

Microclimatic niche partitioning and conservatism in tropical canopy-dwelling bryophytes: a window into their vulnerability to climate change

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Macroclimate



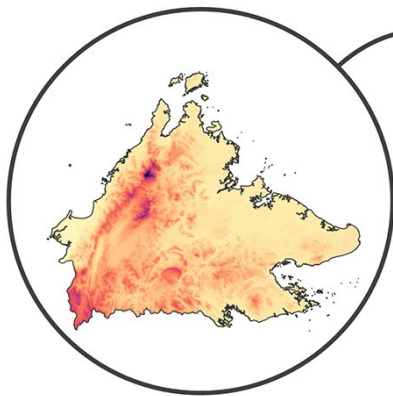
Microclimate

A Regional

B Landscape

c Plot

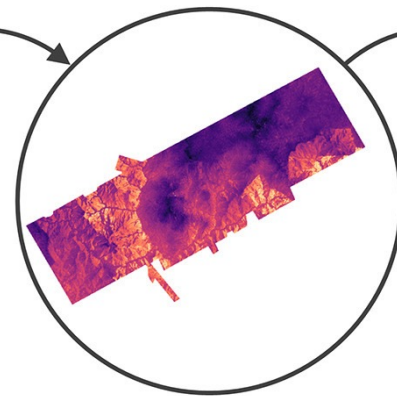
D Individual



6.3 27.8°C

0 200 km

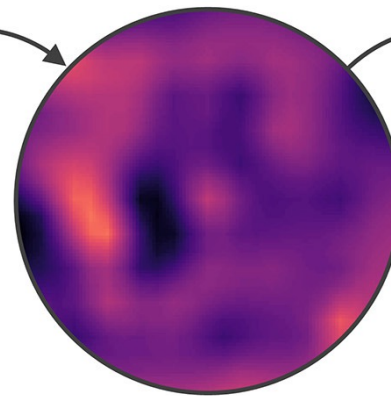
1 km² pixel⁻¹



21.9 27.7°C

0 7.5 km

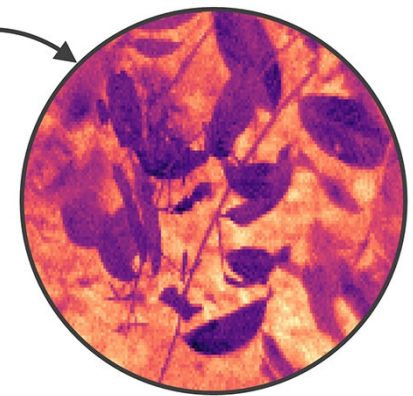
50 m² pixel⁻¹



22.5 24.9°C

0 50 m

1 m² pixel⁻¹



25.0 27.5°C

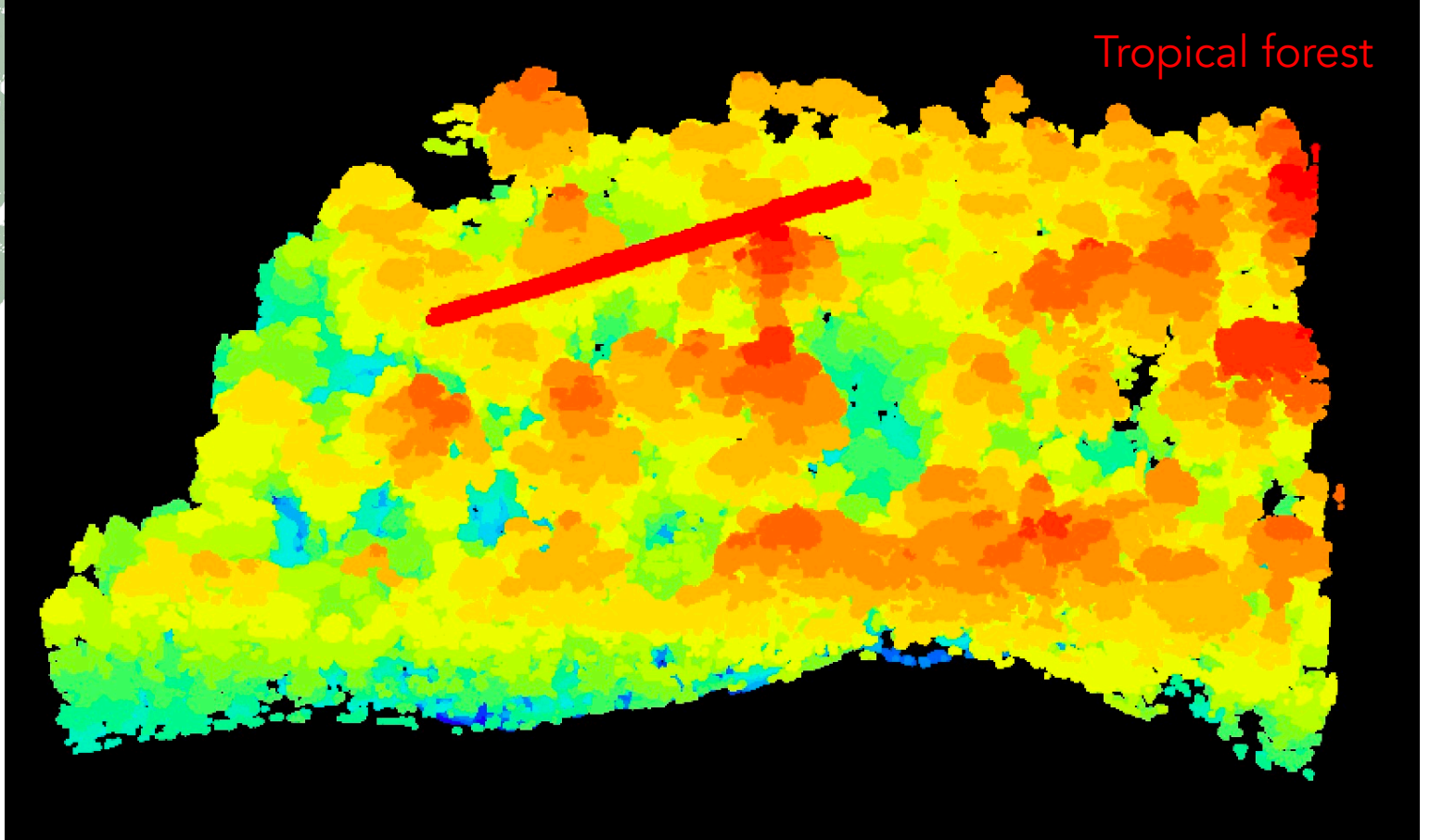
0 1 m

0.5 cm² pixel⁻¹

Temperatures at different scales

Temperature, light intensity, Air humidity ...

Vertical gradient



Topography...

Horizontal gradient

Trees as habitat islands



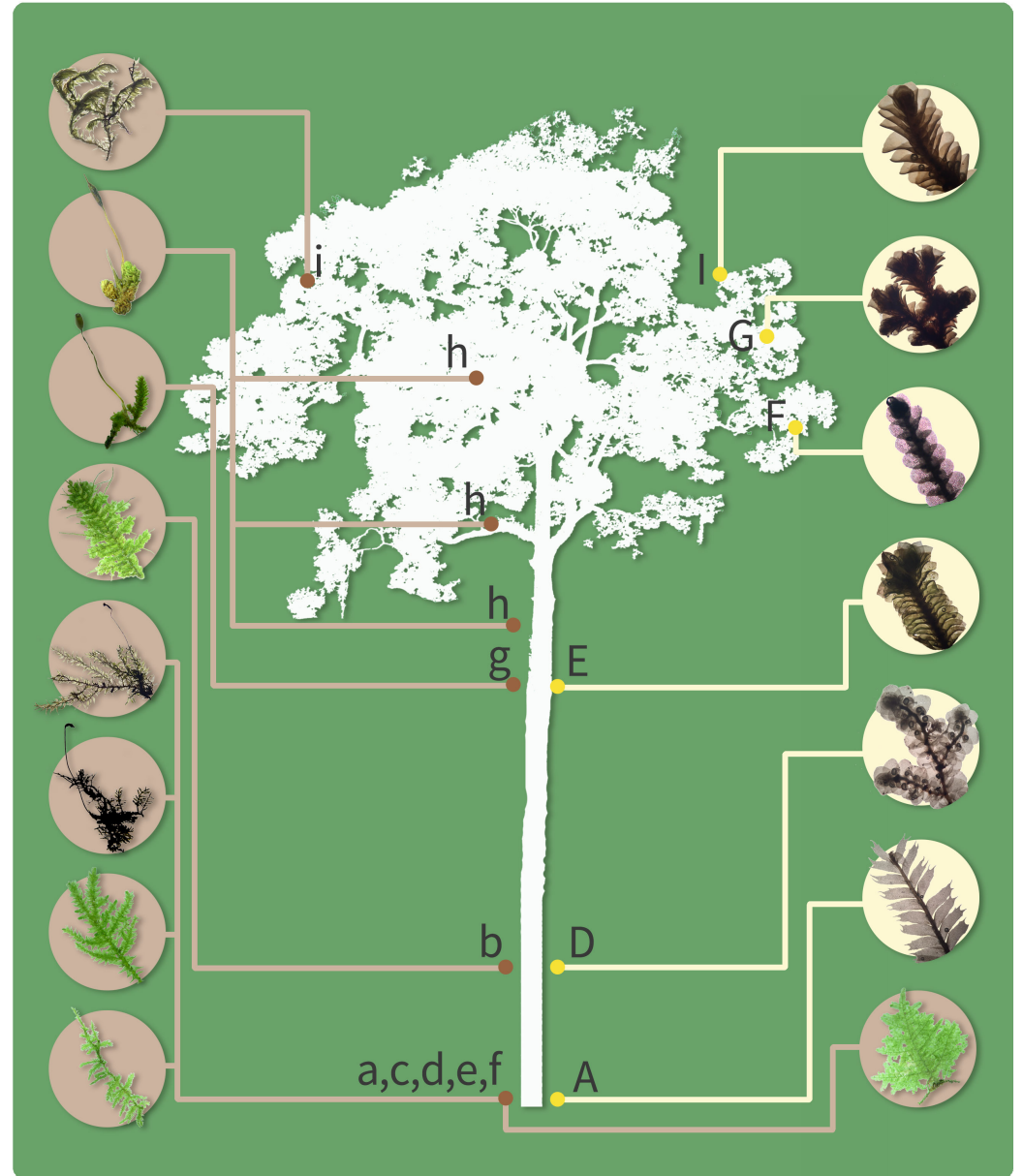
Epiphytes in the air

Objective: epiphytic bryophytes

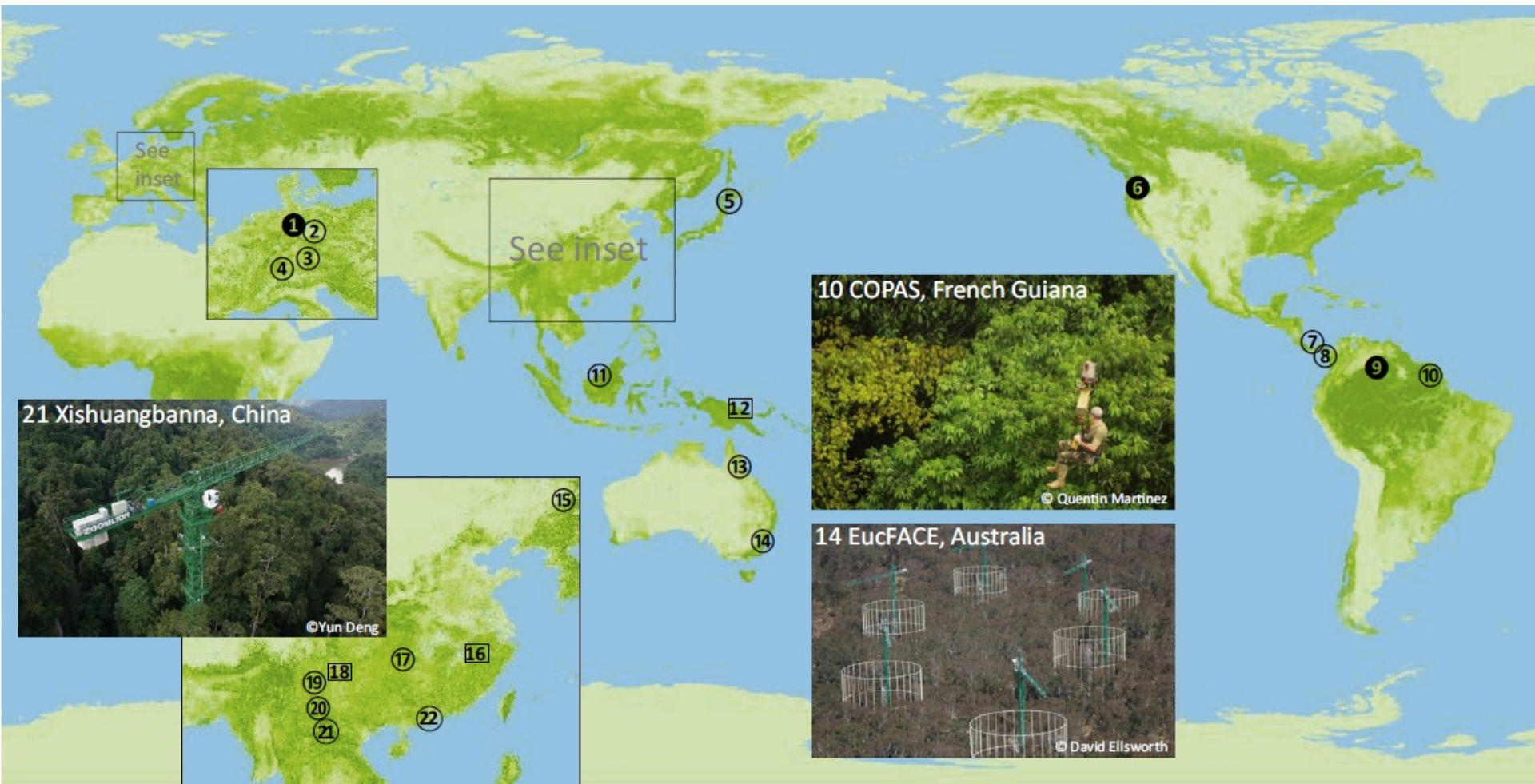
An ideal model



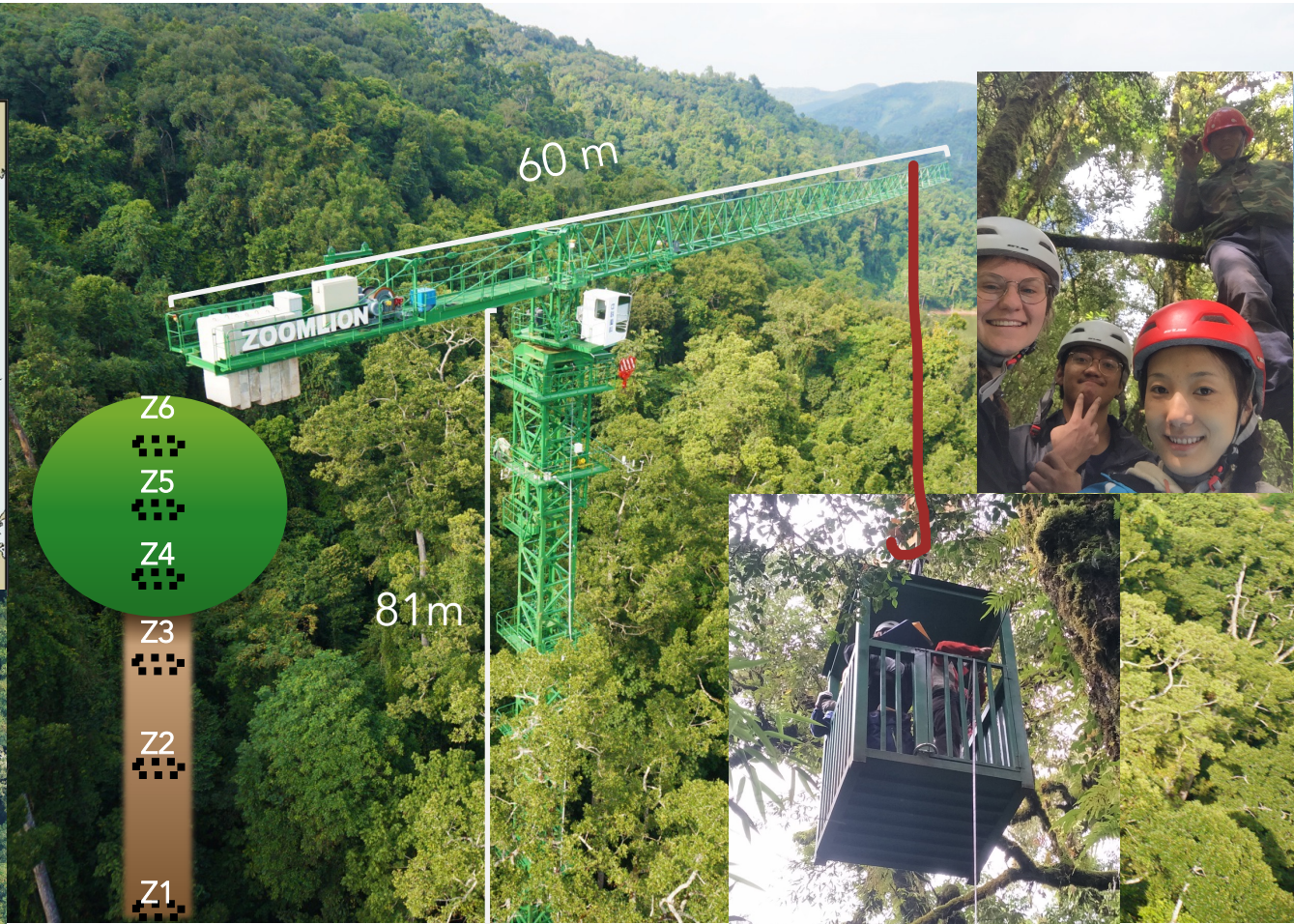
Impact of microclimatic variation on community composition



Global canopy cranes



Study area



Study site: a 1.1 ha tropical canopy crane facility in Yunnan, SW China

(Mittermeier et al. 2004)



Question & Hypothesis

Q1: What are the mechanisms shaping species turnover and phylogenetic turnover of moss and liverwort epiphytic communities along vertical microclimatic gradients?

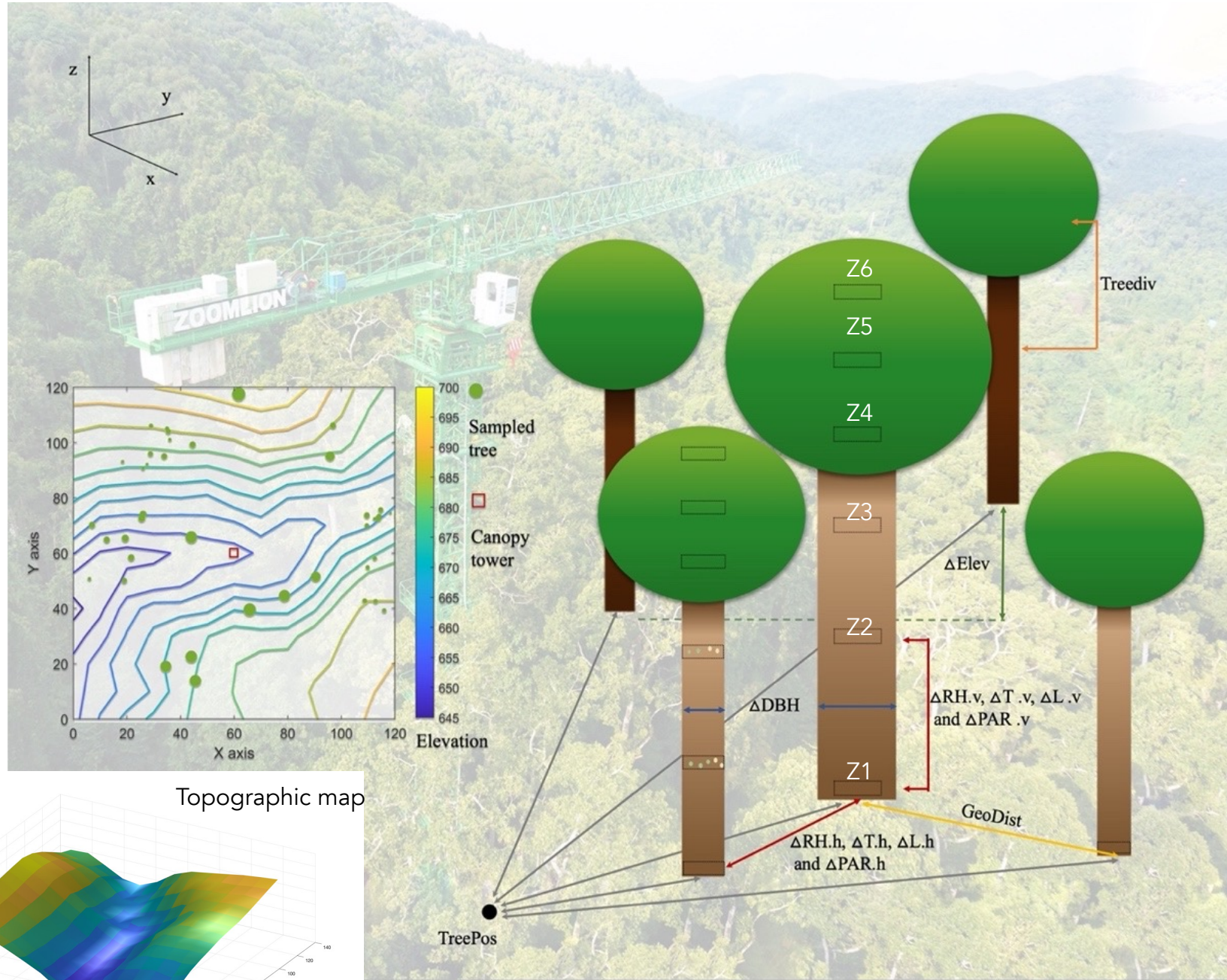
H1: We test the hypotheses that both **taxonomic and phylogenetic turnover correlate with microclimatic variation**, evidencing microclimatic niche conservatism.



Question & Hypothesis

Q2: To what extent are these changes in community composition phylogenetically constrained?

H2: Within communities, we test the hypotheses that species exhibit increasingly competitive interactions, and hence, increasing phylogenetic overdispersion, from the canopy to the base, and from young to old trees.



Experimental design

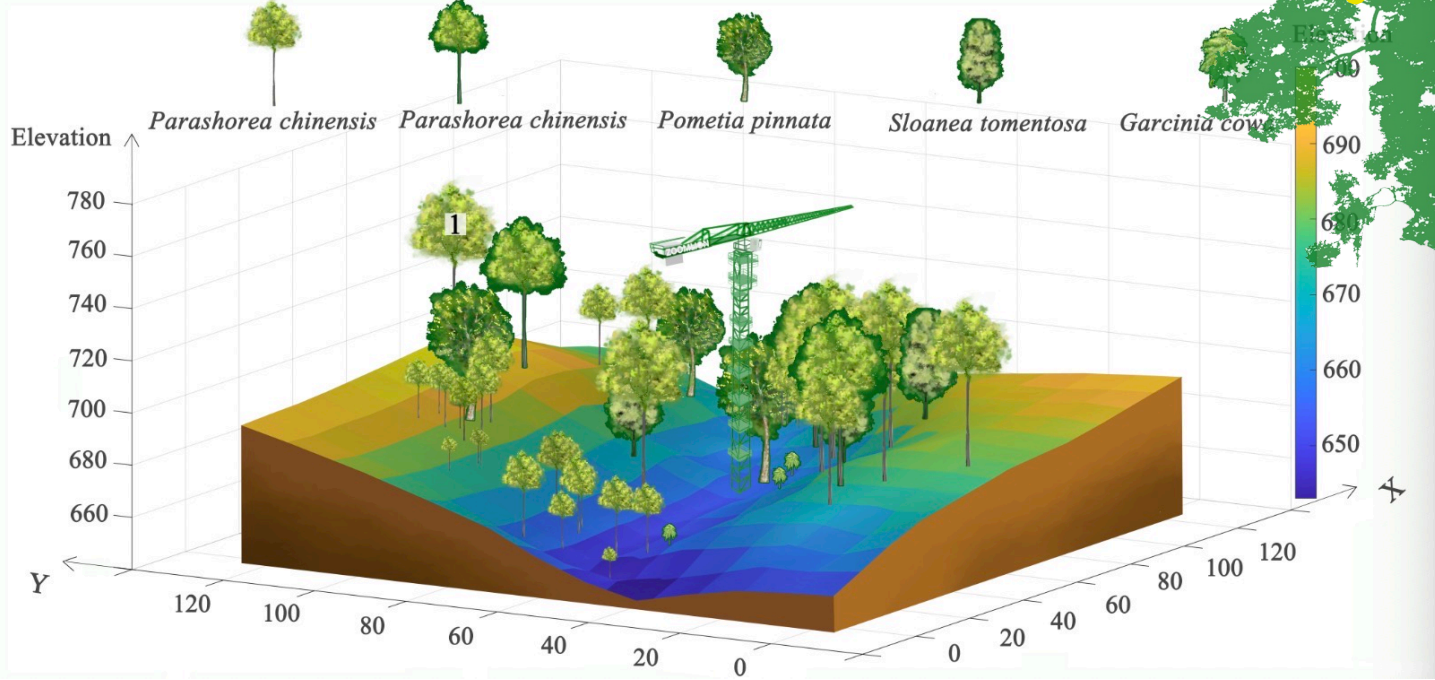
42 predicted trees

4 host tree species * 3 replicates

60 sensors for Temperature, humidity, light & PAR

42 sampled host trees

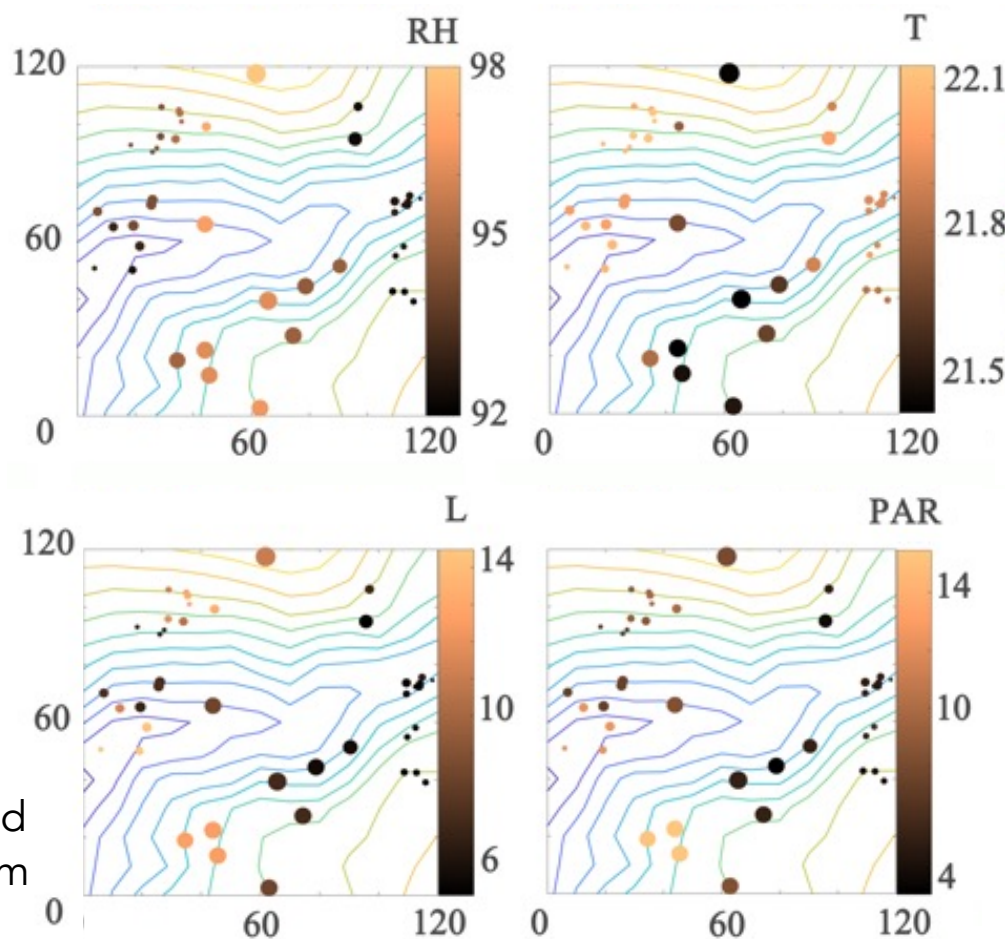
12 host trees with dataloggers



5 height zones

Microclimate modelling

Huge vertical variation
Subtle horizontal variation



42 sampled trees at 2 m

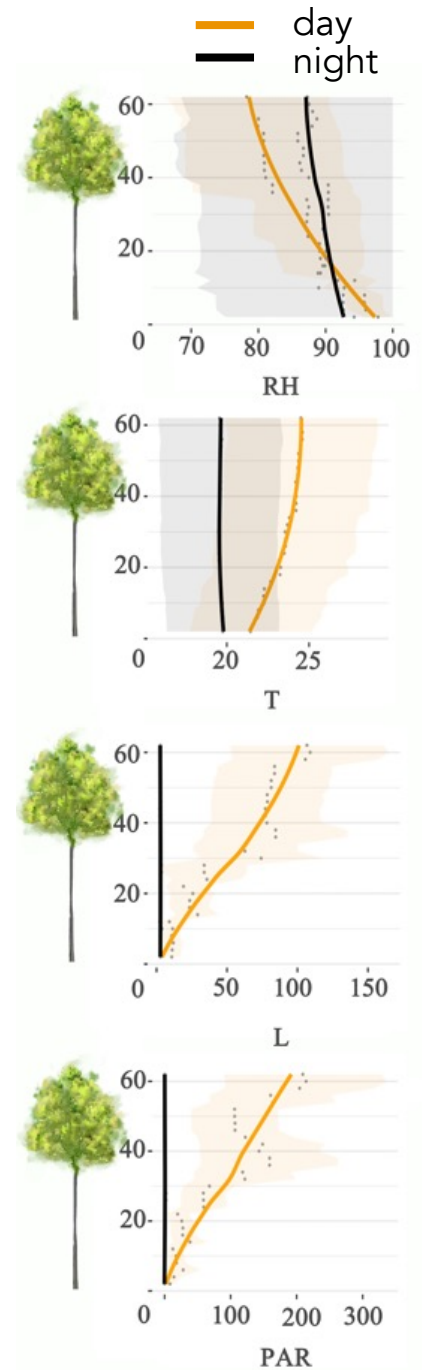


Figure 1 Microclimate modelling of relative humidity (RH), Temperature (T), photosynthetically active radiation (PAR) and light intensity (L)

Taxonomic species turnover

Turnover = 0.59 ± 0.25 in mosses, $p < 0.001$
Turnover = 0.66 ± 0.24 in liverworts, $p < 0.001$

Q1

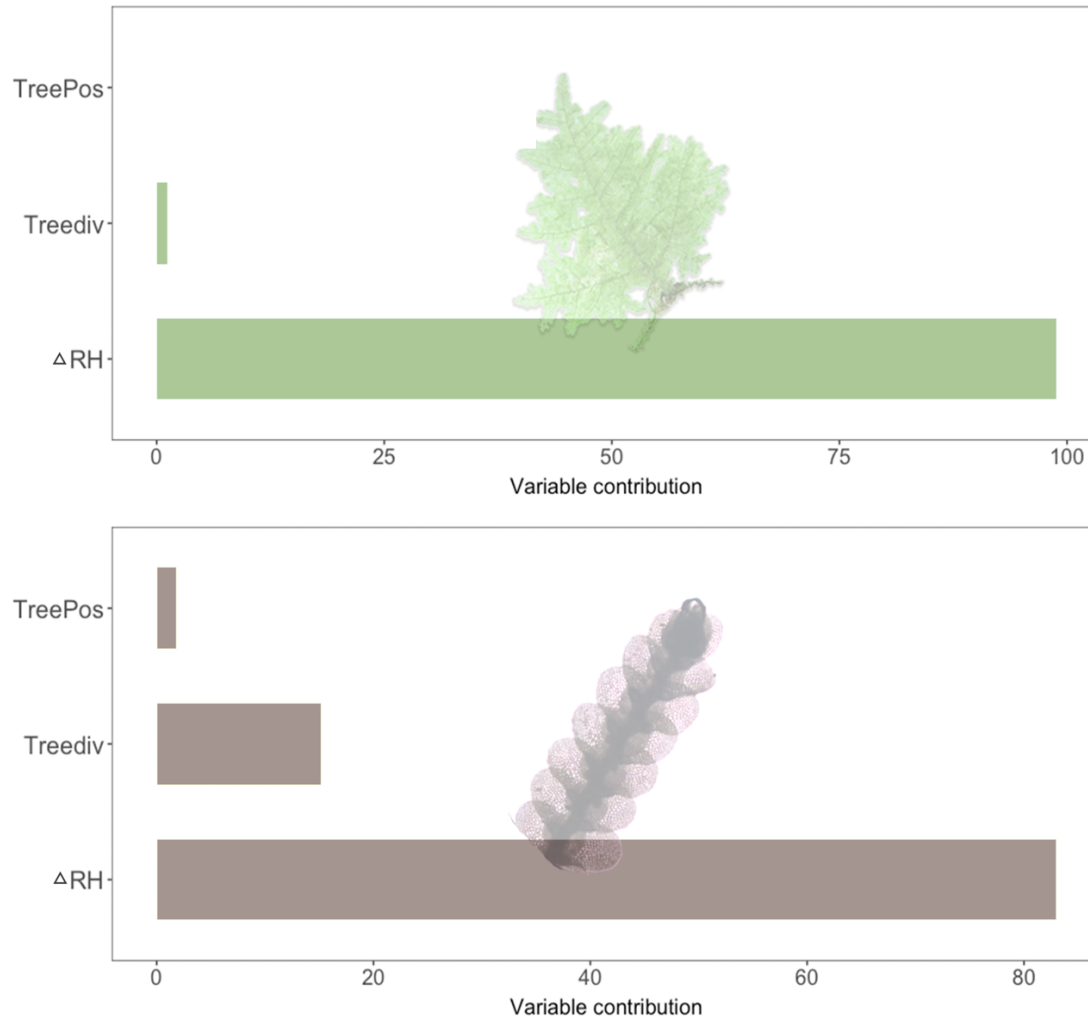
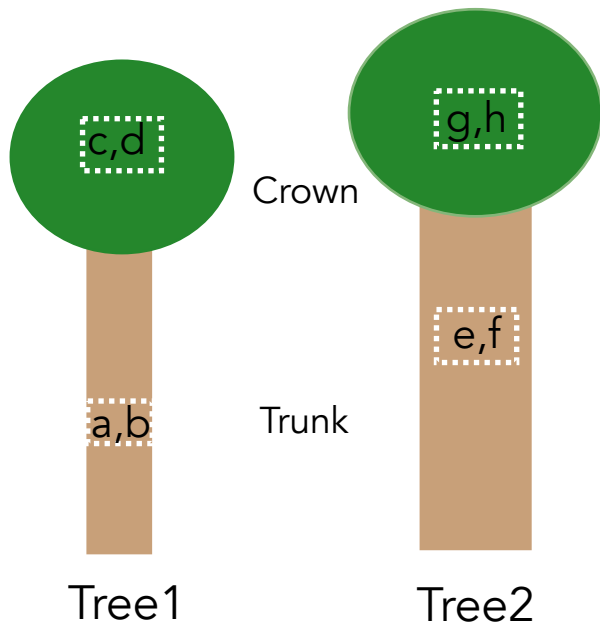


Figure 2 Vertical variable contribution in taxonomic species turnover among epiphytic moss (green) and liverwort (brown) communities

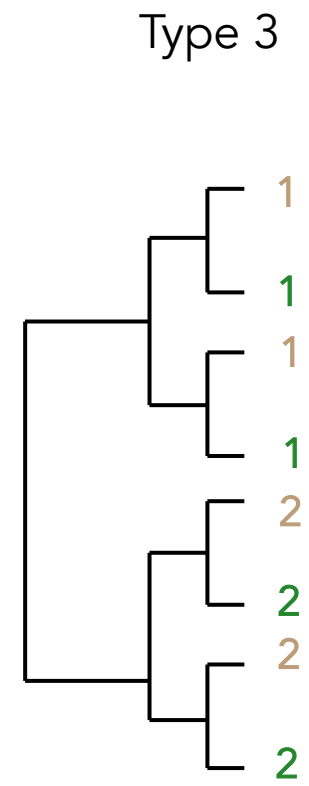
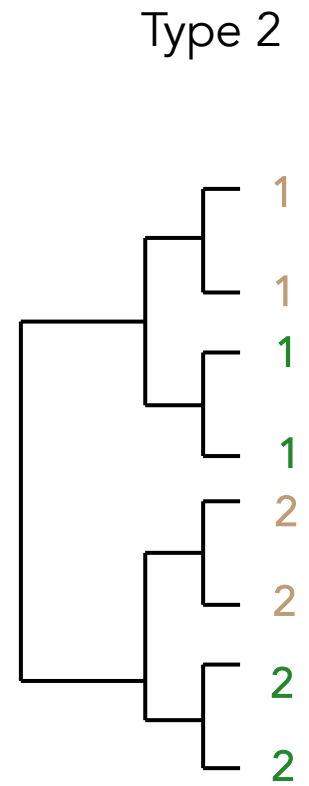
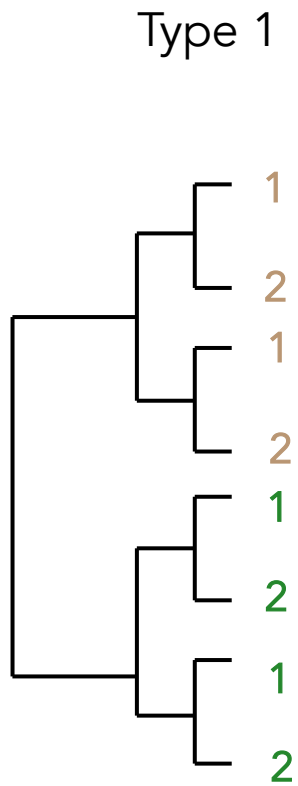
Niche conservatism ?



Phylogenetic turnover (π_{st})



2 isolated trees
2 habitats



Structuring factors

Habitat,
not host tree

Primarily host tree,
secondarily habitat

Host tree,
but not habitat

Phylogeny turnover

$\pi_{st} > 0$: 'Phylogenetic clustering'

$\pi_{st} < 0$: 'Phylogenetic overdispersion'

Environmental variation



Niche conservatism



Phylogenetic turnover

$\pi_{st} > 0, p < 0.001 \rightarrow$ Phylogenetic clustering

Q1

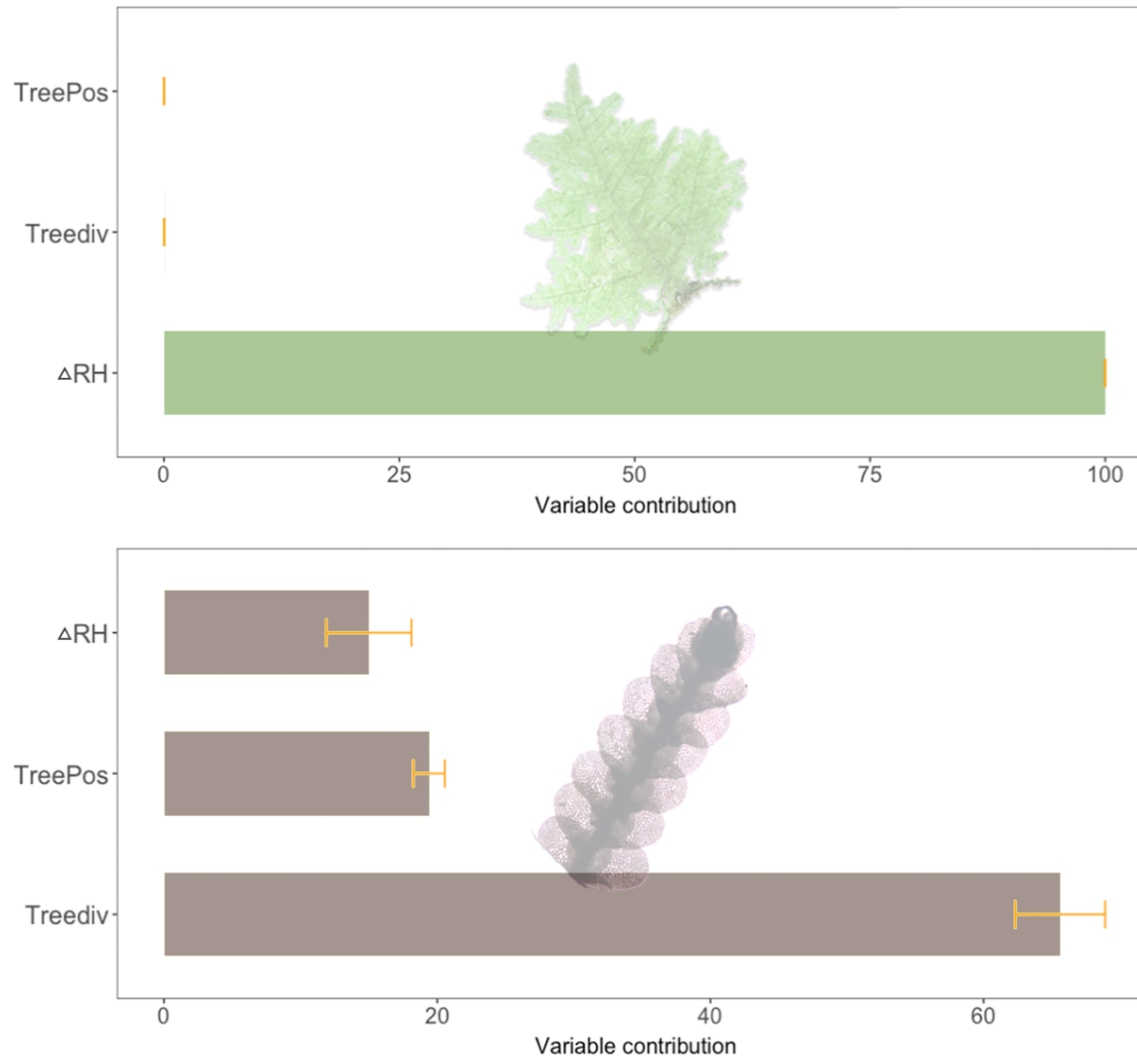


Figure 3 Vertical variable contribution in phylogenetic turnover among epiphytic **moss (green)** and **liverwort (brown)** communities

Phylogenetic constraints contribute to shaping the assembly

Q2

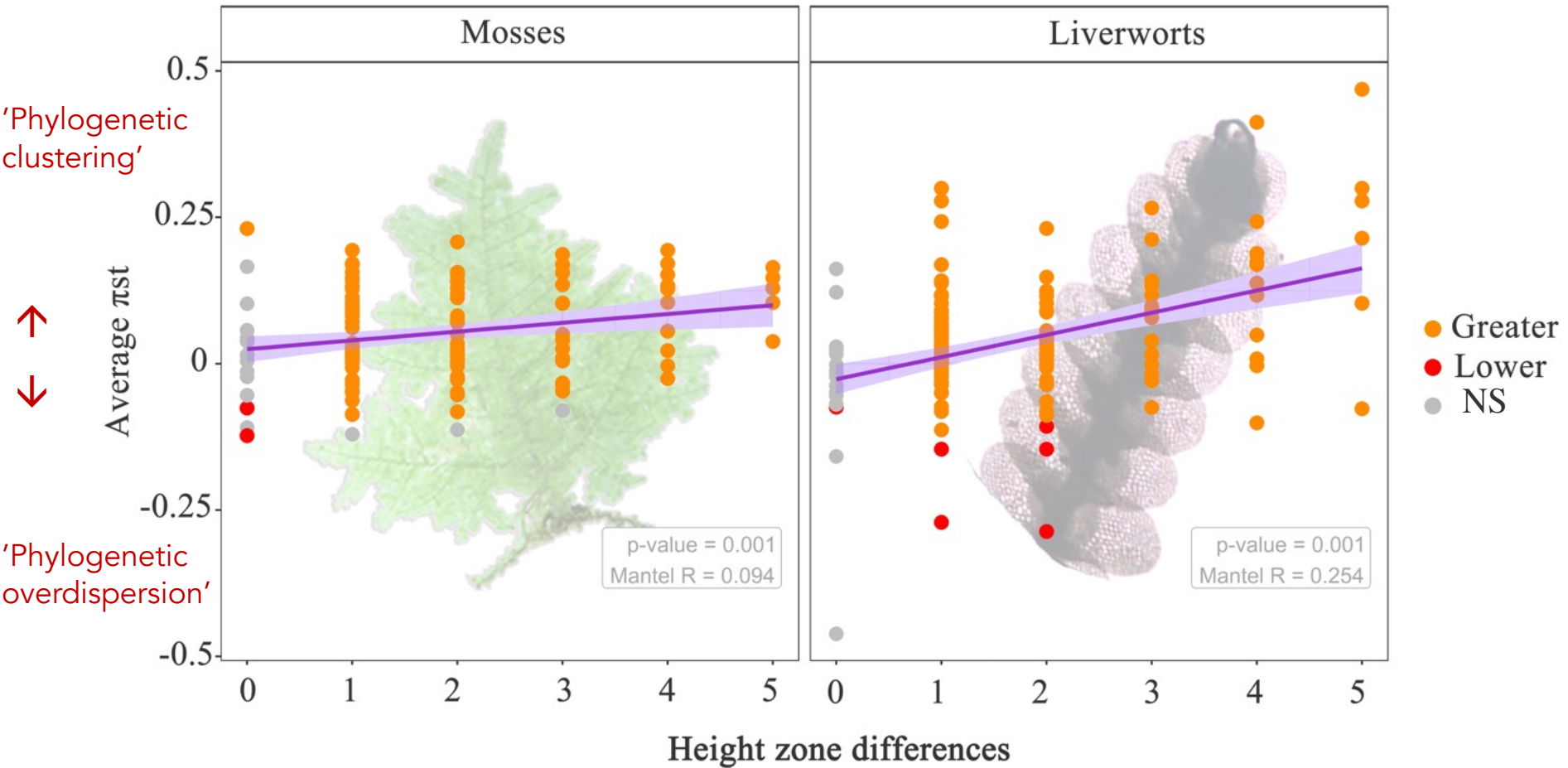


Figure 4 Variation of average phylogenetic turnover within epiphytic moss and liverwort communities along a gradient of height zone difference.

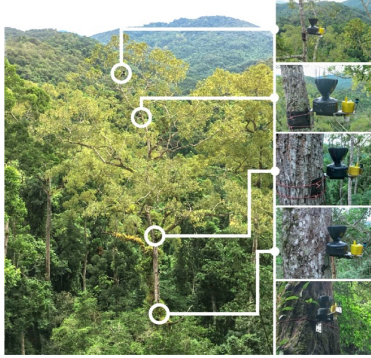
Conclusion

- **Microclimatic variation** is the main driver of community composition and phylogenetic structure.
- Epiphytic community assembly mechanisms **shift from competitive interactions to phylogenetic constraints** upon colonization of different micro-habitats.
- An emerging evidence for the role of **phylogenetic niche conservatism** in community assembly, including at the small spatial scale

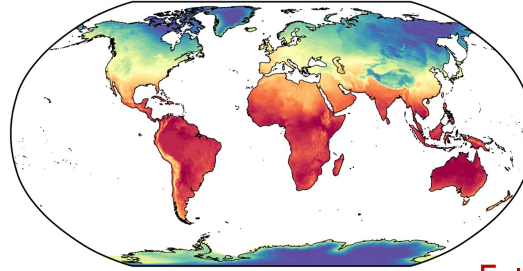
→ But what will happen in the future

Perspective: a tropical forest microclimate impacts on vascular epiphyte redistribution under macroclimate change

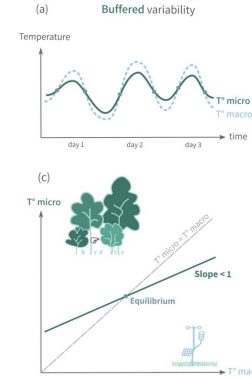
Dataloggers recorded microclimate conditions



ERA5-Land for macroclimatic time series



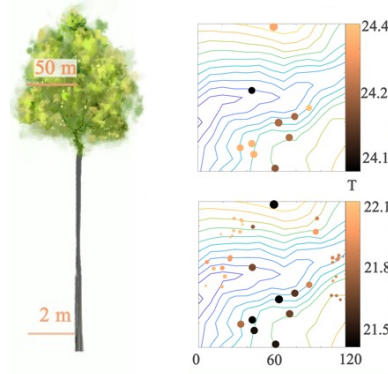
Equilibrium & slope approach



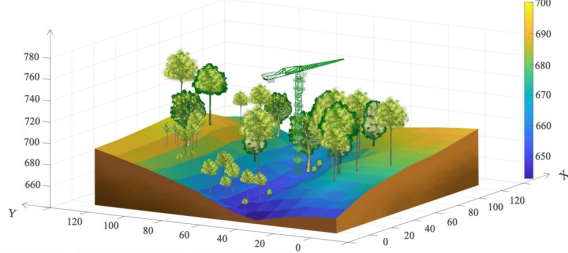
(Gril et al., 2022)

Future Microclimate

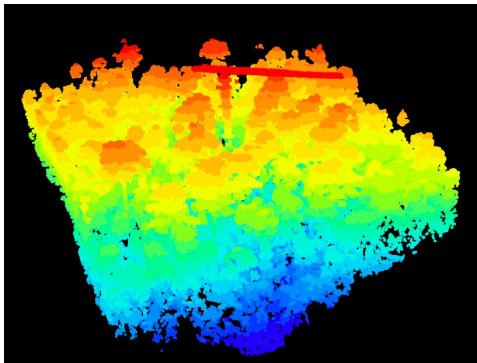
Microclimates at different heights



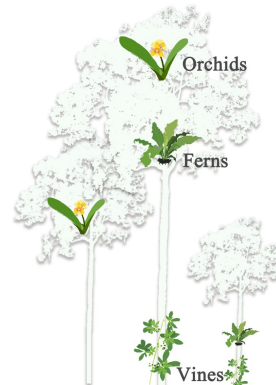
Forest structures & topography



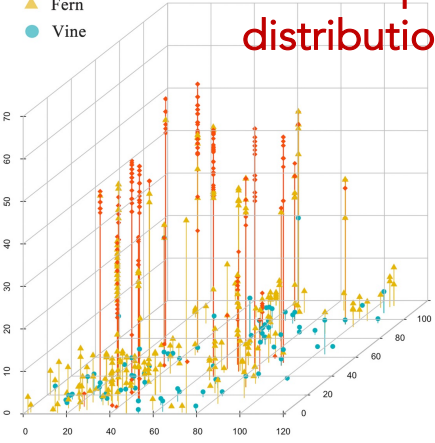
LiDAR cloud points in 3D forest



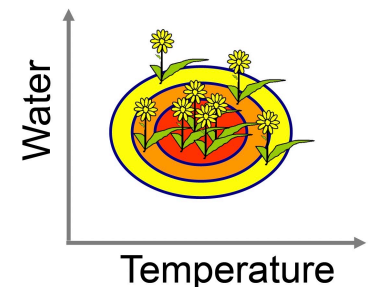
Current epiphyte distribution



Future epiphyte distribution



Species distribution model



Thank you for your attention!

