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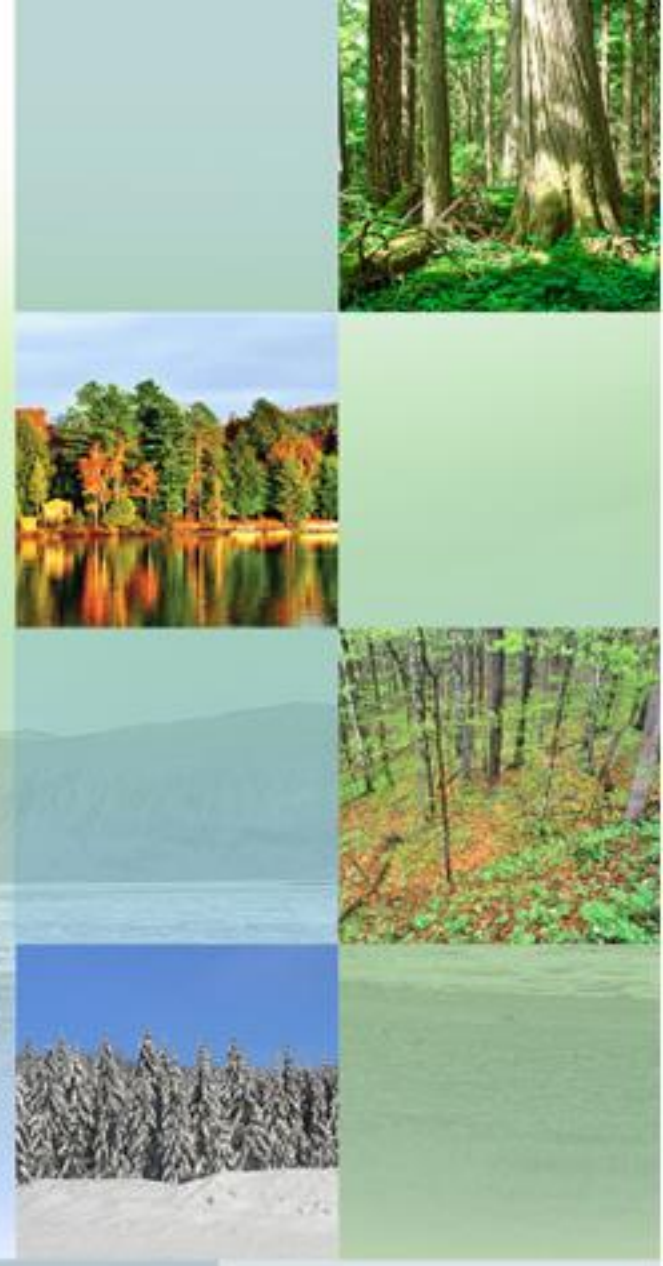
Climate adaptation in the lineages of the Swiss needle cast agent *Nothophaeocryptopus gaeumanii*



Nicolas Feau, PhD
Canadian Forest Service/Natural Resources Canada
Pacific Forestry Centre, Victoria

2023 Swiss Needle Cast Cooperative Meeting
November 30th, 2023

CFS CANADIAN FOREST SERVICE

Canada

What's up with SNC in British Columbia?

David Rusch will tell you in the next presentation

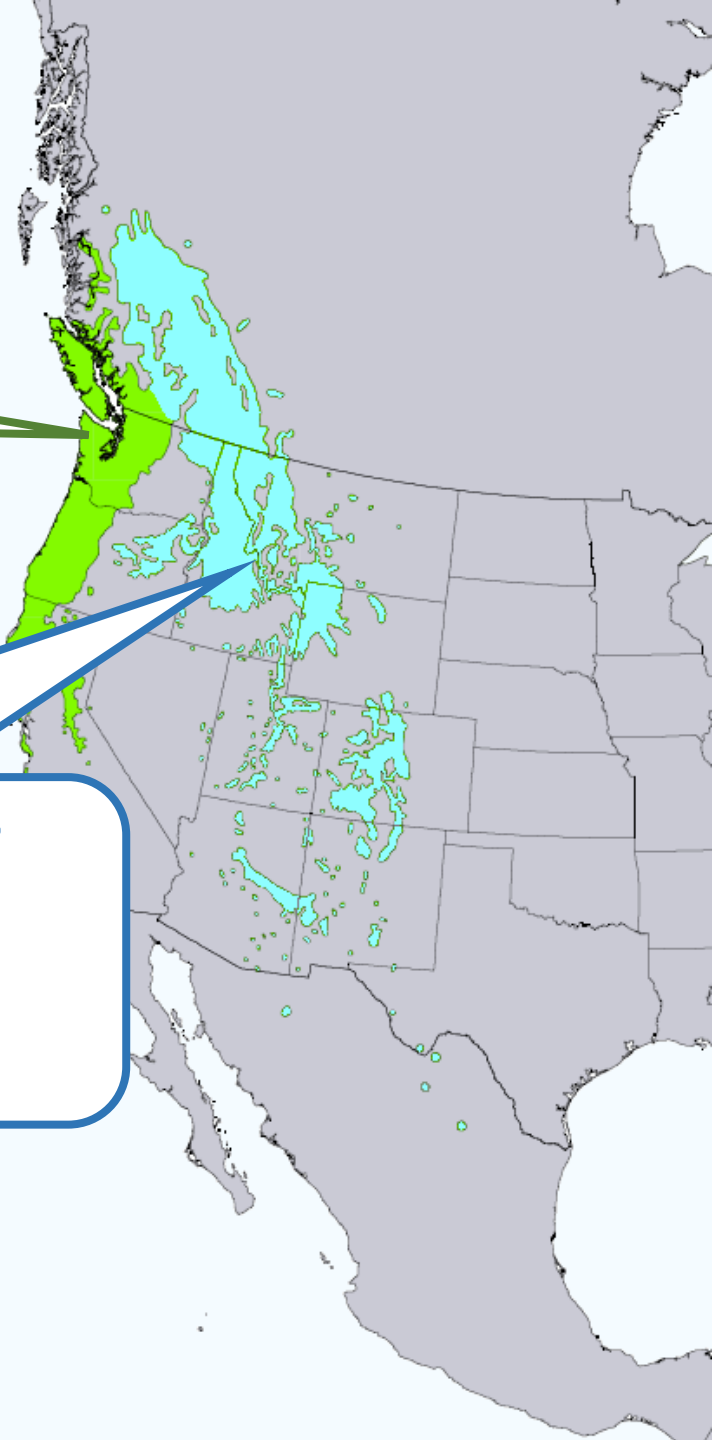
Me: I will talk about SNC lineages & adaptation and of course some ACGT stuff

SNC in the Chilliwack river valley in British Columbia

One species, three genetic lineages

Coastal Douglas-fir
(*P. menziesii var. menziesii)*
Lineage 1c and Lineage 2

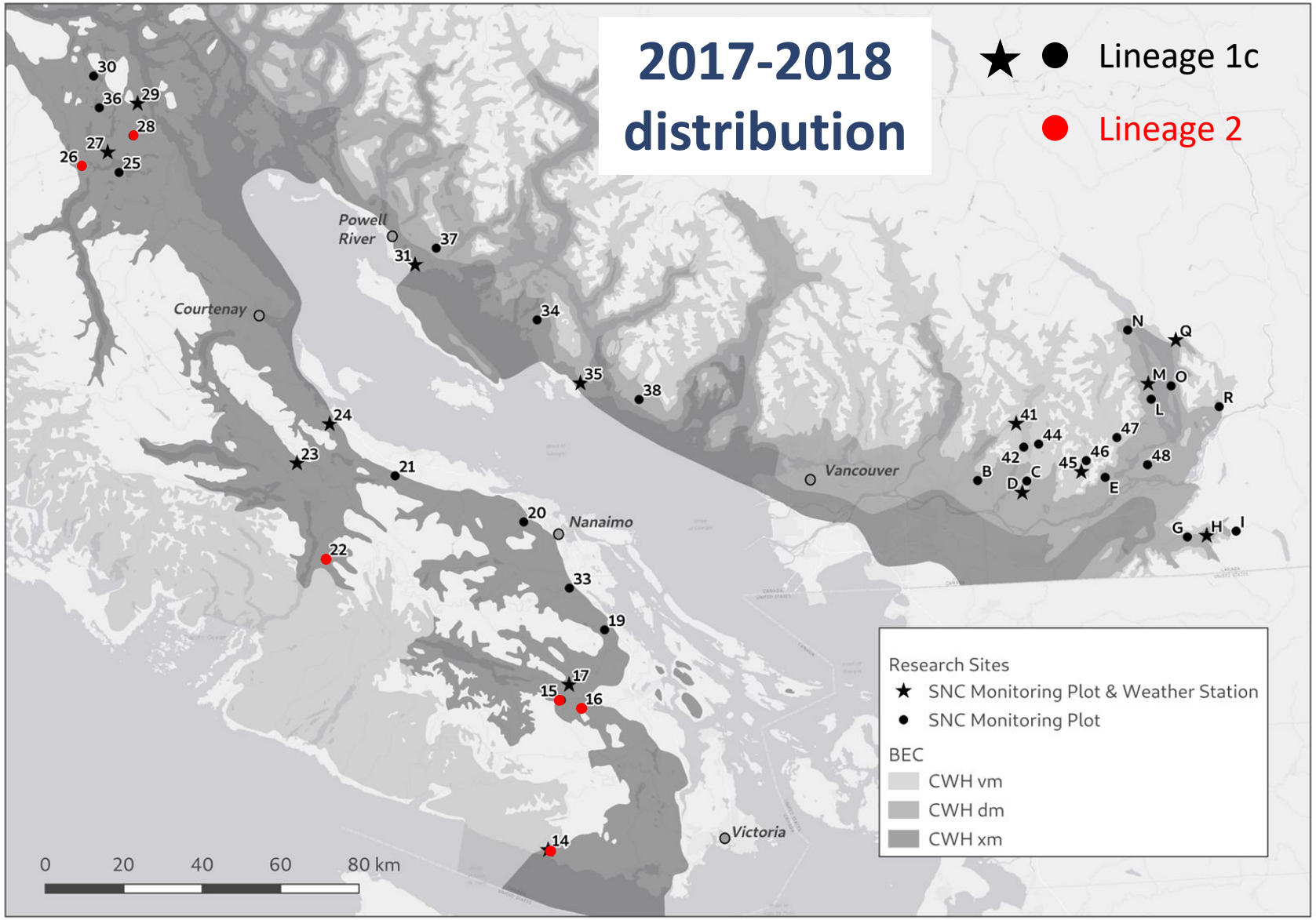
Rocky Mountains Douglas-fir
(P. *menziesii var. glauca)*
Lineage 1i



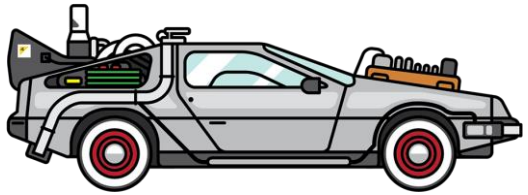
Collection covering OR, WA, ID and BC
200 SNC genomes sequenced
3 lineages morphologically identical

Lineage 2 seems to like the humidity and cooler temperatures of the coast

2022-2023's survey suggests that L2 is becoming difficult to find



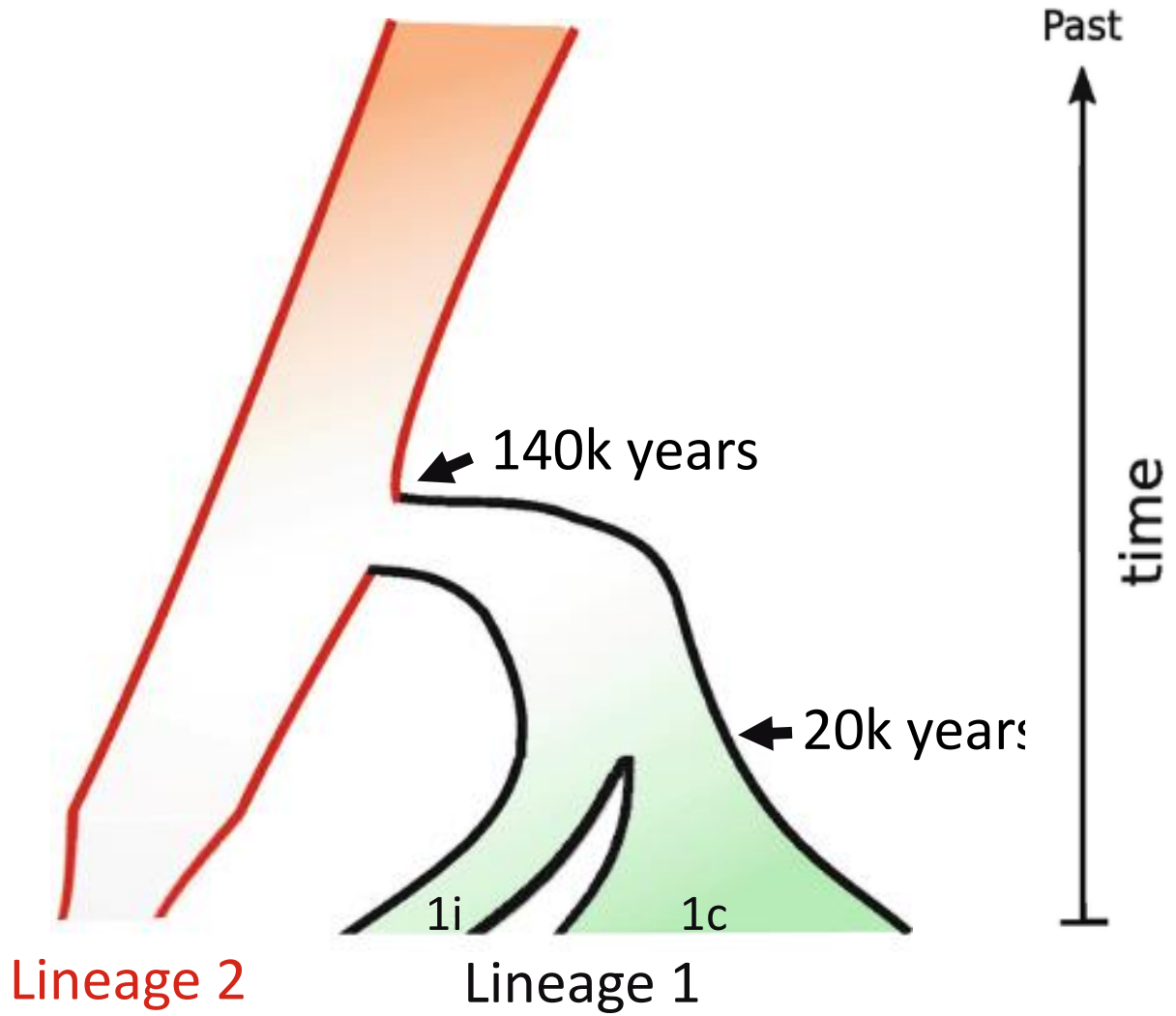
Riding the “genomics time travelling machine”



Genomes were used to infer SNC evolutionary & demographic history

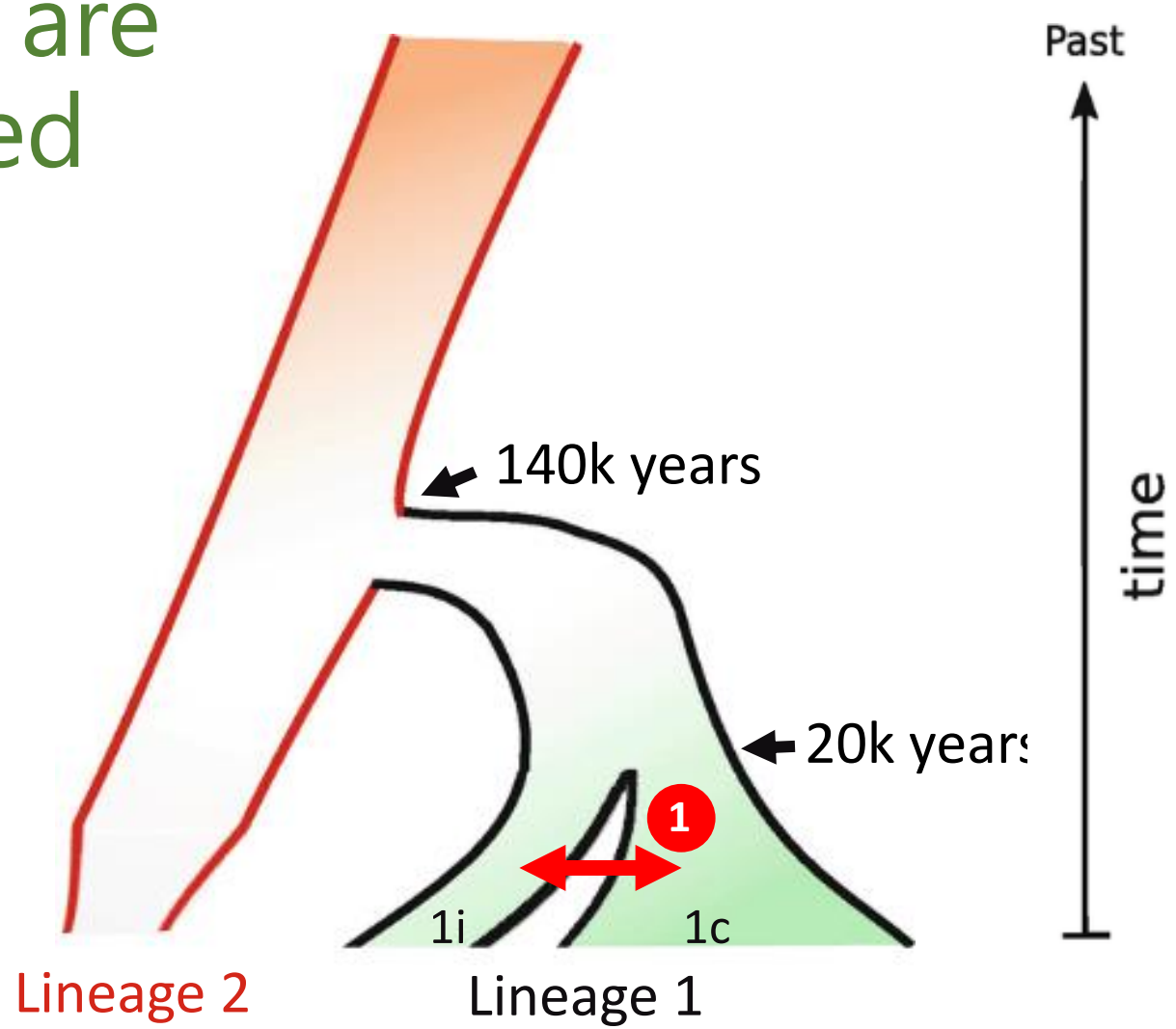
Time estimate of lineages divergence

Demographic expansion of Lineage 1c



The three genetic lineages are not reproductively isolated

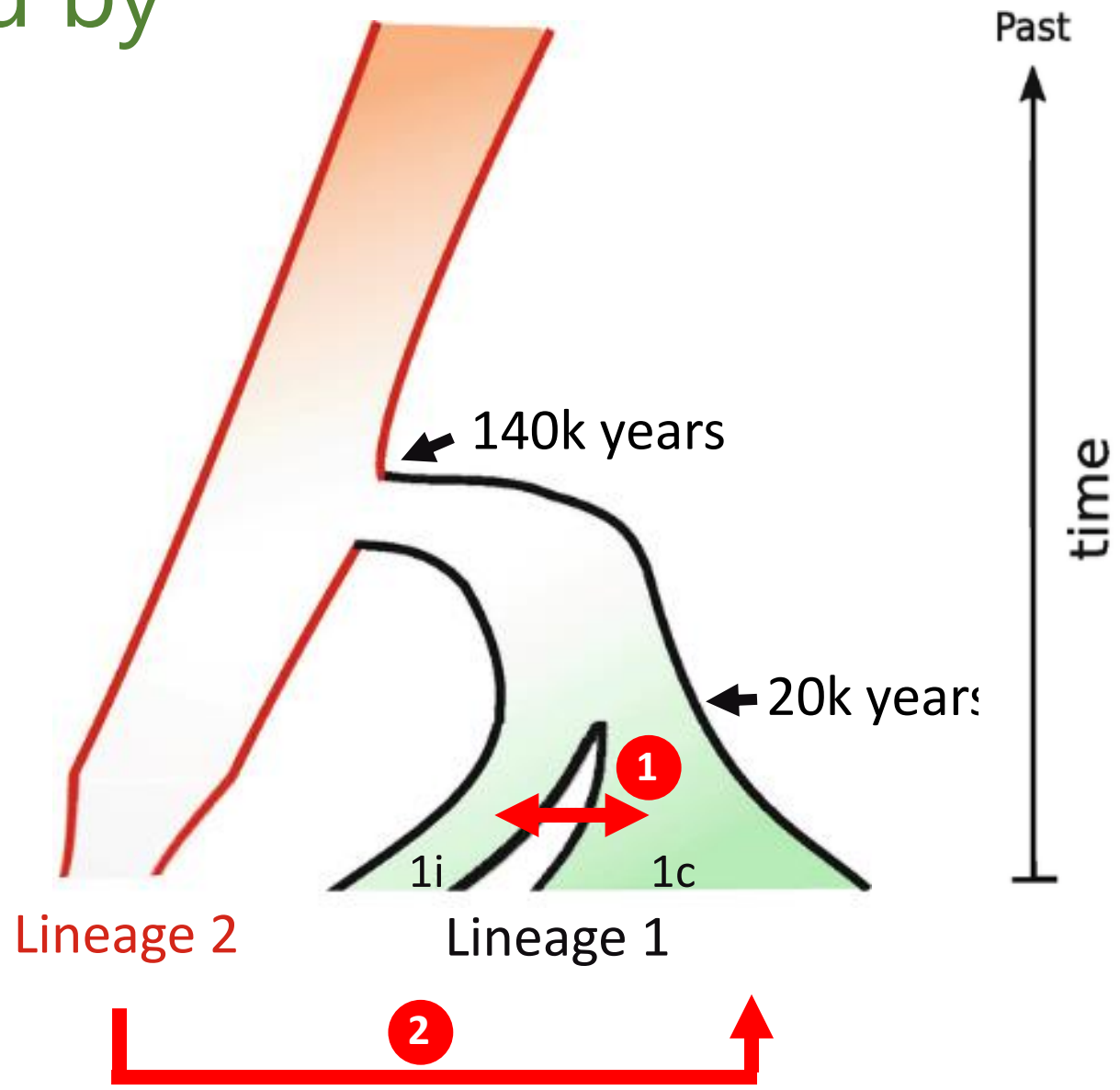
		Model likelihood
	No gene flow	-2847.73
1	**Lin1c <-> Lin1i**	**-2559.29**



Lineage 1c is introgressed by Lineage 2

		Model likelihood
	No gene flow	-2847.73
1	**Lin1c <-> Lin1i**	**-2559.29**
2	**Lin2 => Lin1c**	**-2511.67**

No barriers to gene flow between the three lineages



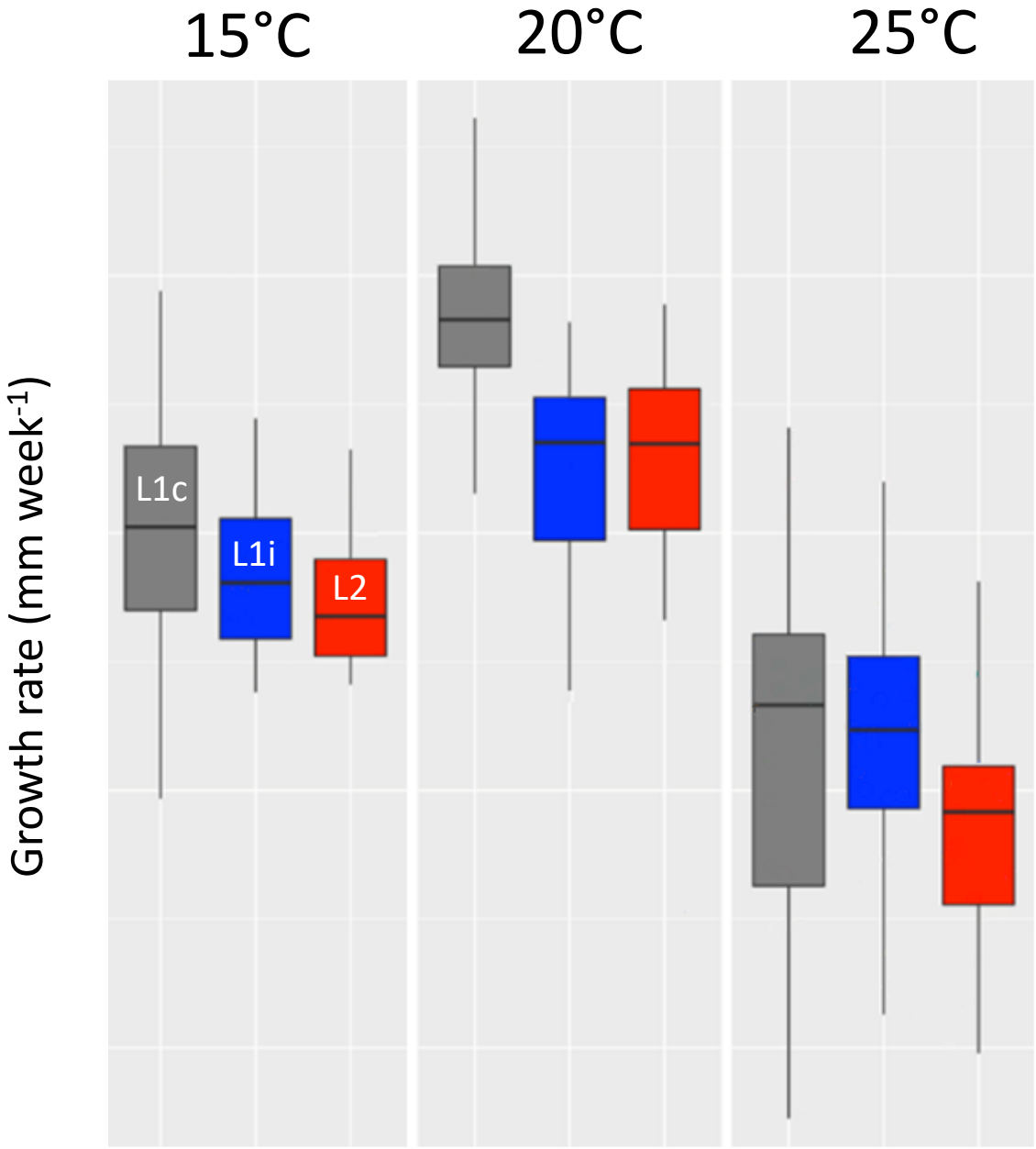
Lineage 1c has a higher adaptive plasticity than Lineage 2

1 - Temperature

Lineage response (30 ind./lineage) to temperature changes differs

Growth rate at different temperatures:

Lin. 1c > Lin. 2 & Lin. 1i

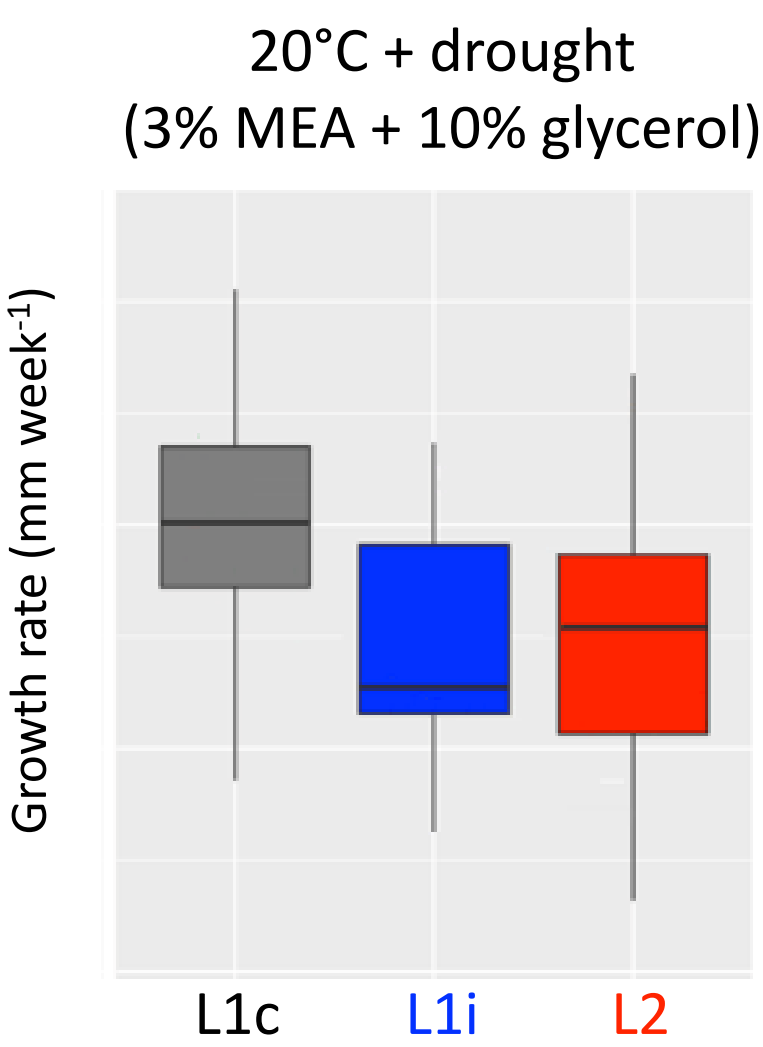


Lineage 1c has a higher adaptive plasticity than Lineage 2

2 - Drought

Growth rate at 20°C under drought stress:

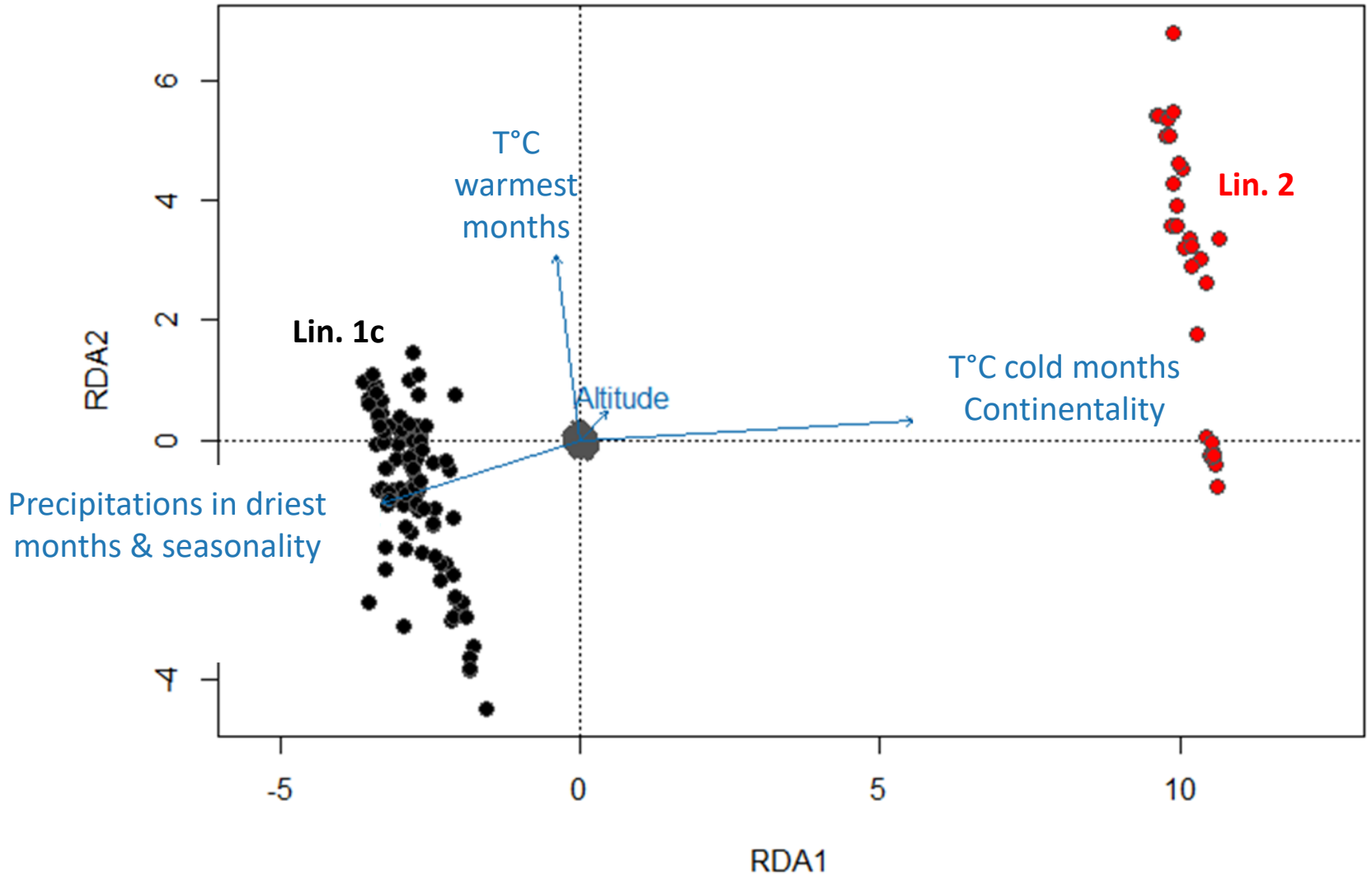
Lin.1c > Lin. 2 & Lin. 1i



The genetic variation between SNC lineages is explained by spatial and environmental variables

Adpative genetic variation in Lin. 1i explained by host specificity and elevation

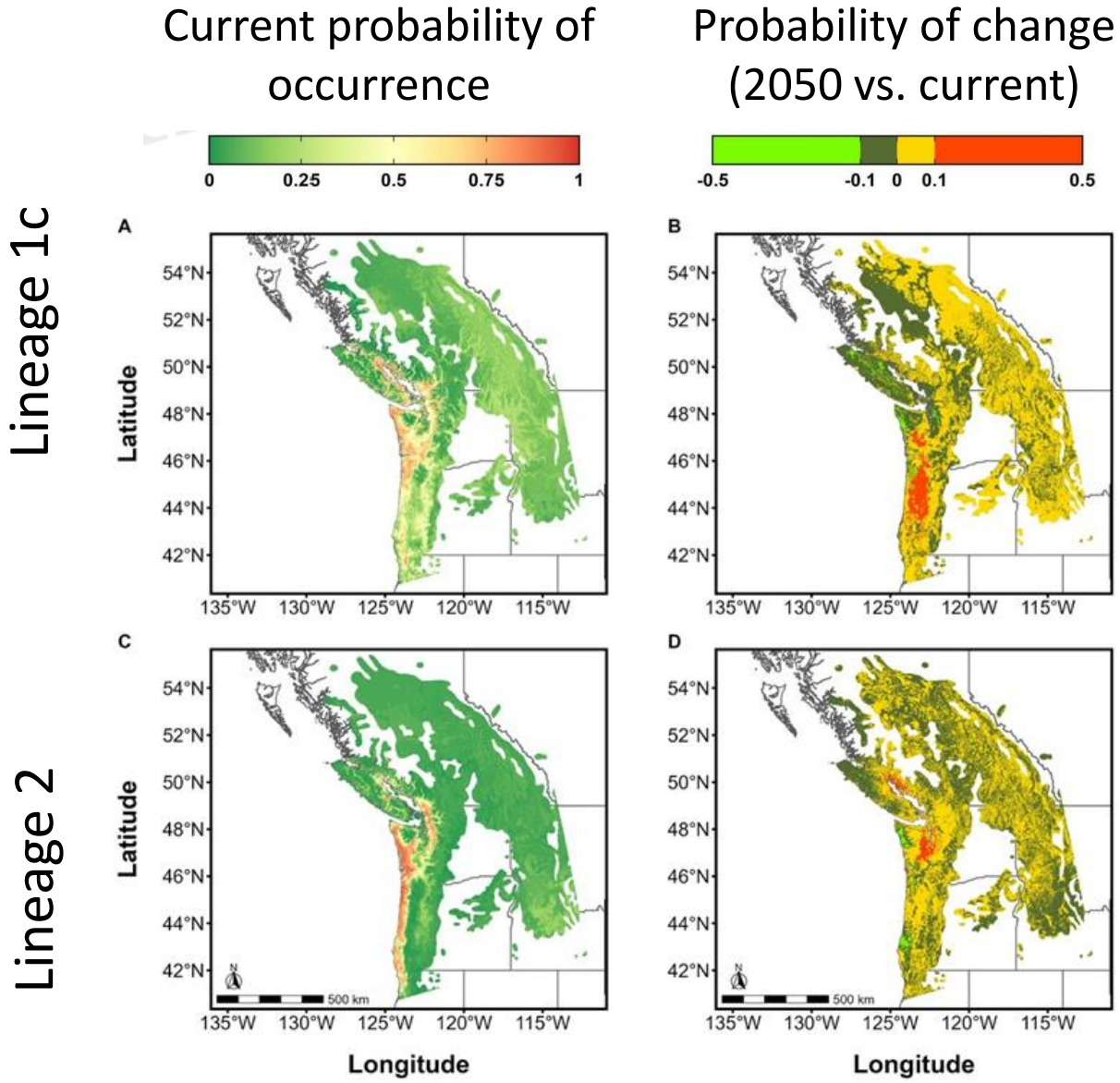
Lin. 1c and Lin. 2: can be explained by only few climatic variables ($P < 0.001$)



Climate is triggering some changes in lineages distribution

Modeling of SNC expected distribution (Naomie Herpin-Saunier et al. 2022)

- Environmental tolerance range of Lin. 1c exceeds that of Lin. 2
- Lin. 1c favored by hotter and drier summers
- Lin. 2 has less tolerance to heat

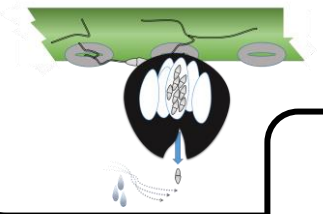


Changes in climatic factors

INDUCE

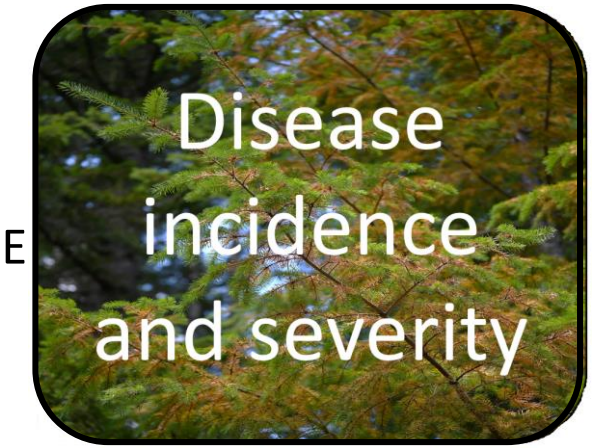
CHANGE

Pathogen life cycle



Lineages distribution

CHANGE



CoAdapTree

Healthy Trees for Future Climates

Drought on Df
Drought x SNC
?

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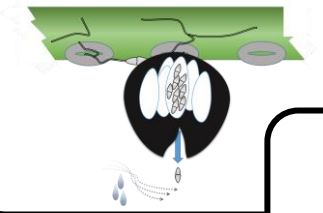
Changes in climatic factors

INDUCE

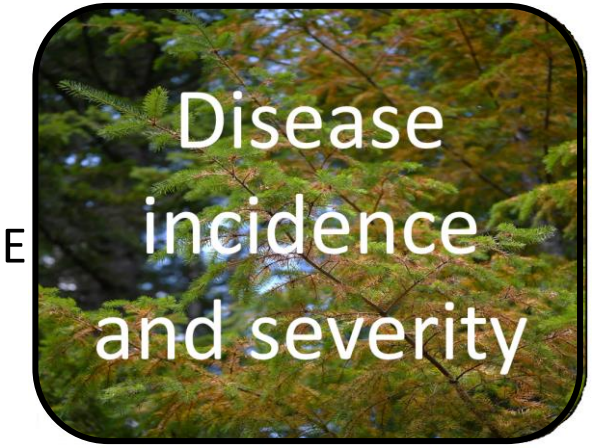
CHANGE

Pathogen life cycle



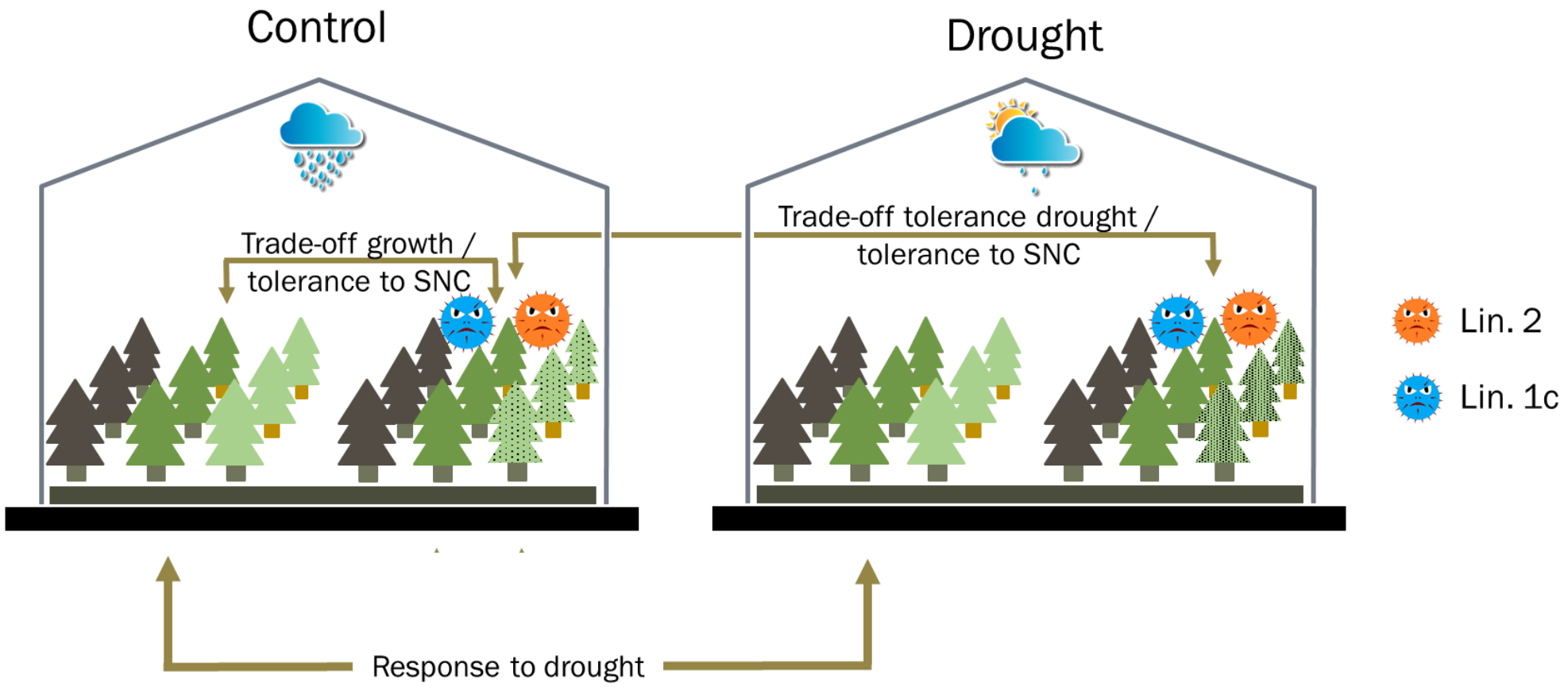
Lineages distribution

CHANGE



CoAdapTree
Healthy Trees for Future Climates

Studying Df x SNC x Drought



Phenotyping (growth & SNC severity) 4 Douglas-fir families from BC-MoF

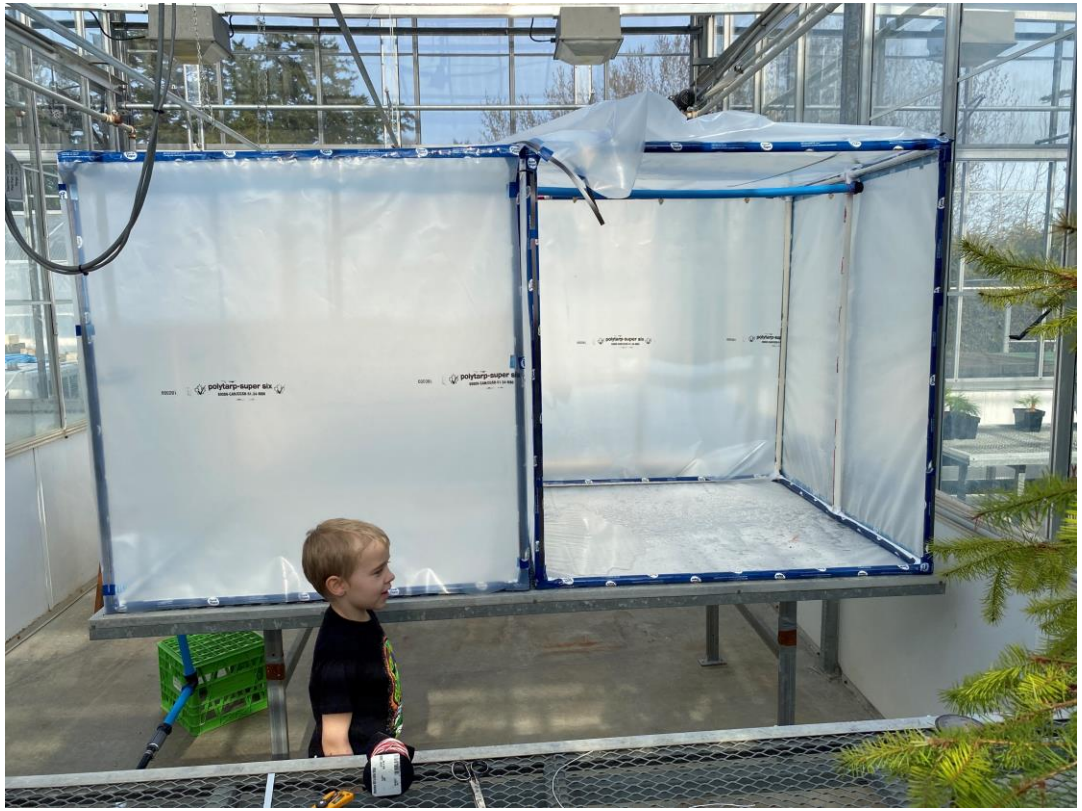
Transcriptomics (gene expression)

Controlling SNC infections in the lab: Mission impossible?

N. gaeumannii does not sporulate in Petri dish

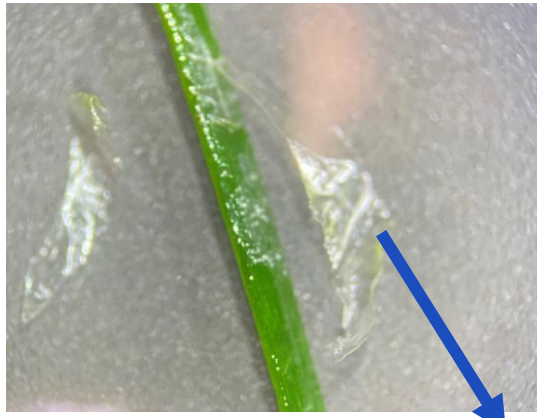
Sprayed fragmented mycelium (20gr/L);

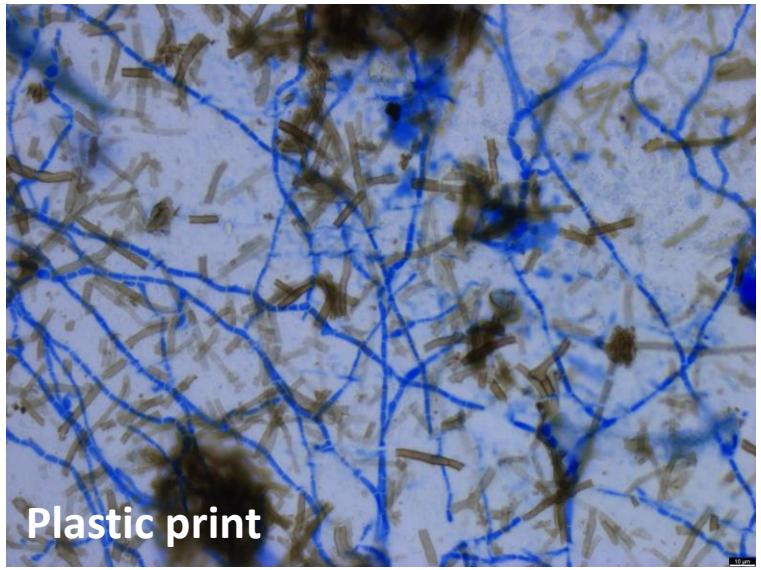
Mist chambers 17-21°C, >80% humidity

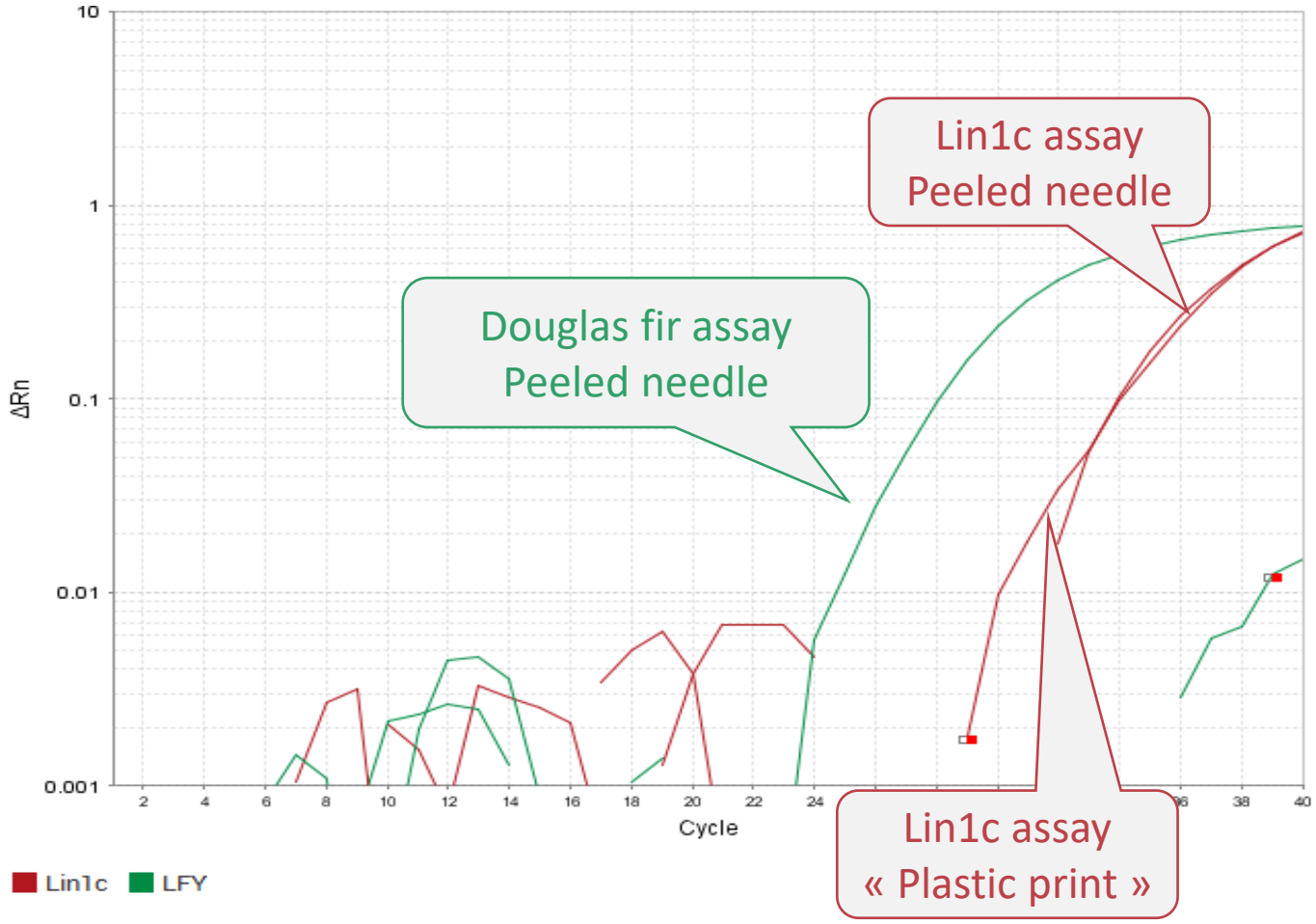


Mission possible!

3 weeks post inoculation :



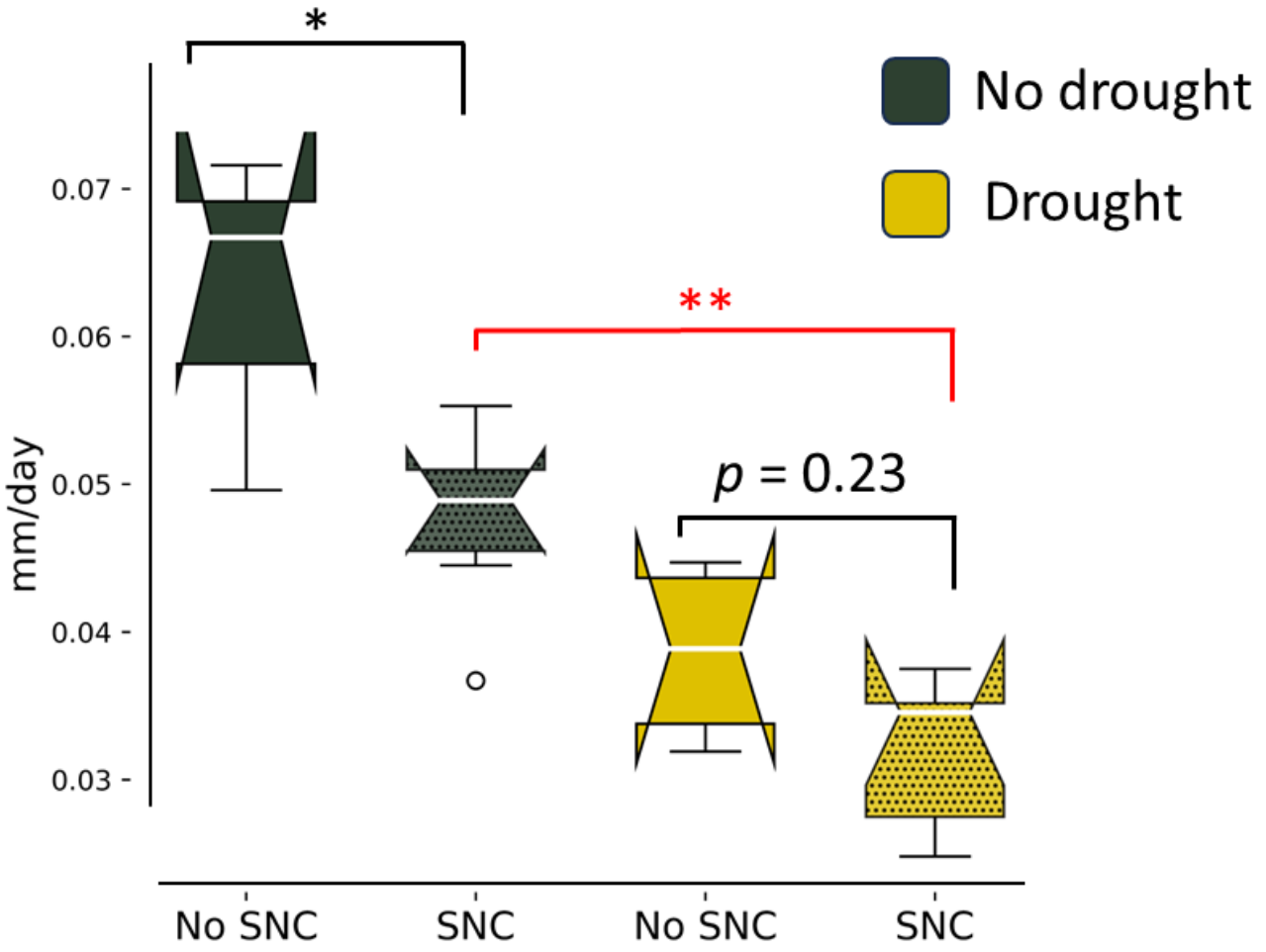




qPCR detection confirmed at 6-months post-inoculation

Six months after the first inoculation :

- Drought impacts tree growth (we knew that)
- **SNC impacts diameter growth**
- **Trend visible (and significant) in 3 families (out of 4 tested)**
- SNC effect not visible on tree lenght



Diameter growth in Df family 81

Acknowledgments

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Sally Aitken
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Richard Hamelin

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nicolas.feau@nrcan-rncan.gc.ca