

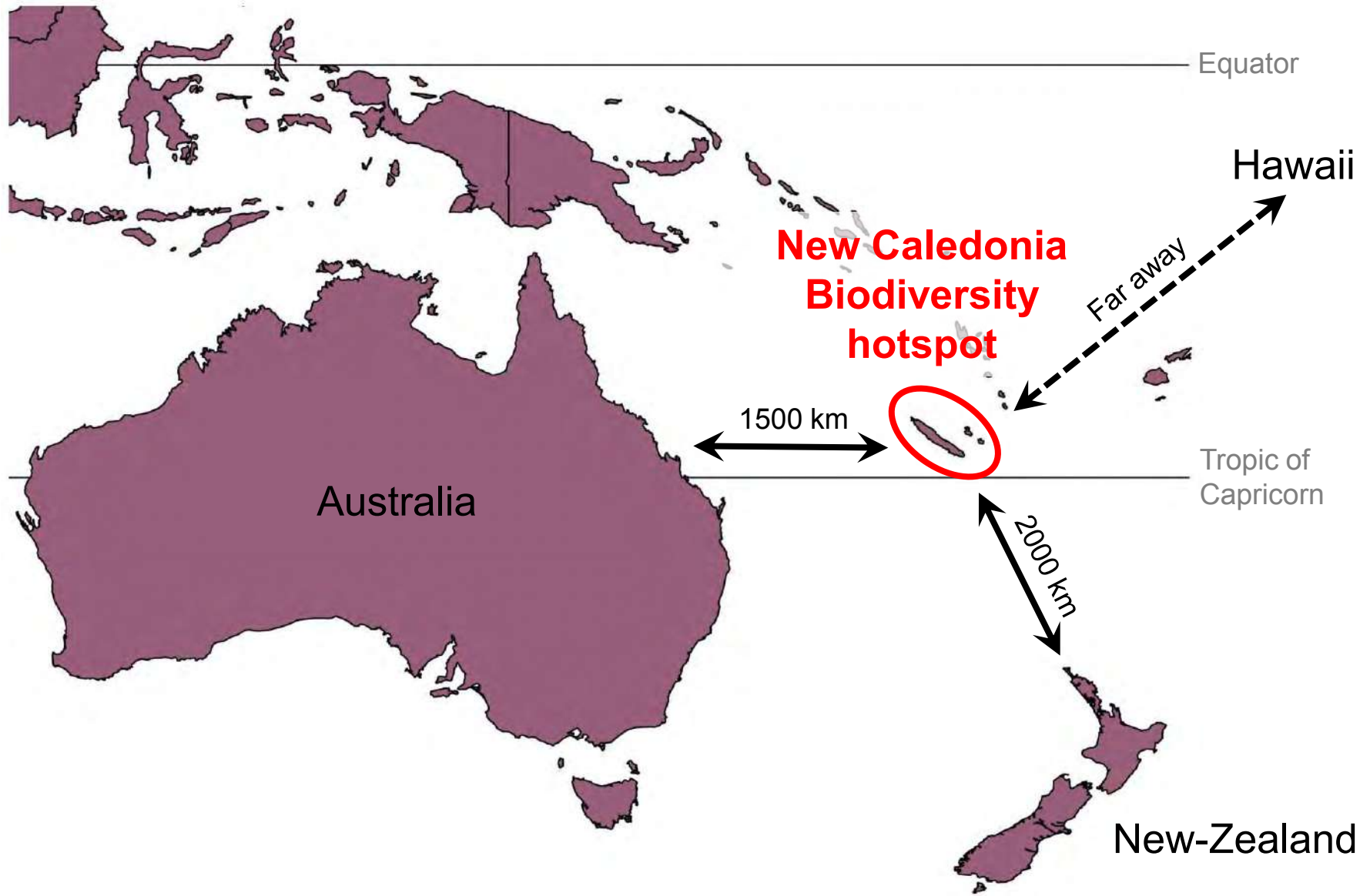
Wood density facing ecological challenges in New Caledonia

Thomas Ibanez (ibanez@iac.nc),

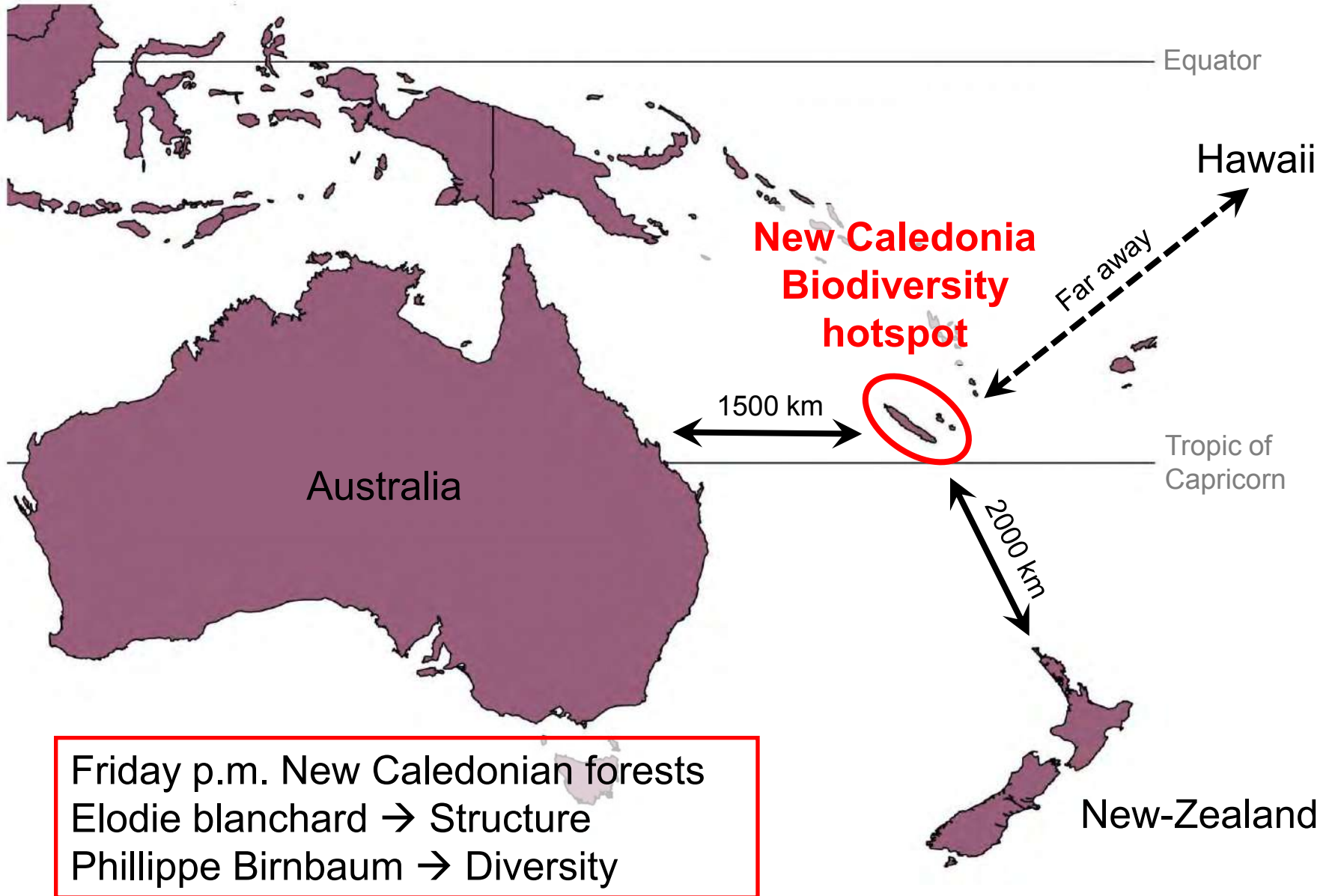
P. Birnbaum, E. Blanchard, V. Hequet, S. Isnard & H. Vandrot



Small islands, big ecological challenges



Small islands, big ecological challenges



Small islands, big ecological challenges

Many species

- > 3000 phanerogam species
- > 75 % endemism
- ≈ 1000 tree species



+

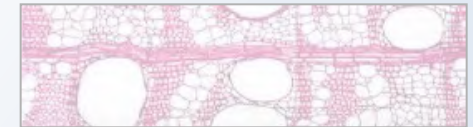
Few ecological knowledge

- Demographic parameters
- Environmental drivers
- Ecosystems dynamics



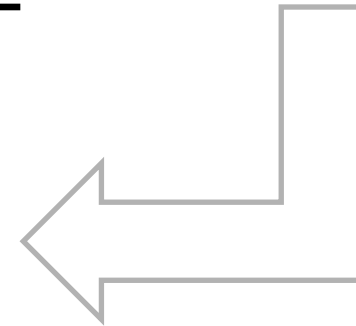
Functional ecology

- Key approach
- Wood density



Ecological challenges

- Species & diversity distribution patterns
- Environmental & functional drivers
- Conservation & management



Small islands, big ecological challenges

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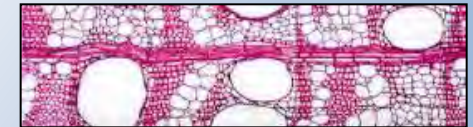
Few ecological knowledge

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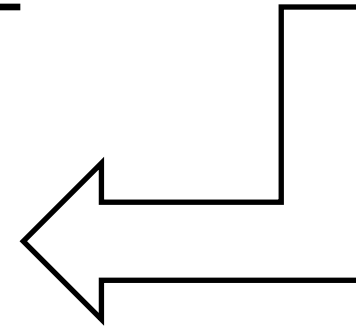
Functional ecology

- Key approach
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Ecological challenges

- Species & diversity distribution patterns
- Environmental & functional drivers
- Conservation & management



Wood density, from functions to patterns

Wood Functions

Mechanic

Hydraulic

Storage

Defence

Wood density Proxy

Growth-survival trade off

Maximum height

Drought tolerance

Ecological Patterns

Species distribution along **environmental gradients**

Species distribution in **forest dynamics**

Wood density, from functions to patterns

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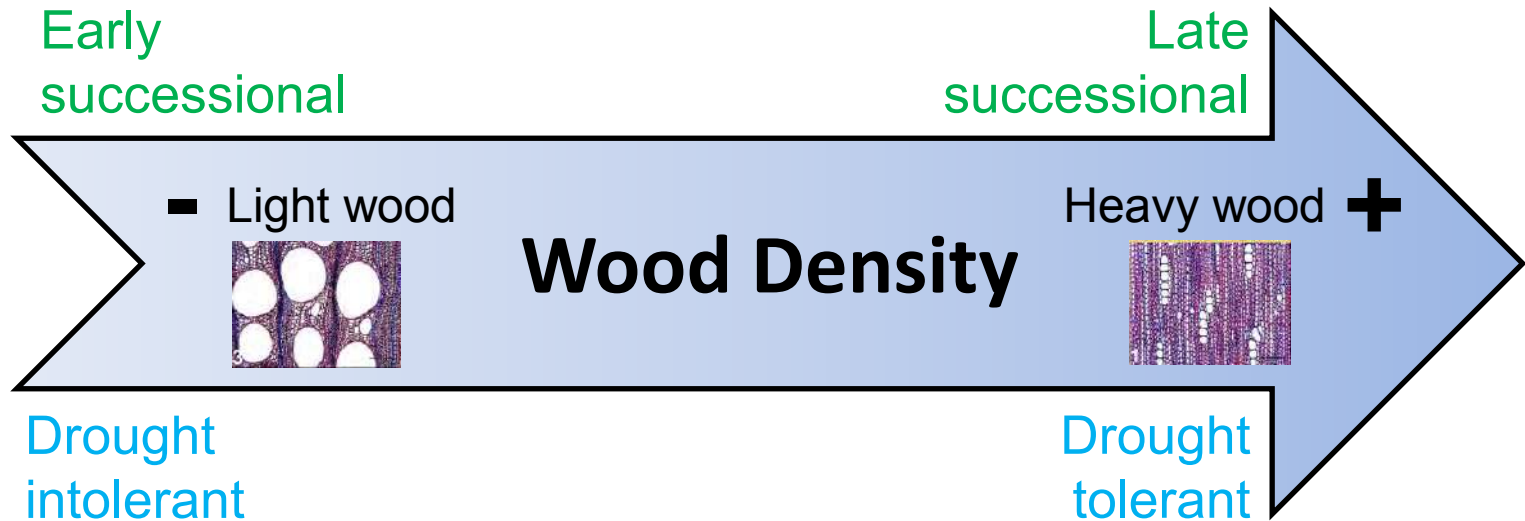
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Ecological Patterns

Species
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**environmental
gradients**

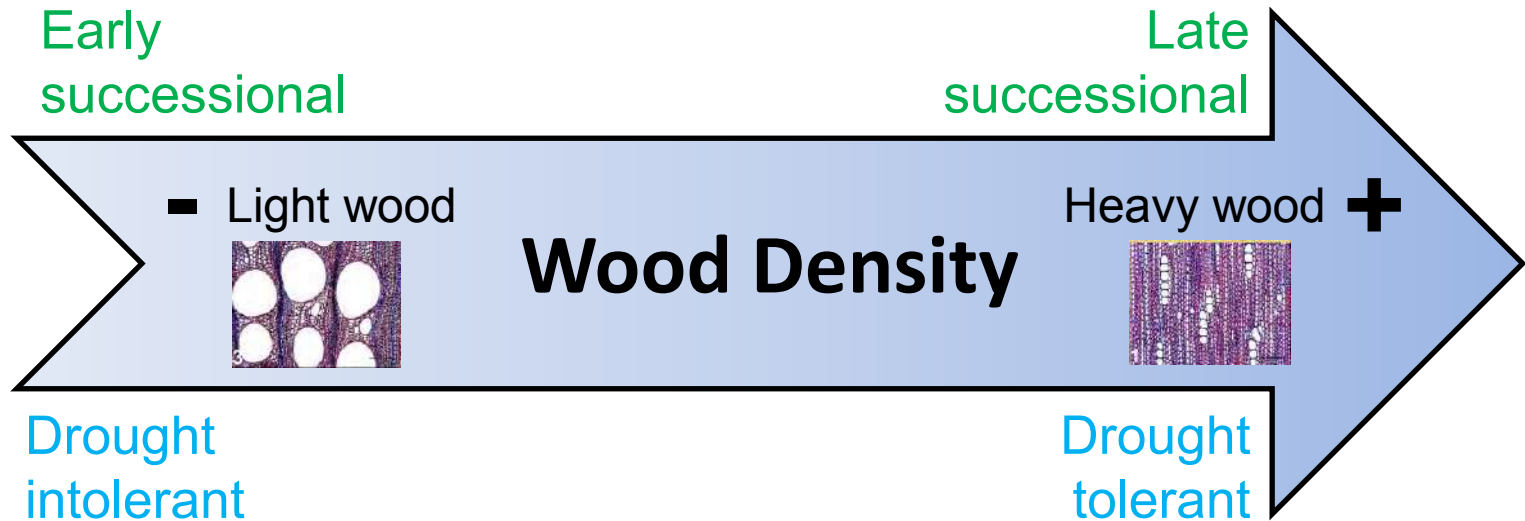
Species
distribution in **forest
dynamics**

Does extensive measure of wood density may enhance our ecological knowledge ?



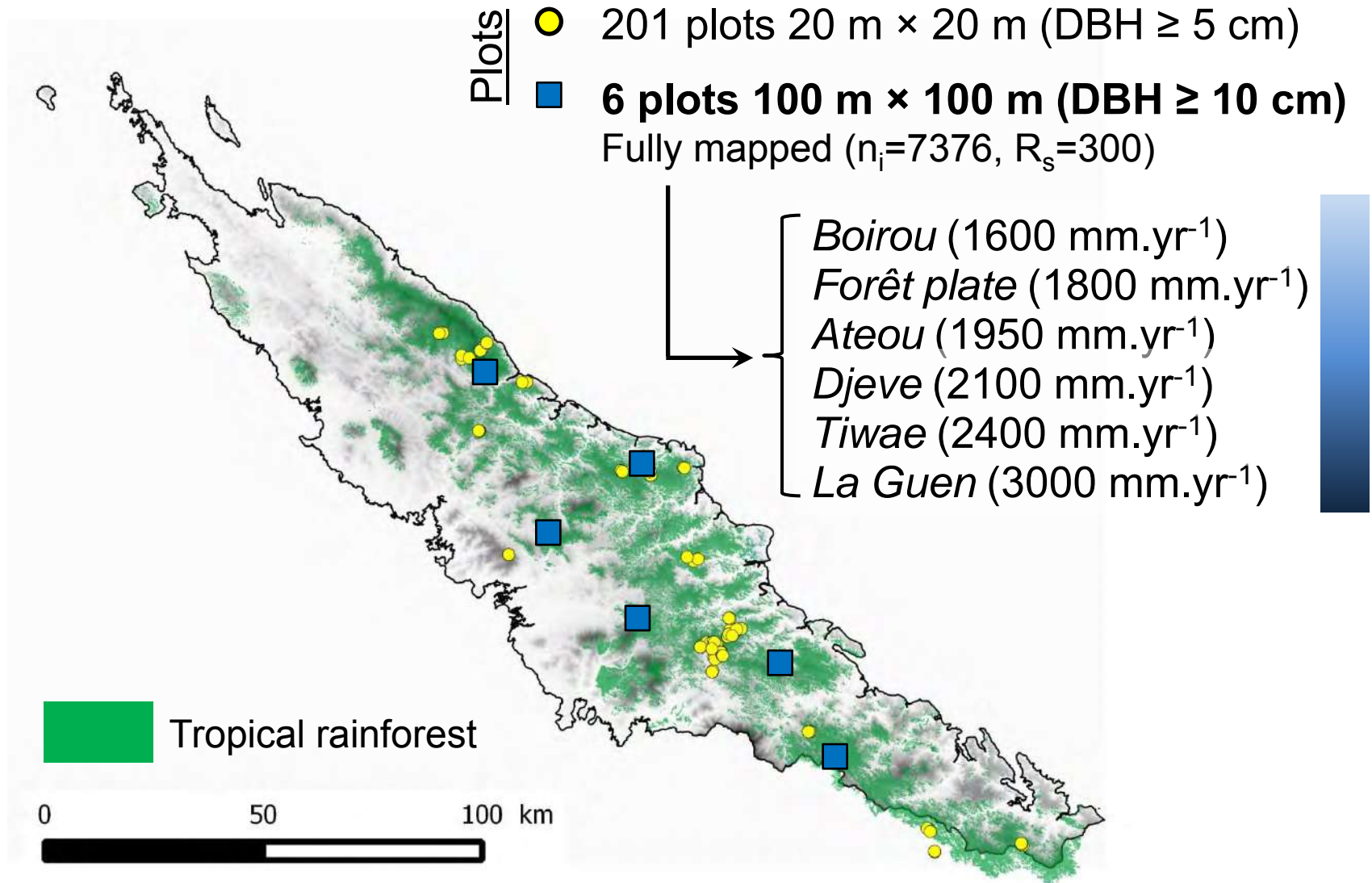
- Australasia
→ Taxonomic & environmental drivers
- New Caledonia (Northern Province)
→ Dynamics & environmental drivers

Does extensive measure of wood density may enhance our ecological knowledge ?



- **Australasia**
 - Taxonomic & environmental drivers
- **New Caledonia (Northern Province)**
 - Dynamics & environmental drivers

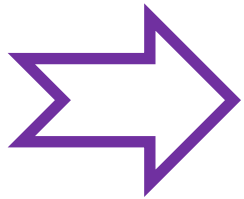
Plant Inventory and Permanent Plot Network



(Ibanez *et al.* 2014, *Applied Vegetation Science*)

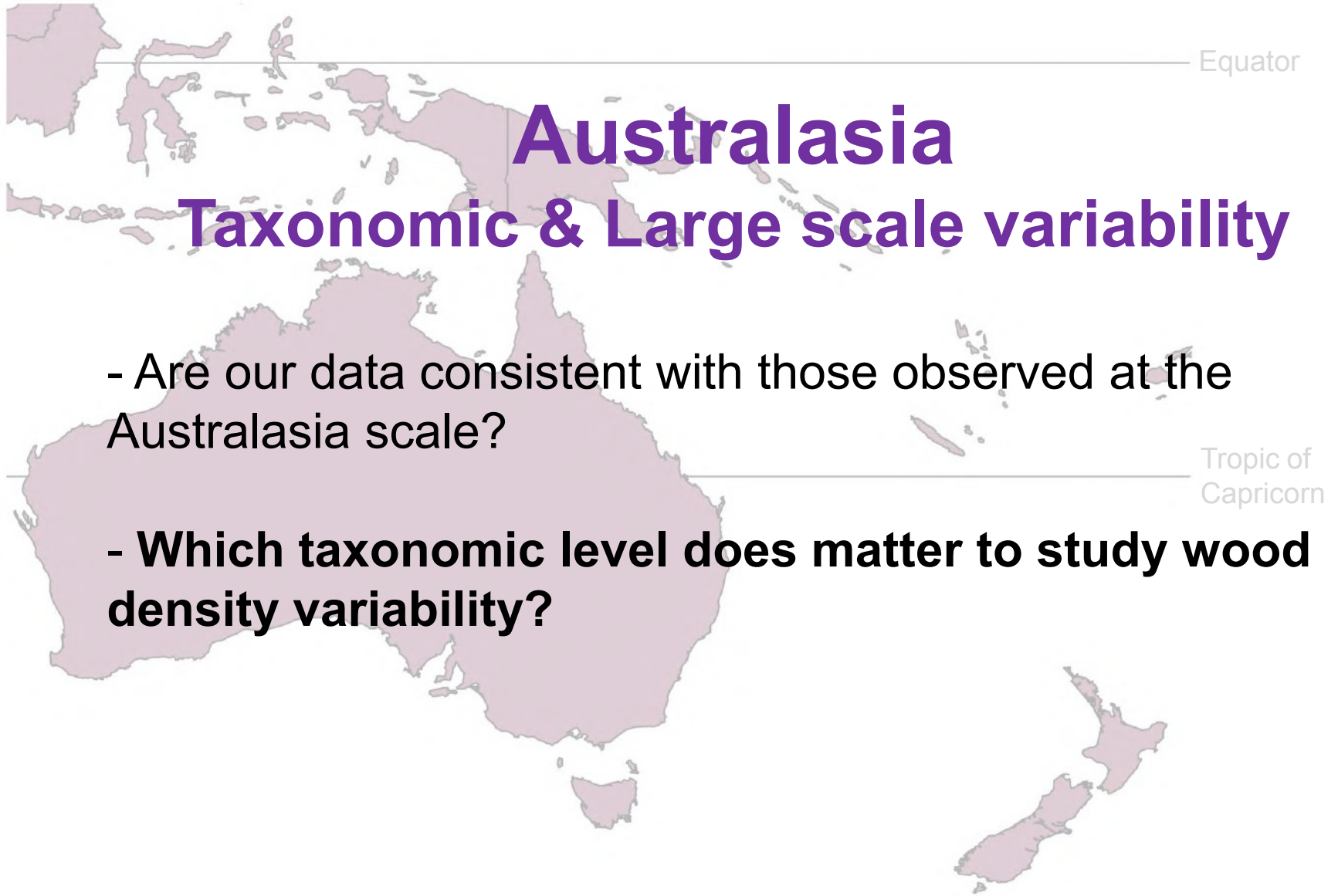
Wood density measurement

$$\text{Wood density (g.cm}^{-3}\text{)} = \frac{\text{Oven-dry mass (g)}}{\text{Green volume (cm}^3\text{)}}$$



DATA SET

- 6 fully mapped 1-ha plots (all species with $n_i \geq 5$)
- 1226 trees cores (5 cores per species & per plot)
- 139 species / 86 genus / 47 families / 21 orders

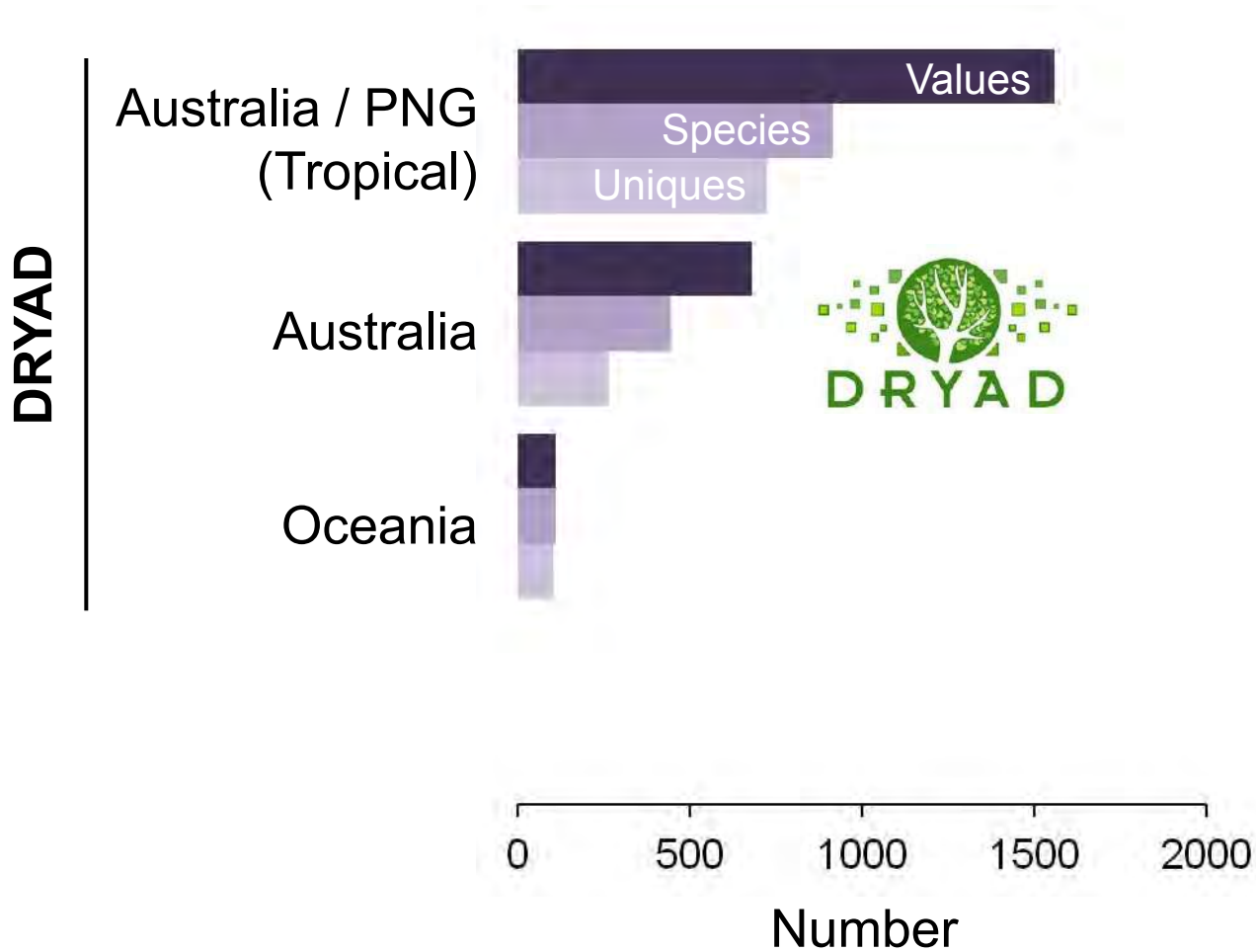


Australasia

Taxonomic & Large scale variability

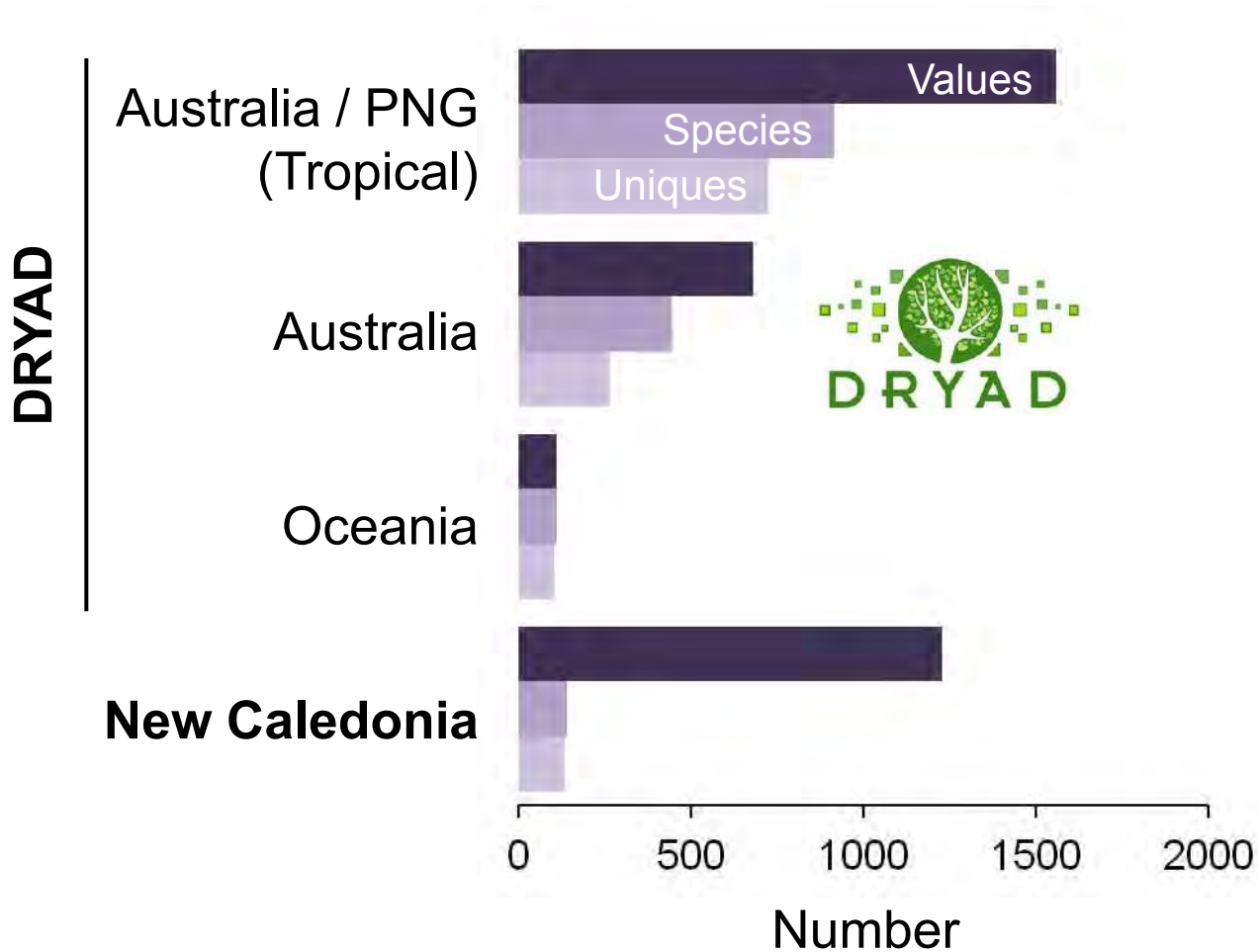
- Are our data consistent with those observed at the Australasia scale?
- **Which taxonomic level does matter to study wood density variability?**

DRYAD Wood density database



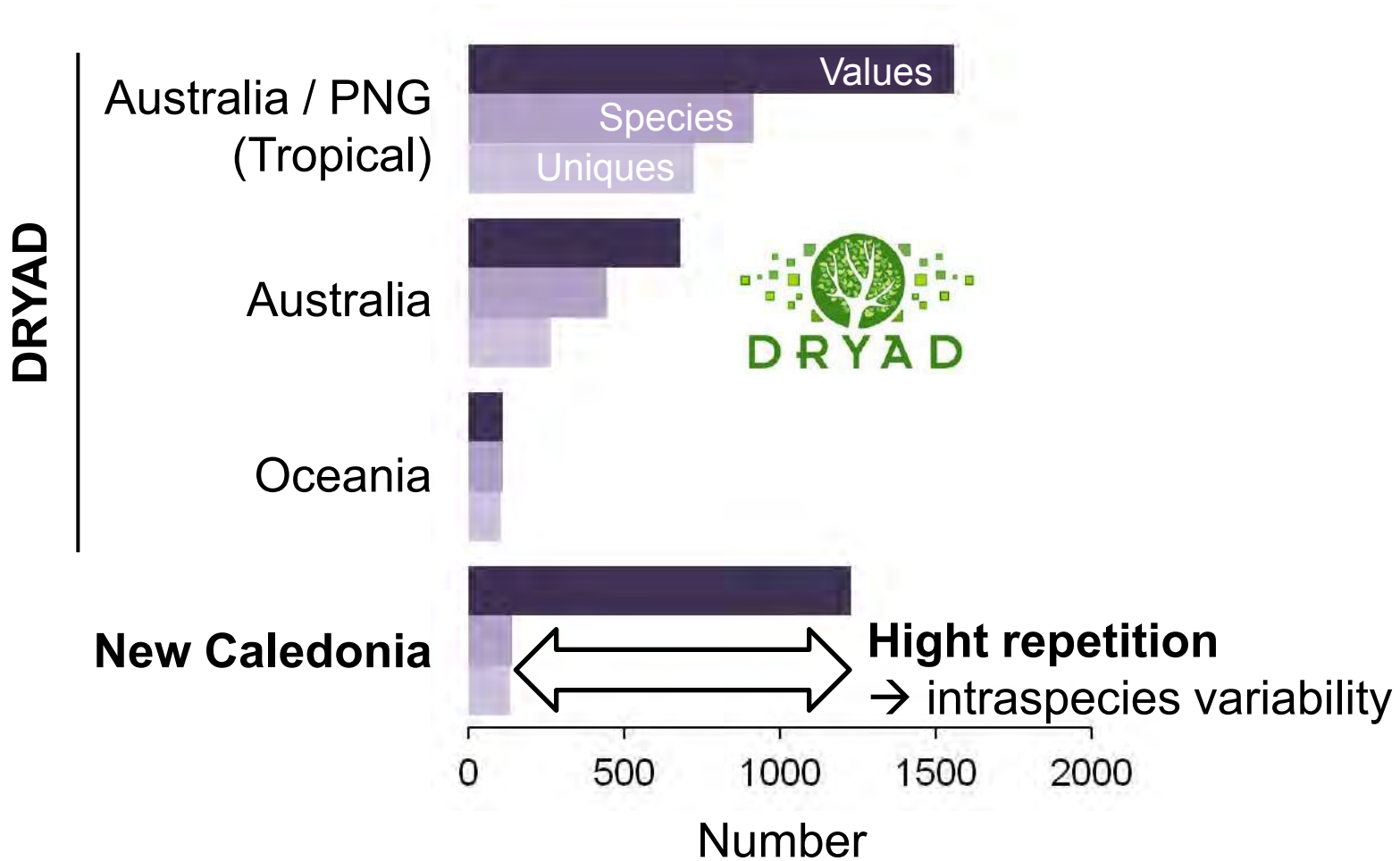
(<http://datadryad.org/> Chave *et al.* 2009, *Ecology Letters*)

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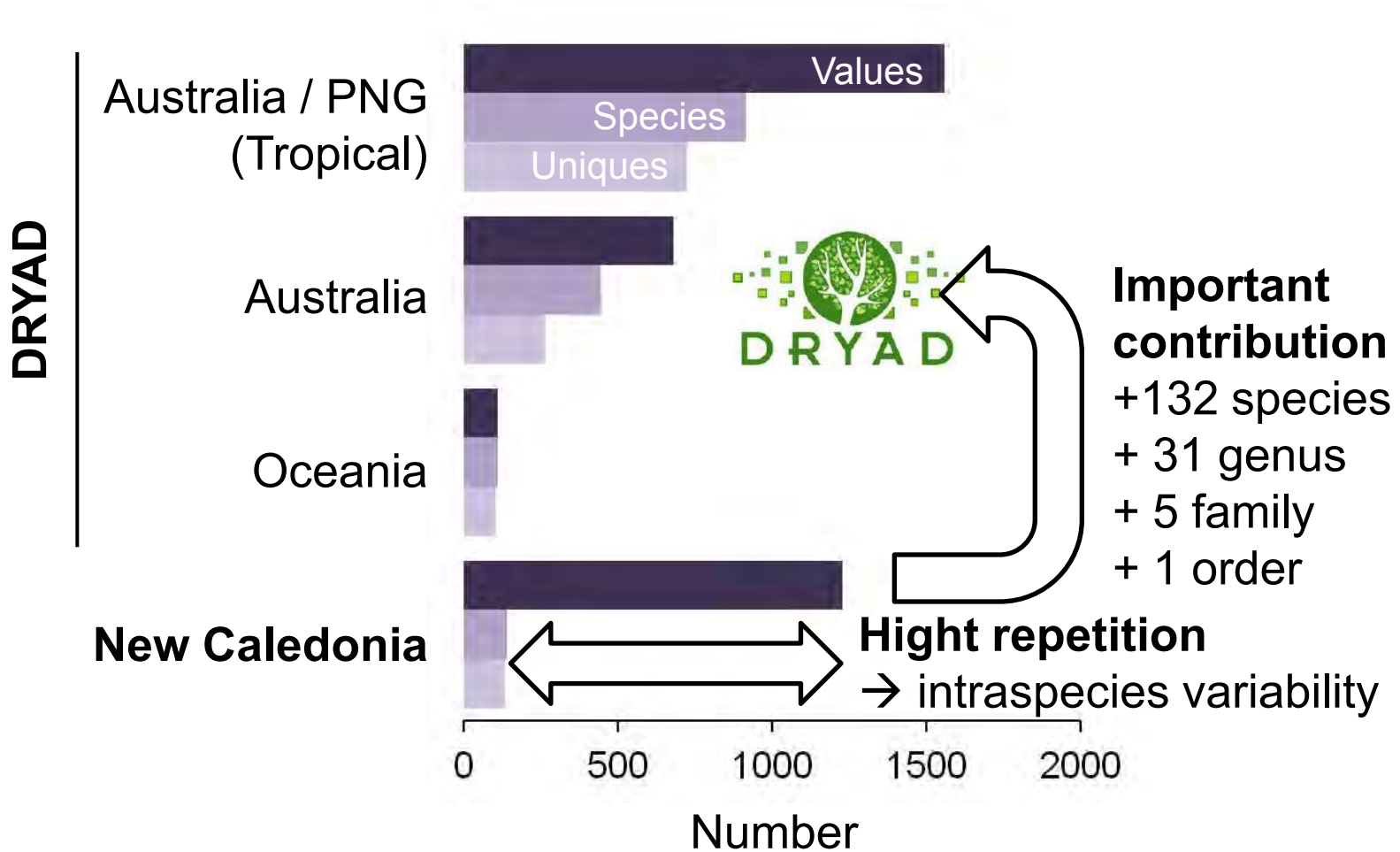
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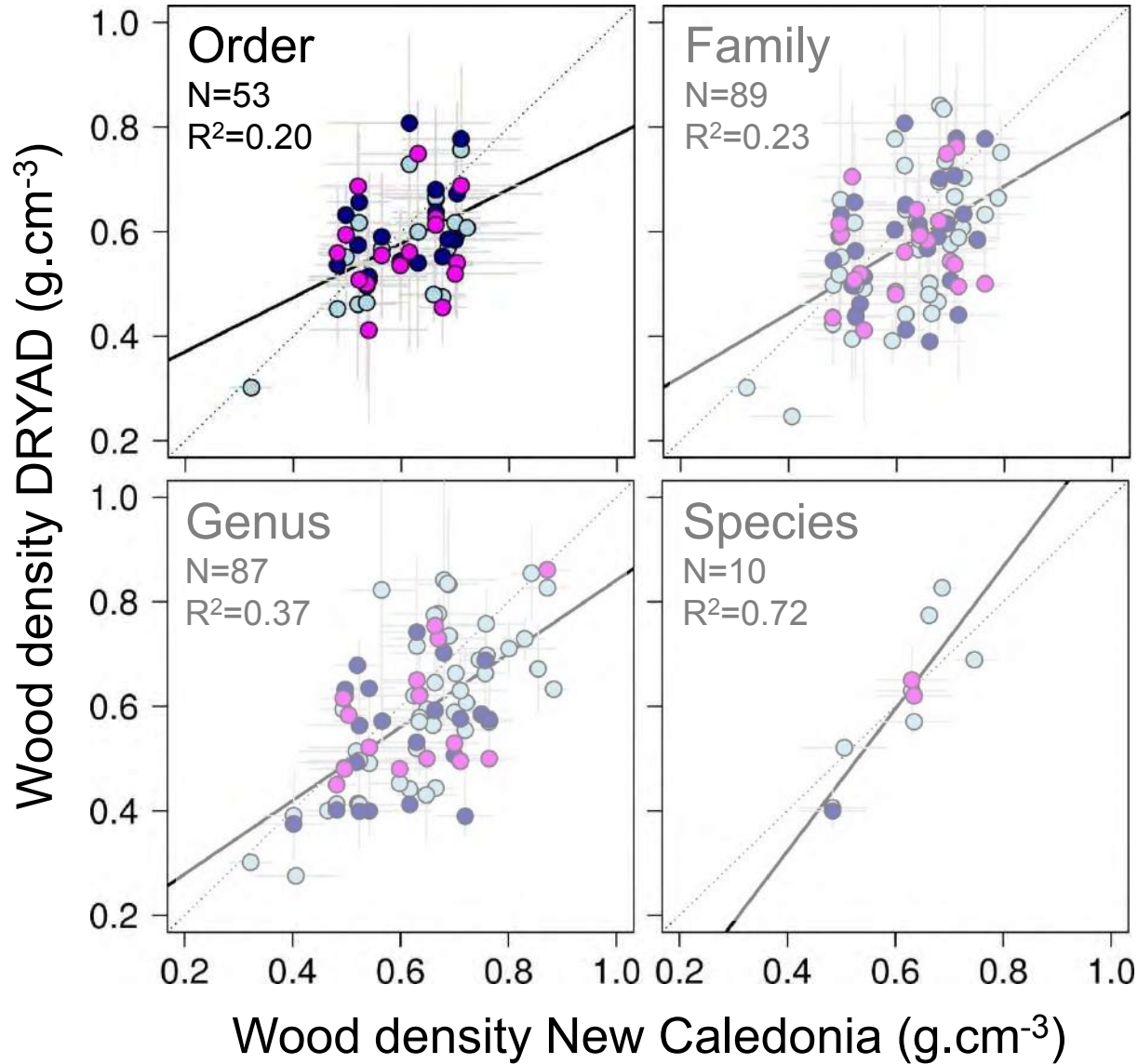
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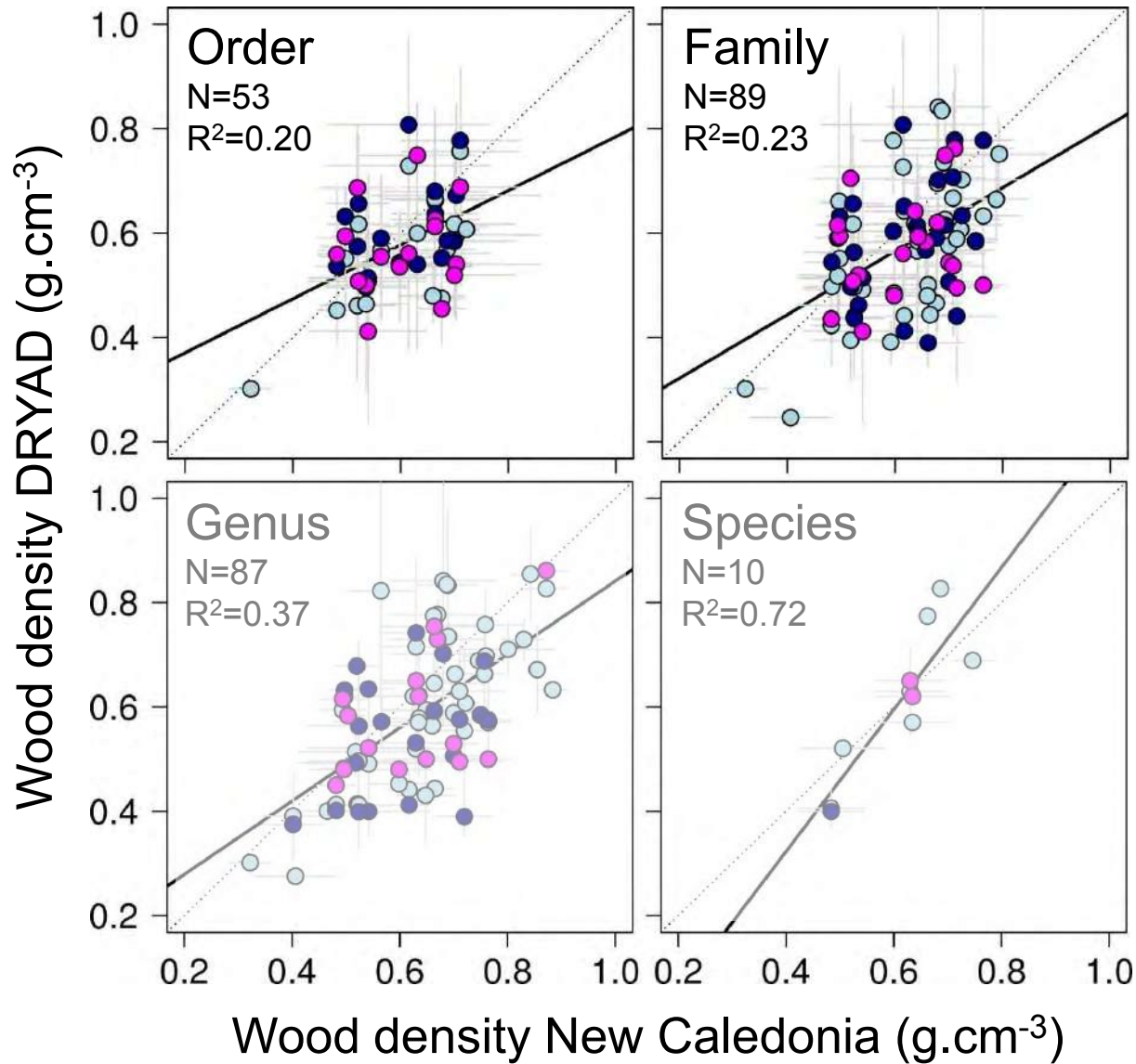
Intra-taxon geographical variation

○ Australia / PNG (Trop.) ● Australia ● Oceania



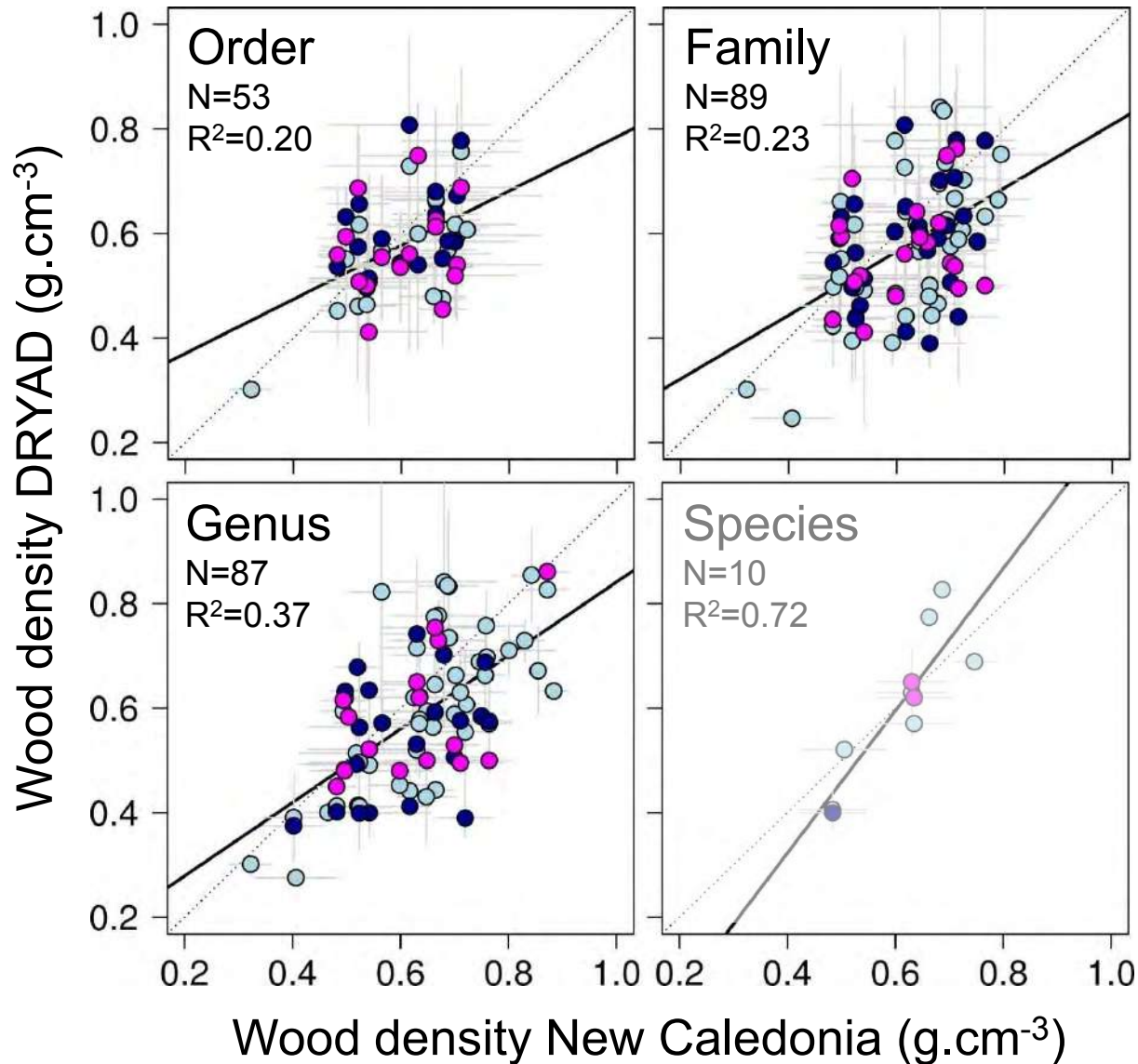
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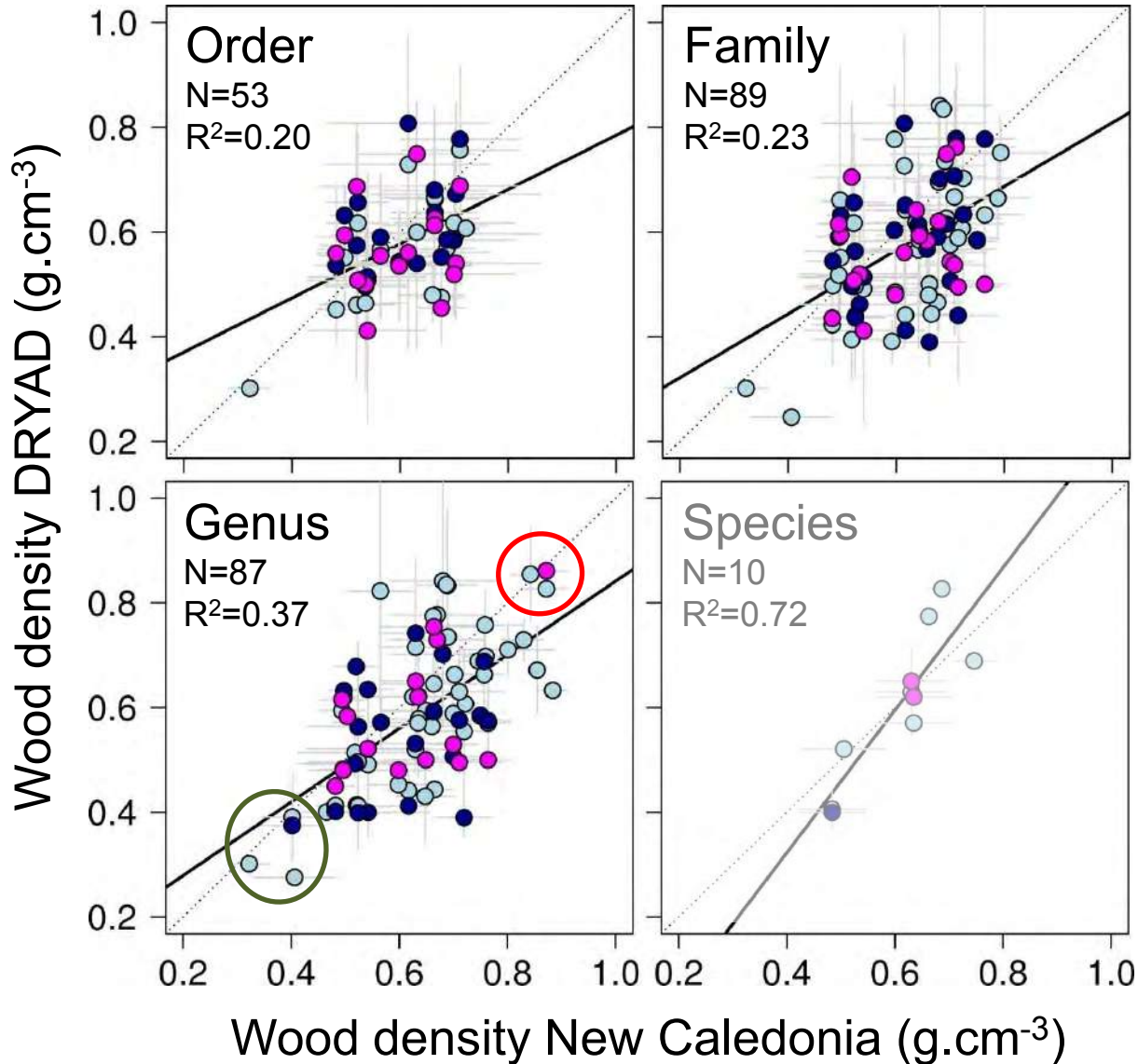
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Intra-taxon geographical variation

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Higher WD
Mammea
 (Calophyllaceae)

Geijera
 (Rutaceae)

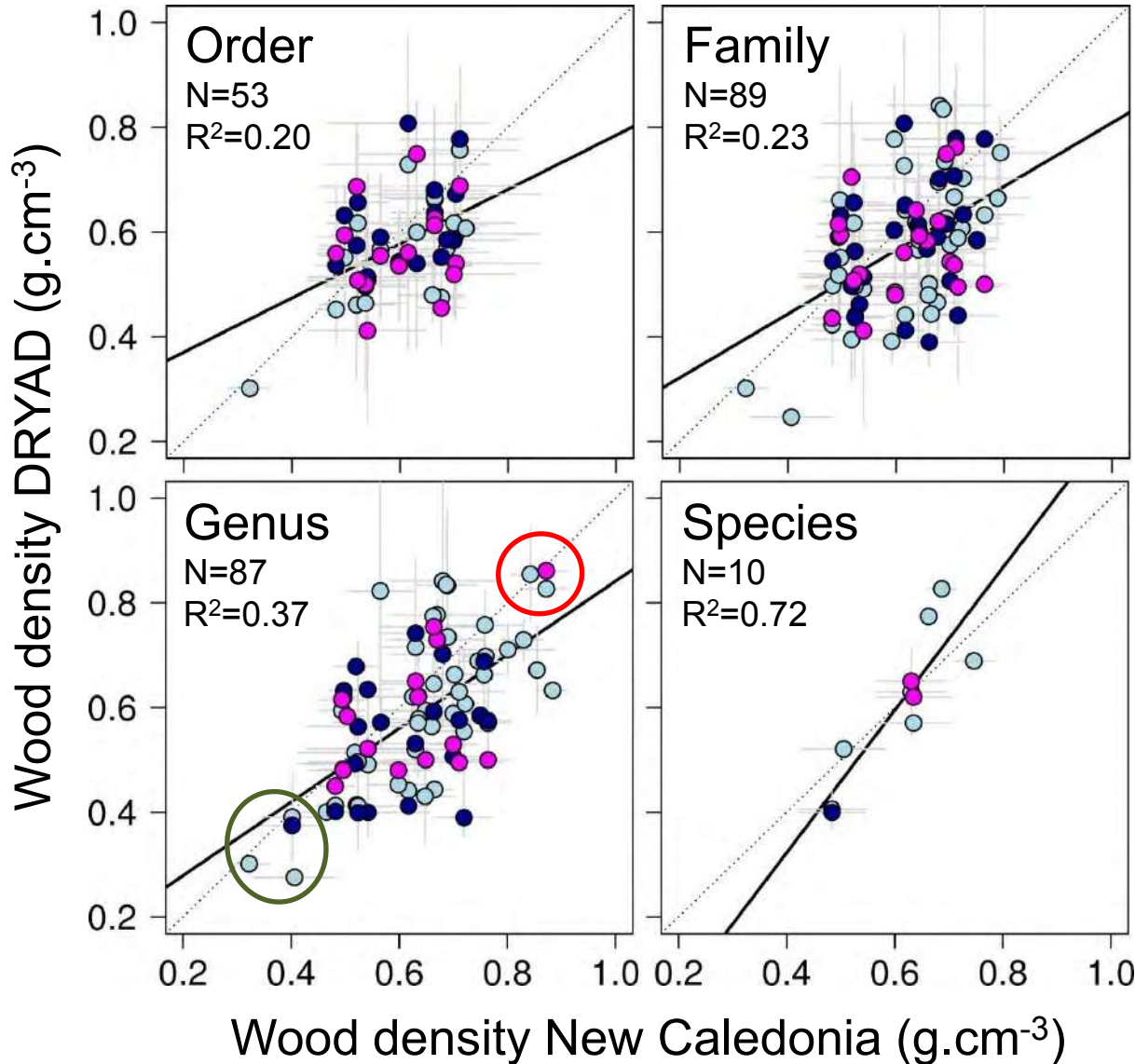
Lower WD
Pisonia
 (Nyctagynaceae)

Polyscias
 (Araliaceae)

Hernandia
 (Hernandiaceae)

Intra-taxon geographical variation

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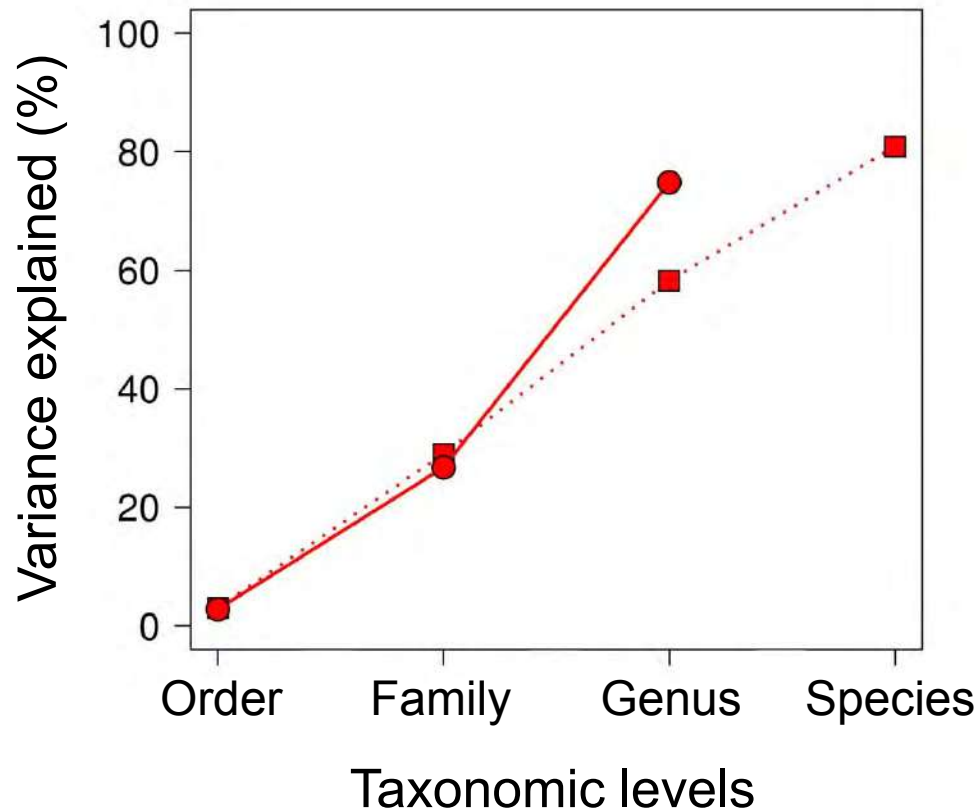


Higher WD
Mammea
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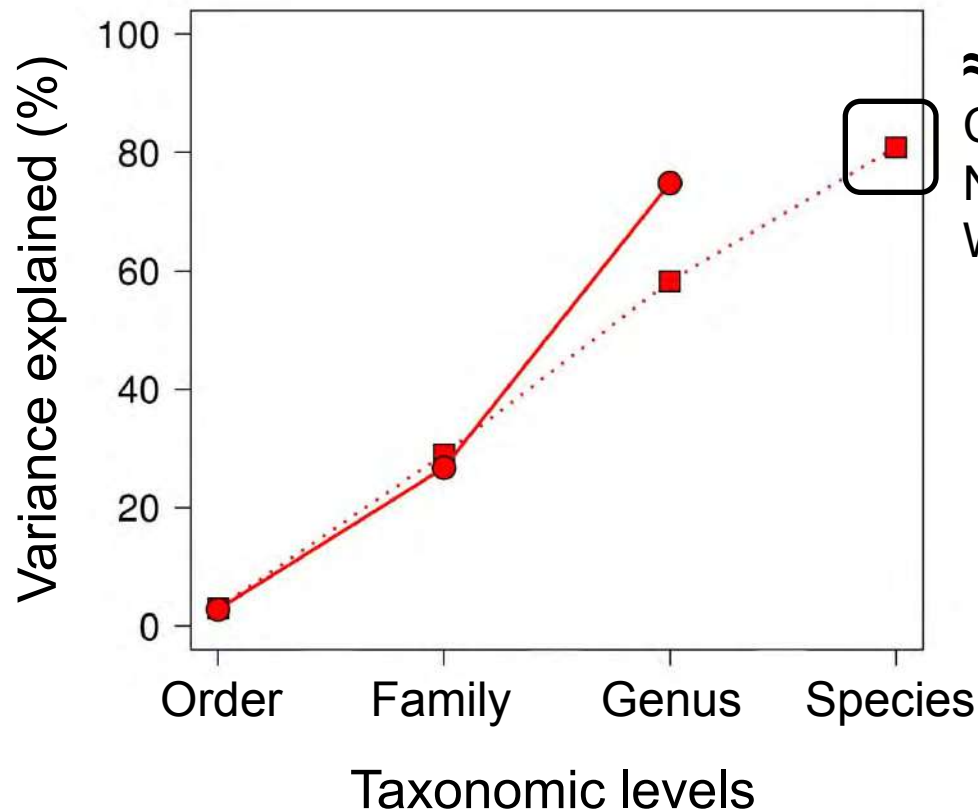
Taxonomic variation, which level matter?

NC
● Genus level
■ Species level



Taxonomic variation, which level matter?

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≈ 80% of variance explained

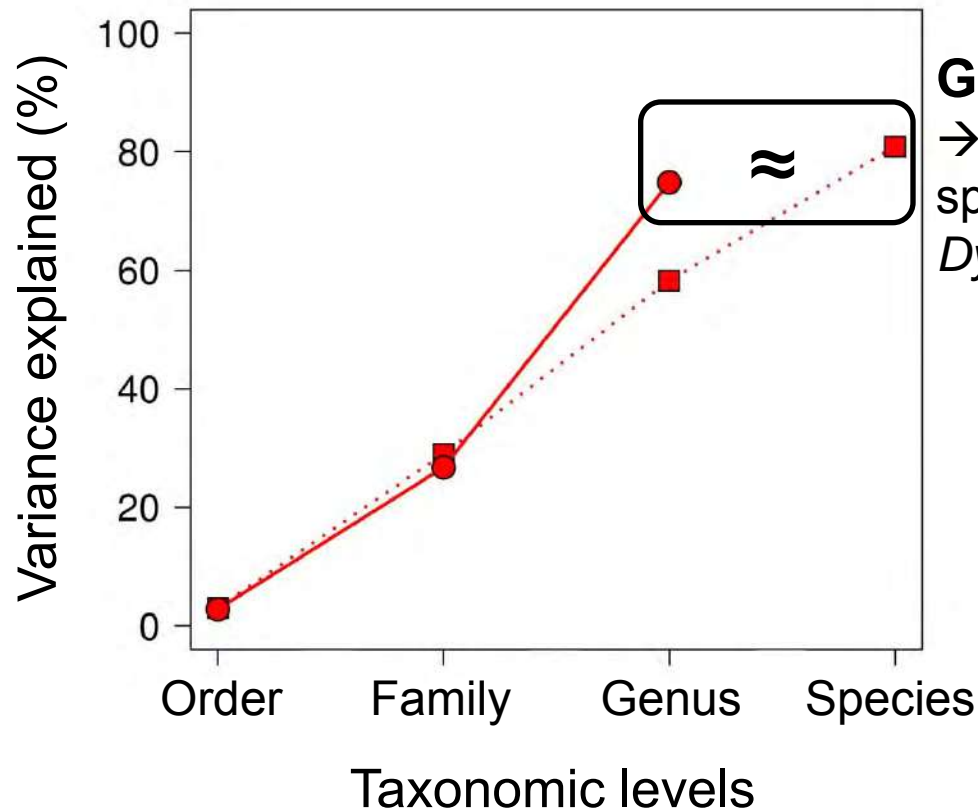
Coefficient of variation = 8% ($\pm 3\%$)

No significant DBH effect

Weak site effect

Taxonomic variation, which level matter?

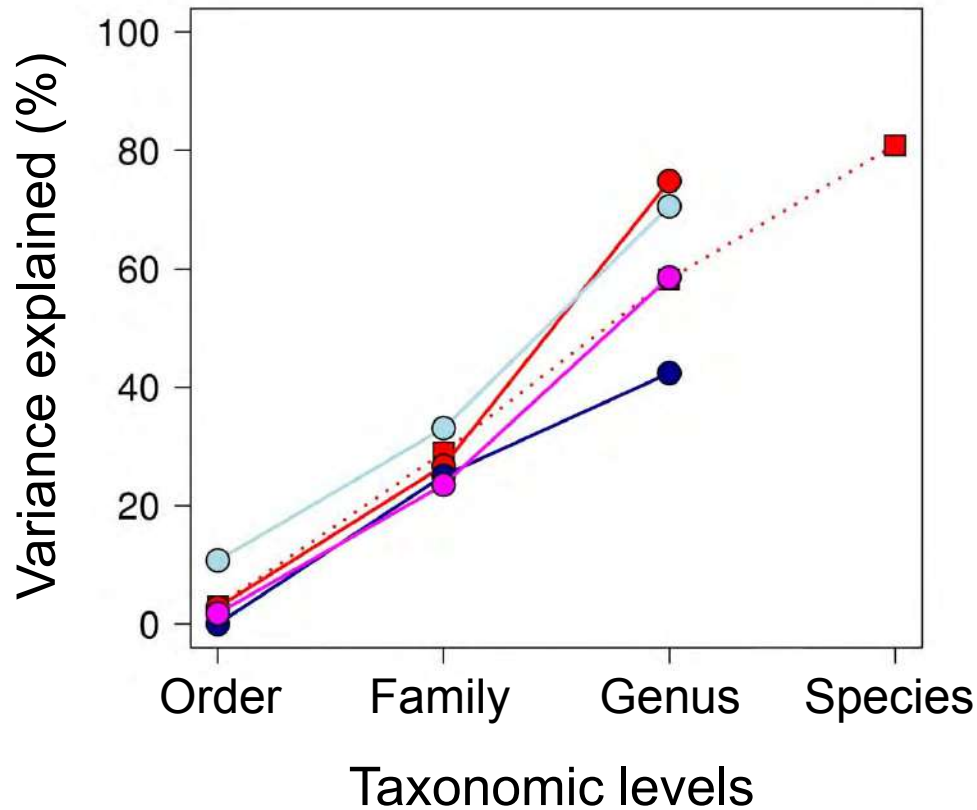
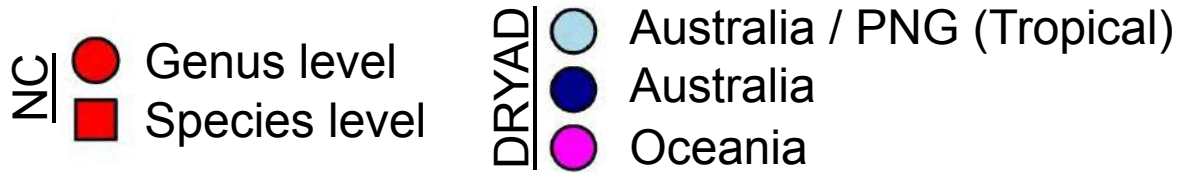
NC | ● Genus level
■ Species level



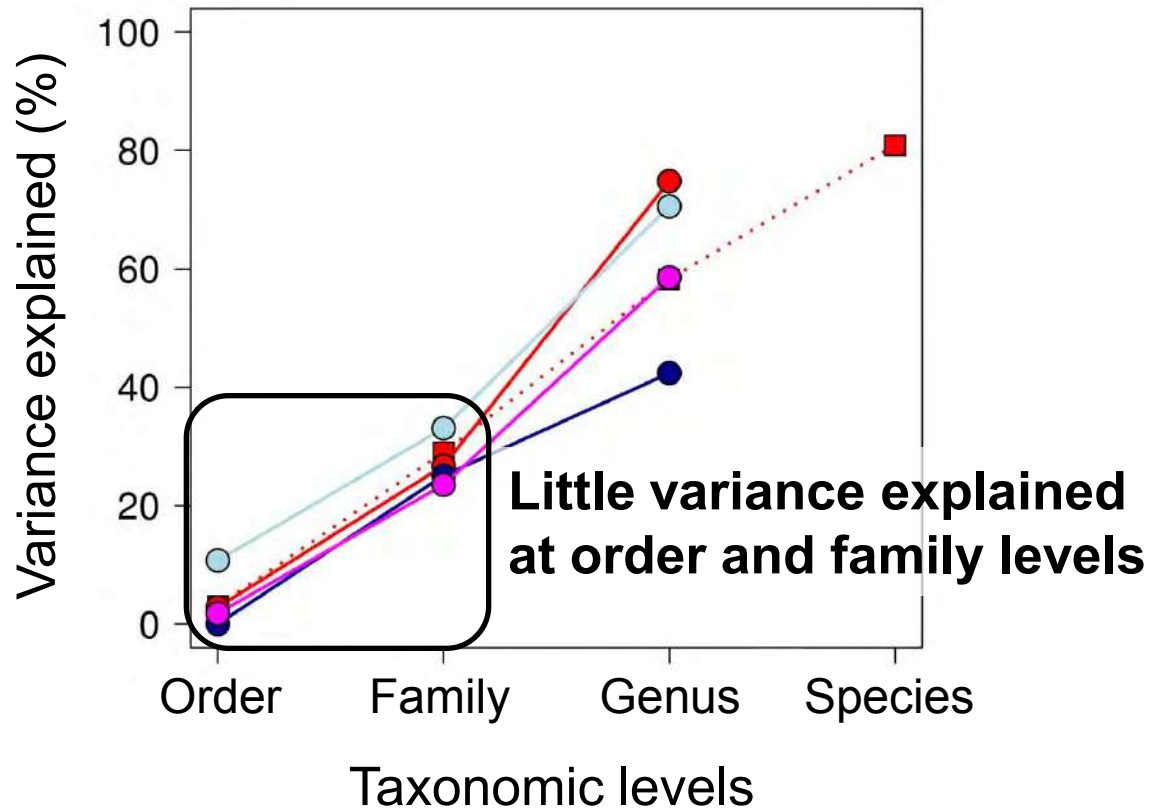
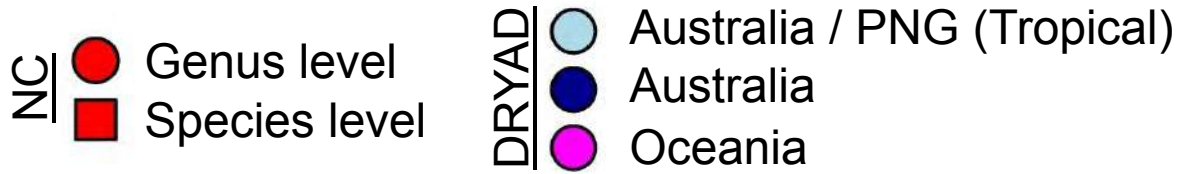
Genus ≈ species levels

→ 67% of genus represented by 1 species (only *Ficus*, *Cryptocarya* and *Dysoxylum* > 5 species)

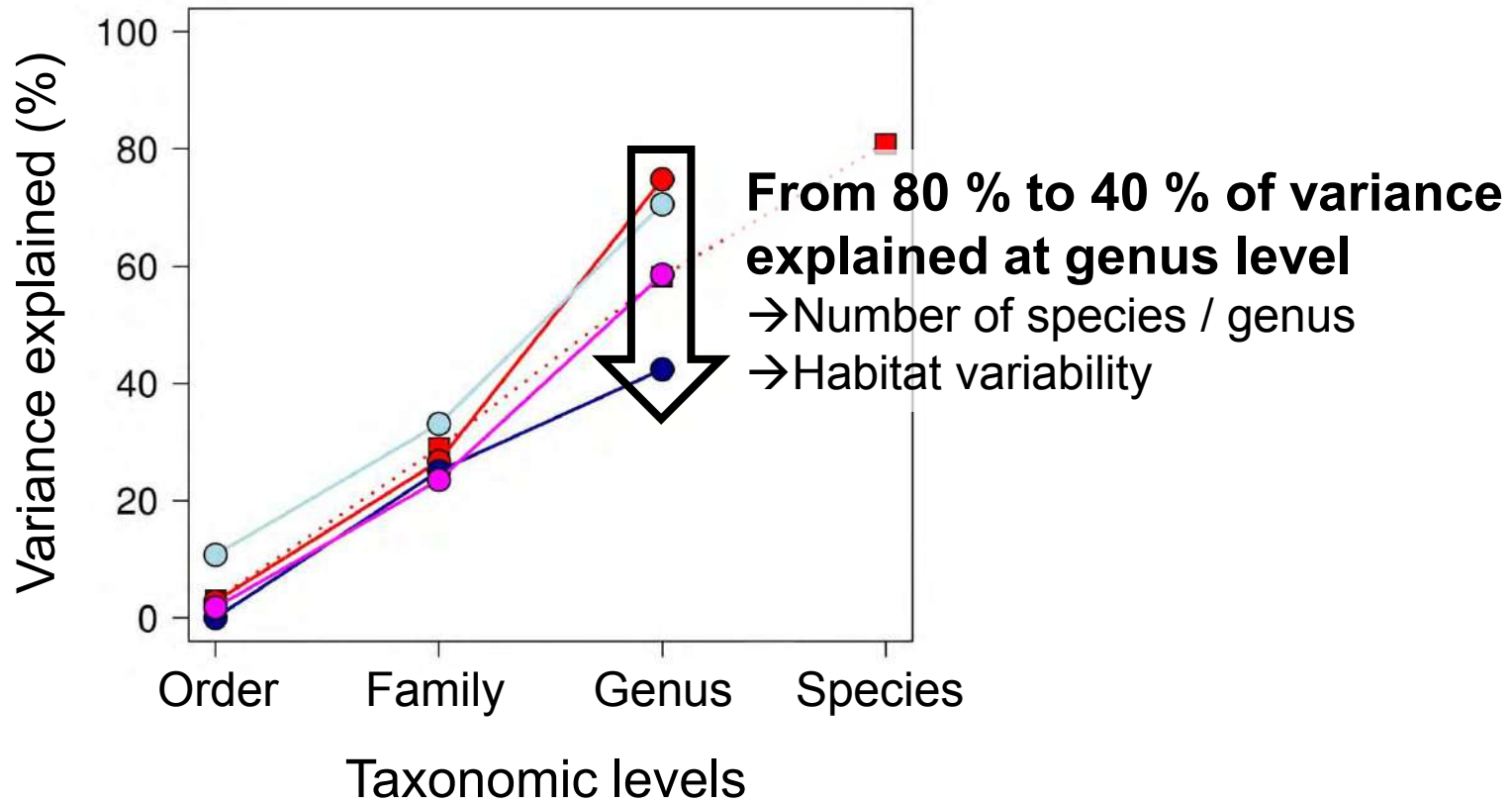
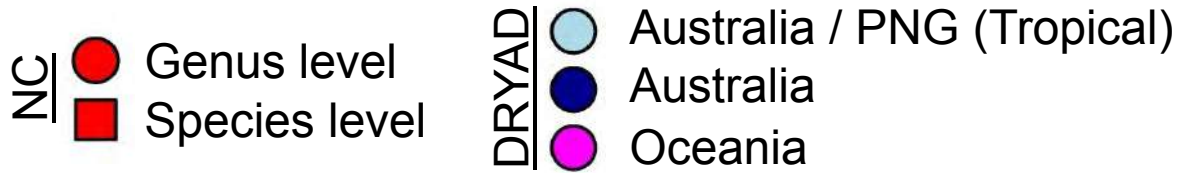
Taxonomic variation, which level matter?



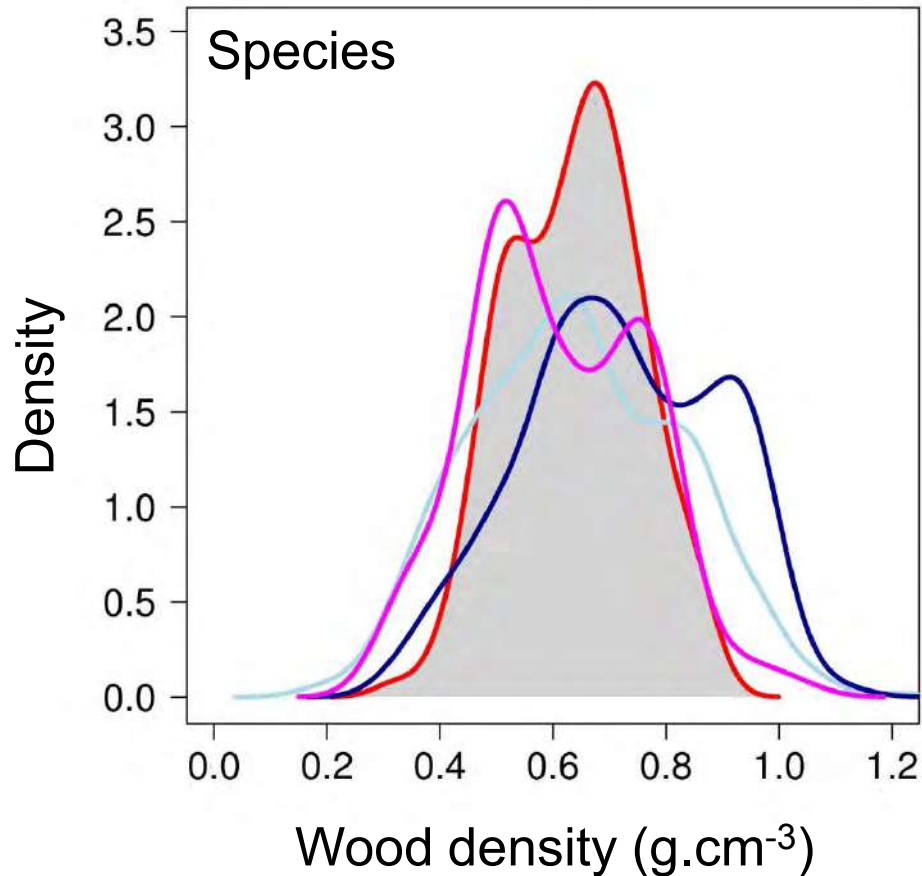
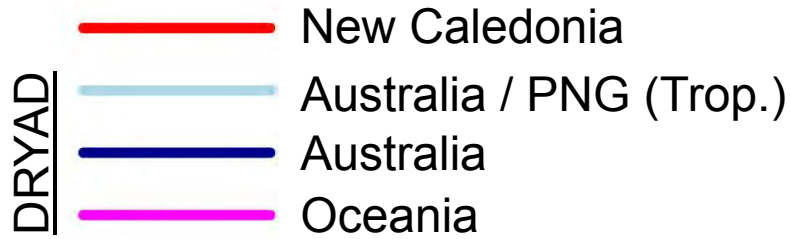
Taxonomic variation, which level matter?



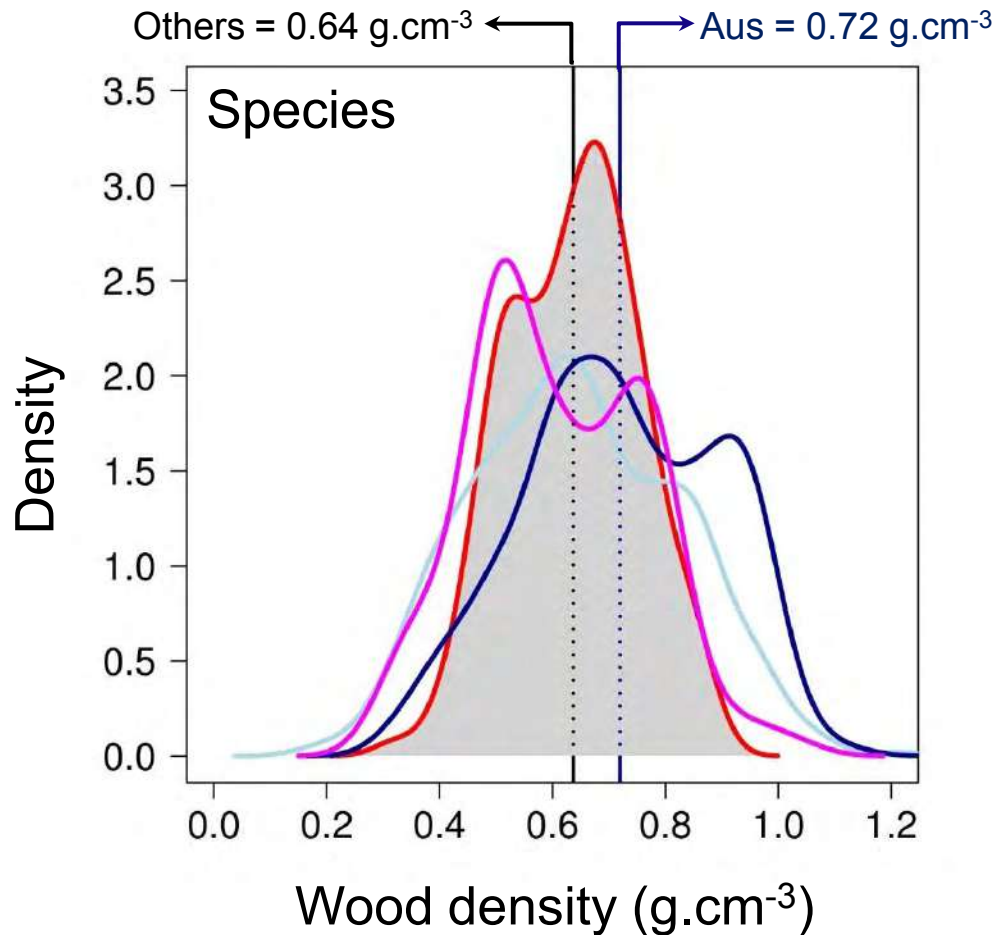
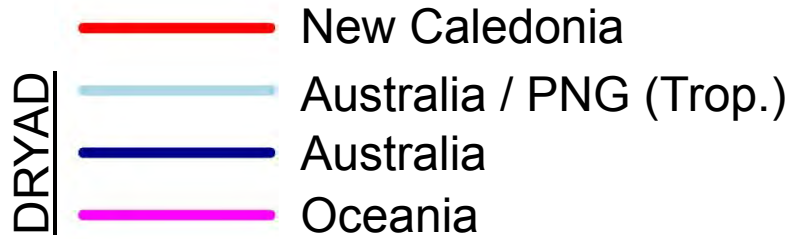
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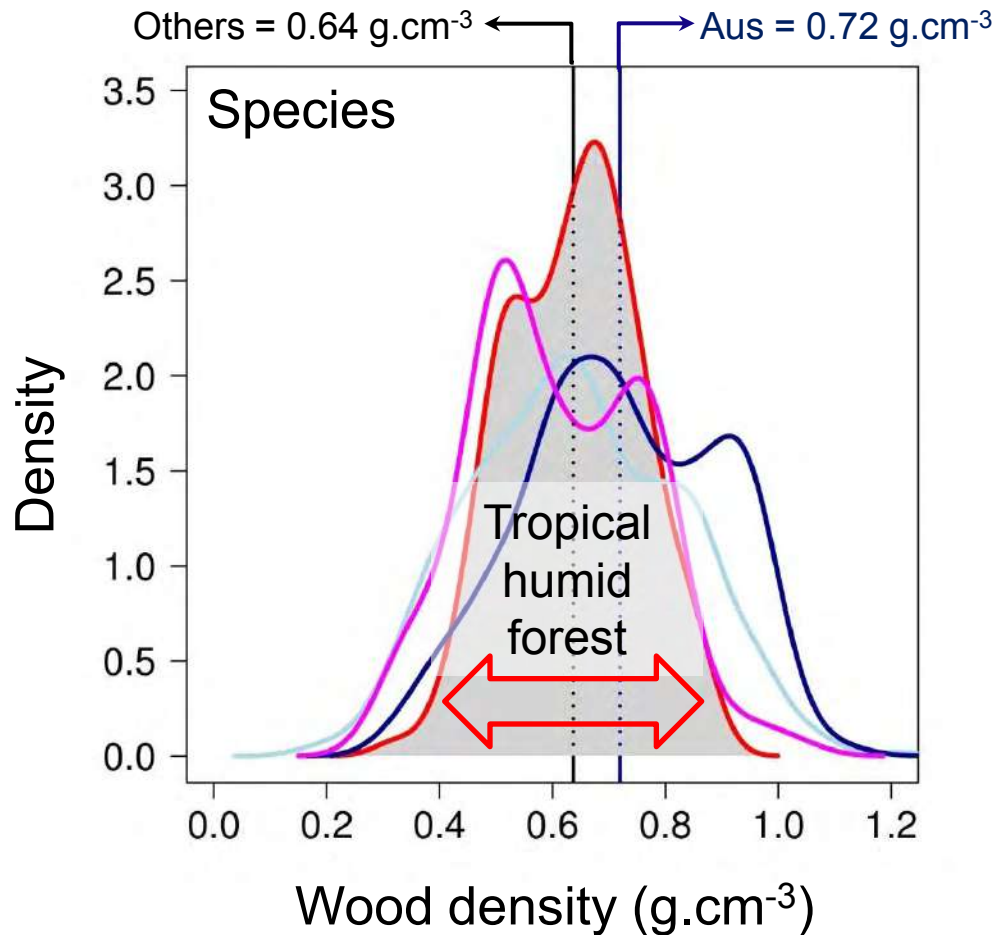
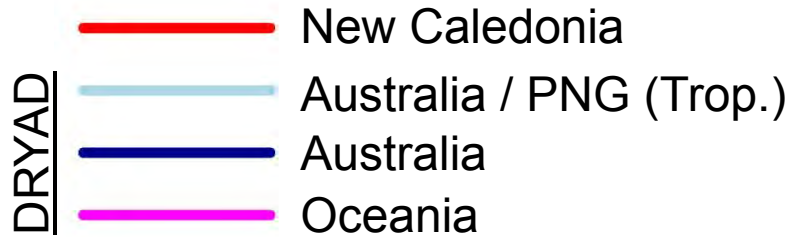
Ranges of variation & environment



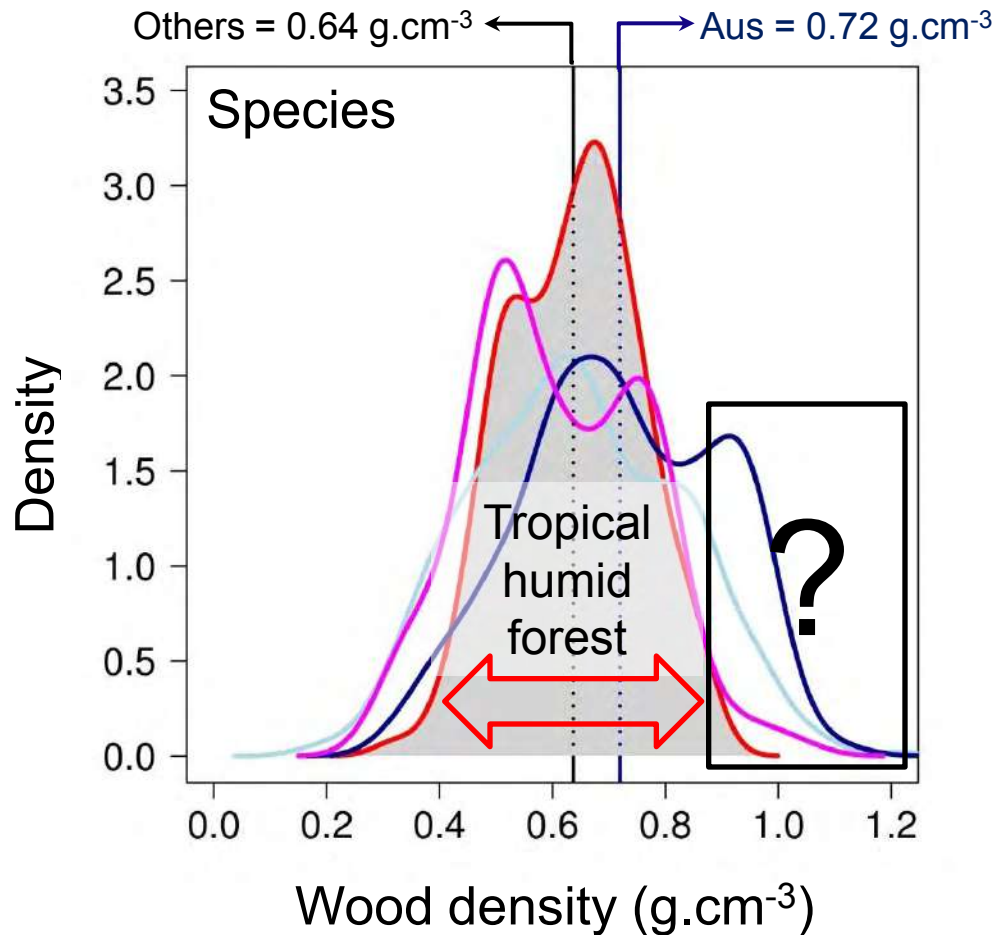
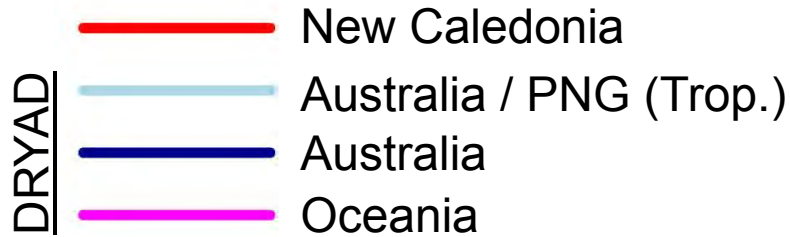
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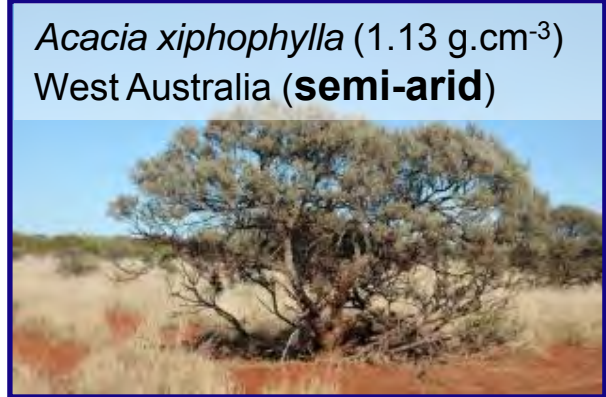
Ranges of variation & environment



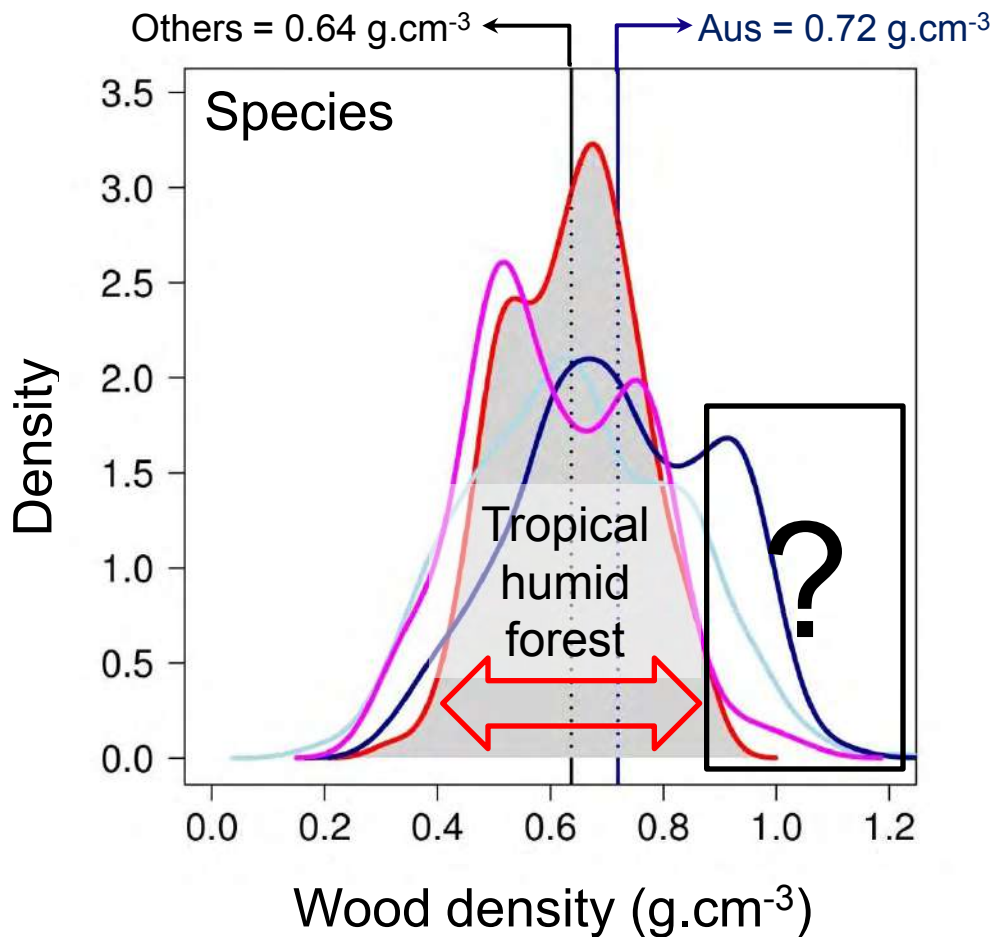
Ranges of variation & environment



Ranges of variation & environment



Heaviest wood / region

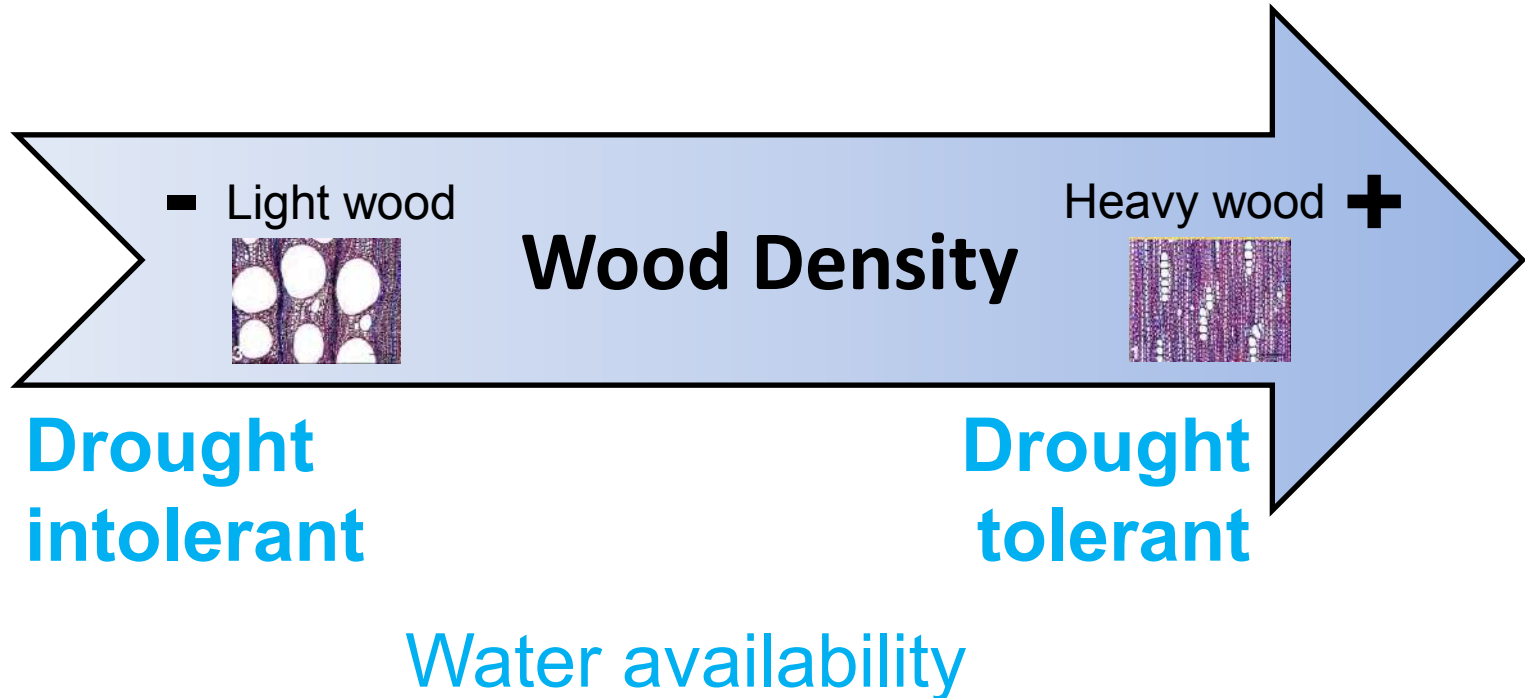


Taxonomic & Large scale variability

Strong taxonomic signal at the **genus level**

BUT

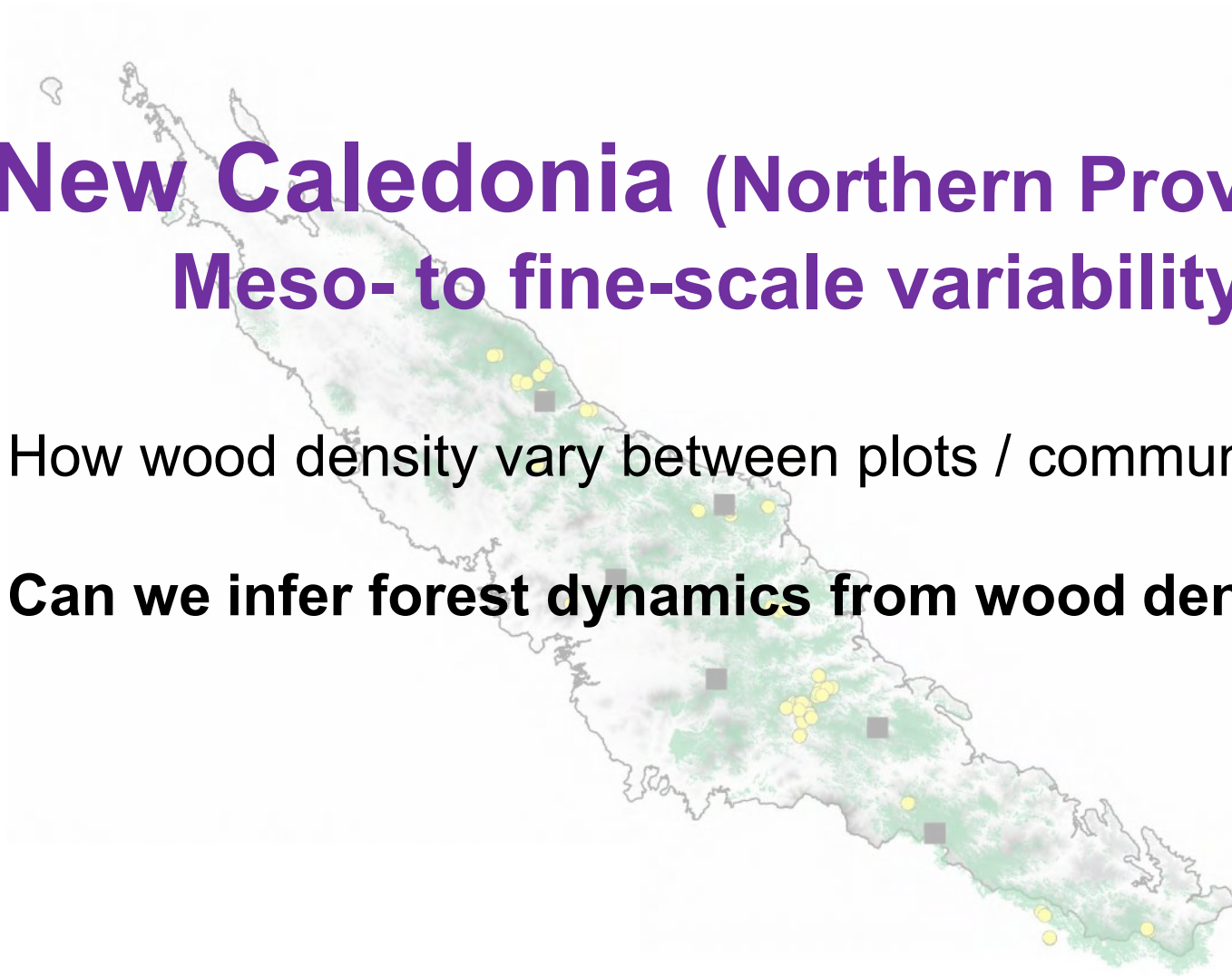
Wood density is driven by **environmental gradients**



New Caledonia (Northern Province)

Meso- to fine-scale variability

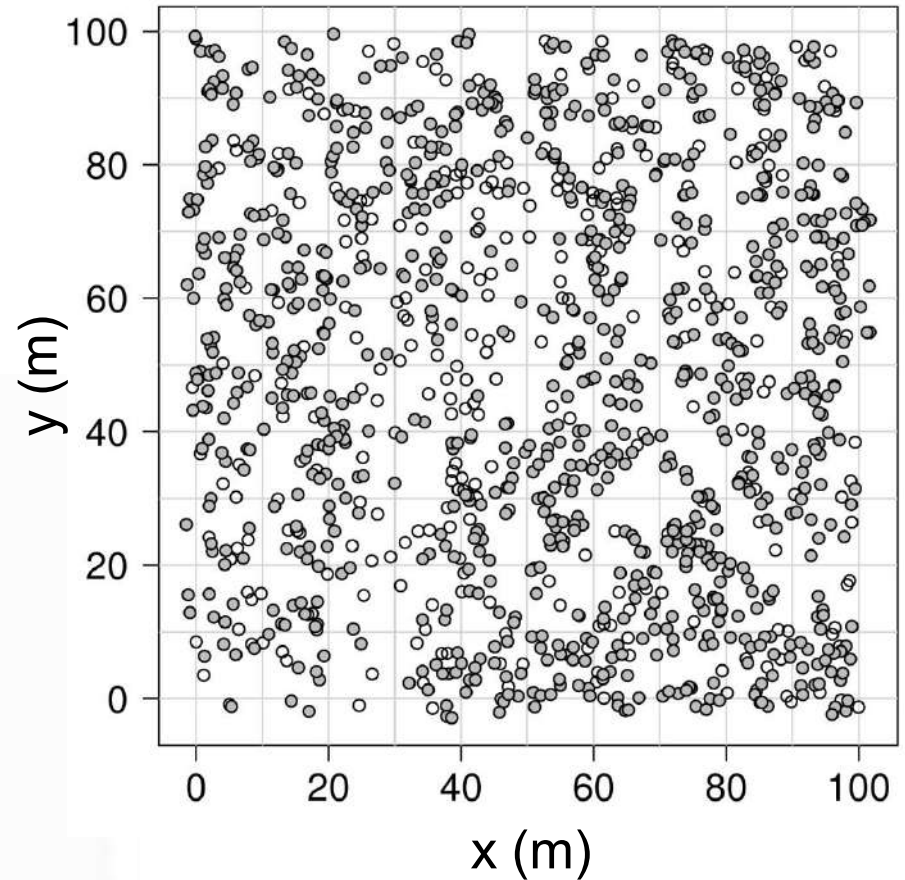
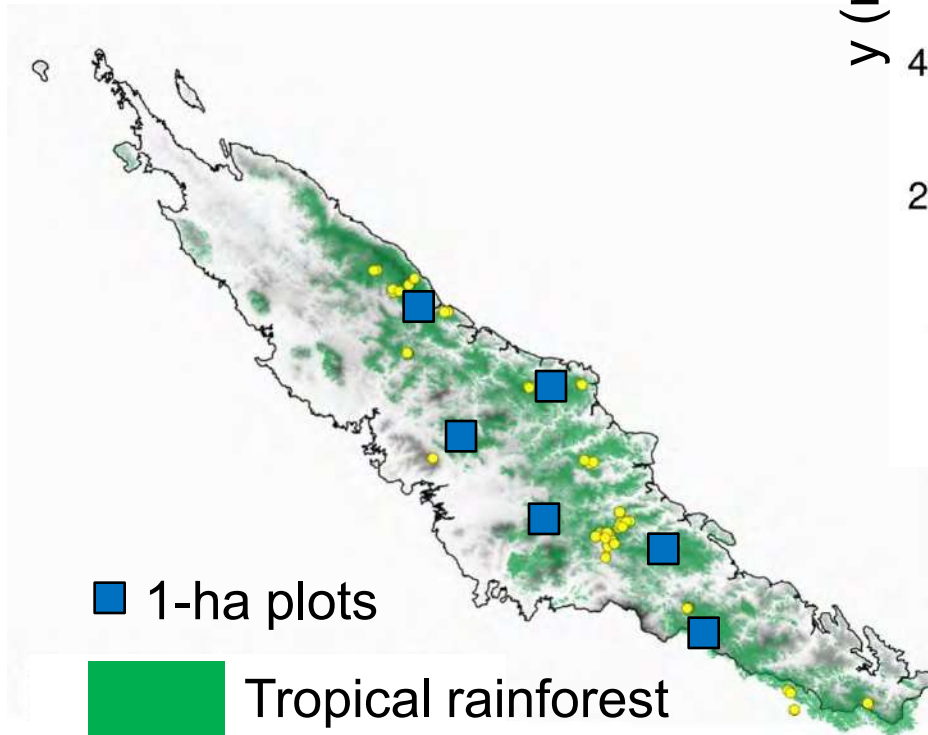
- How wood density vary between plots / communities ?
- **Can we infer forest dynamics from wood density ?**



Meso- and fine-scale data

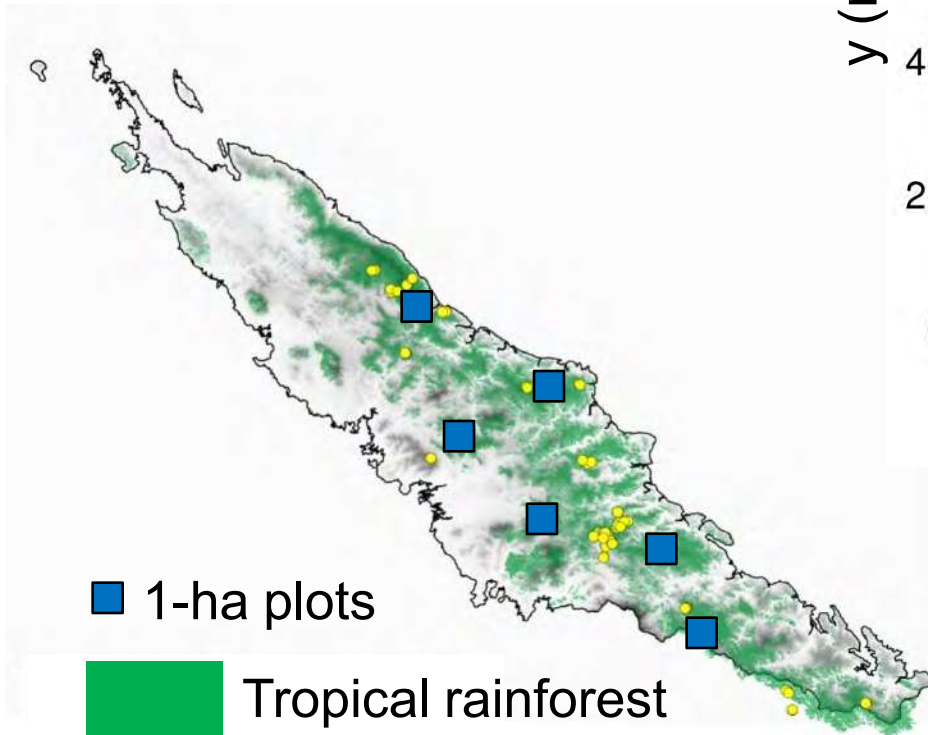
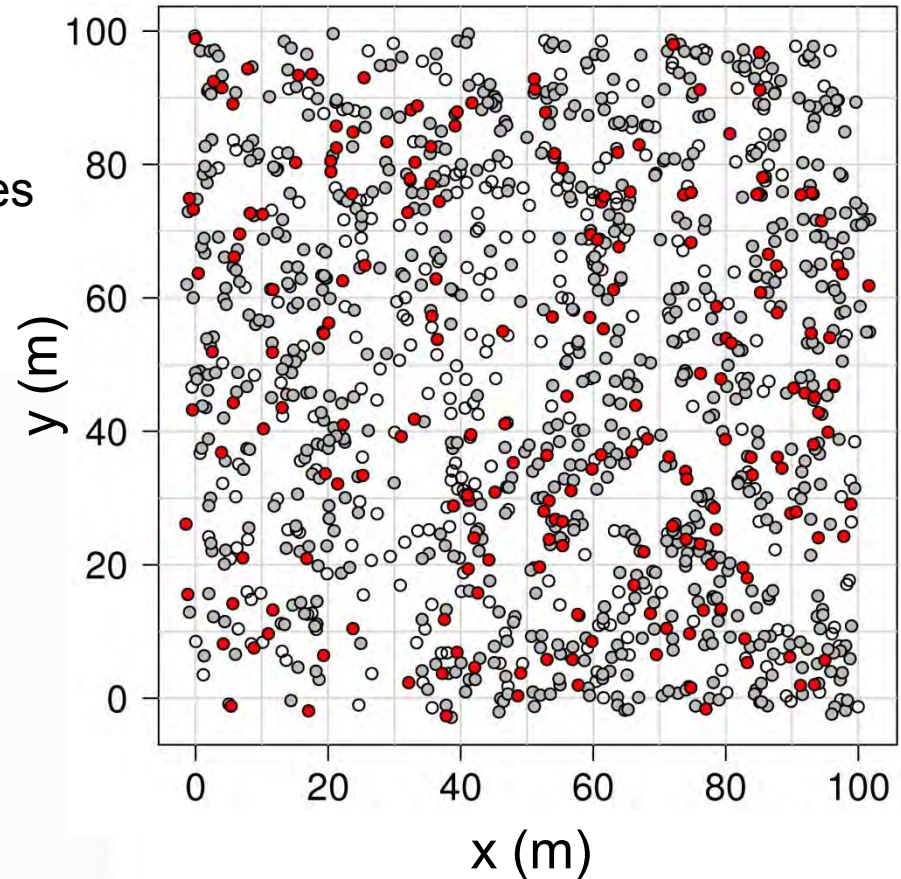
○ Ferns and palms (DBH ≥ 10 cm)

● Trees (DBH ≥ 10 cm)



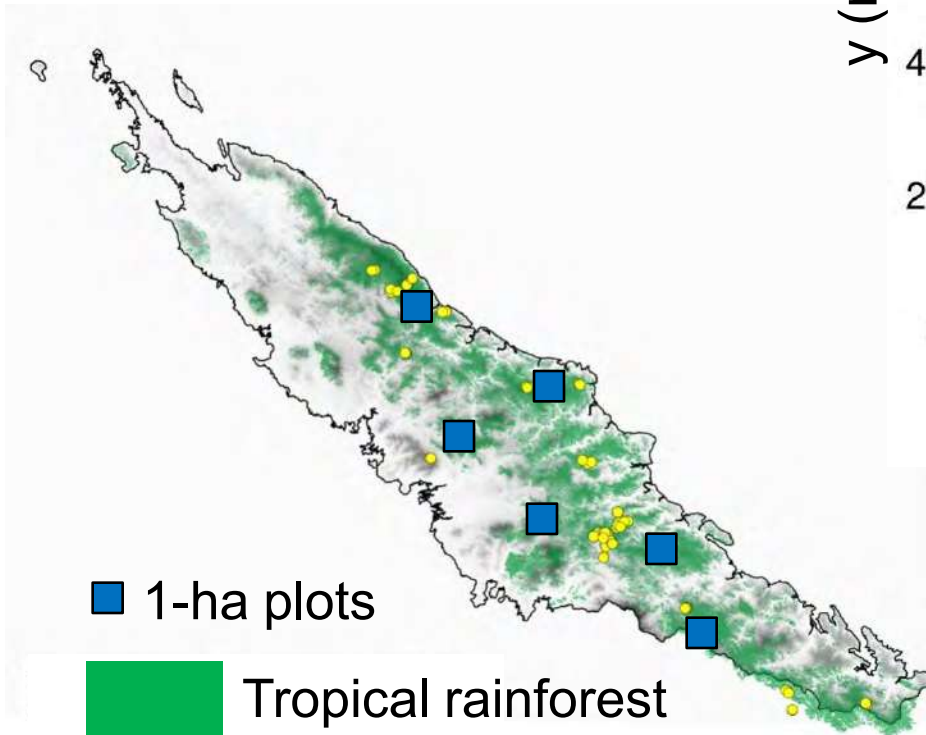
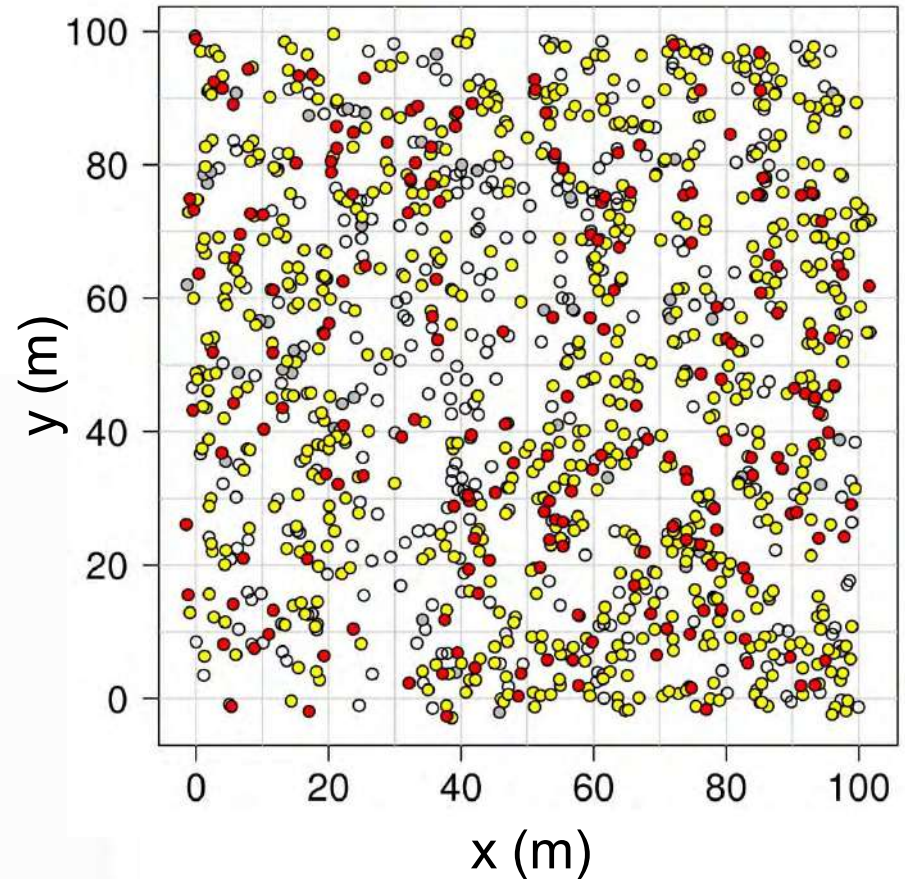
Meso- and fine-scale data

- Ferns and palms (DBH ≥ 10 cm)
- Trees (DBH ≥ 10 cm)
- Sampled trees (cores)
→ 50 % of inventoried trees species

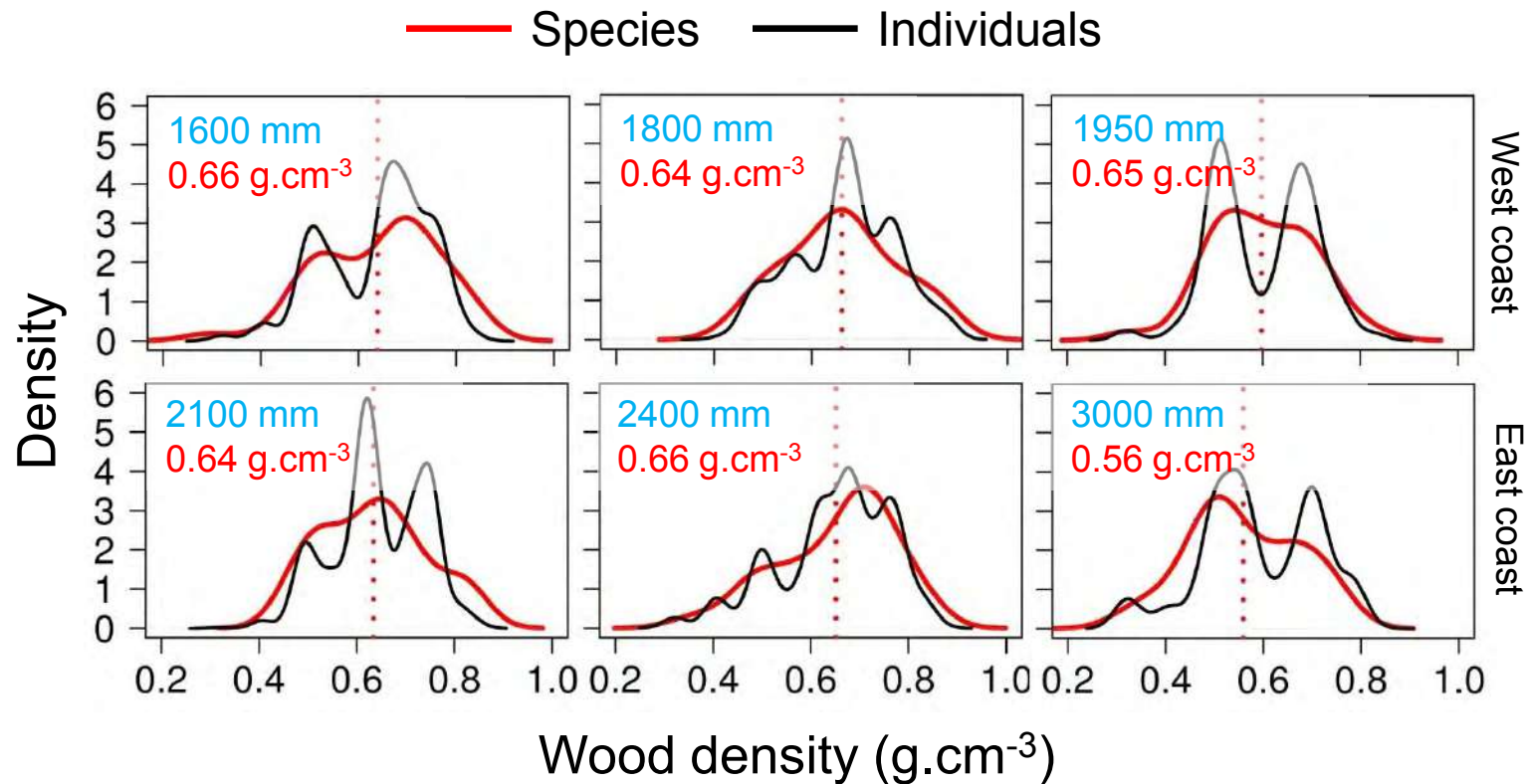


Meso- and fine-scale data

- Ferns and palms (DBH \geq 10 cm)
- Trees (DBH \geq 10 cm)
- Sampled trees (cores)
- WD extrapolated at species or genus levels
→ 94 % of inventoried trees



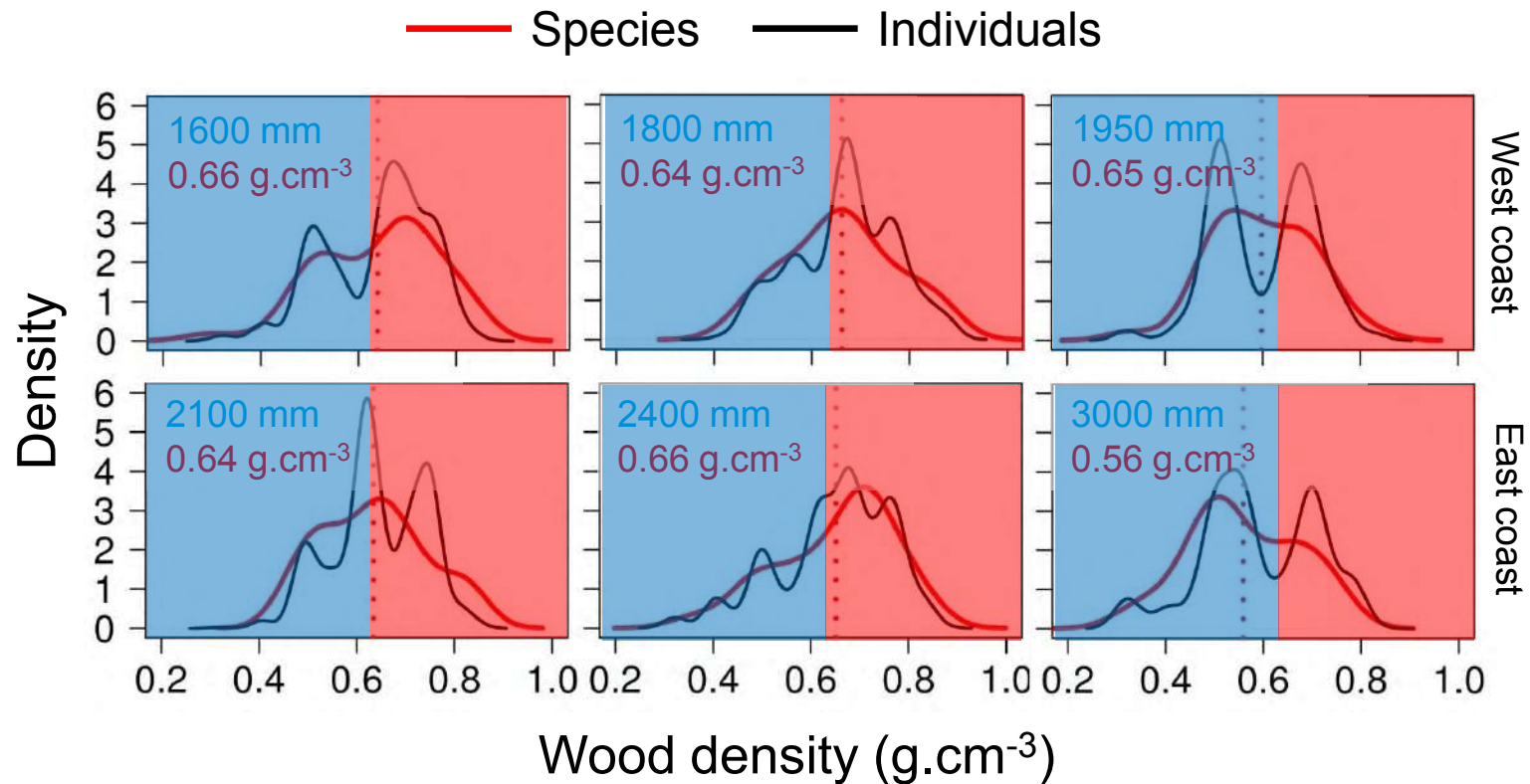
Inter-plot variation



No significant relationship between mean wood densities
& annual rainfalls

BUT small ranges of variations

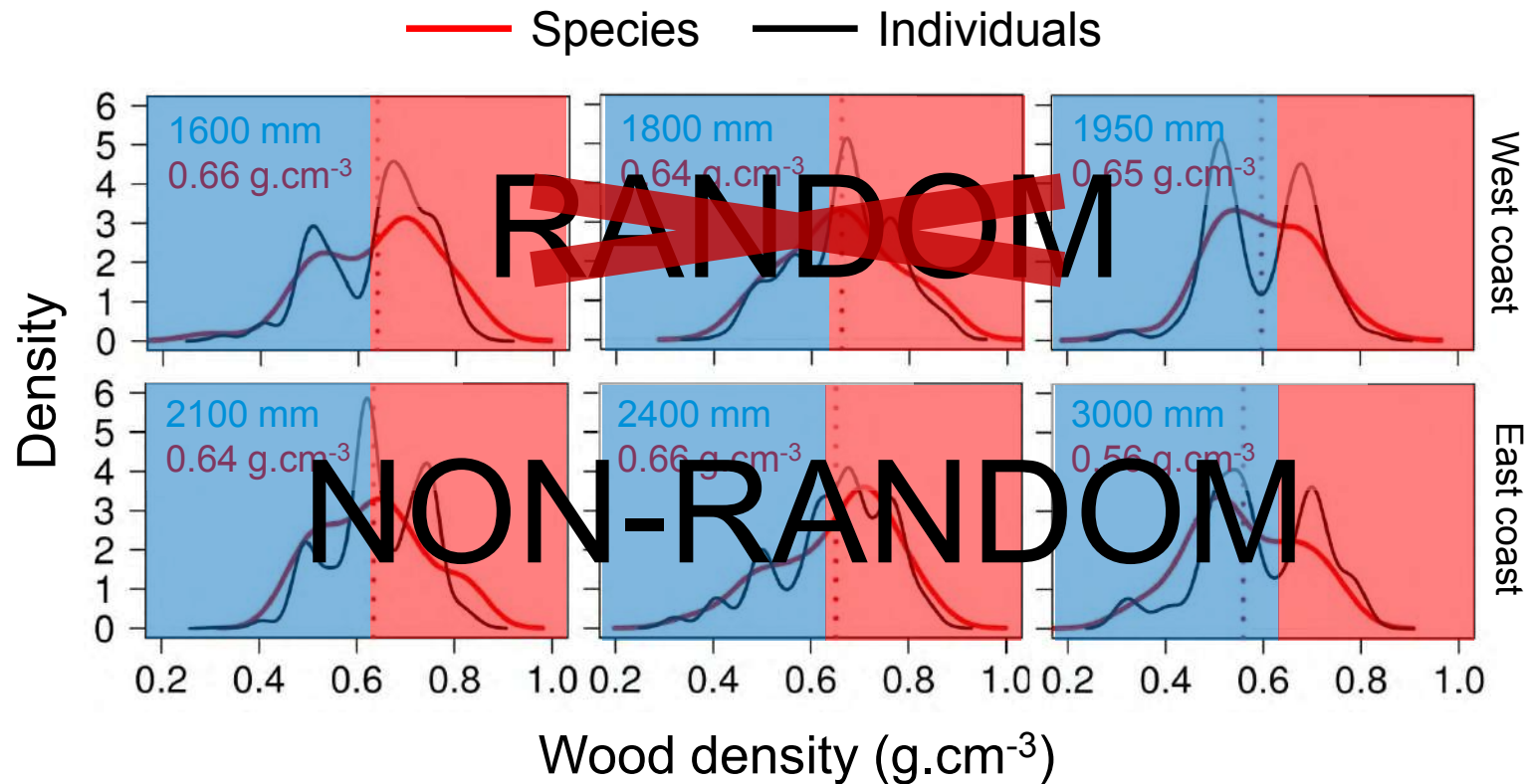
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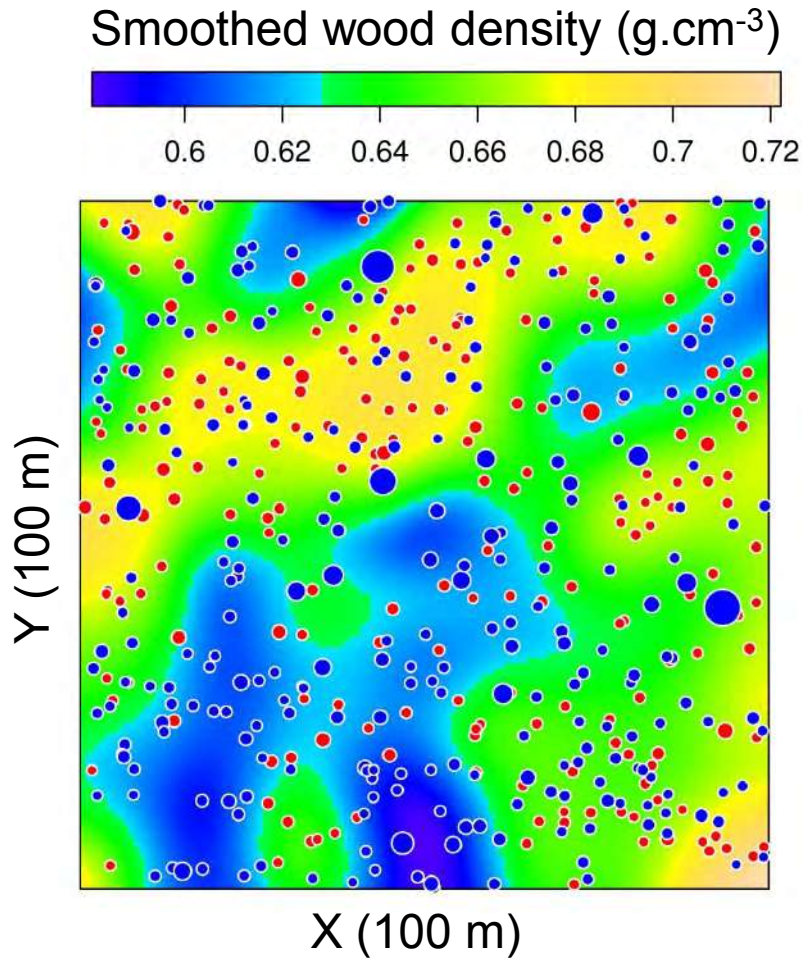
Inter-plot variation



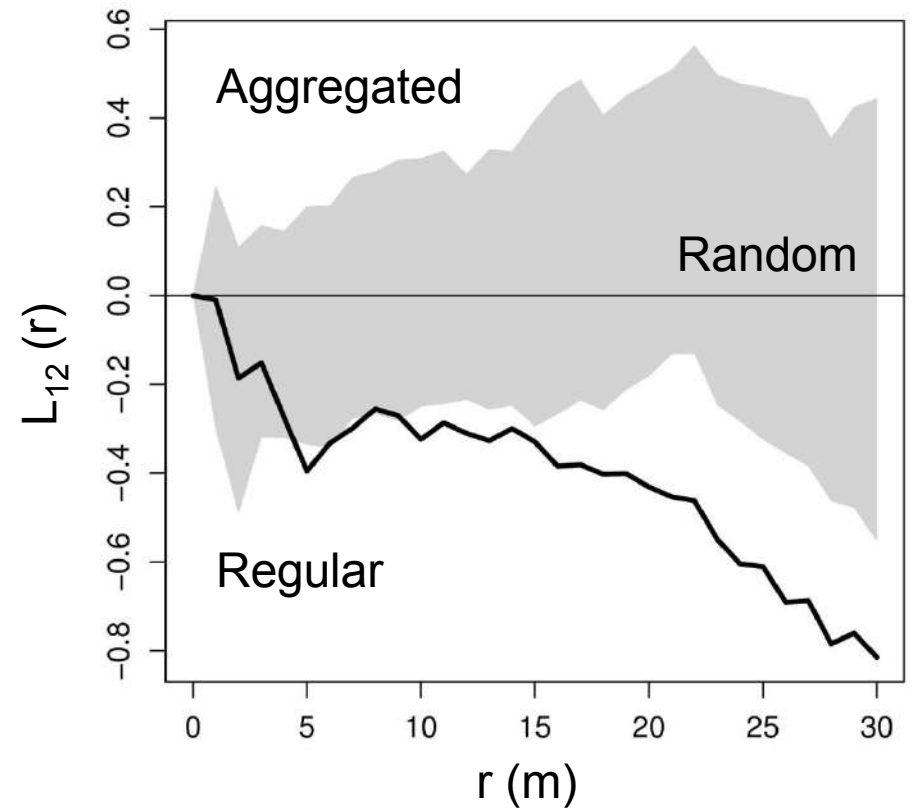
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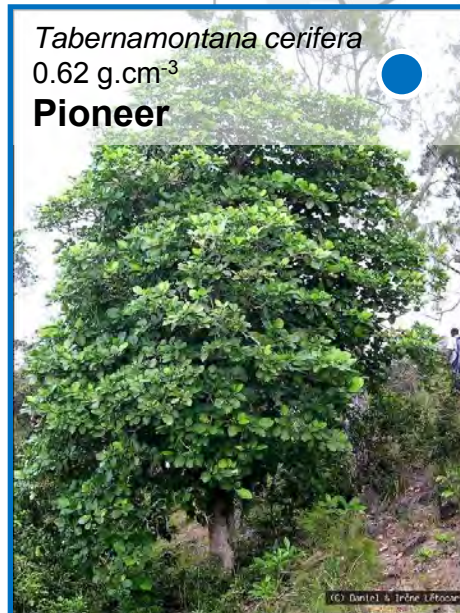
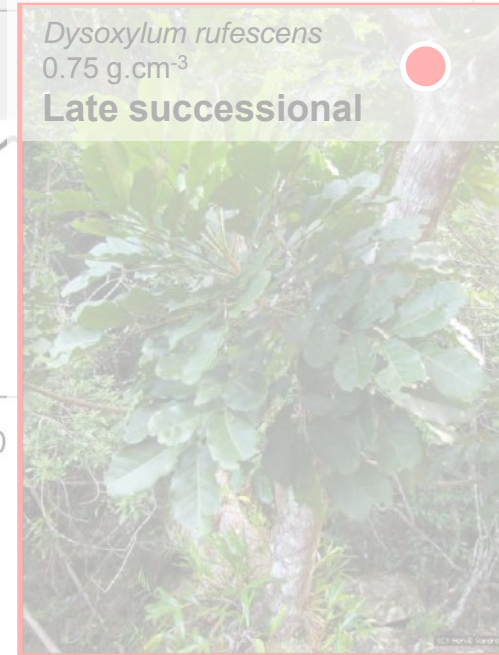
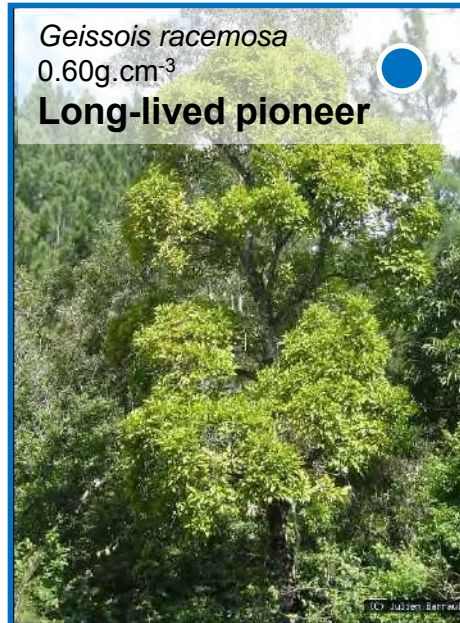
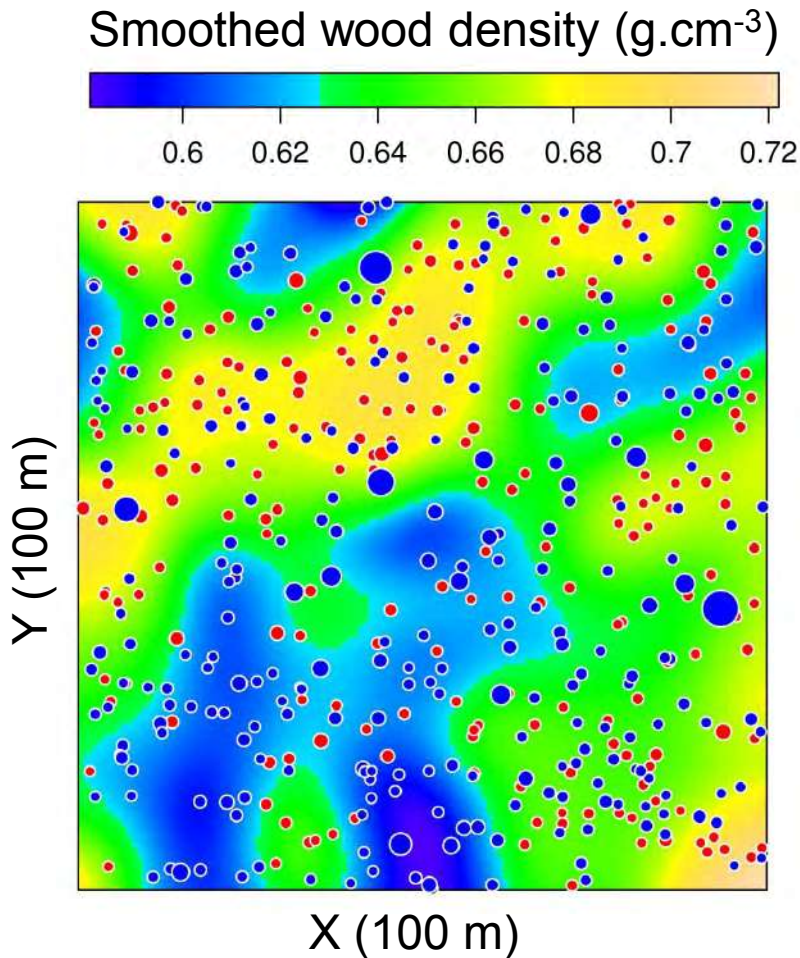
Fine-scale variation & vegetation dynamics



● $\text{WD} > 0.63 \text{ g}\cdot\text{cm}^{-3}$ ● $\text{WD} < 0.63 \text{ g}\cdot\text{cm}^{-3}$



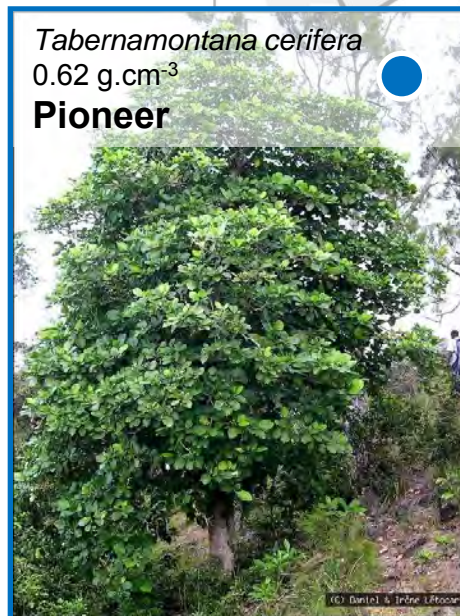
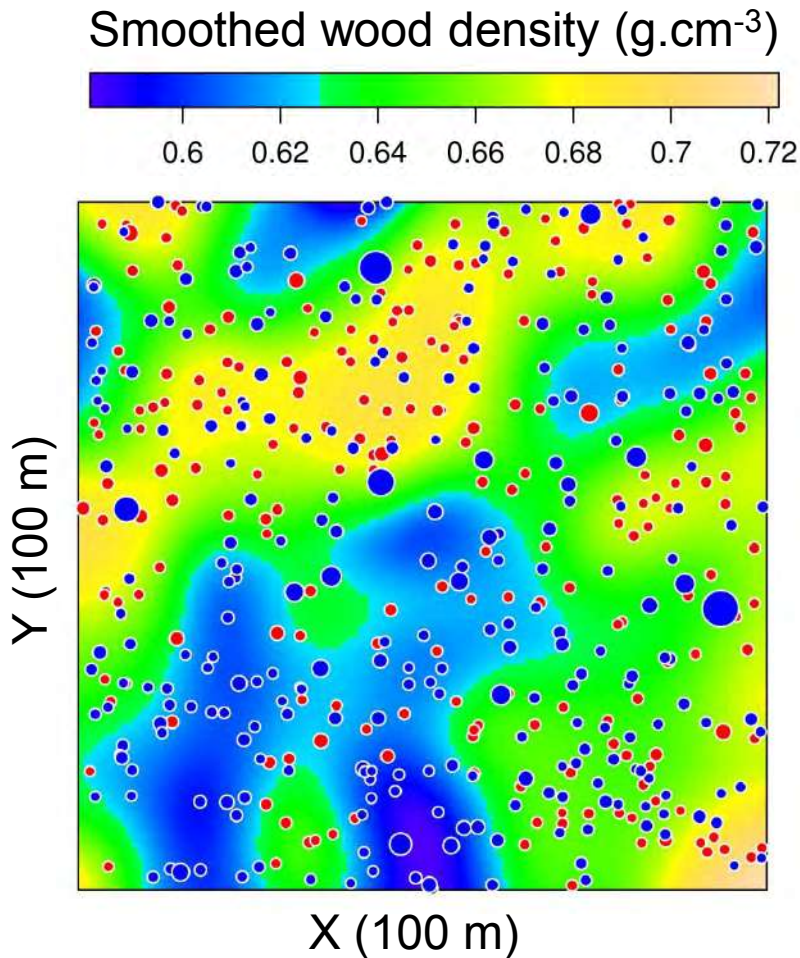
Fine-scale variation & vegetation dynamics



Dynamic hypothesis:

- Early successional area light wood
- Late successional area heavy wood

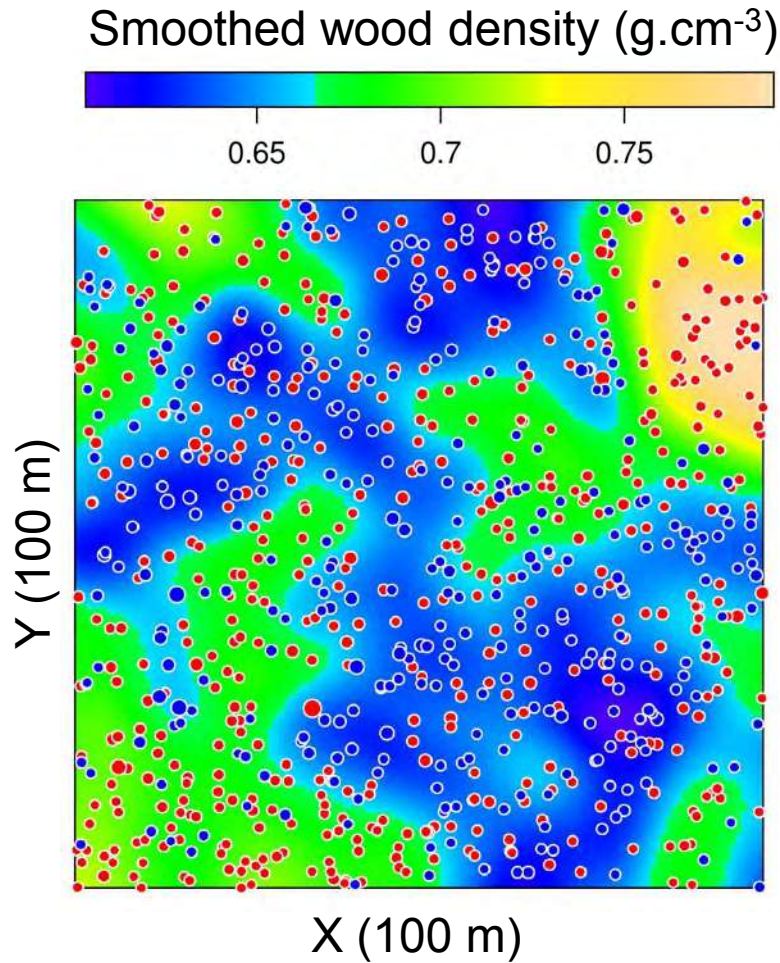
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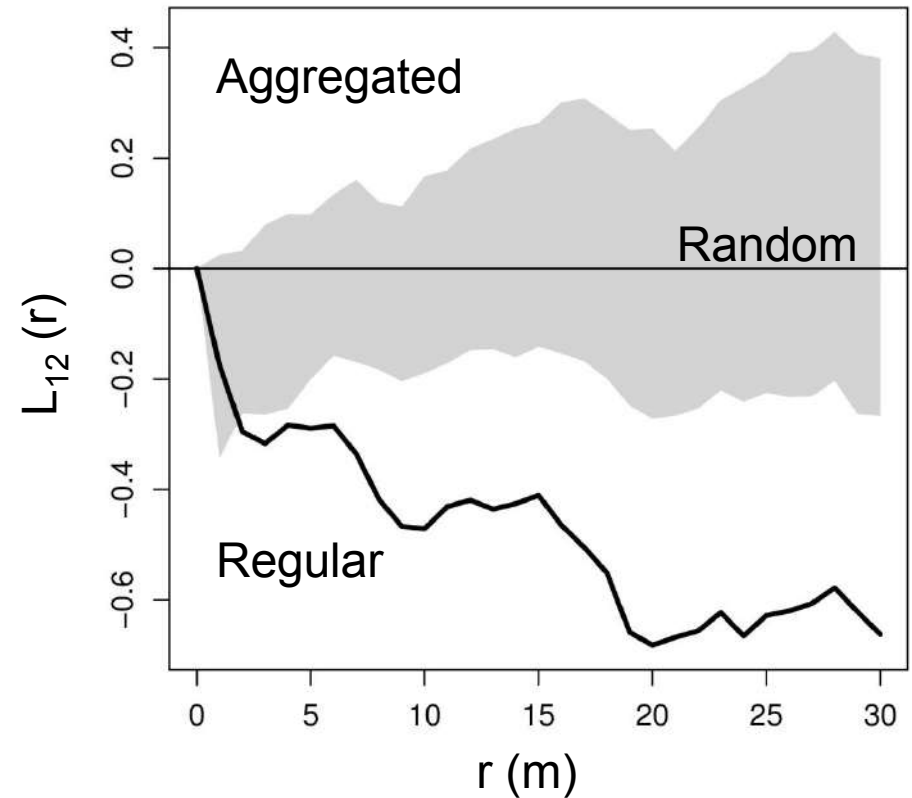
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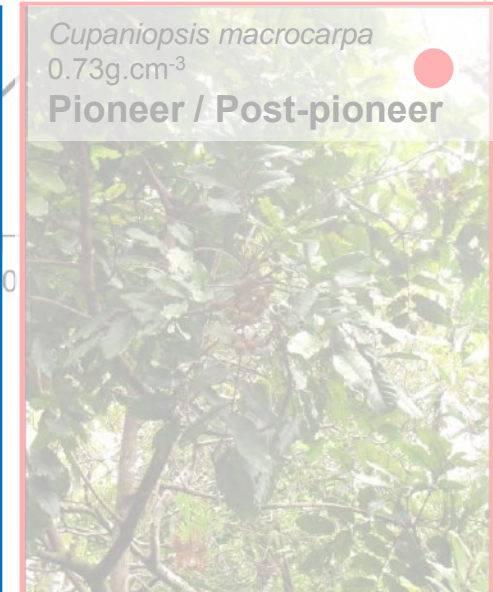
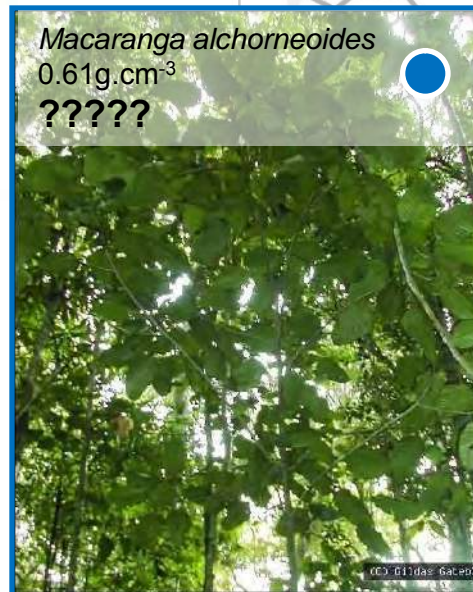
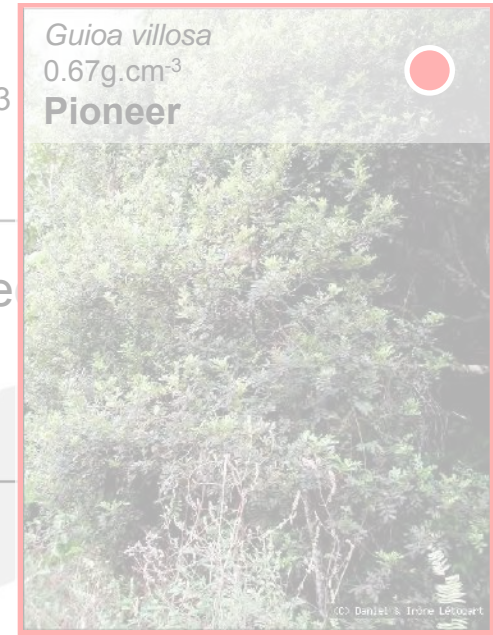
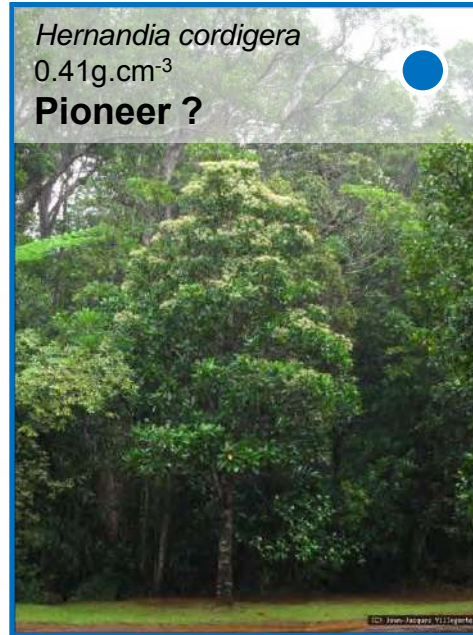
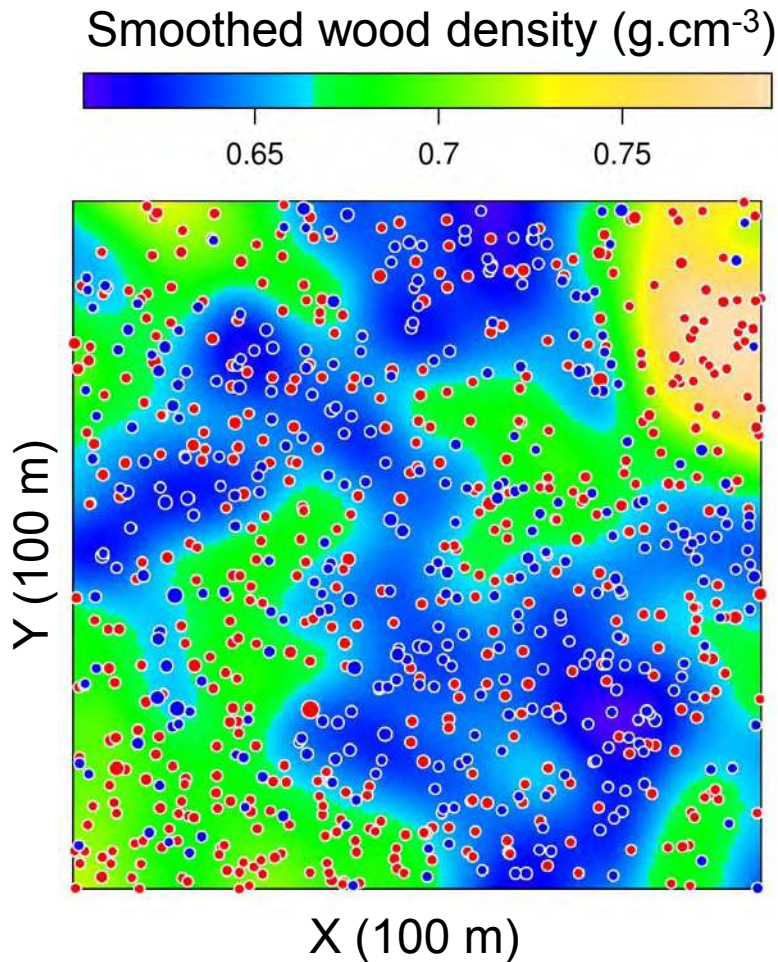
Fine-scale variation & vegetation dynamics



● $\text{WD} > 0.64 \text{ g}\cdot\text{cm}^{-3}$ ● $\text{WD} < 0.64 \text{ g}\cdot\text{cm}^{-3}$

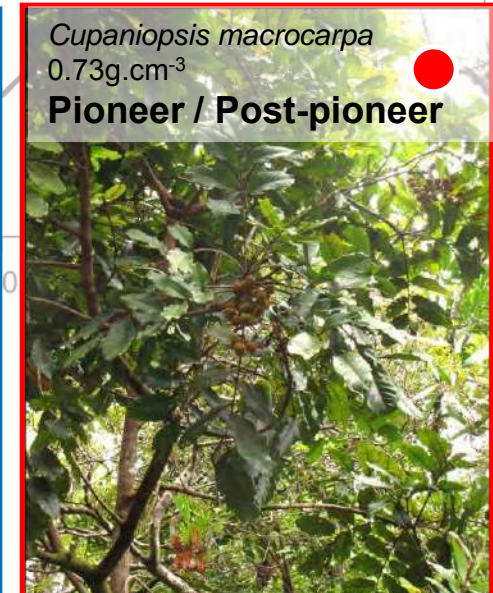
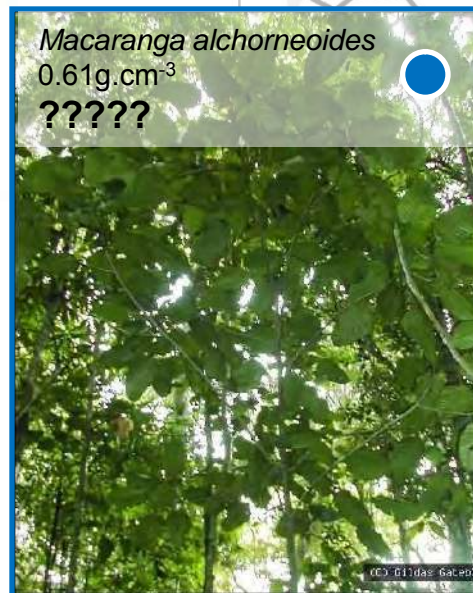
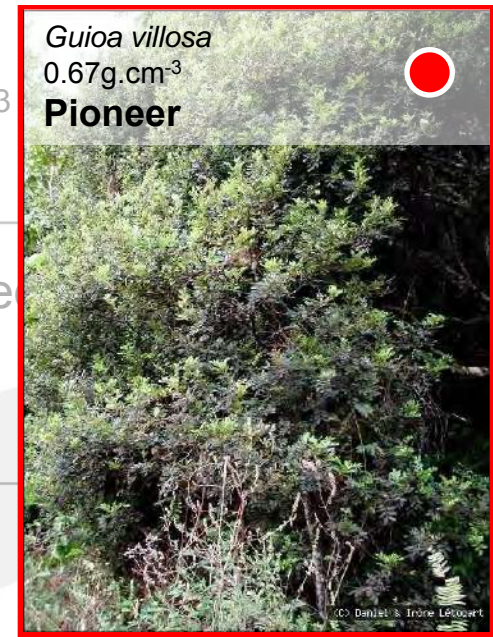
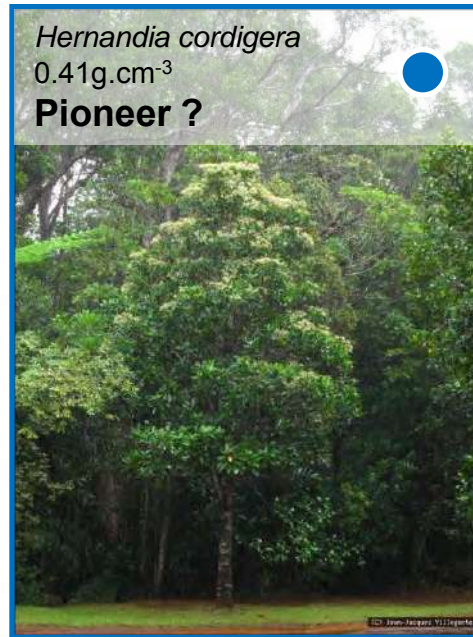
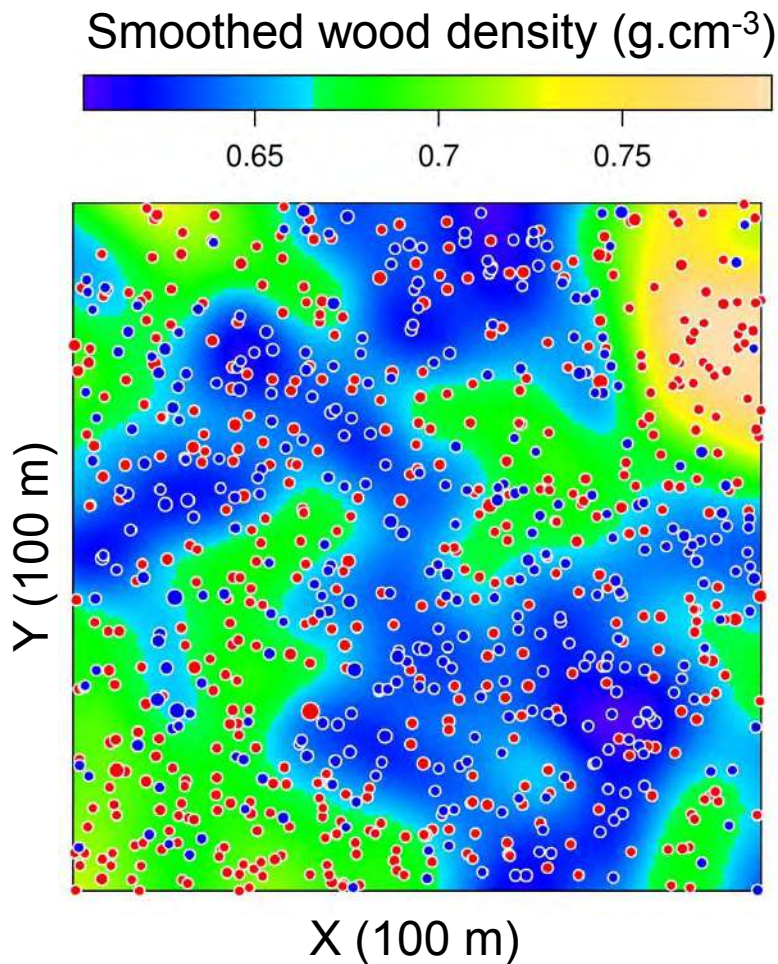


Fine-scale variation & vegetation dynamics



- Dynamic hypothesis:**
- Early successional area light wood
 - Late successional area heavy wood

Fine-scale variation & vegetation dynamics

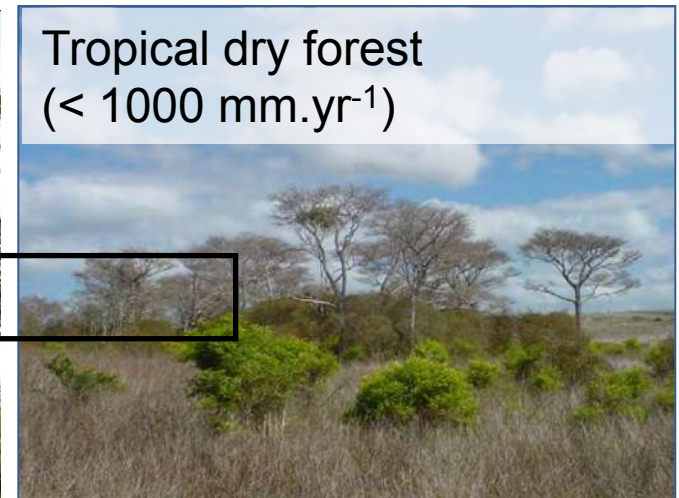
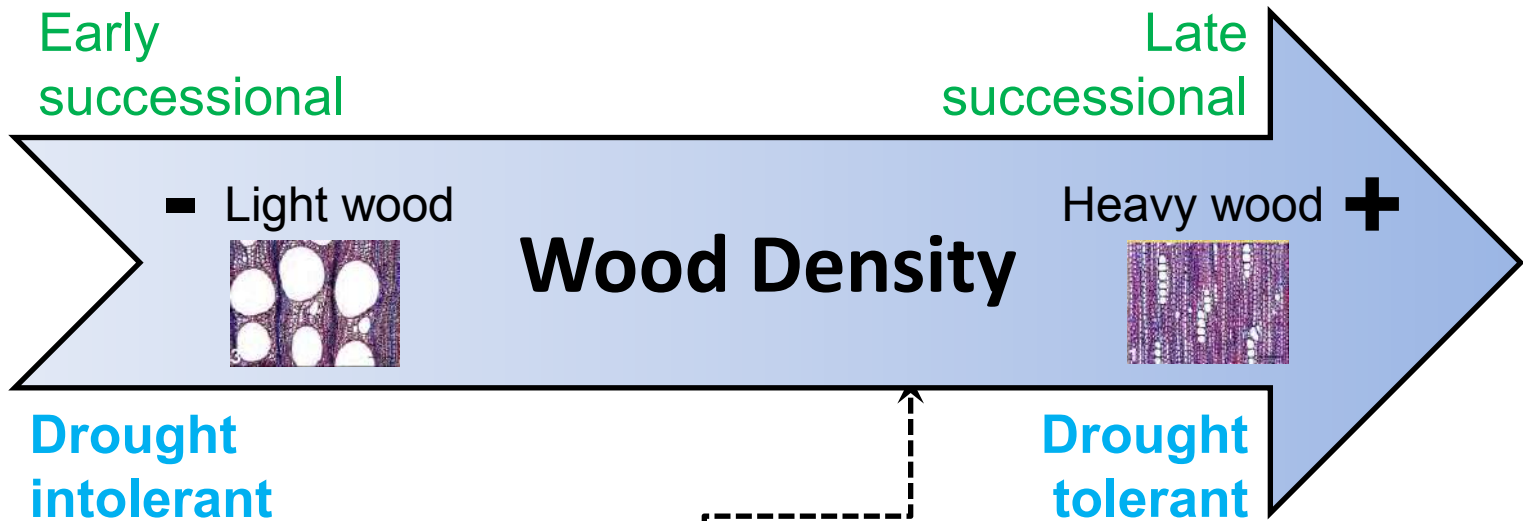


- Dynamic hypothesis:**
- Early successional area light wood
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Meso & fine scale variability

(1) Dealing with ubiquist species !

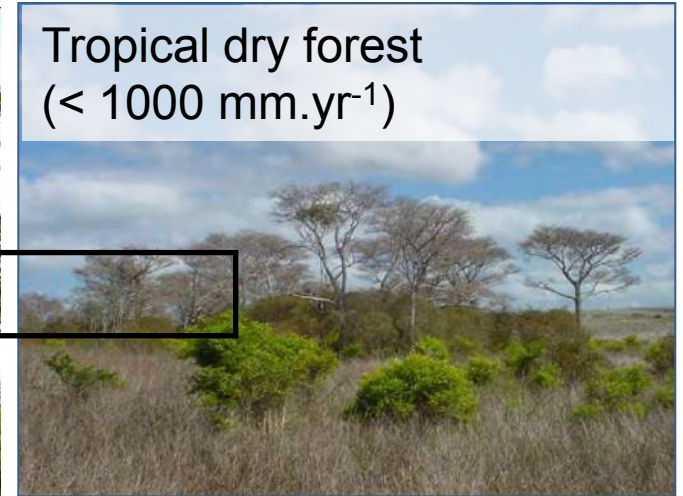
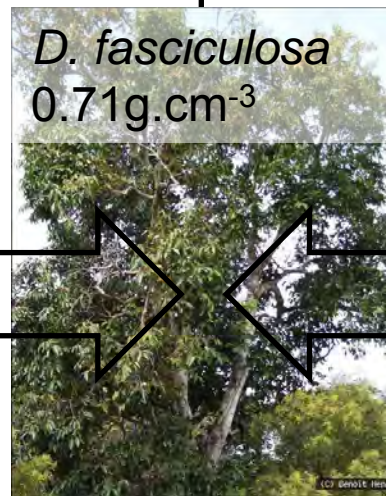
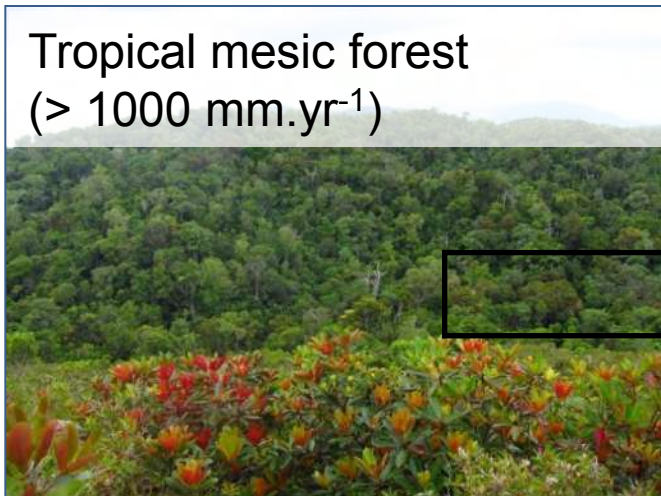
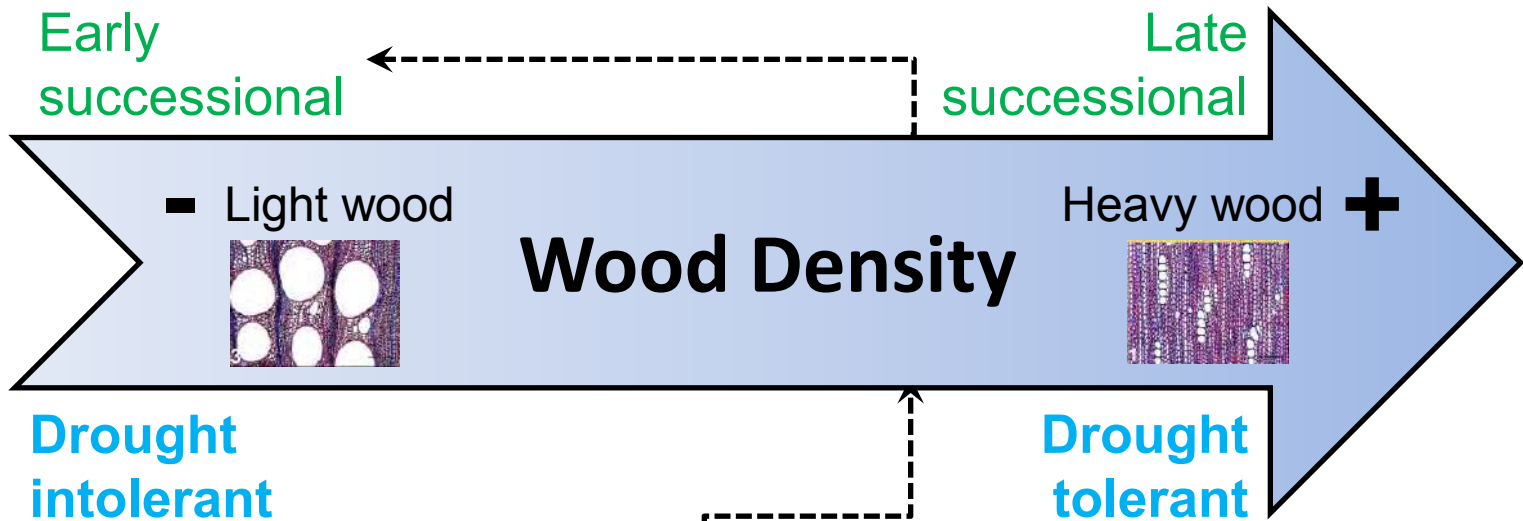
→ Early successional species with heavy wood



Meso & fine scale variability

(1) Dealing with ubiquist species !

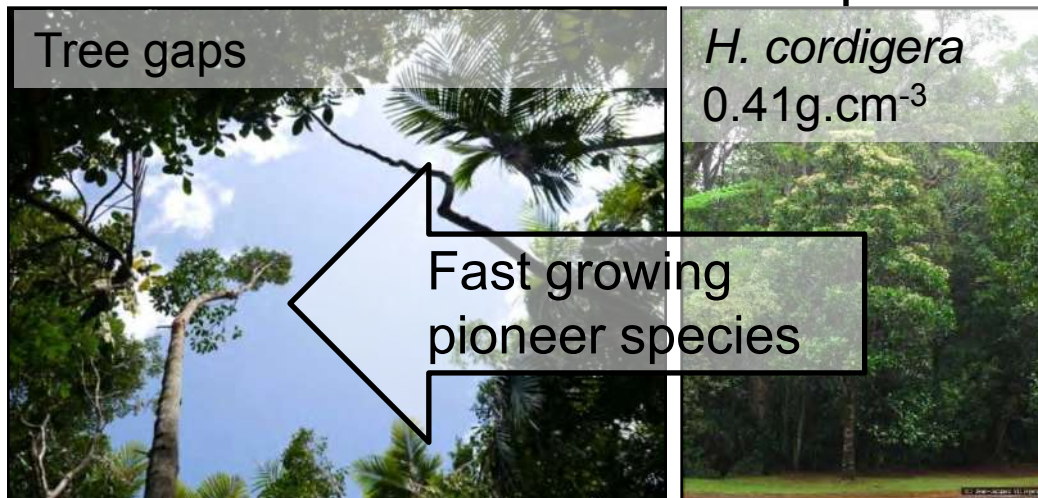
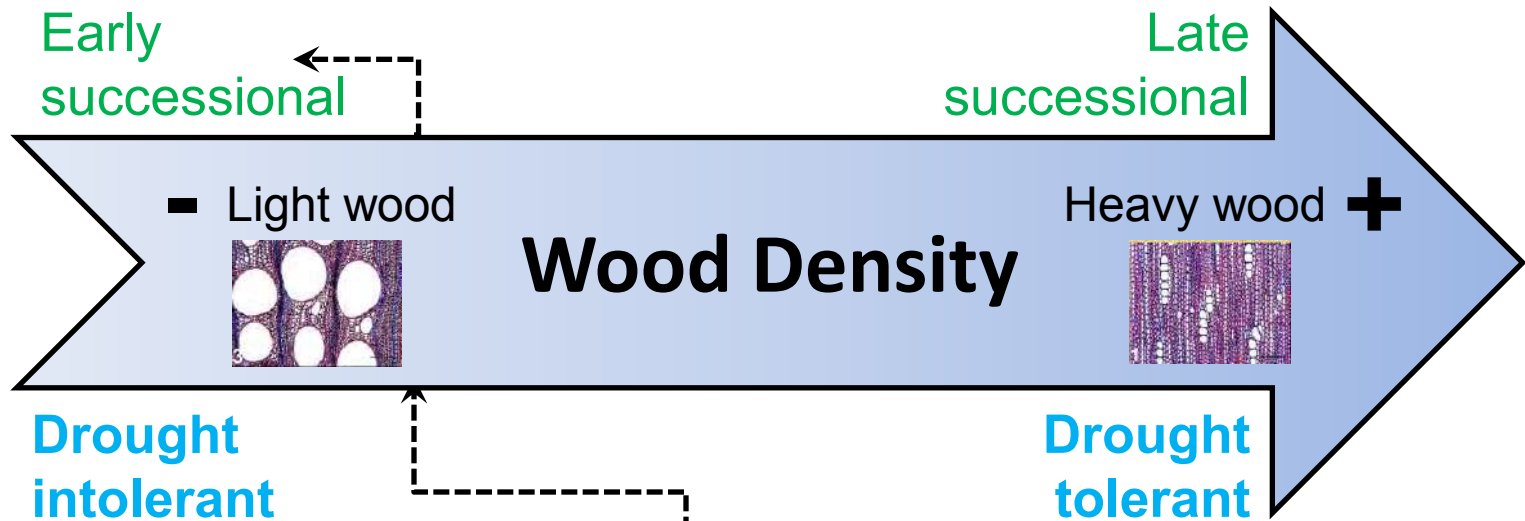
→ Early successional species with heavy wood



Meso & fine scale variability

(2) Dealing with different dynamics !

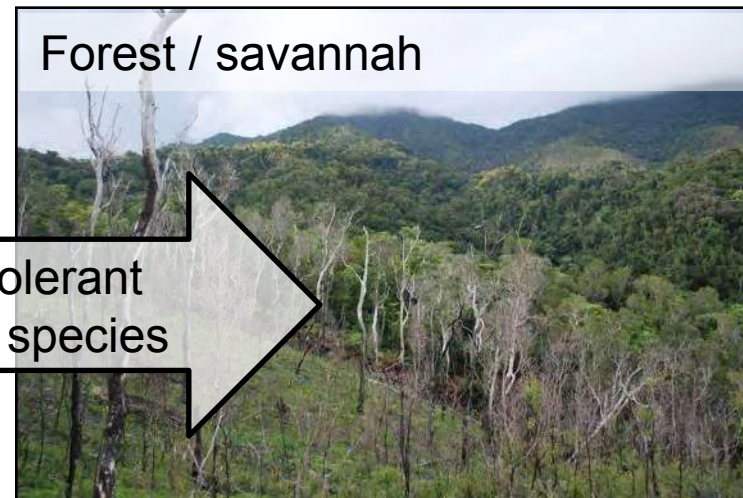
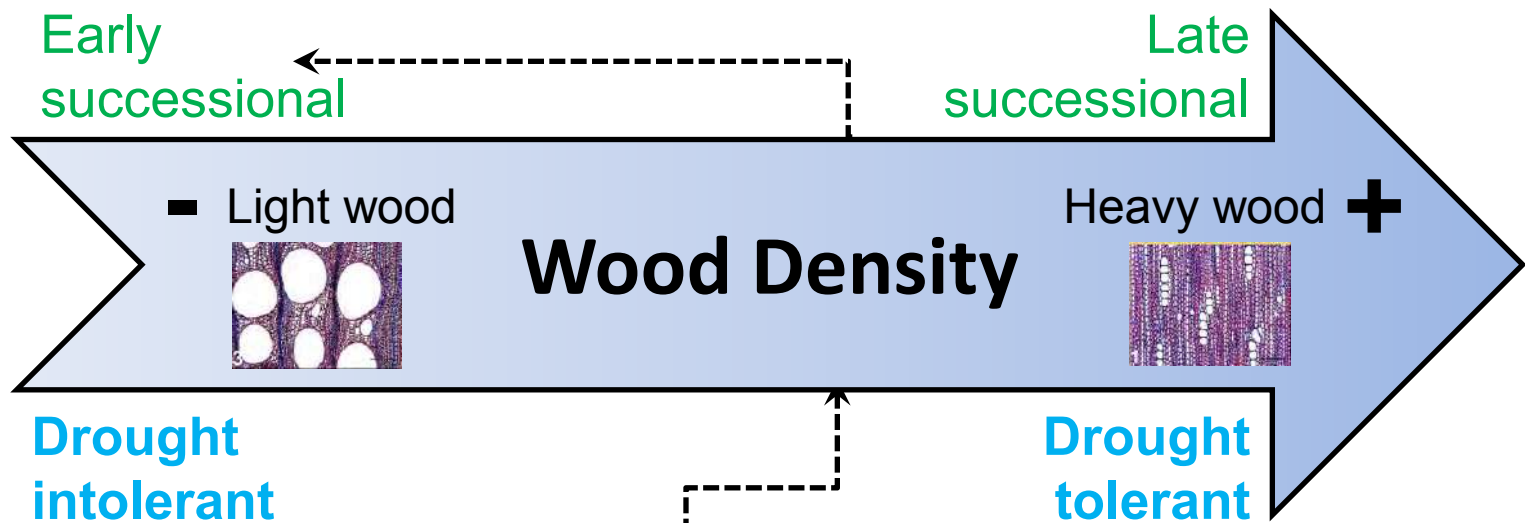
→ Fast growing vs. stress tolerant early successional species



Meso & fine scale variability

(2) Dealing with different dynamics !

→ Fast growing vs. stress tolerant early successional species



Stress tolerant pioneer species

Conclusions & perspectives

Preliminary results

Are our data consistent with those observed at the Australasia scale?

Yes

Which taxonomic level does matter to study wood density variability?

Strong taxonomic signal at GENUS LEVEL

BUT wood density likely drive by environment (WATER AVAILABILITY)

How wood density vary between plots / communities?

NEED to extend or environmental gradient

Can we infer forest dynamics from wood density?

Inferring dynamic status from wood density threshold is tricky!

→ Focus on rainfall gradients and range of distribution of species / genus according to wood density

Oléti (Thank you)

