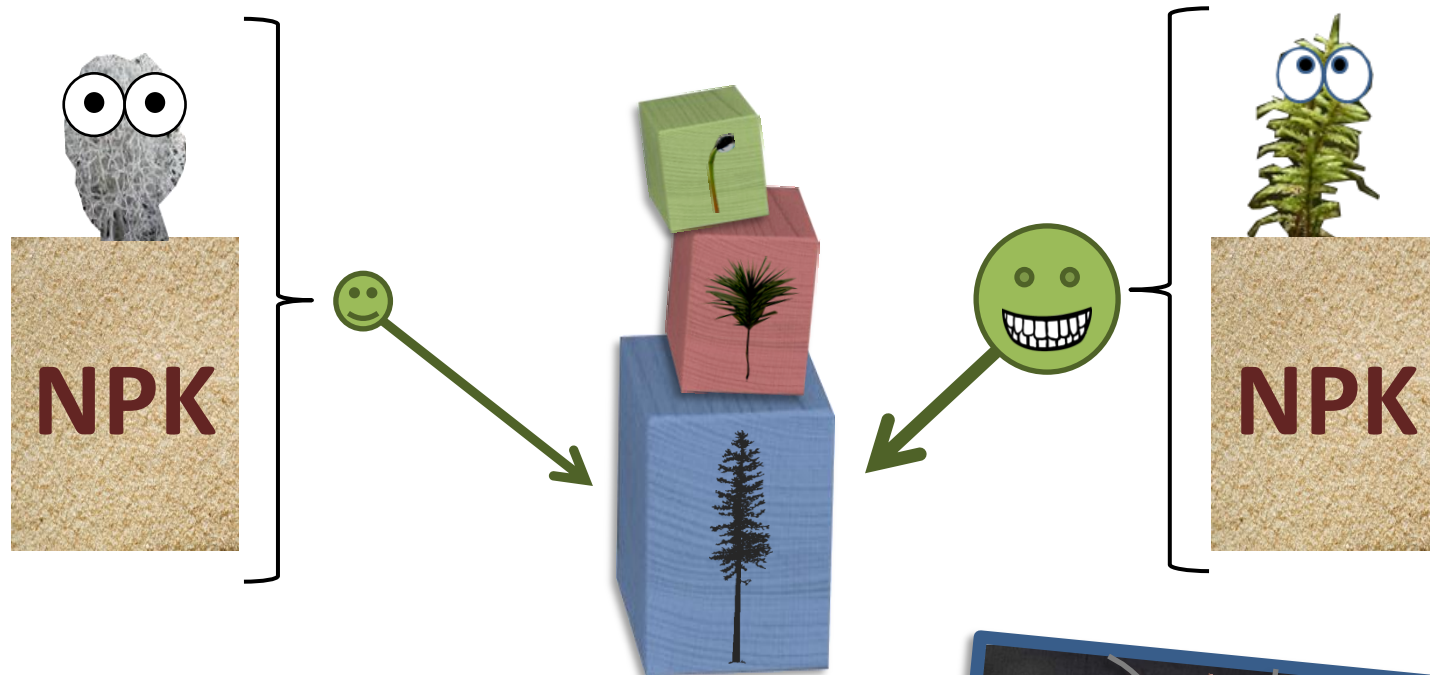


... And tree growth on lichen ground cover remains **lower** despite the fertilization ...

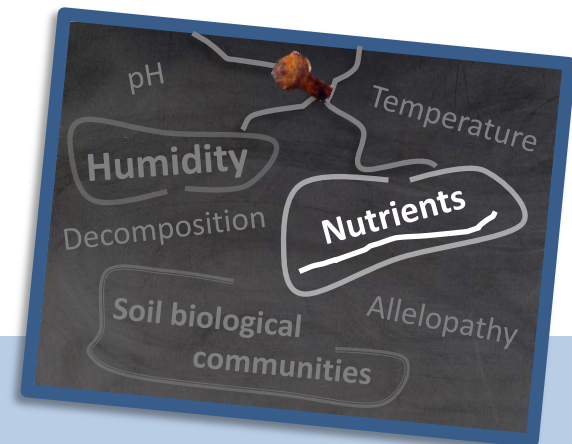


# Discussion

## Effect *via* soil nutrients



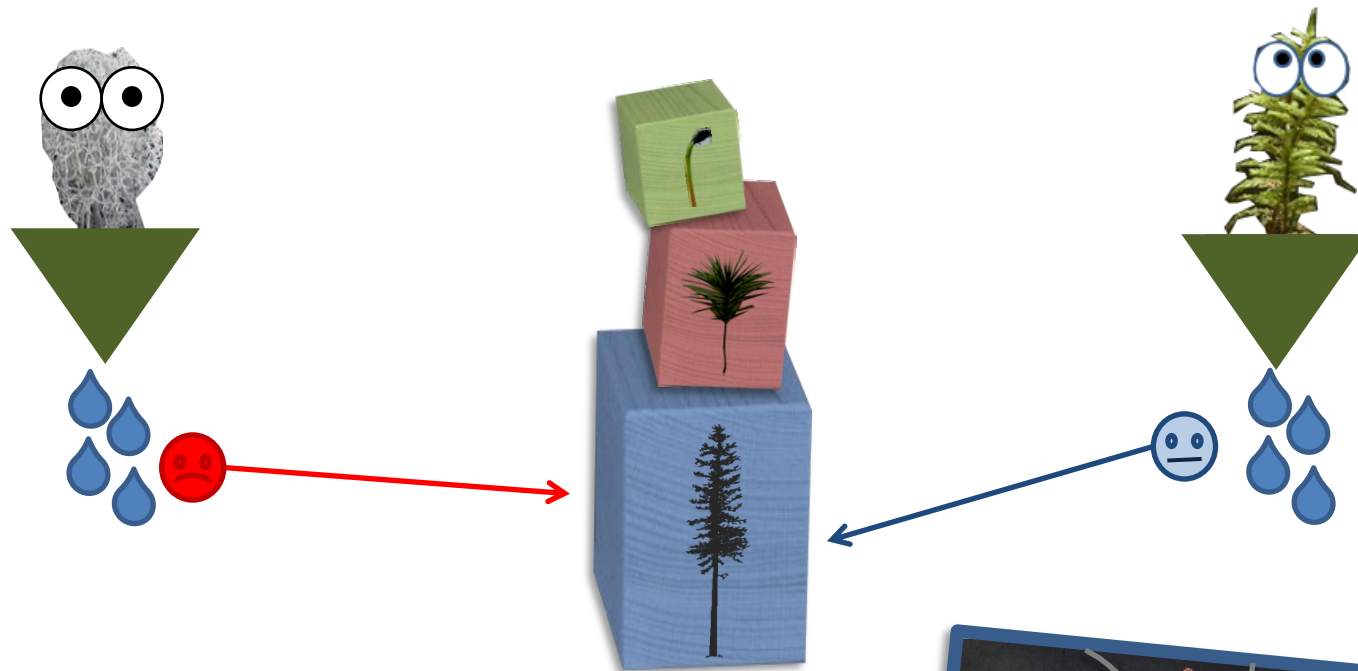
The negative effects of lichen are not only linked to soil nutrients.





# Discussion

## Effect *via* soil solution

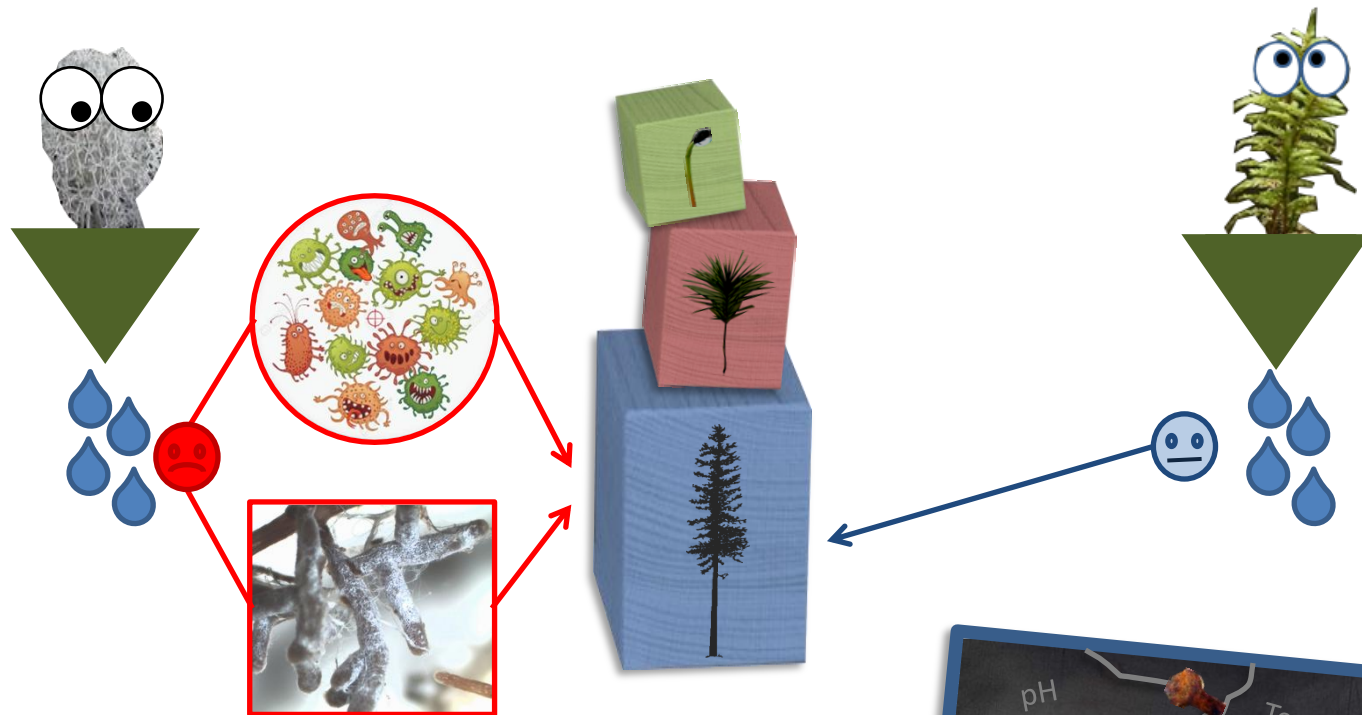


**Negative effect** of lichen leachates  
on tree growth  
**Direct effect ...**



# Discussion

## Effect *via* soil solution



...Or **indirect** *via* the soil biological communities





# Conclusion



- Lichens affect jack pine development at different stages
- Effect *via* nutrients, but not only...
- Effect *via* the soil solution, allelopathy ?

# Conclusion



- Lichens affect jack pine development at different stages
- Effect *via* nutrients, but not only...
- Effect *via* the soil solution, allelopathy ?

**Lichens are likely to contribute to the absence of stand reclosure in the boreal forest.**





Thanks for your attention !



# Aknowlegments

Hugues, Linda, Nicole, Franck, Denis, Sylvie, Armand, Michel, Marie-Hélène, Serge, Sébastien, Jacques, Fanny, Laurence, Samuel, Jonathan, Pauline, Lili, Benjamin, Roch, Danielle, Danièle, Marc, Raynald, Marie...

And to all the people who have contributed to this study... Thanks !



Matériaux **Blanchet** Inc.  
Produits Forestiers



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Natural Resources  
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**UQAT**  
INSTITUT DE RECHERCHE  
SUR LES FORÊTS