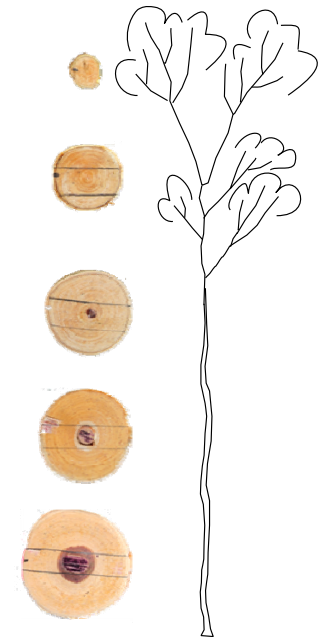


Wood specific gravity variations within tree trunk: the case study of Legumes representatives in French Guiana



Romain LEHNEBACH^{1,2}

H. MOREL¹, N. AMUSANT³, S. GRIFFON¹, J.F. BARCZI¹, J. BEAUCHÊNE³
and E. NICOLINI¹

¹JRU AMAP : botAny and bioinforMatics of Plant Architecture, Montpellier, France

²University of Montpellier II, Montpellier, France

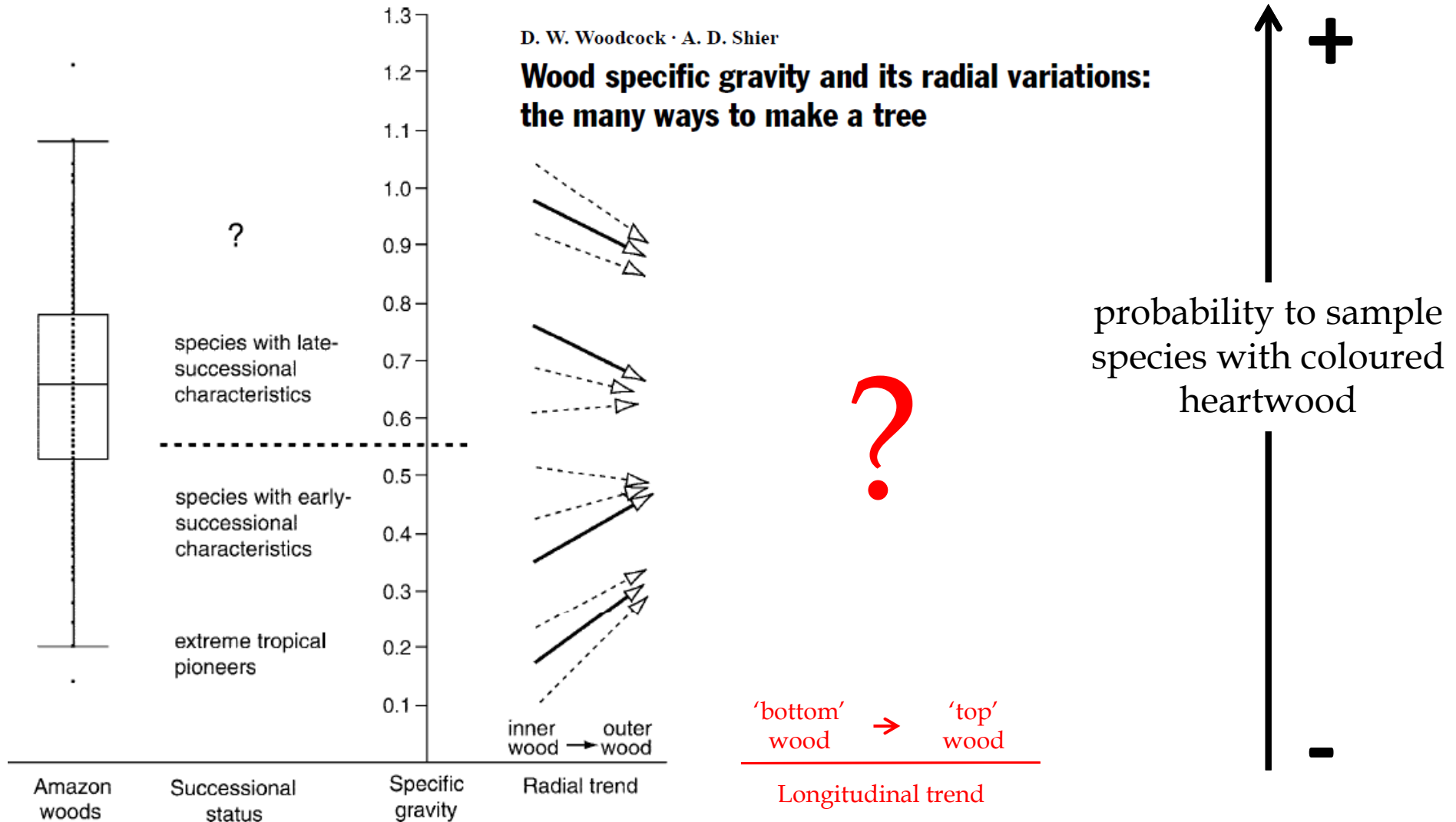
³JRU EcoFoG : Wood sciences laboratory, Kourou, French Guiana



Introduction:

Trees (2002) 16:437–443
DOI 10.1007/s00468-002-0173-7

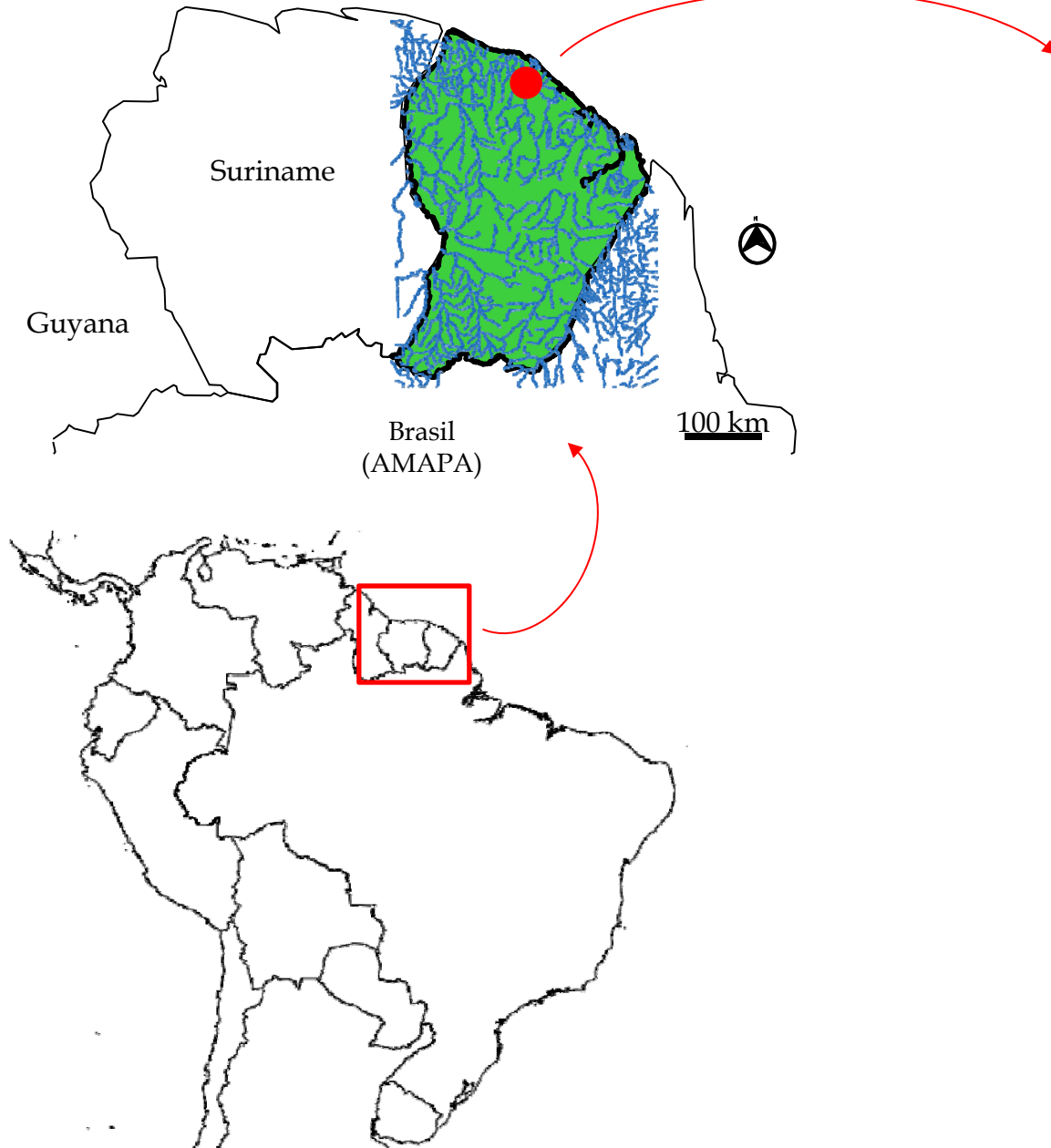
ORIGINAL ARTICLE



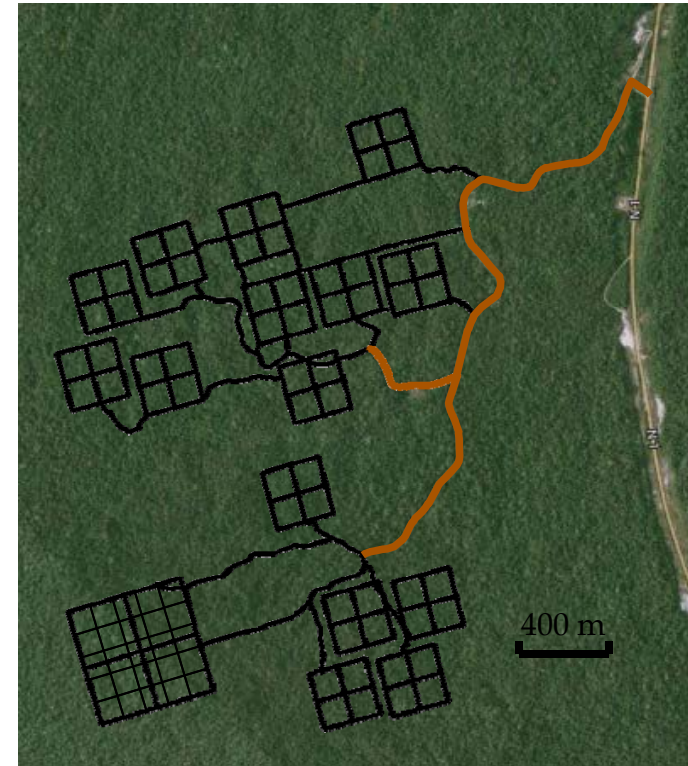
Objectives

1. How WSG varies radially and longitudinally within tree and between species?
2. What are the trends of WSG radial variations and what are the possible misinterpretations of these trends due to the effect of heartwood?
3. Does these variations and patterns, are related to the successional status of the species ?

Experimental site:

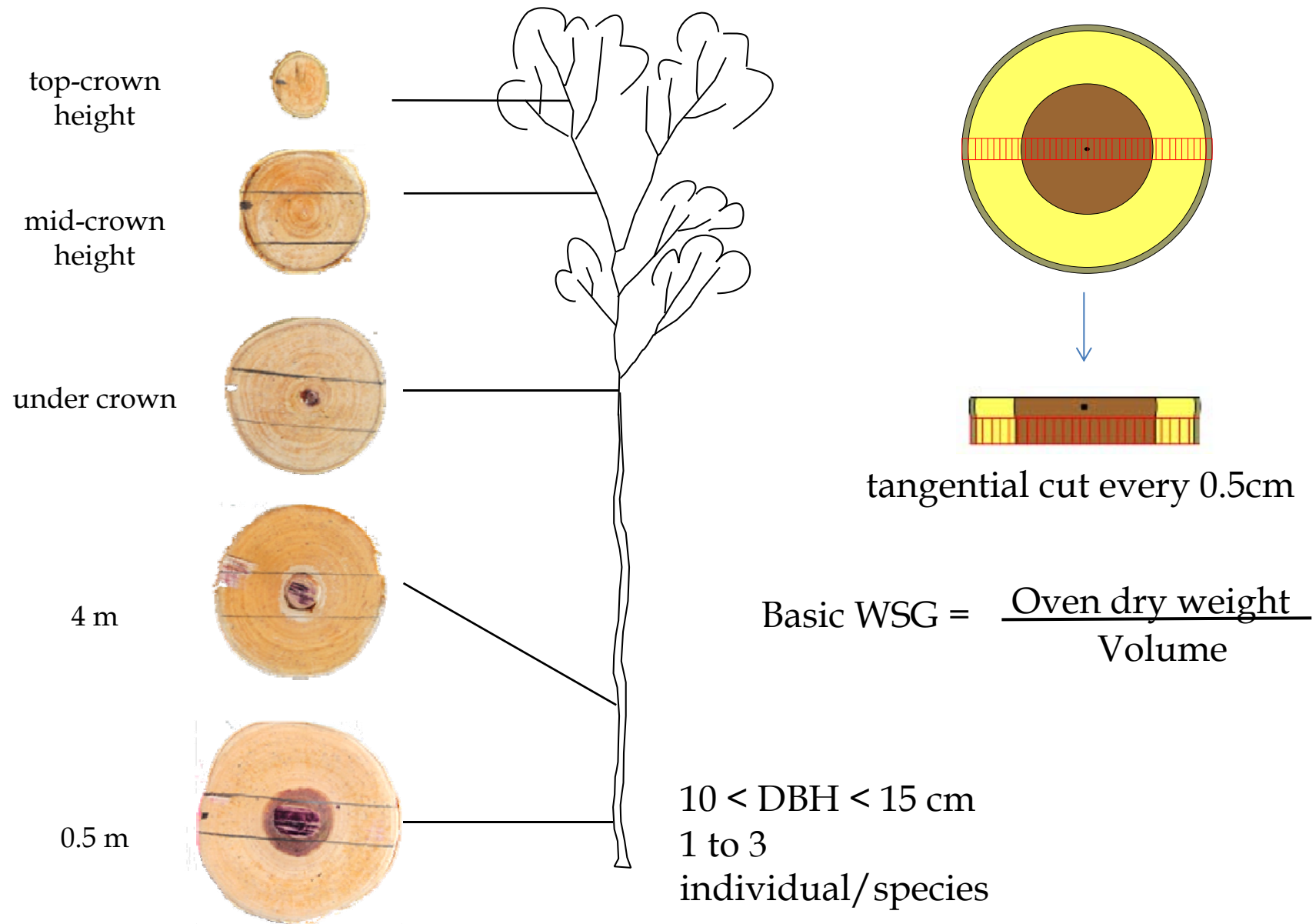


Paracou field station



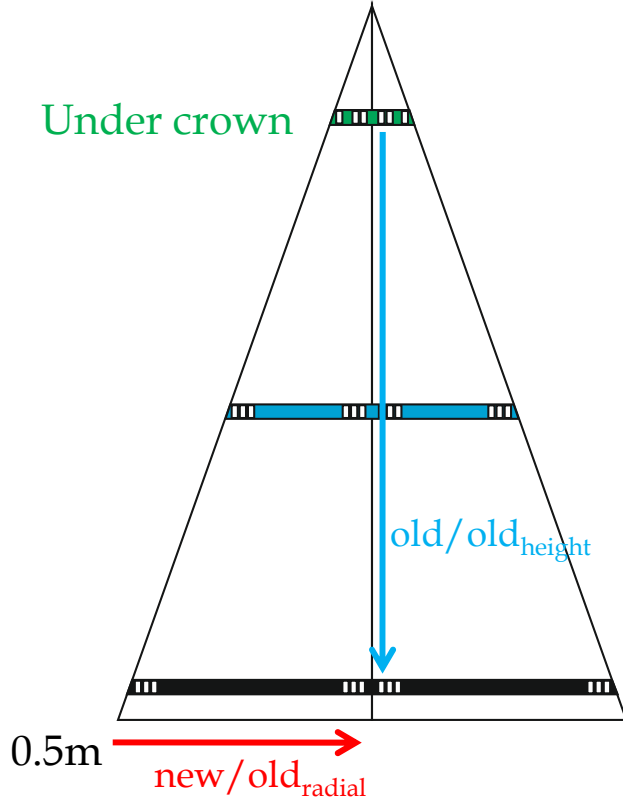
30 years of monitoring
Access to growth rate, mortality
rate ..

Data collection: Field sampling and WSG measurements



Statistical analysis

- Radial and Longitudinal gradient assessed by:



$$\text{new/old}_{\text{radial}} = \frac{\mu(\text{WSG near pith 0.5m})}{\mu(\text{WSG below bark 0.5m})}$$

> 1 → WSG increases on the radius

< 1 → WSG decreases on the radius

$$\text{old/old}_{\text{height}} = \frac{\mu(\text{WSG near pith under crown})}{\mu(\text{WSG near pith 0.5m})}$$

> 1 → WSG increases with height

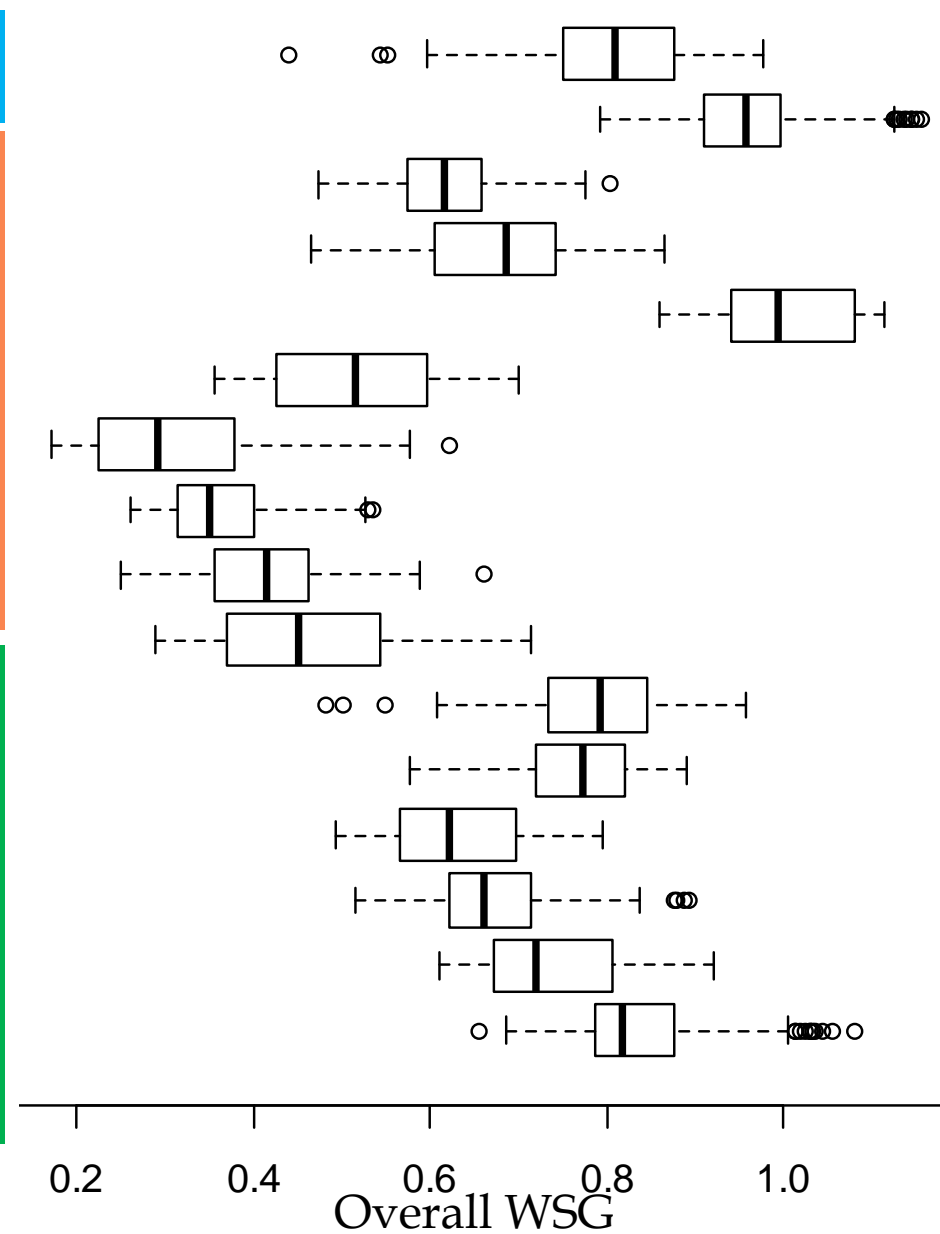
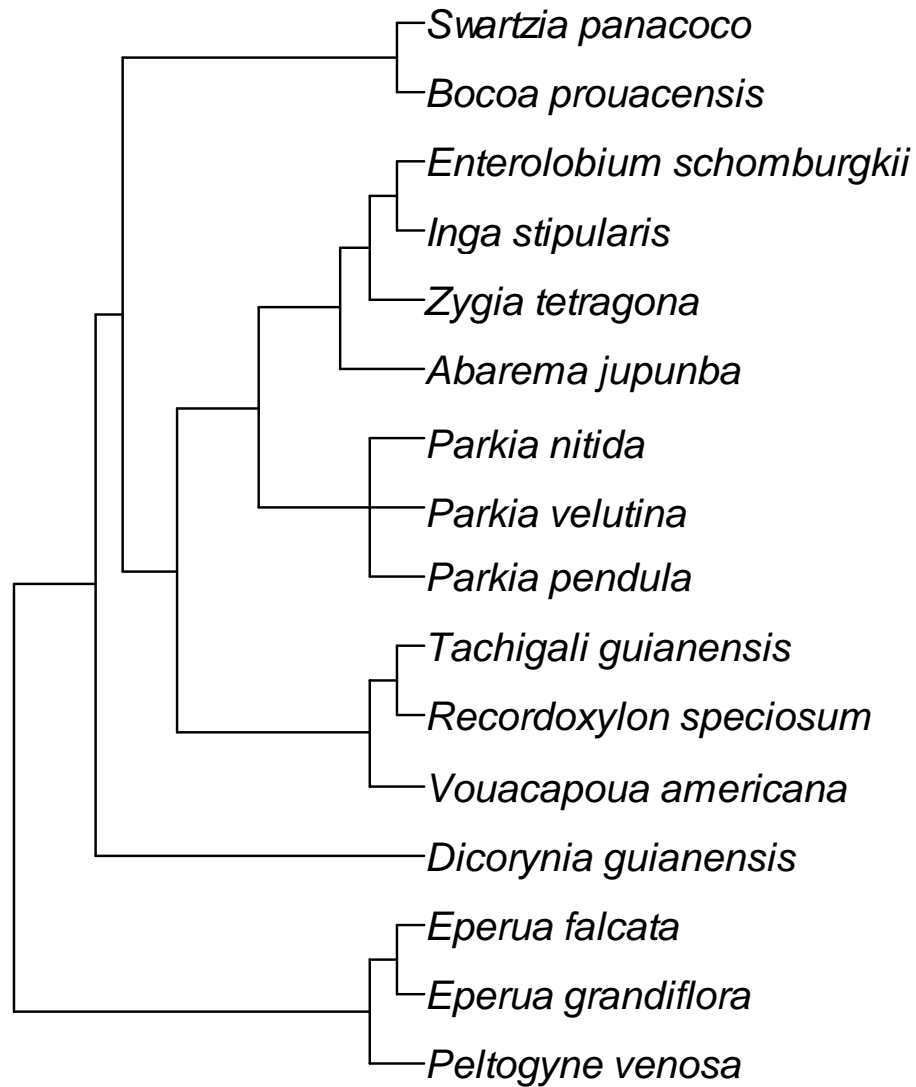
< 1 → WSG decreases with height

- Radial trends assessed by linear mixed model (lme) :

linear: $\text{WSG} \sim \beta_0 + \beta_1 \cdot \text{radial distance}$,

quadratic: $\text{WSG} \sim \beta_0 + \beta_1 \cdot \text{radial distance} + \beta_3 \cdot \text{radial distance}^2$

Collected species: phylogeny & overall WSG



Faboideae Mimosoideae Caesalpinioideae

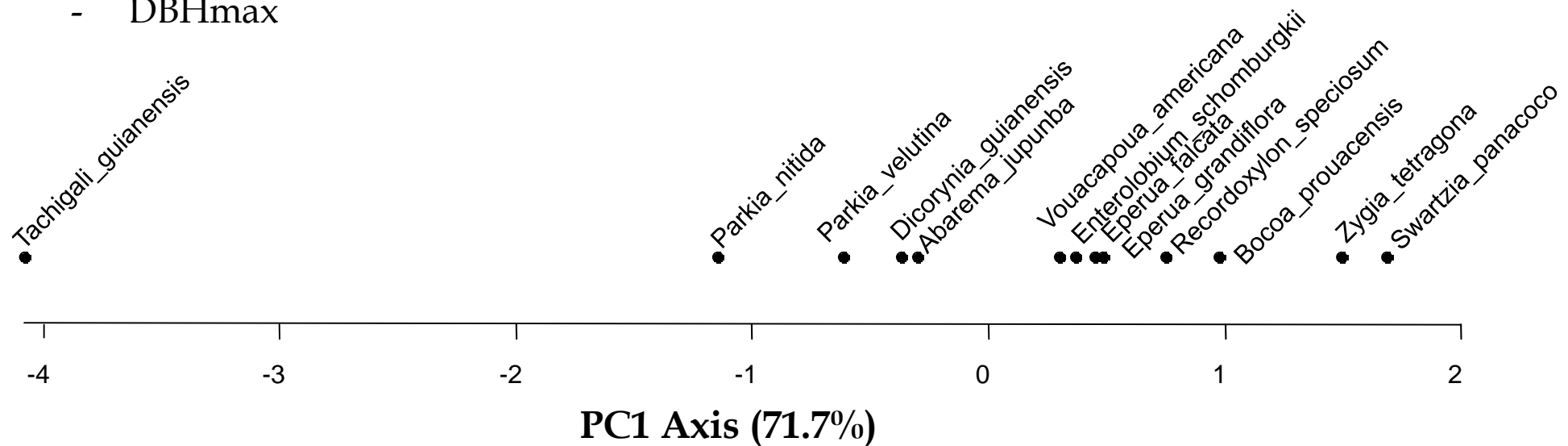
Collected Species

WSUFEM, Tervuren, Belgium, May 2015

Defining successional status

Using Paracou database : computation of variables related to successional status

- RGR95: (95th quantile of the growth rate distribution)
- Mr: mortality rate:
- DBHmax



PC1 scores uses as synthetic variable describing successional status

Results: Radial & longitudinal gradients

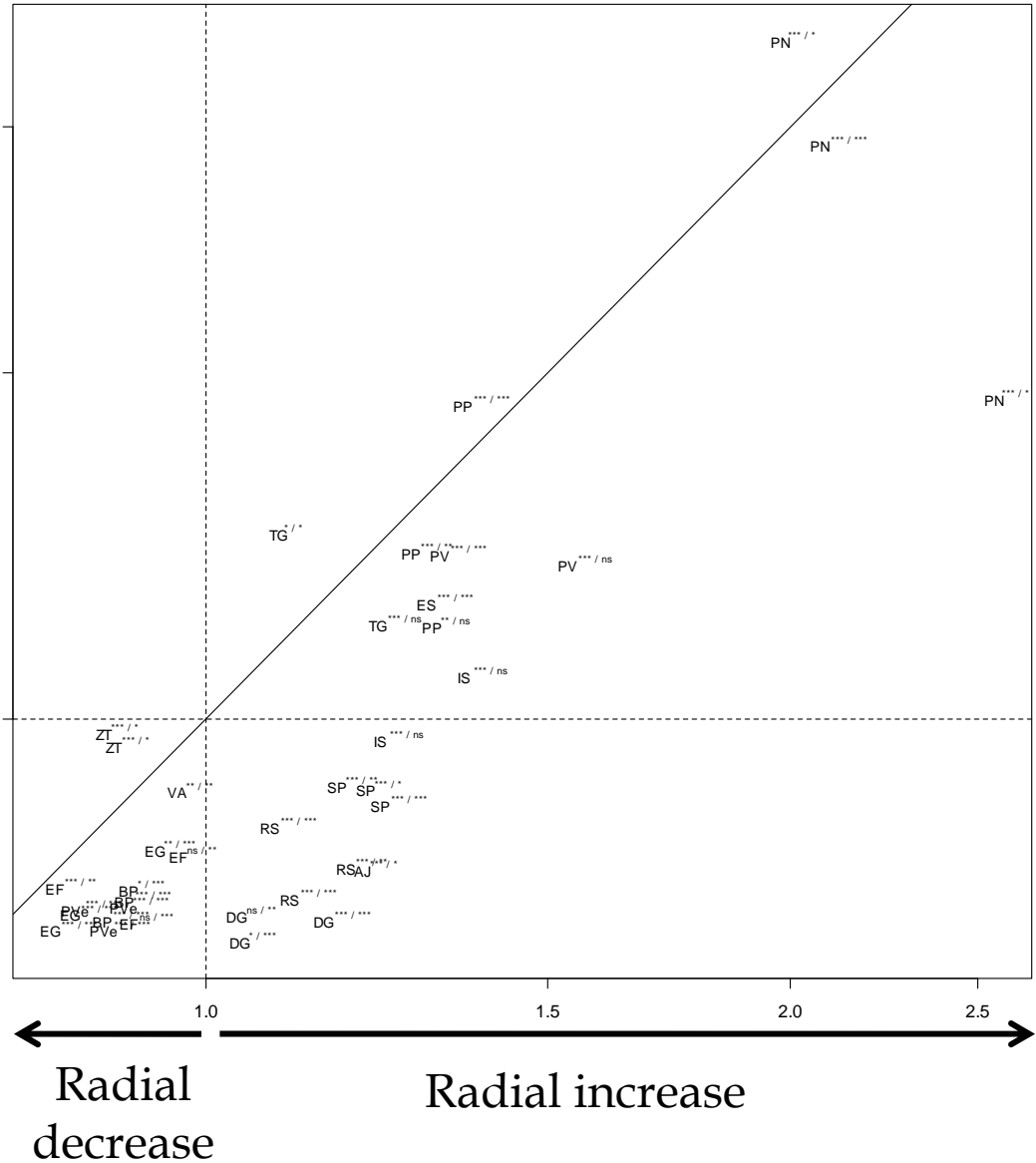
Taxon	new/old _{radial}	old/old _{height}	
<i>Parkia nitida</i>	1,977	***	2,212 *
<i>Parkia nitida</i>	2,073	***	1,959 ***
<i>Parkia nitida</i>	2,549	***	1,455 *
<i>Parkia pendula</i>	1,357	***	1,445 ***
<i>Parkia velutina</i>	1,537	***	1,198 ns
<i>Parkia velutina</i>	1,320	***	1,212 ***
<i>Tachigali guianensis</i>	1,090	*	1,243 *
<i>Parkia pendula</i>	1,276	***	1,215 **
<i>Parkia pendula</i>	1,307	**	1,115 ns
<i>Tachigali guianensis</i>	1,226	***	1,118 ns
<i>Abarema jupunba</i>	1,204	***	0,838 *
<i>Dicorynia guianensis</i>	1,042	*	0,770 ***
<i>Enterolobium schomburgkii</i>	1,300	***	1,146 ***
<i>Inga stipularis</i>	1,229	***	0,976 ns
<i>Dicorynia guianensis</i>	1,038	ns	0,795 **
<i>Dicorynia guianensis</i>	1,151	***	0,790 ***
<i>Eperua falcata</i>	0,913	ns	0,788 ***
<i>Eperua falcata</i>	0,836	***	0,821 **
<i>Eperua falcata</i>	0,968	ns	0,852 **
<i>Eperua grandiflora</i>	0,832	***	0,781 ***
<i>Inga stipularis</i>	1,358	***	1,052 ns
<i>Eperua grandiflora</i>	0,851	***	0,796 ***
<i>Recordoxylon speciosum</i>	1,105	***	0,810 ***
<i>Vouacapoua americana</i>	0,967	**	0,919 **
<i>Swartzia panacoco</i>	1,230	***	0,904 ***
<i>Recordoxylon speciosum</i>	1,181	***	0,840 **
<i>Eperua grandiflora</i>	0,941	**	0,858 ***
<i>Recordoxylon speciosum</i>	1,079	***	0,881 ***
<i>Swartzia panacoco</i>	1,209	***	0,921 *
<i>Swartzia panacoco</i>	1,168	***	0,924 **
<i>Peltogyne sp.</i>	0,886	***	0,781 ***
<i>Peltogyne sp.</i>	0,906	***	0,803 ***
<i>Peltogyne sp.</i>	0,856	***	0,800 ***
<i>Bocoa prouacensis</i>	0,913	*	0,819 ***
<i>Bocoa prouacensis</i>	0,884	***	0,790 ***
<i>Bocoa prouacensis</i>	0,908	***	0,808 ***
<i>Zygia tetragona</i>	0,896	***	0,968 *
<i>Zygia tetragona</i>	0,8853	***	0,984 *

Mean WSG

+

Longitudinal decrease

Longitudinal increase

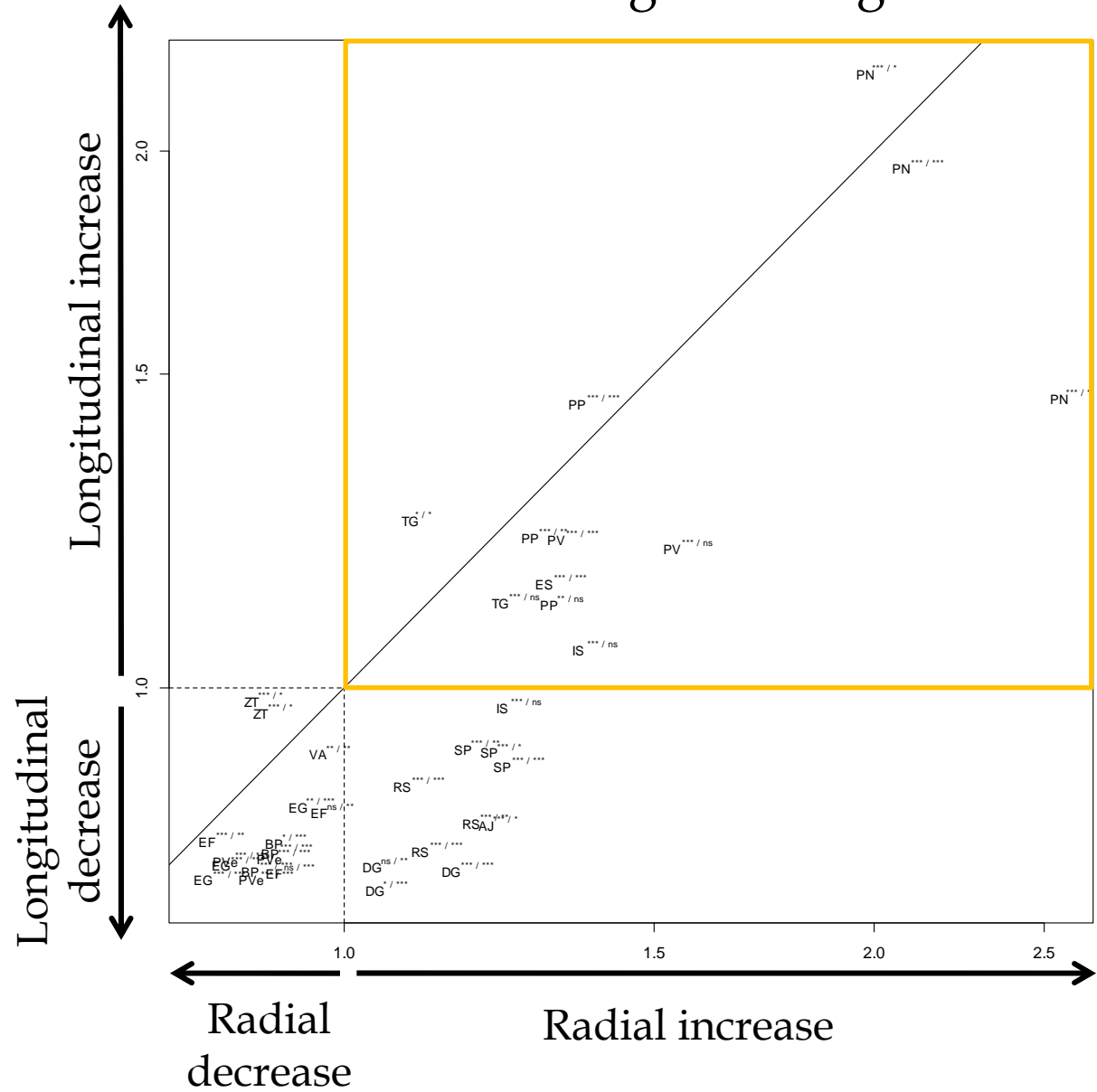


Results: Radial & longitudinal gradients

Taxon	new/old _{radial}	old/old _{height}	
<i>Parkia nitida</i>	1,977	2,212	*** *
<i>Parkia nitida</i>	2,073	1,959	*** ***
<i>Parkia nitida</i>	2,549	1,455	*** *
<i>Parkia pendula</i>	1,357	1,445	*** ***
<i>Parkia velutina</i>	1,537	1,198	*** ns
<i>Parkia velutina</i>	1,320	1,212	*** ***
<i>Tachigali guianensis</i>	1,090	1,243	* *
<i>Parkia pendula</i>	1,276	1,215	*** **
<i>Parkia pendula</i>	1,307	1,115	** ns
<i>Tachigali guianensis</i>	1,226	1,118	*** ns
<i>Abarema jupunba</i>	1,204	0,838	*** *
<i>Dicorynia guianensis</i>	1,042	0,770	* ***
<i>Enterlobium schomburg</i>	1,300	1,146	*** ***
<i>Inga stipularis</i>	1,229	0,976	*** ns
<i>Dicorynia guianensis</i>	1,038	0,795	ns **
<i>Dicorynia guianensis</i>	1,151	0,790	*** ***
<i>Eperua falcata</i>	0,913	0,788	ns ***
<i>Eperua falcata</i>	0,836	0,821	*** **
<i>Eperua falcata</i>	0,968	0,852	ns **
<i>Eperua grandiflora</i>	0,832	0,781	*** ***
<i>Inga stipularis</i>	1,358	1,052	*** ns
<i>Eperua grandiflora</i>	0,851	0,796	*** ***
<i>Recordoxylon speciosum</i>	1,105	0,810	*** ***
<i>Vouacapoua americana</i>	0,967	0,919	** **
<i>Swartzia panacoco</i>	1,230	0,904	*** ***
<i>Recordoxylon speciosum</i>	1,181	0,840	*** **
<i>Eperua grandiflora</i>	0,941	0,858	** ***
<i>Recordoxylon speciosum</i>	1,079	0,881	*** ***
<i>Swartzia panacoco</i>	1,209	0,921	*** *
<i>Swartzia panacoco</i>	1,168	0,924	*** **
<i>Peltogyne sp.</i>	0,886	0,781	*** ***
<i>Peltogyne sp.</i>	0,906	0,803	*** ***
<i>Peltogyne sp.</i>	0,856	0,800	*** ***
<i>Bocoa prouacensis</i>	0,913	0,819	* ***
<i>Bocoa prouacensis</i>	0,884	0,790	*** ***
<i>Bocoa prouacensis</i>	0,908	0,808	*** ***
<i>Zygia tetragona</i>	0,896	0,968	*** *
<i>Zygia tetragona</i>	0,8853	0,984	*** *

Mean WSG

+



Results: Radial & longitudinal gradients

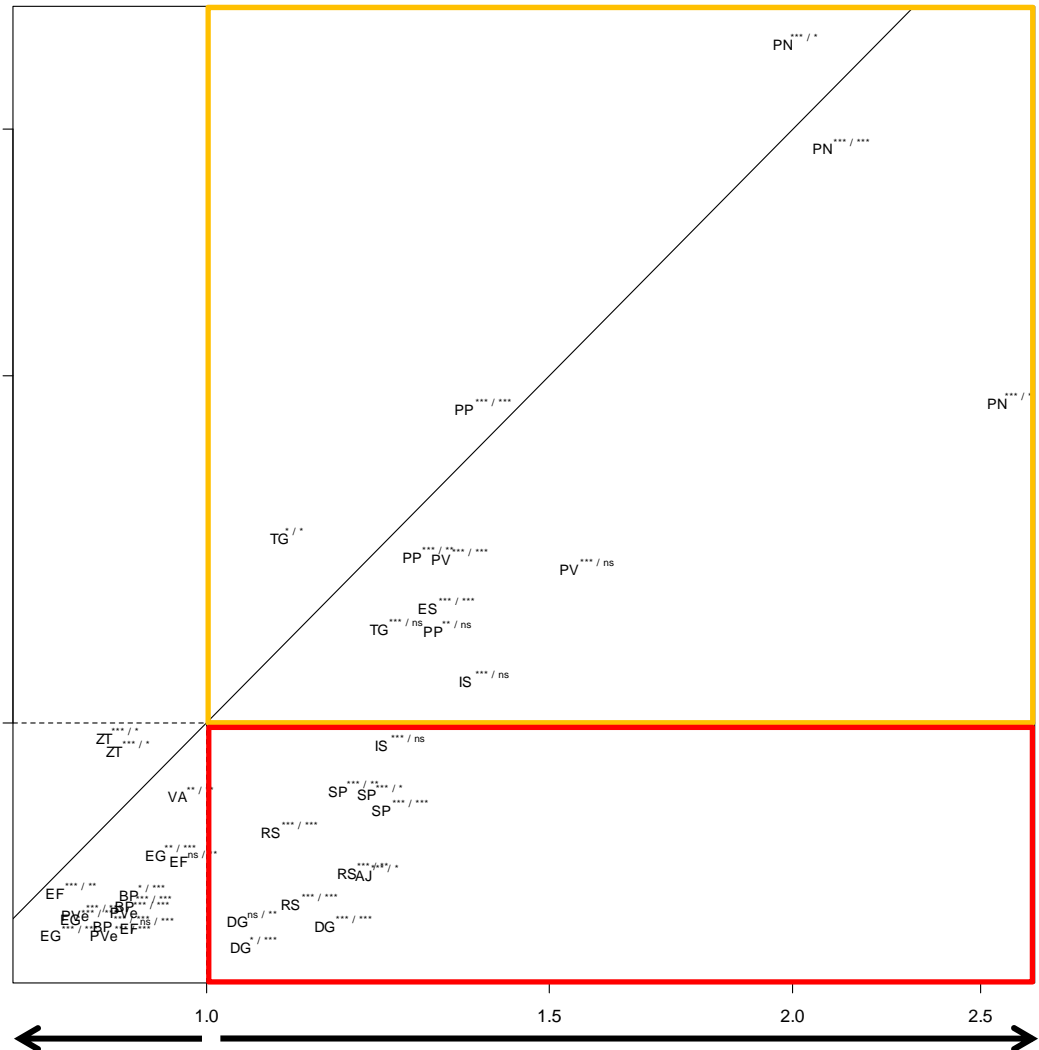
Taxon	new/old _{radial}	old/old _{height}
<i>Parkia nitida</i>	1,977 ***	2,212 *
<i>Parkia nitida</i>	2,073 ***	1,959 ***
<i>Parkia nitida</i>	2,549 ***	1,455 *
<i>Parkia pendula</i>	1,357 ***	1,445 ***
<i>Parkia velutina</i>	1,537 ***	1,198 ns
<i>Parkia velutina</i>	1,320 ***	1,212 ***
<i>Tachigali guianensis</i>	1,090 *	1,243 *
<i>Parkia pendula</i>	1,276 ***	1,215 **
<i>Parkia pendula</i>	1,307 **	1,115 ns
<i>Tachigali guianensis</i>	1,226 ***	1,118 ns
<i>Abarema jupunba</i>	1,204 ***	0,838 *
<i>Dicorynia guianensis</i>	1,042 *	0,770 ***
<i>Enterolobium schomburg</i>	1,300 ***	1,146 ***
<i>Inga stipularis</i>	1,229 ***	0,976 ns
<i>Dicorynia guianensis</i>	1,038 ns	0,795 **
<i>Dicorynia guianensis</i>	1,151 ***	0,790 ***
<i>Eperua falcata</i>	0,913 ns	0,788 ***
<i>Eperua falcata</i>	0,836 ***	0,821 **
<i>Eperua falcata</i>	0,968 ns	0,852 **
<i>Eperua grandiflora</i>	0,832 ***	0,781 ***
<i>Inga stipularis</i>	1,358 ***	1,052 ns
<i>Eperua grandiflora</i>	0,851 ***	0,796 ***
<i>Recordoxylon speciosum</i>	1,105 ***	0,810 ***
<i>Vouacapoua americana</i>	0,967 **	0,919 **
<i>Swartzia panacoco</i>	1,230 ***	0,904 ***
<i>Recordoxylon speciosum</i>	1,181 ***	0,840 **
<i>Eperua grandiflora</i>	0,941 **	0,858 ***
<i>Recordoxylon speciosum</i>	1,079 ***	0,881 ***
<i>Swartzia panacoco</i>	1,209 ***	0,921 *
<i>Swartzia panacoco</i>	1,168 ***	0,924 **
<i>Peltogyne sp.</i>	0,886 ***	0,781 ***
<i>Peltogyne sp.</i>	0,906 ***	0,803 ***
<i>Peltogyne sp.</i>	0,856 ***	0,800 ***
<i>Bocoa prouacensis</i>	0,913 *	0,819 ***
<i>Bocoa prouacensis</i>	0,884 ***	0,790 ***
<i>Bocoa prouacensis</i>	0,908 ***	0,808 ***
<i>Zygia tetragona</i>	0,896 ***	0,968 *
<i>Zygia tetragona</i>	0,8853 ***	0,984 *

Mean WSG

+

Longitudinal increase

Longitudinal decrease



Radial decrease

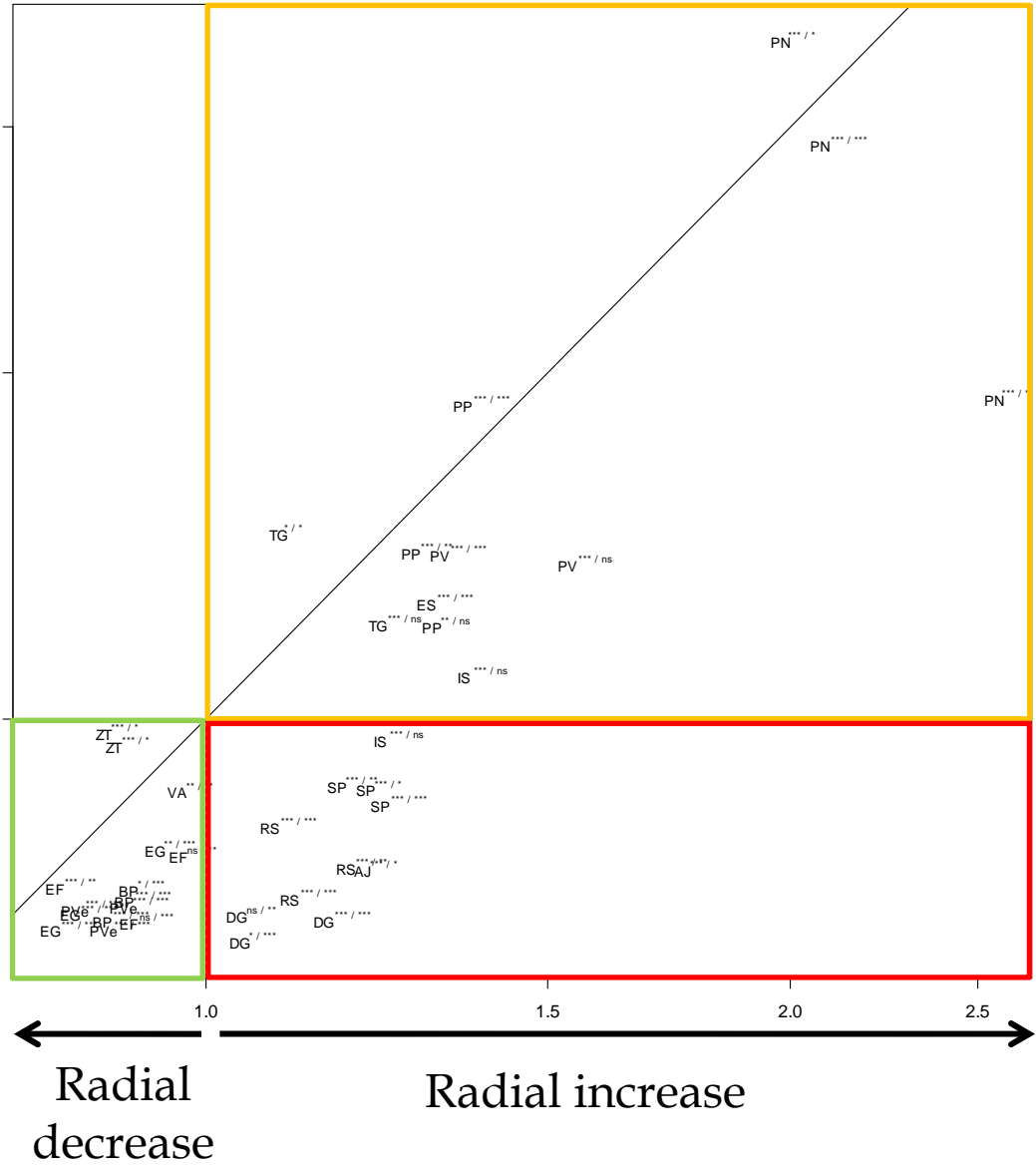
Radial increase

Results: Radial & longitudinal gradients

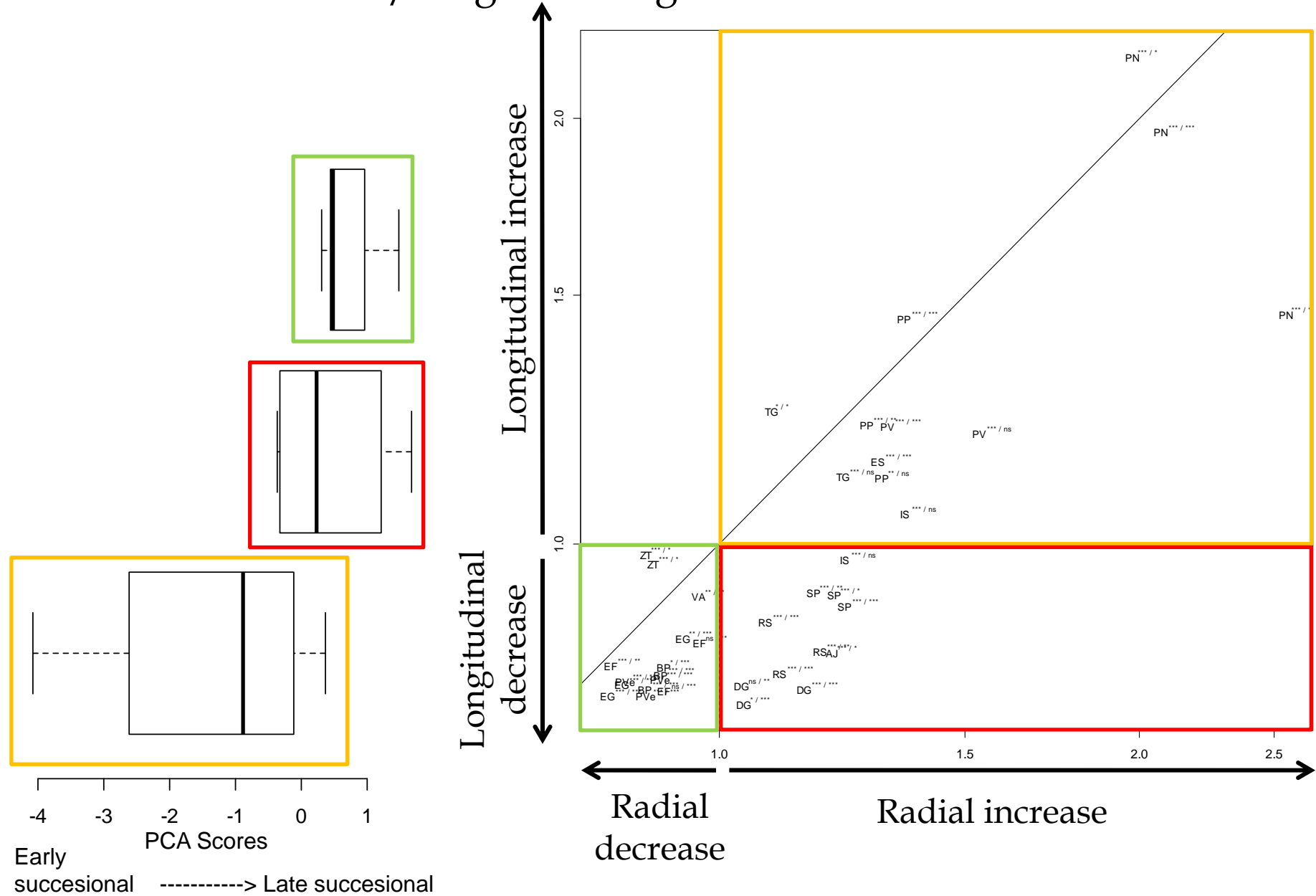
Taxon	new/old _{radial}	old/old _{height}	
<i>Parkia nitida</i>	1,977	2,212	***
<i>Parkia nitida</i>	2,073	1,959	***
<i>Parkia nitida</i>	2,549	1,455	***
<i>Parkia pendula</i>	1,357	1,445	***
<i>Parkia velutina</i>	1,537	1,198	***
<i>Parkia velutina</i>	1,320	1,212	***
<i>Tachigali guianensis</i>	1,090	1,243	*
<i>Parkia pendula</i>	1,276	1,215	***
<i>Parkia pendula</i>	1,307	1,115	**
<i>Tachigali guianensis</i>	1,226	1,118	***
<i>Abarema jupunba</i>	1,204	0,838	***
<i>Dicorynia guianensis</i>	1,042	0,770	*
<i>Enterolobium schomburg</i>	1,300	1,146	***
<i>Inga stipularis</i>	1,229	0,976	***
<i>Dicorynia guianensis</i>	1,038	0,795	ns
<i>Dicorynia guianensis</i>	1,151	0,790	***
<i>Eperua falcata</i>	0,913	0,788	ns
<i>Eperua falcata</i>	0,836	0,821	***
<i>Eperua falcata</i>	0,968	0,852	ns
<i>Eperua grandiflora</i>	0,832	0,781	***
<i>Inga stipularis</i>	1,358	1,052	***
<i>Eperua grandiflora</i>	0,851	0,796	***
<i>Recordoxylon speciosum</i>	1,105	0,810	***
<i>Vouacapoua americana</i>	0,967	0,919	**
<i>Swartzia panacoco</i>	1,230	0,904	***
<i>Recordoxylon speciosum</i>	1,181	0,840	***
<i>Eperua grandiflora</i>	0,941	0,858	**
<i>Recordoxylon speciosum</i>	1,079	0,881	***
<i>Swartzia panacoco</i>	1,209	0,921	***
<i>Swartzia panacoco</i>	1,168	0,924	***
<i>Peltogyne sp.</i>	0,886	0,781	***
<i>Peltogyne sp.</i>	0,906	0,803	***
<i>Peltogyne sp.</i>	0,856	0,800	***
<i>Bocoa prouacensis</i>	0,913	0,819	*
<i>Bocoa prouacensis</i>	0,884	0,790	***
<i>Bocoa prouacensis</i>	0,908	0,808	***
<i>Zygia tetragona</i>	0,896	0,968	***
<i>Zygia tetragona</i>	0,8853	0,984	***

Longitudinal decrease

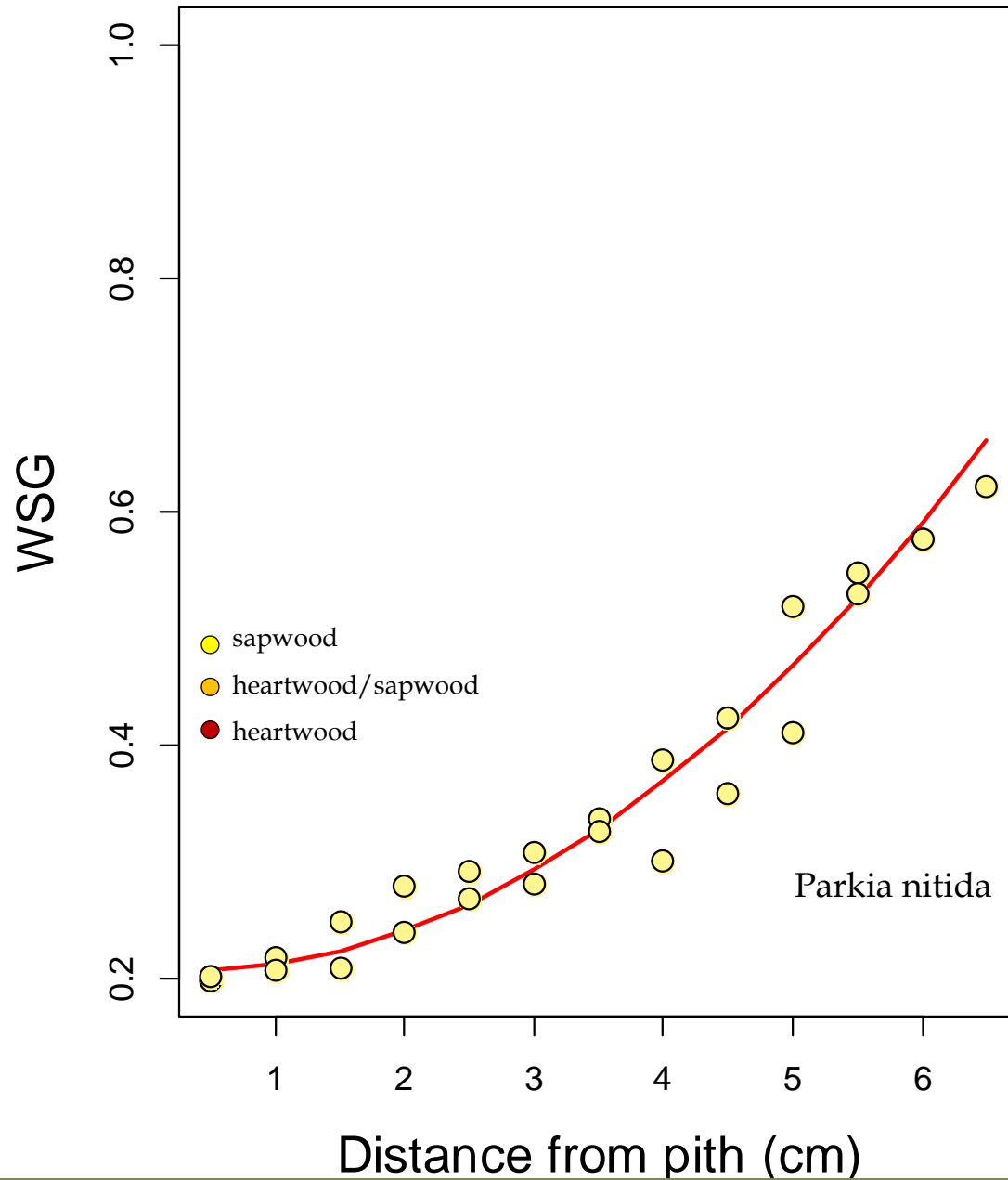
Longitudinal increase



Links between radial/longitudinal gradients and successional status

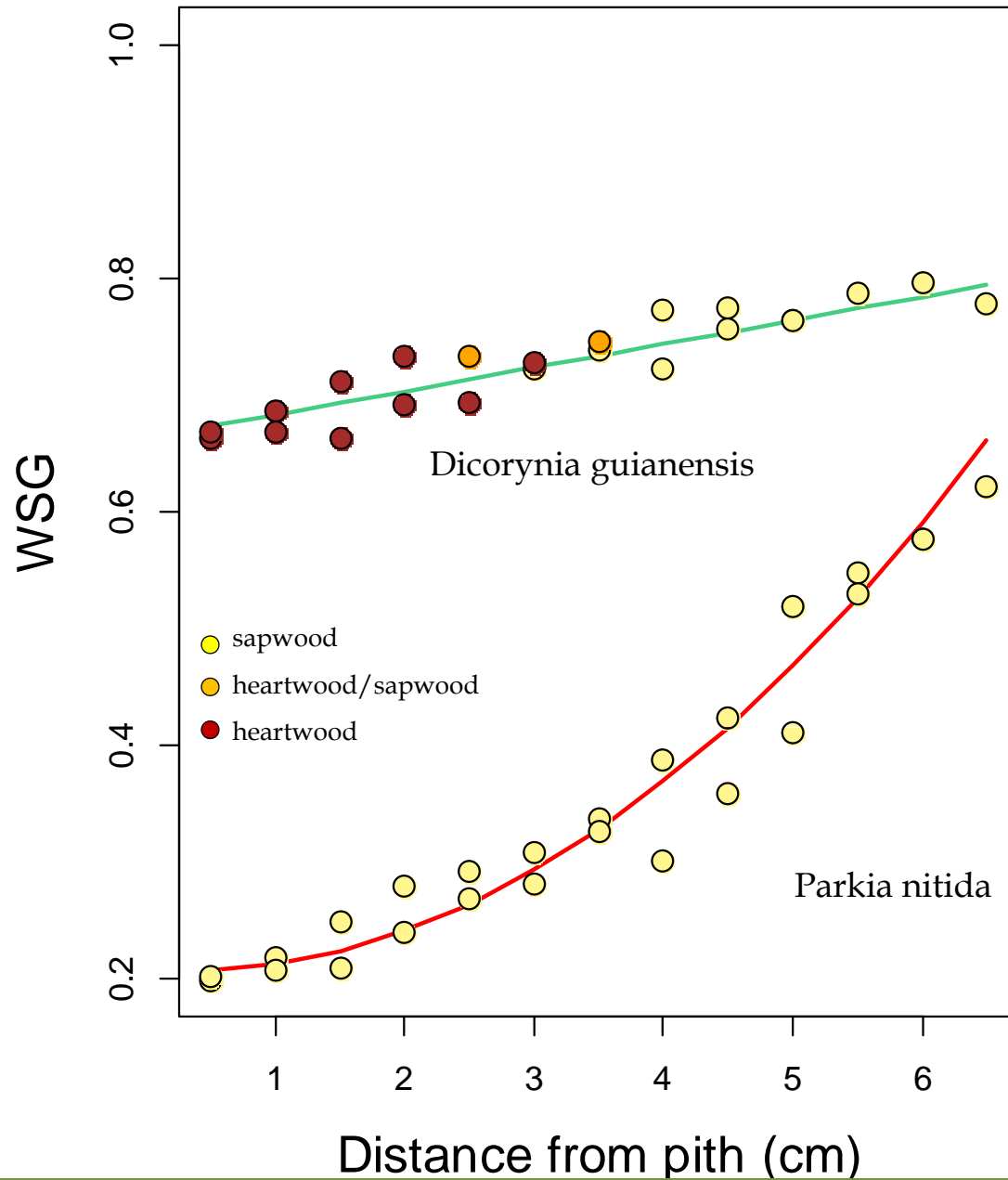


Results: Radial trends (1)



Convex curvilinear increase

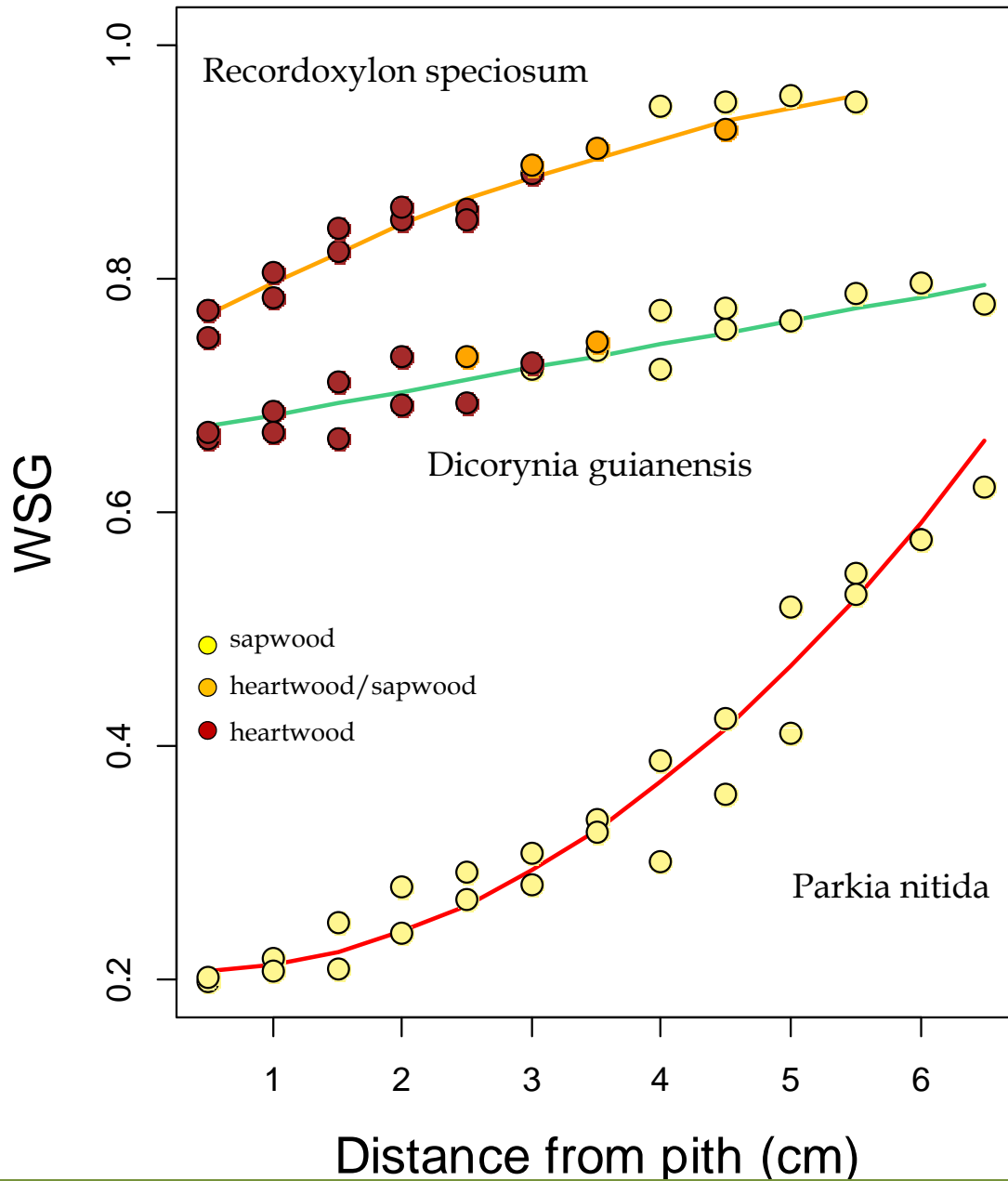
Results: Radial trends (1)



Linear increase

Convex curvilinear increase

Results: Radial trends (1)



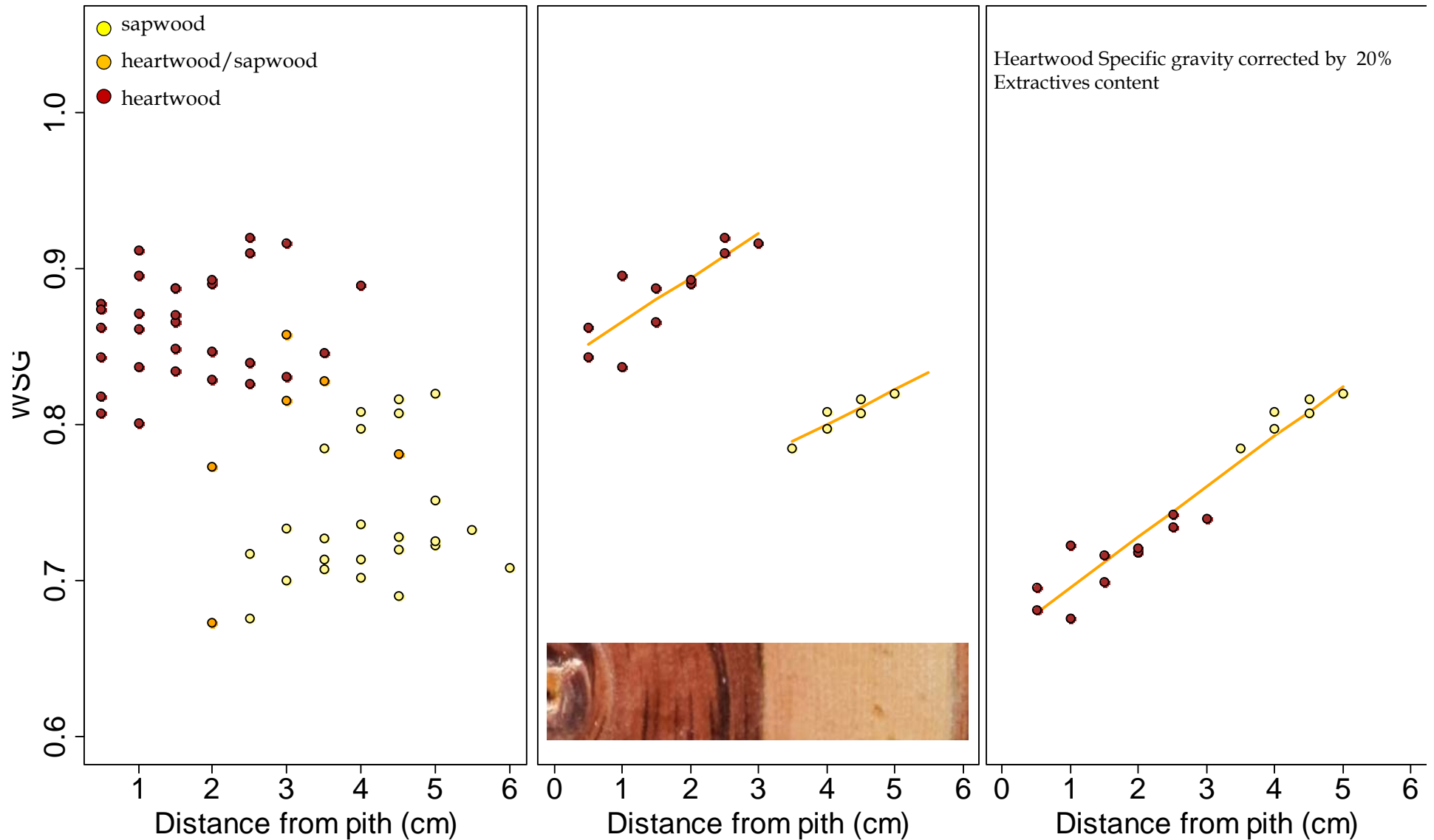
Concave curvilinear increase

Linear increase

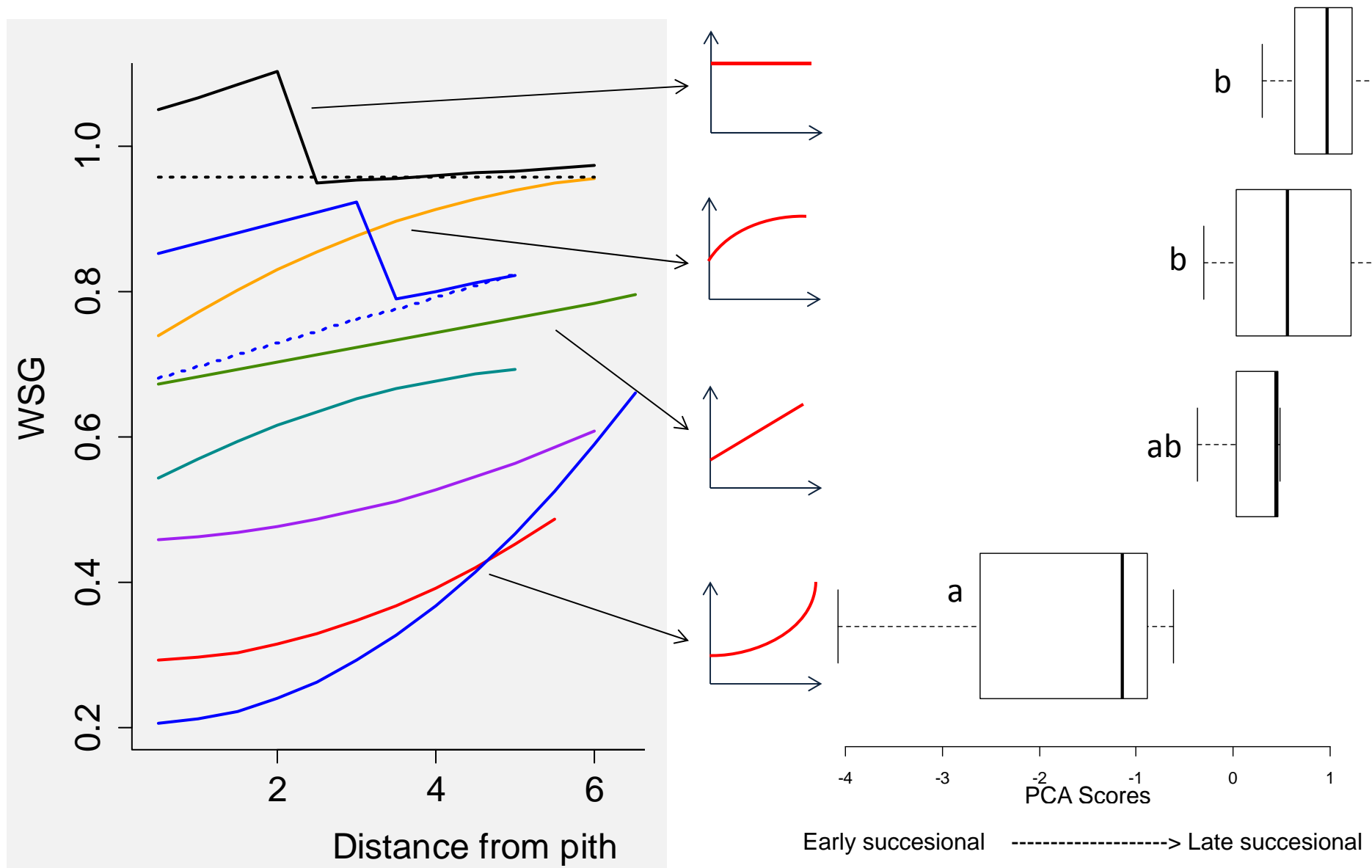
Convex curvilinear increase

Results: Radial trends (2)

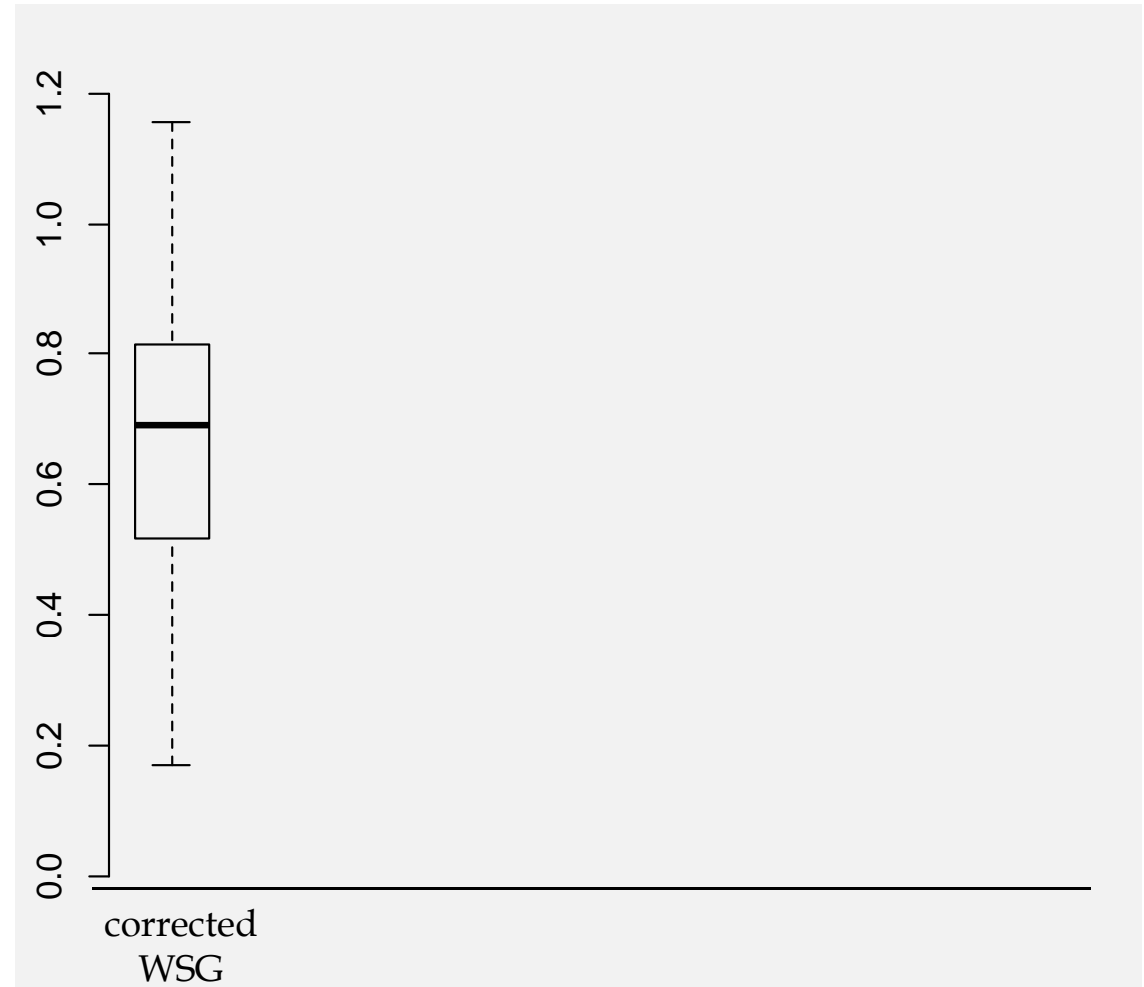
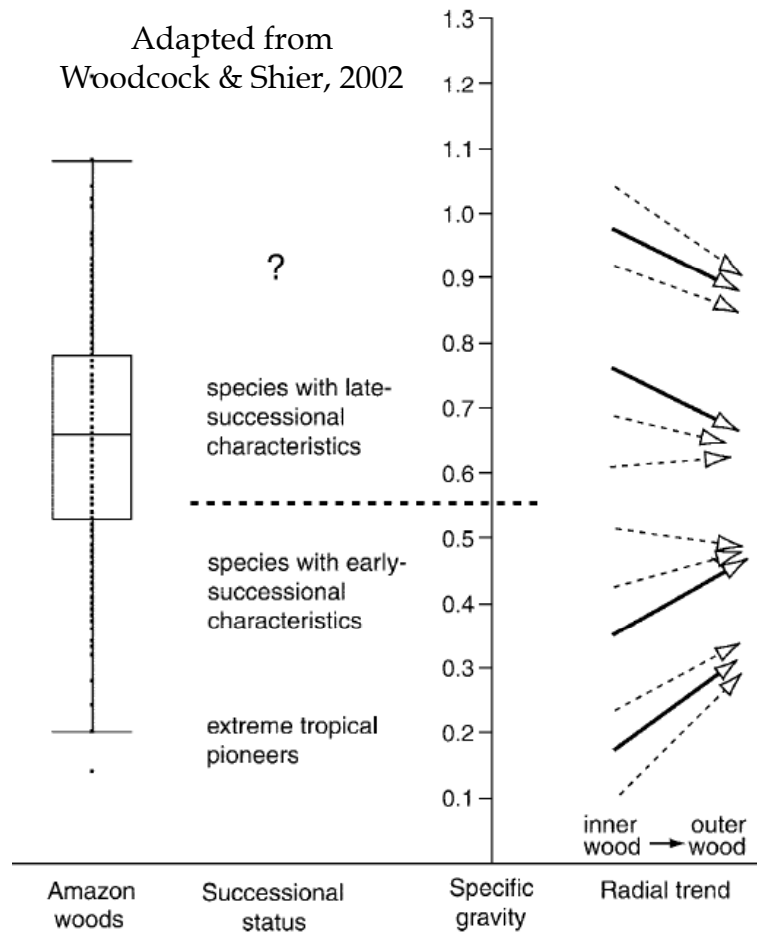
Eperua grandiflora



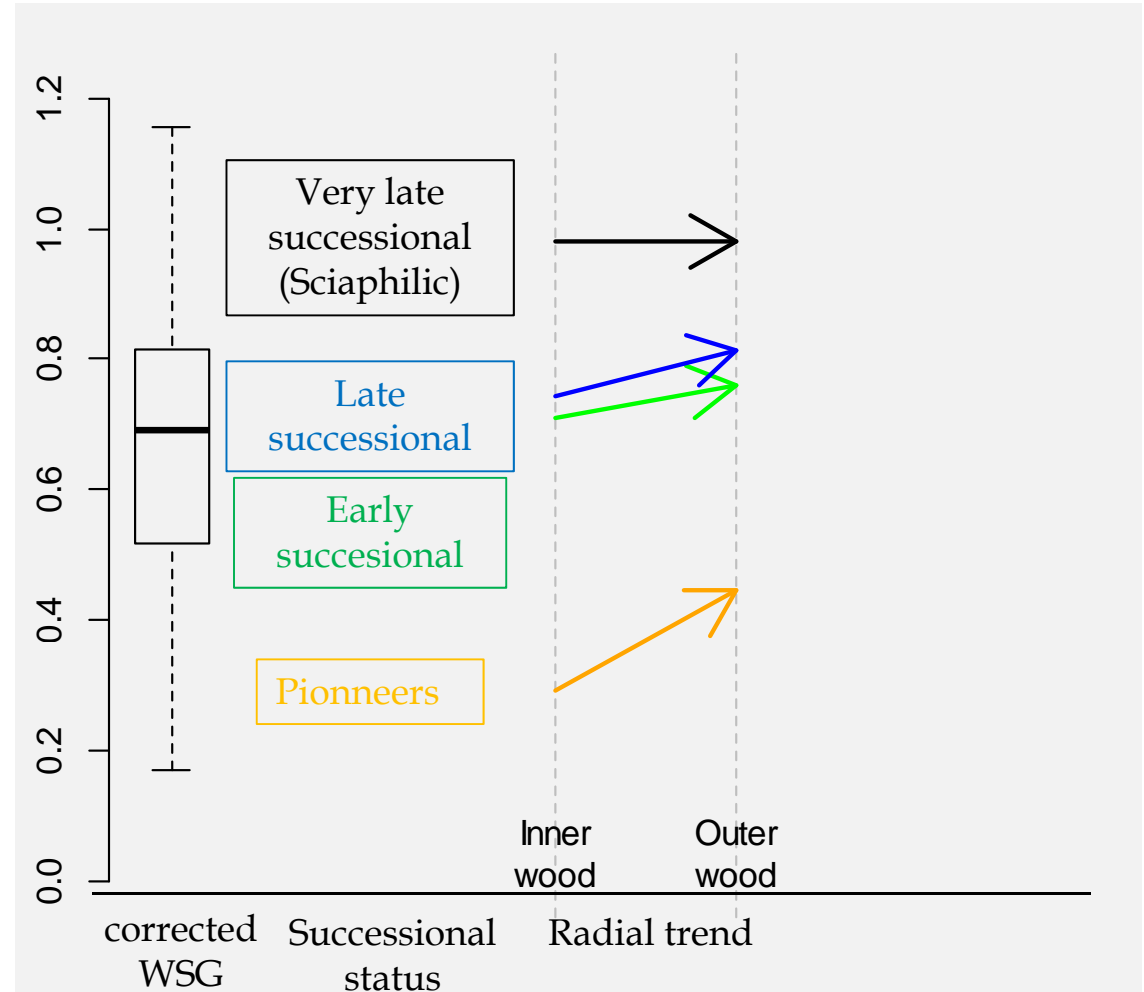
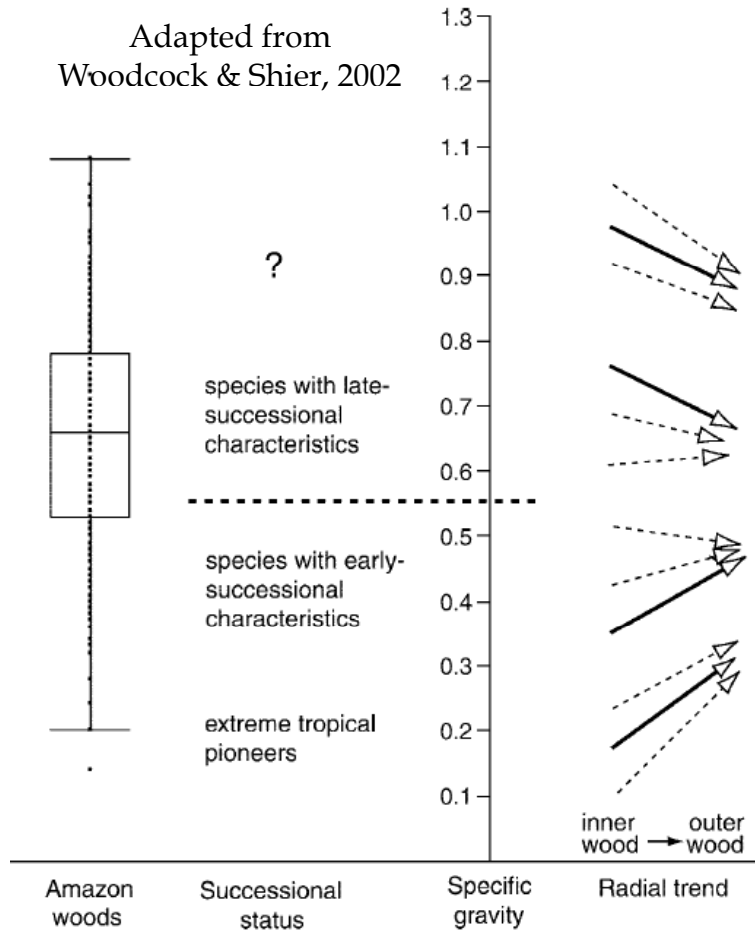
Links between radial trends and successional status



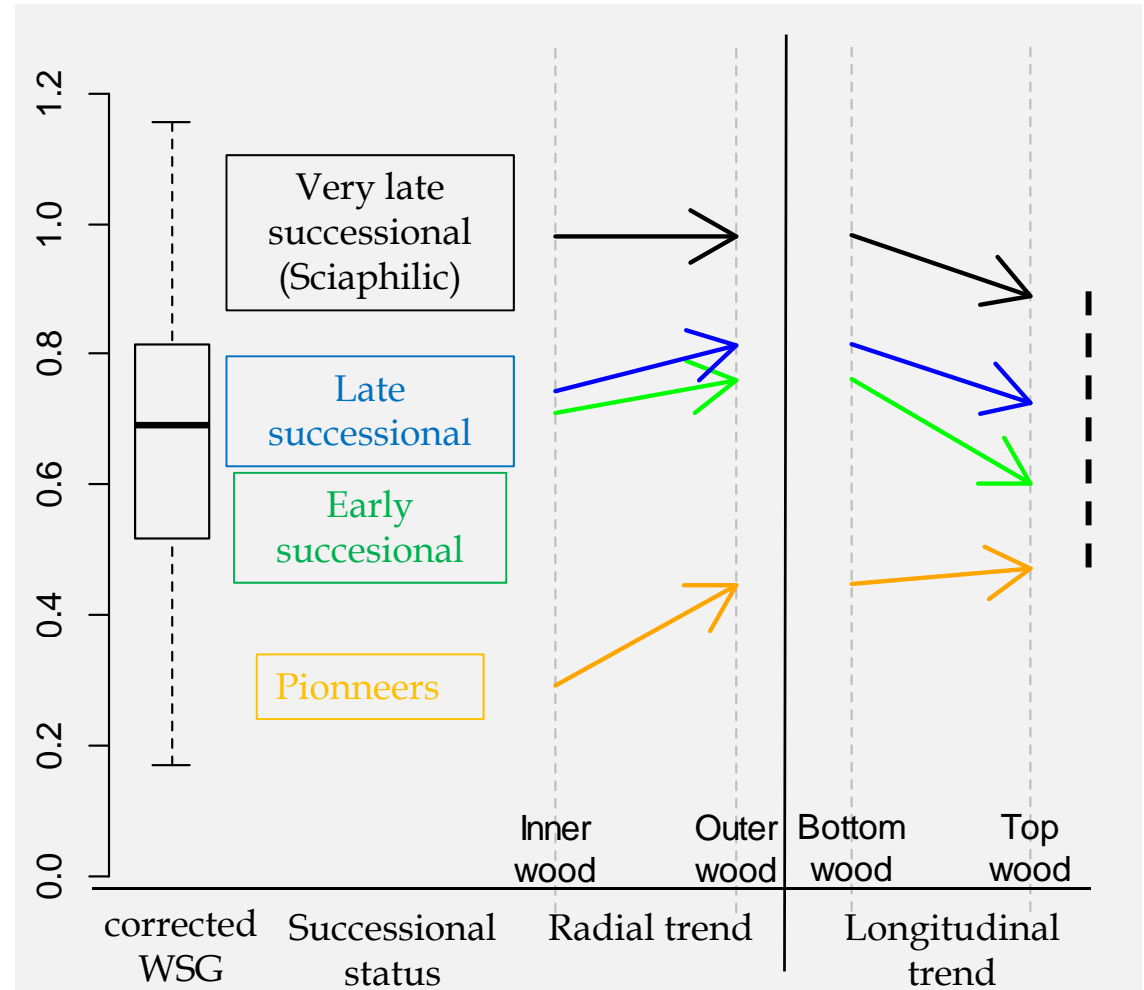
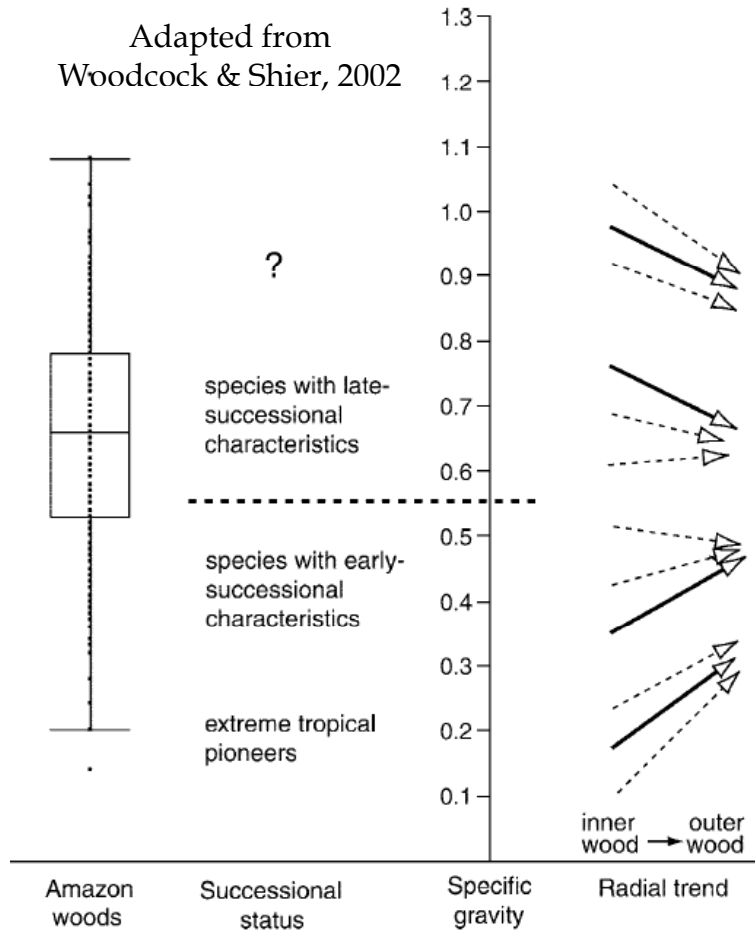
Links between radial trends and successional status



Links between radial trends and successional status



Links between radial trends and successional status



Conclusion

1. Radial and longitudinally variations ?

- Increase or constant WSG along the radius but NO radial decrease !
- Decreasing WSG from bottom to top is a general case, excepted for species with low WSG.
- All studied species tend to the same range of WSG values with height (~ 0.6-0.9) !
Supported by a higher WSG under bark within trunk

2. Radial trends of WSG // the effect of heartwood?

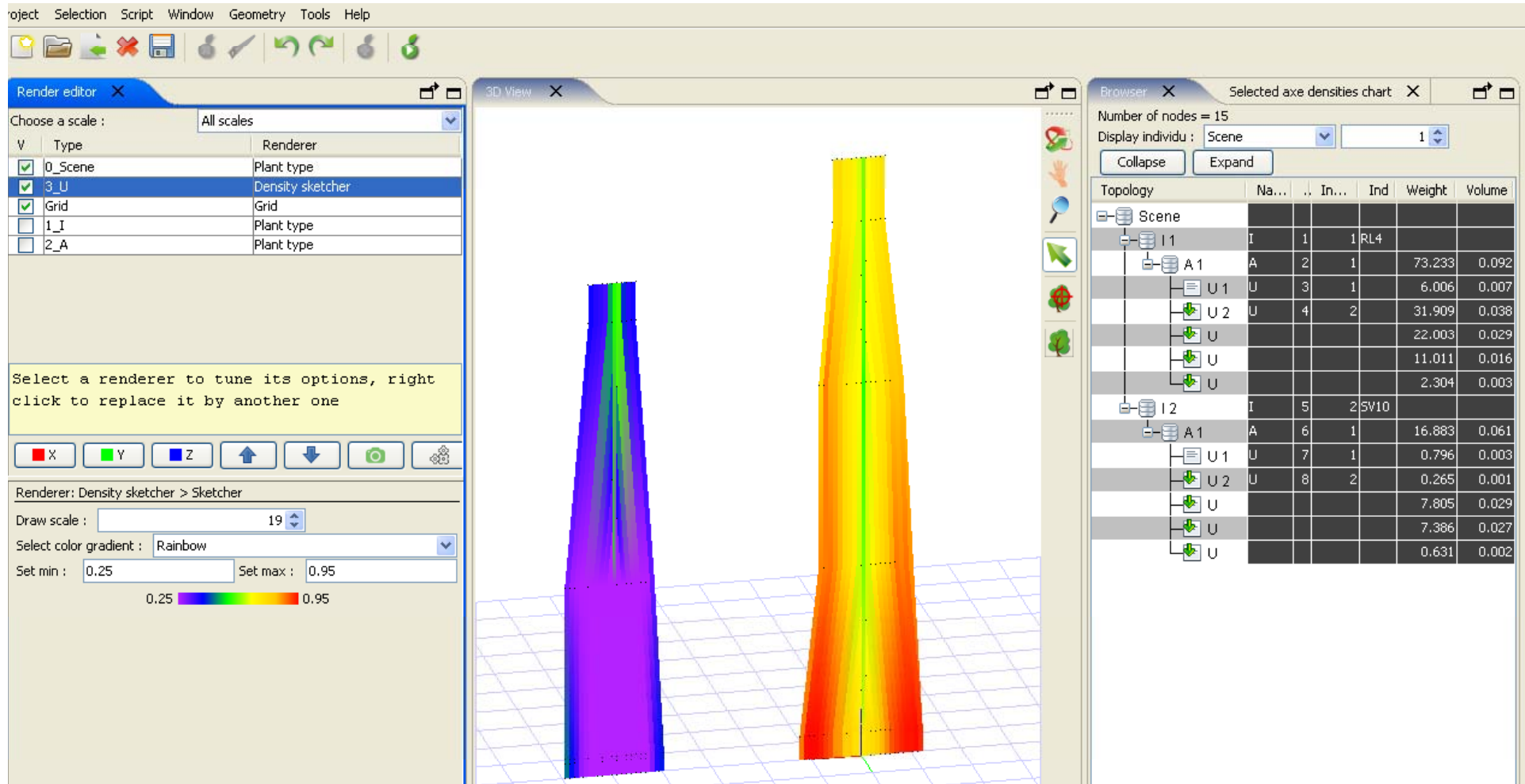


- Potential decreasing trends are due to heartwood effect in our samples.

3. Does these variations and patterns, are related to the successional status of the species ?

- Extreme radial increase & slight increase with height = pioneers species.
 - Radial increase & longitudinal decrease = late successional
 - Sciaphilic species differs by their constant WSG across the radius

Xplo Software to visualize and compute biomass estimates ..



Parkia nitida

Swartzia panacoco

Biomass estimate by Xplo

16.8 Kg

73.23Kg

Biomass estimate by WSG under bark at 1m30

25.9 Kg

85.1 Kg

Over-estimation 35%

Over-estimation 14%