UNIVERSITE D'ANTANANARIVO
ECOLE SUPERIEURE DES SCIENCES AGRONOMIQUES
DEPARTEMENT DES EAUX ET FORETS
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Influence of the tree diameter, shade-tolerance, altitude and soil type on wood density and its radial variation in Madagascar Rainforest

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1. INTRODUCTION

2. MATERIALS AND METHODS

3. RESULTS

4. DISCUSSIONS

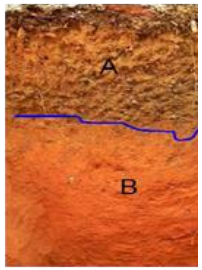
5. CONCLUSION

1. INTRODUCTION

Intrinsic factor : genetic, anatomy
(Polge, 1964; Guilley et Nepveu, 1999)

External factor: environment

Altitude, slope (Mazet et Nepveu, 1991; Ruelle *et al*., 2007)



Soil properties (Nicault *et al*., 2009)

Heterogeneity of wood properties

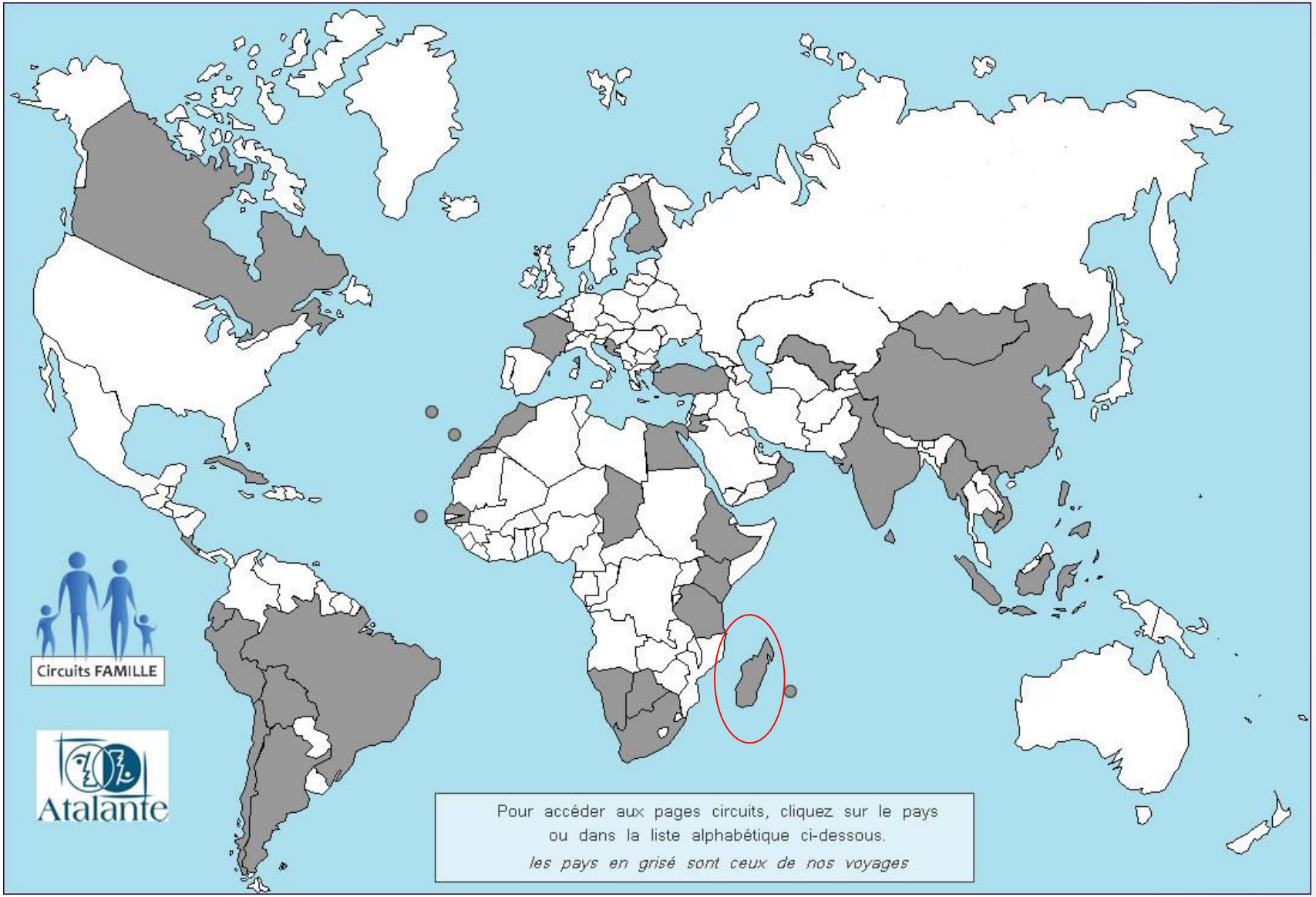
Growth of the tree
(Wimmer *et al.,* 2002)

Two levels of the wood density variability:

→Within-tree

→Between trees

2. MATERIALS AND METHODS


Circuits FAMILLE
Atalante
Pour accéder aux pages circuits, cliquez sur le pays
ou dans la liste alphabétique ci-dessous.
les pays en grisé sont ceux de nos voyages

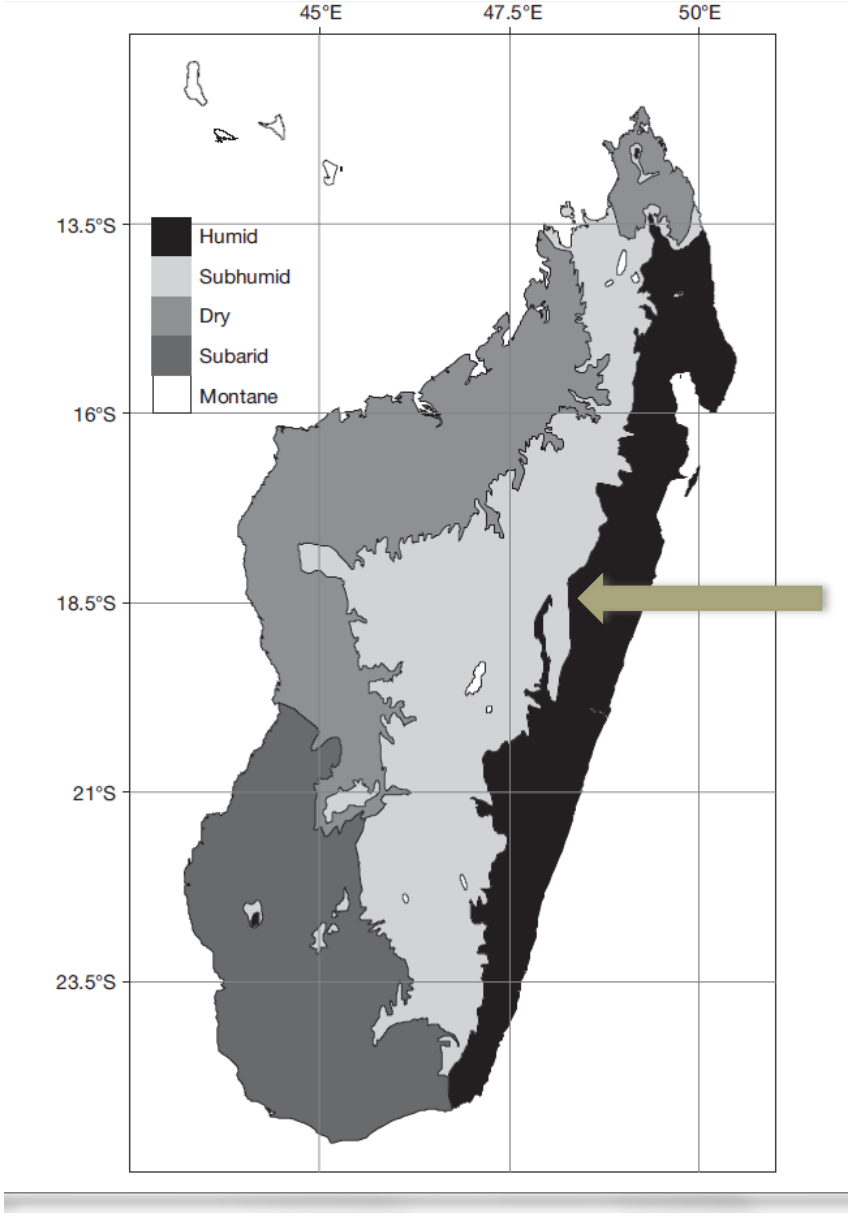
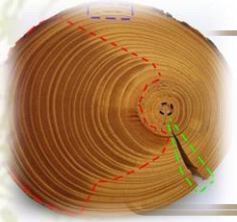


Photo credit: Lafforest

Mandraka natural forest
T° : 17.5° C (13.7 – 20.2° C)
RH = 82%
Altitude = 1300 m
9.9 ha
73 species: 52 genera, 42 families

RESEARCH QUESTIONS

« What are the main factors that have significant effects on wood density and its radial variation in the Mandraka forest ? »



In which extent does the wood density vary in the Mandraka forest?

Is there any effect of the tree diameter and the shade tolerance of the species ?

Is there any effect of local environmental factors (soil property, altiture)?

APPROACH

Variation:
Within tree
Between trees

1

Investigation of the factors

2

Wood density measurements

3

Statistical analysis

1

Study of the factors

« Diameter » et « Distance to pith »

« Shade tolerance »

« Altitude », « Soil types »

- Forest inventory
- Two diameter classes: 5 ≤ D ≤ 15cm et D>15 cm
- At least 5 trees per diameter class per species

1

Study of the factors

« Diameter », « distance to pith »

« Shade tolerance »

« Altitude », « soil properties

23 species (abundance: 50 %), 18 families, 20 genera

Primary and secondary forests

Random sampling of the trees

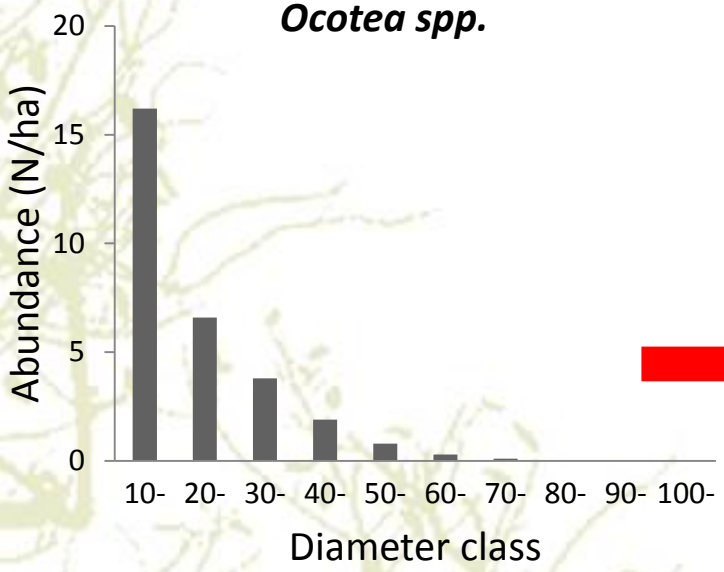
Study of the factors

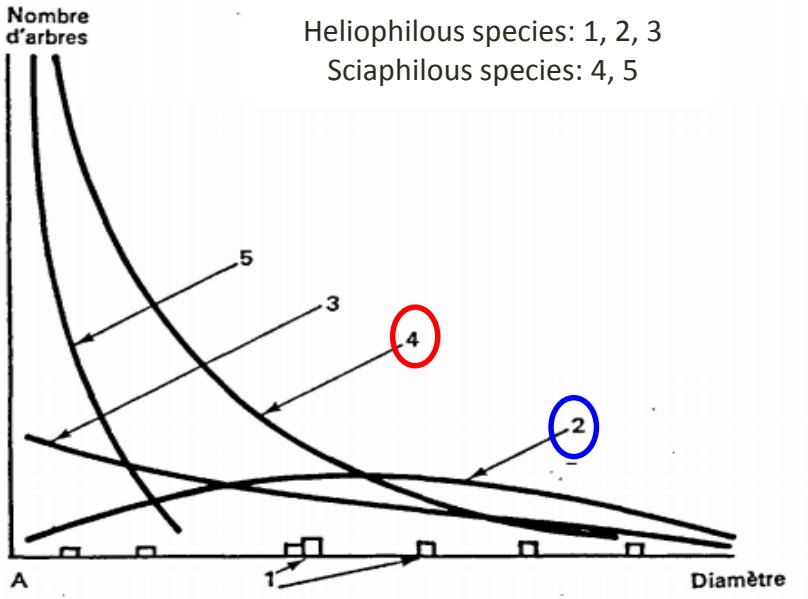
« Diameter », « distance to pith »

« Shade tolerance »

« Altitude », « Type of soil »

Ocotea spp.

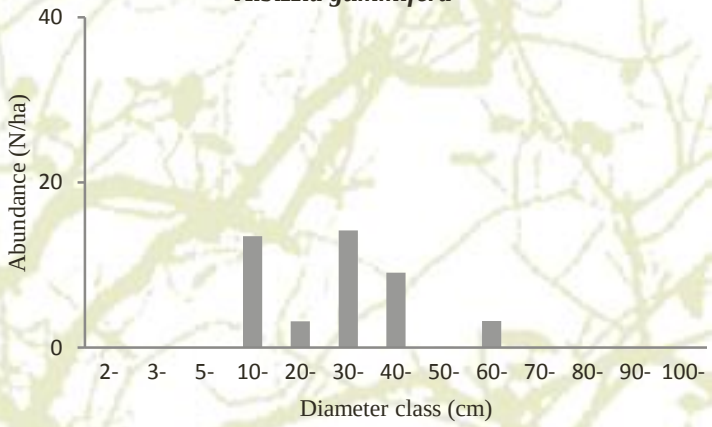




Heliophilous species: 1, 2, 3
Sciaphilous species: 4, 5

Rollet curve (1974)

Albizzia gummifera



Shade tolerance	Taxa
Héliophilous	*Albizzia gummifera*
	Nuxia capitata
	Schefflera longipedicellata
	Schefflera vantsilana
	Harungana madagascariensis
	Ravensara crassifolia
	Ravensara acuminata
	Anthocleista madagascariensis
	Dombeya lucida
	Macaranga cuspidata
	Chrysophyllum boivinianum
	Mussaenda sp.
Sciaphilous	*Protorhus ditimena*
	Calophyllum sp.
	Ocotea sp.(1)
	Ocotea sp.(2)
	Bosqueia danguyana
	Syzygium cumini
	Uapaca densifolia
	Dilobeia thouarsii
	Ilex mitis

1

Study of the factors

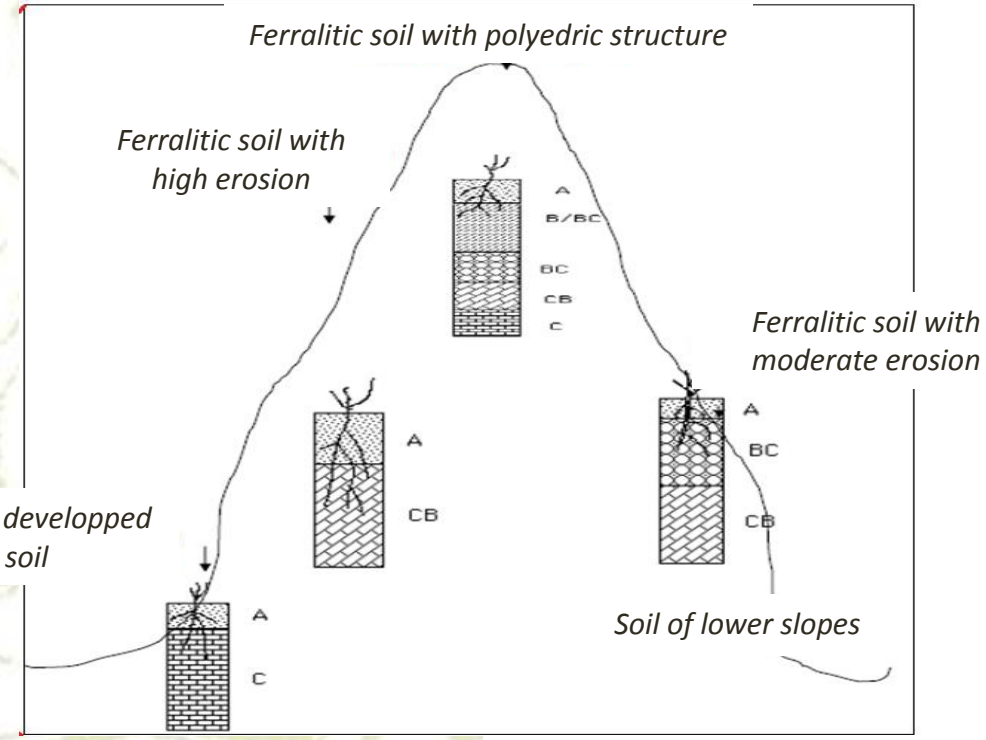
Diameter and distance to pith

Species and shade tolerance

Altitude and soil type

Altitude → GPS

Soil types → Pedology



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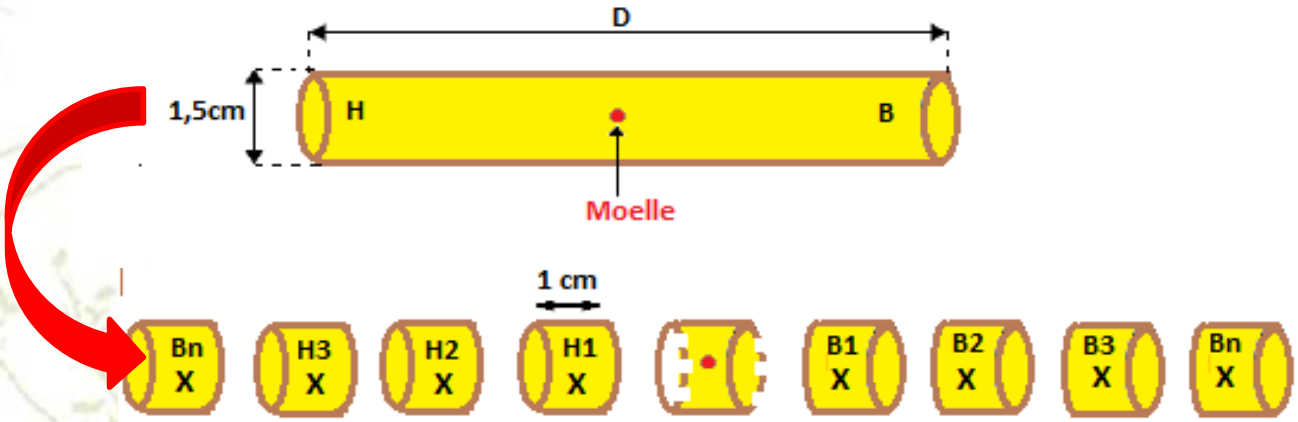
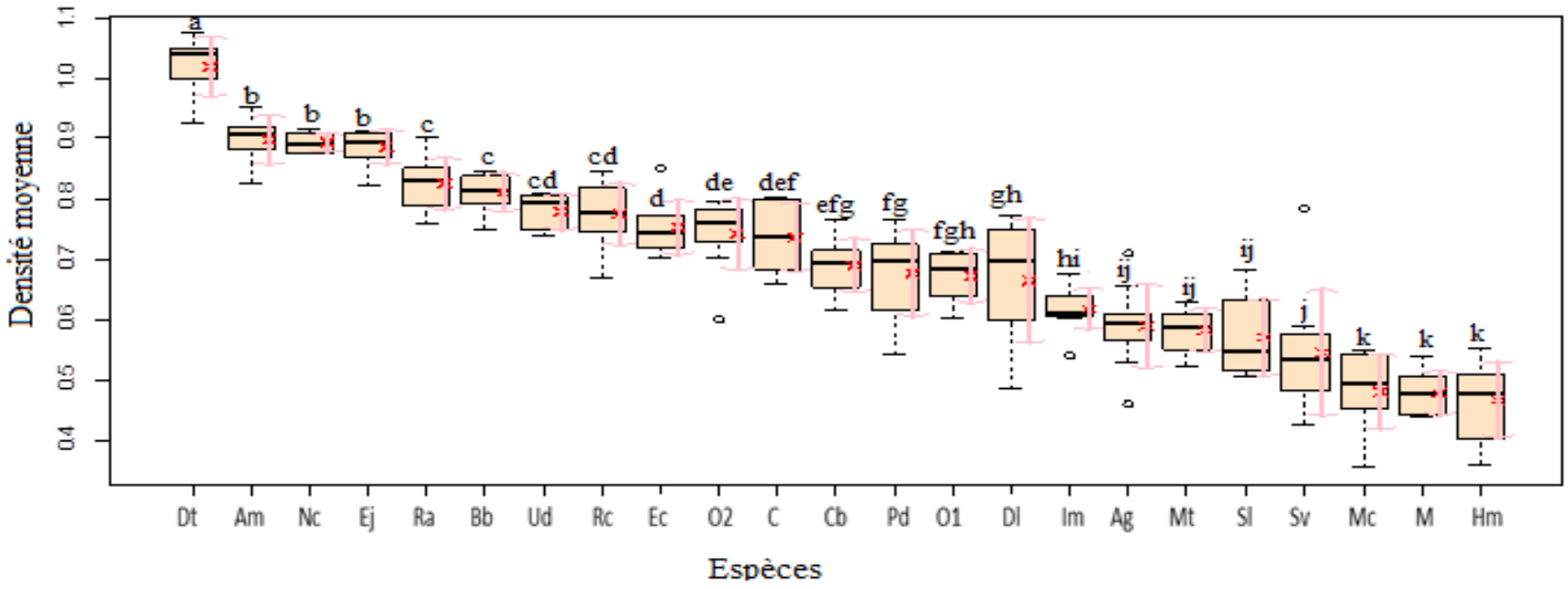
WOOD DENSITY MEASUREMENT



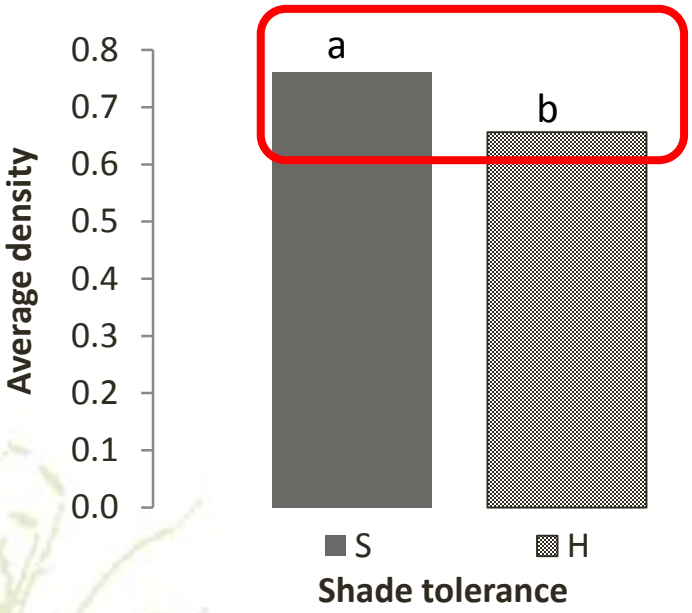
3. RESULTS

WOOD DENSITY VARIATION
- BETWEEN TREES

	Number	Significance
Diemeter	2	
Species	23	***
Shade tolerance	5	***
Altitude	6	***
Soil properties	5	***

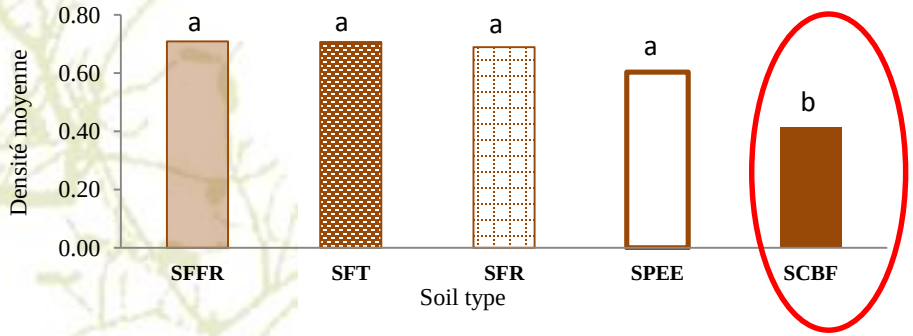


Dt, Dilobeia thouarsii; Am, Anthocleista madagascariensis; Nc, Nuxia capitata; Ej, Eugenia jambolana; Ra, Ravensara acuminata; Bb, Bosqueia boiviniana; Ud, Uapaca densifolia ; Rc, Ravensara crassifolia; Ec, Erythroxyllum corimbosum; O2, Ocotea sp.2; Calophyllum sp., Cb, Chysophyllum boivinianum; Pd, Protorhus ditimena; O1, Ocotea sp.1; Dl, Dombeya lucida; Im, Ilex mitis; Ag, Albizzia gummifera ; Mt, Michronychia tsiramiramy; Sl, Shefflera longipedicellata; Sv, Shefflera vantsilana; Mc, Macaranga cuspidata; M, Mussaenda sp.; Hm, Harungana madagascariensis


0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0.0
Average density
a
b
S
H
Shade tolerance

ALTITUDE

SOIL TYPES



SFT, Ferralitic soil with polyedric structure ; SFFR, Ferralitic soil with high erosion ; SFR, Ferralitic soil with erosion ; SPEE, slightly developed soils *; SCBF:Soil of lower slopes*

WOOD DENSITY VARIATION
- WITHIN TREE

	Number	Significance
Diameter	2	
Species	23	**
Shade tolerance	5	*
Altitude	6	
Soil type	5	

R^2 (Species) = 83,6% : R^2 (Dp) = 0,05% ; R^2 (Species x Dp) = 0,05%

	Estimate	
(Intercept)	0,780	***
Distance to pith Dp	0,001	
Interaction E × Dp		
13 species × Dp	+ ...	
8 species × Dp	- ...	
2 species × Dp	0,00	

	Estimate	
(Intercept)	0,49	***
Distance to pith Dp	0,00	
Interaction : ST × Dp		
Héliophilous x Dp	0.004	*
Sciaphilous x Dp	-0,003	*

R^2 (model) = 19 % ; R^2 (ST) = 18 % ; R^2 (Dp) = 0,7 % ; R^2 (Interaction) = 0,4 %

4. DISCUSSIONS

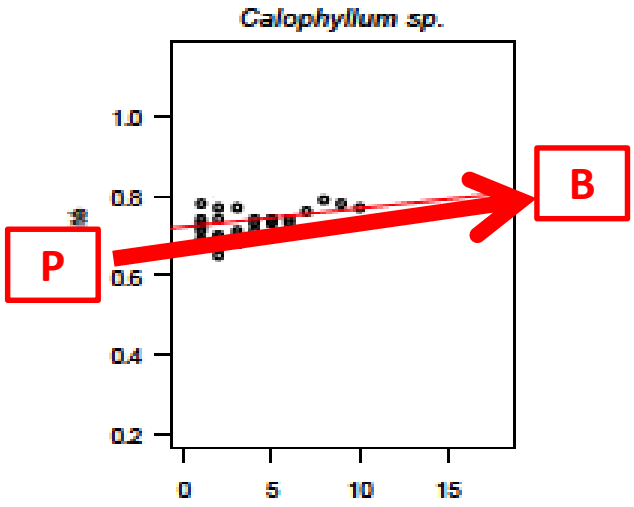
Rapid growing tree

Soil without obstacle
(CRPF & FOGEFOR, 2011)

Fertile soil
(Cown, 2006 ; Nepveu et al., 1993)

Heliophilous
(Van Gelder et al., 2006)

LOW WOOD DENSITY



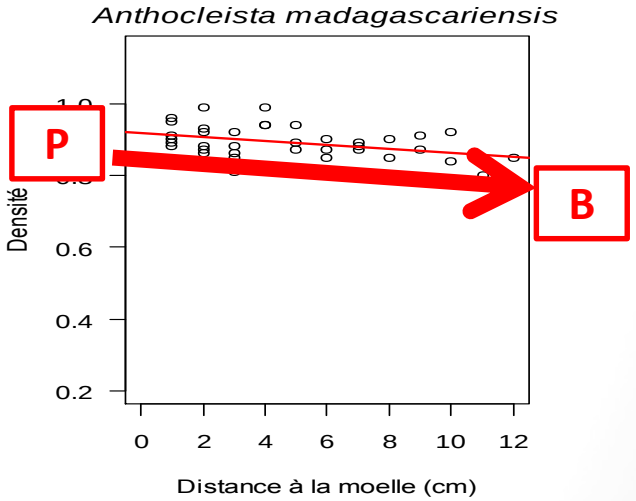
Slow growing tree

Obstacle (CRPF & FOGEFOR, 2011)

Less fertile soil (Muller-Landau, 2004)

Sciaphilous (Van Gelder et al., 2006)

HIGH WOOD DENSITY



5. CONTRIBUTION OF THIS RESERACH AND RECOMMANDATIONS

CONTRIBUTIONS OF THIS RESEARCH

Influence of various factors on wood density

Link with btween « Wood science », « Sylviculture », « Soil science »

New data on the shade tolerance of the 23 native species of Mandraka forest

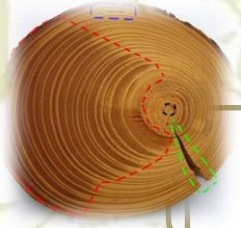
New data on the wood density of 3 species: *Nuxia capitata, Erythroxylum corymbosum, Mussaenda sp.*

Potential substitution species to *Dalbergia sp.: Dilobeia thouarsii, Eugenia jambolana , Anthocleista madagascariensis, Nuxia capitata*

RECOMMANDATIONS

Considering all wood species of Mandraka forest

Wood density measurement



Anatomical studies

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