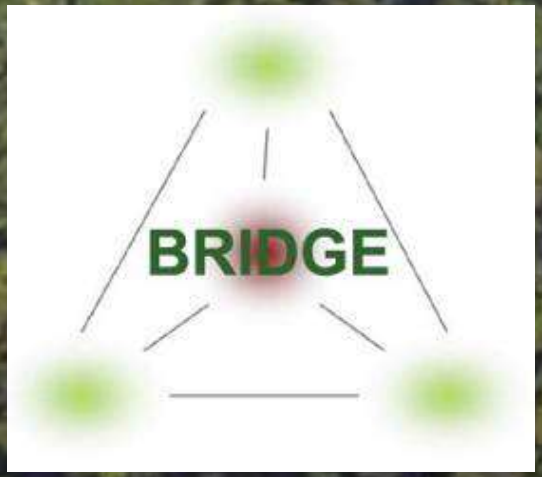


Work Package 2: Functional Traits

1. Introduction to traits
2. Objectives of WP2
3. Measures and limitations
4. Protocols
5. Discussion

Why do we measure traits?

- Identification
- Allocation-based tradeoffs
- Adaptation to environments
- Defining niche space
- Evolutionary patterns
- Estimate of Functional Diversity

A History of Plant Trait Measures

In French Guiana – UMR EcoFoG

1990s Wood Properties (Beauchene, Fournier, Thibauts)

- Niche definition (Hutchinson)
- Axes of plant strategies (Grime, Tilman, Huston)
- Phylogeny and comparative methods (Felsenstein, Westoby)
- Plant Trait Databases and Trait Correlations (I. Wright, Reich, Diaz)
- Linking Traits to Performance and Distributions (Ackerly, Poorter)

Life History Strategies (Sabatier, Forget, Baraloto)

Demographic traits and species groups (Favrichon, Gourlet, Collinet)

Ecophysiological Measures (Bongers & Sterck, Bonal, Roggy)

2000s Biomechanics (Fournier, Clair, Rowe, Speck, Tyree, Jaouen, Almeras)

Response to Light, Drought, Flooding (Coste, Born, etc.)

Establishment of Trait Database (Ollivier, Marcon)

Integration of New Researchers (Stien, Nicolini, Vincent, Herault)

Classifying Plant Functional Traits

http://ecofog.cirad.fr/Mariwenn/

Resource Acquisition

- Leaf Blade Surface
- Specific Leaf Area
- Leaf Thickness
- Leaf Dry Matter Content
- Chlorophyll (SPAD)
- Leaf longevity
- Photosynthetic rate
- Stomatal Conductance
- Stomatal Density
- Leaf N
- Leaf P
- Leaf $\delta^{13}C$
- Leaf $\delta^{15}N$
- Root:Shoot
- Hydraulic Conductance

Defense

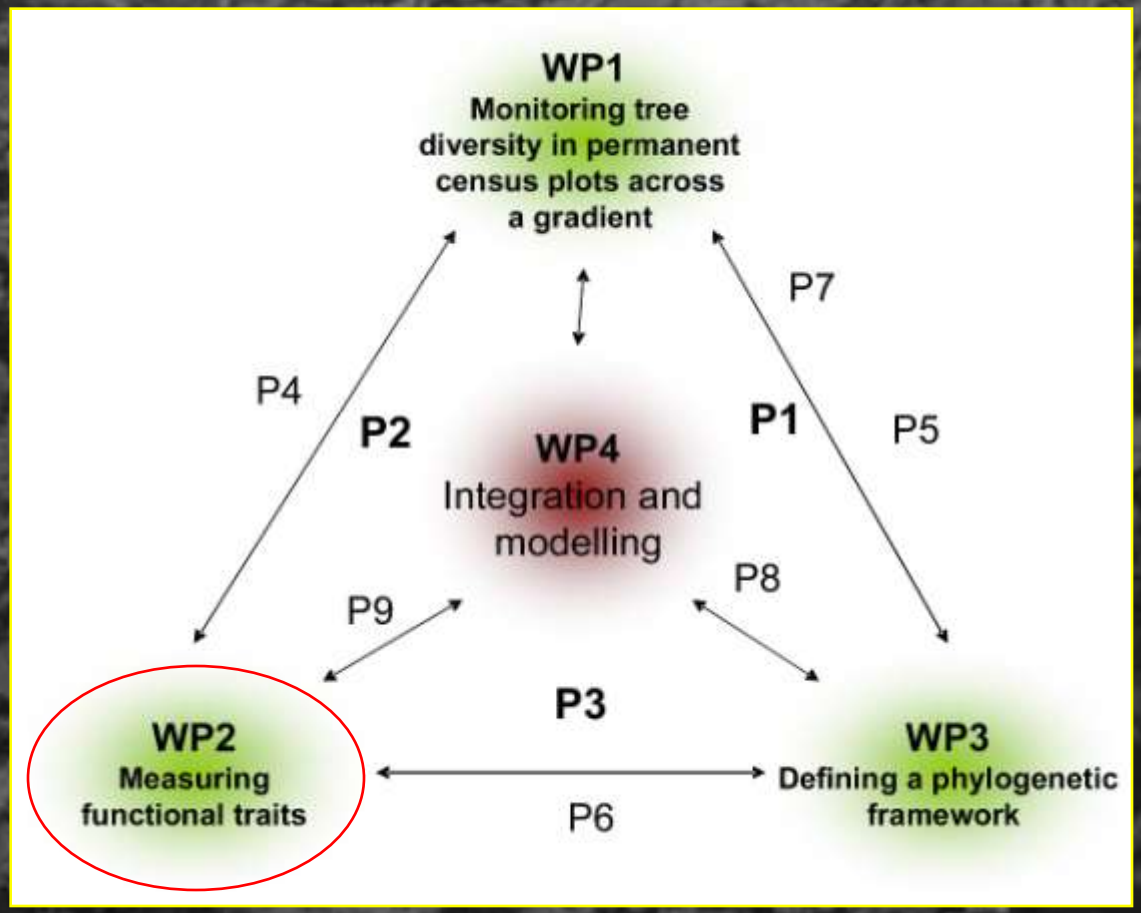
- Leaf toughness
- Leaf tissue density
- Leaf C:N
- Leaf phenols
- Leaf terpenes
- Wood density
- Wood anatomy
- Wood chemistry

Life History

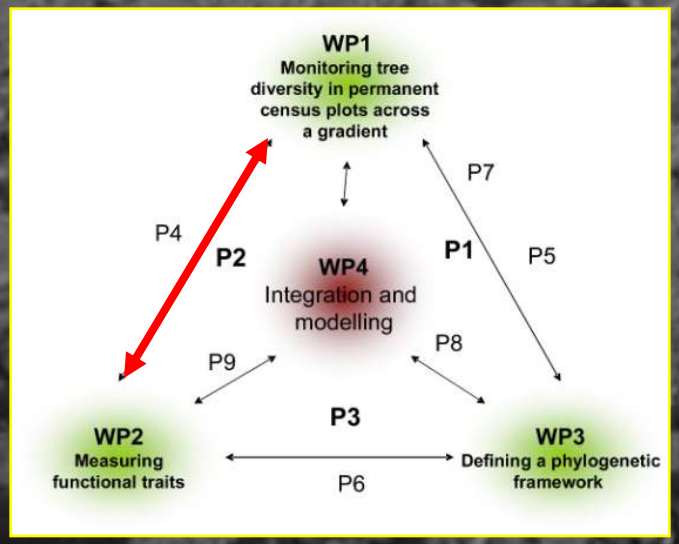
- Seed size
- Cotyledon Morphology
- RGR_{max}
- DBH_{max}
- $Height_{max}$
- Phenology
- Fruit biomass
- Dispersal Curves

Ollivier et al., *in press,* Annals of Forest Science

Objectives of BRIDGE WP2



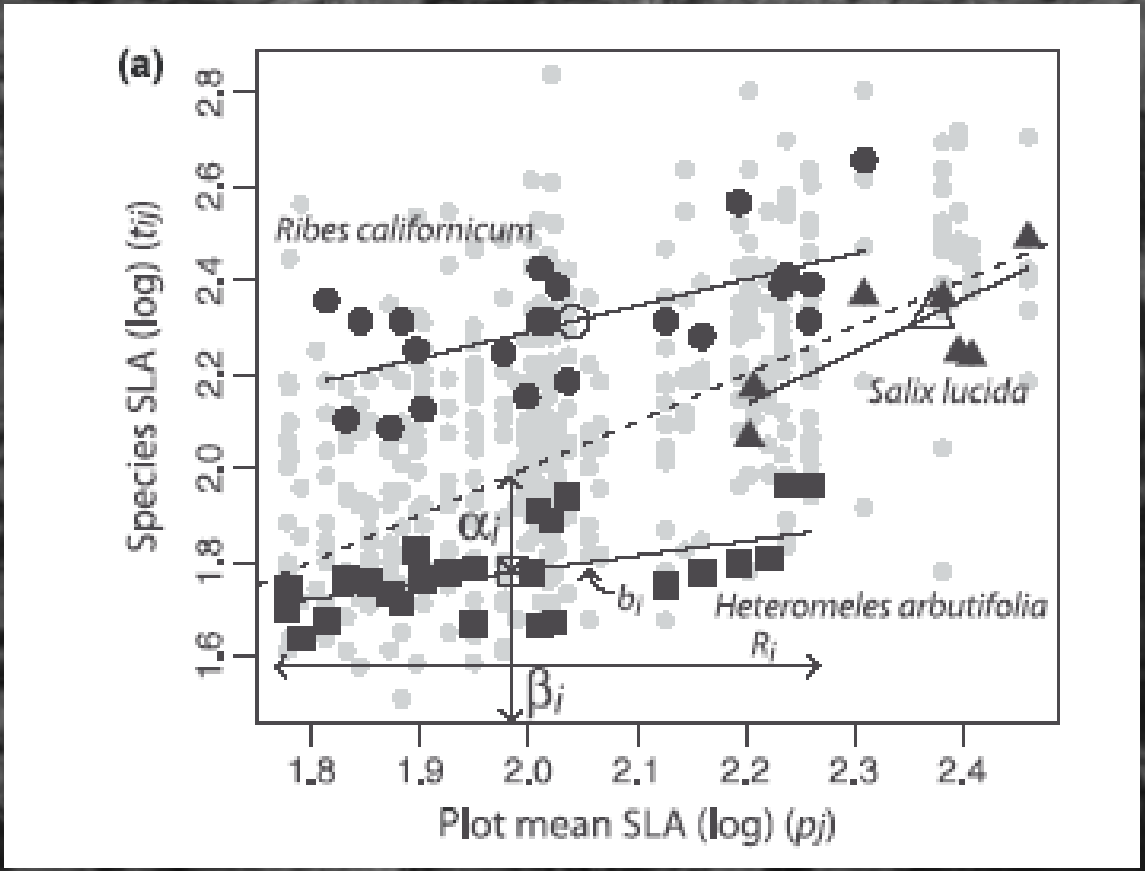
Objectives of BRIDGE WP2



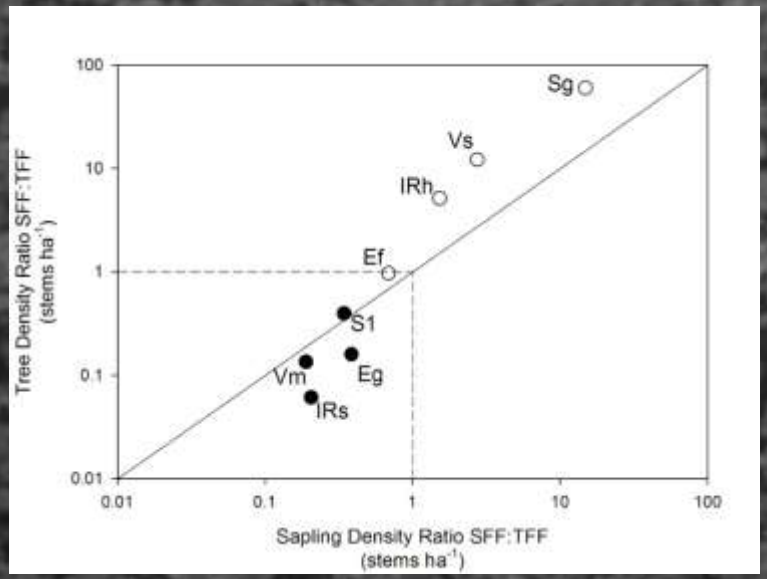
1. Test for *phenotypic* clustering vs. overdispersion
   - at plot scale
   - within plots (if pertinent environmental measures exist)

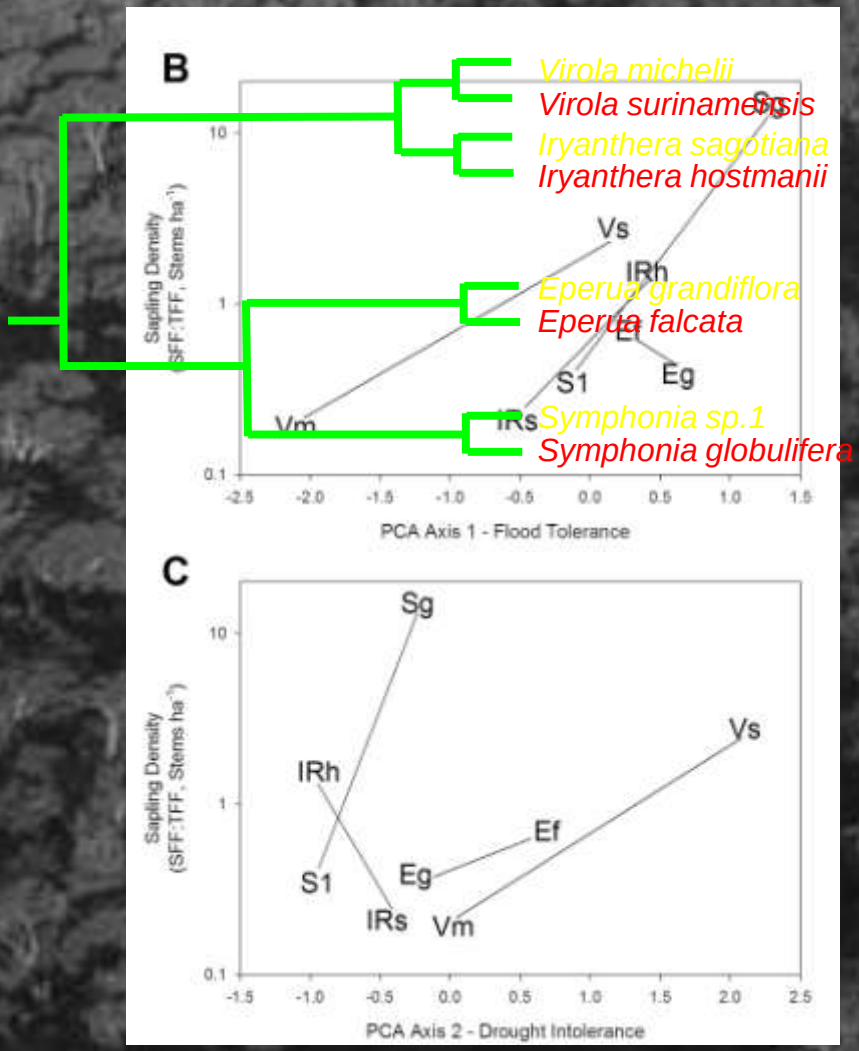
Importance of scale to process

alpha vs. beta traits (Ackerly et al. 2006, 2007)



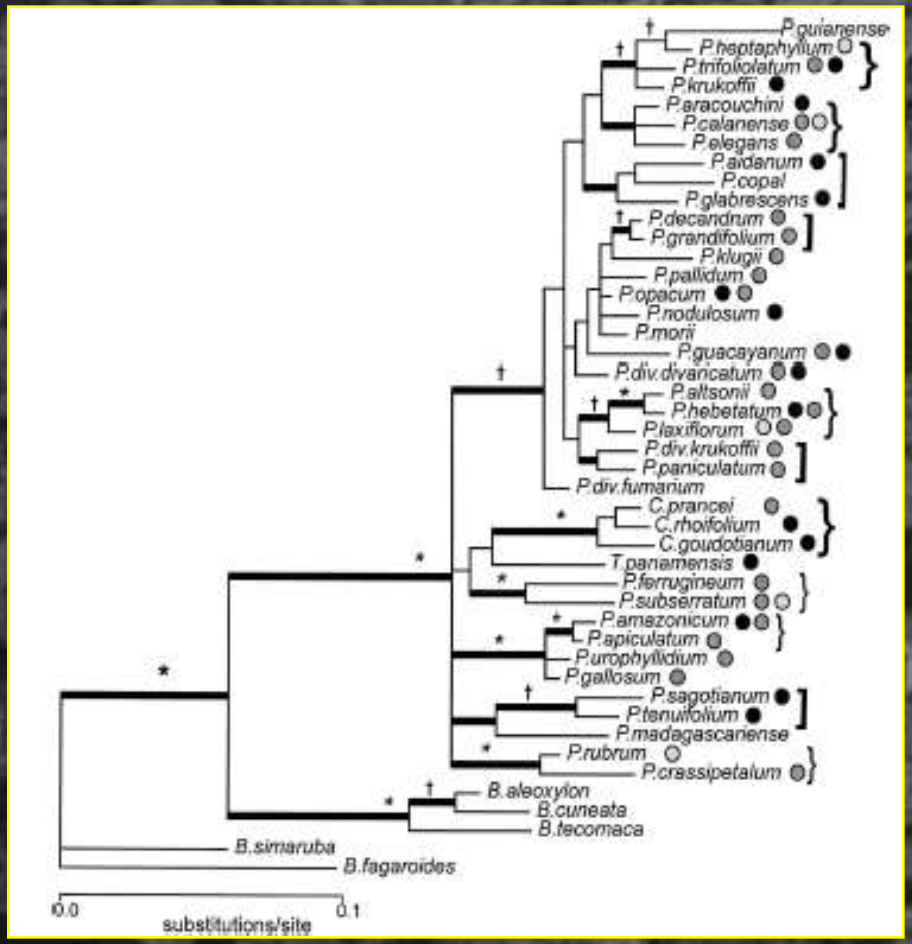
Local phenotypic clustering in flooded vs. terra firme forest

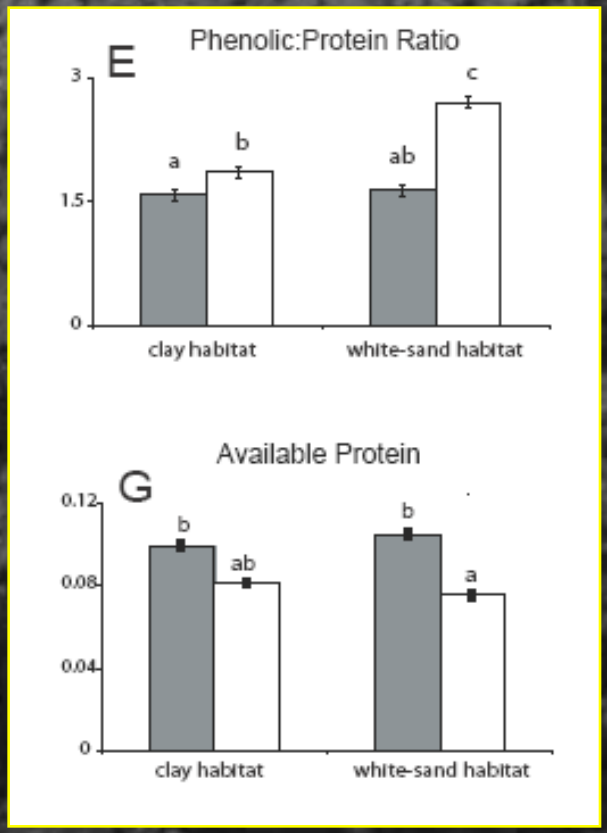




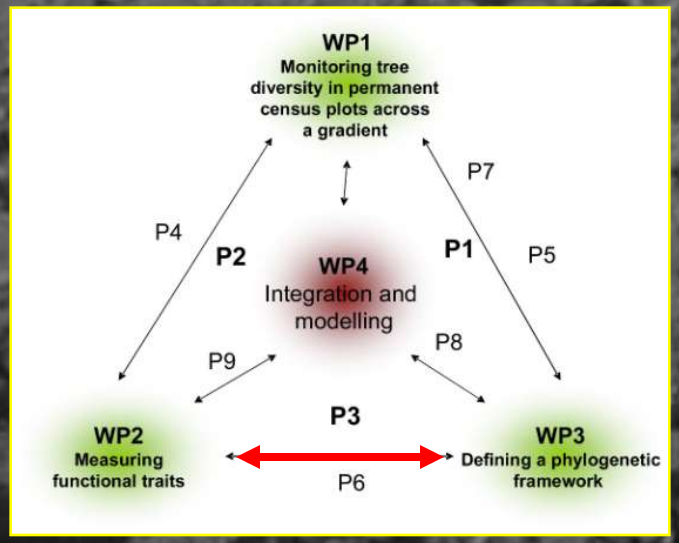
Regional phenotypic clustering in white sand vs. clay forest

Protium in Peru; Fine et al. 2005, 2006



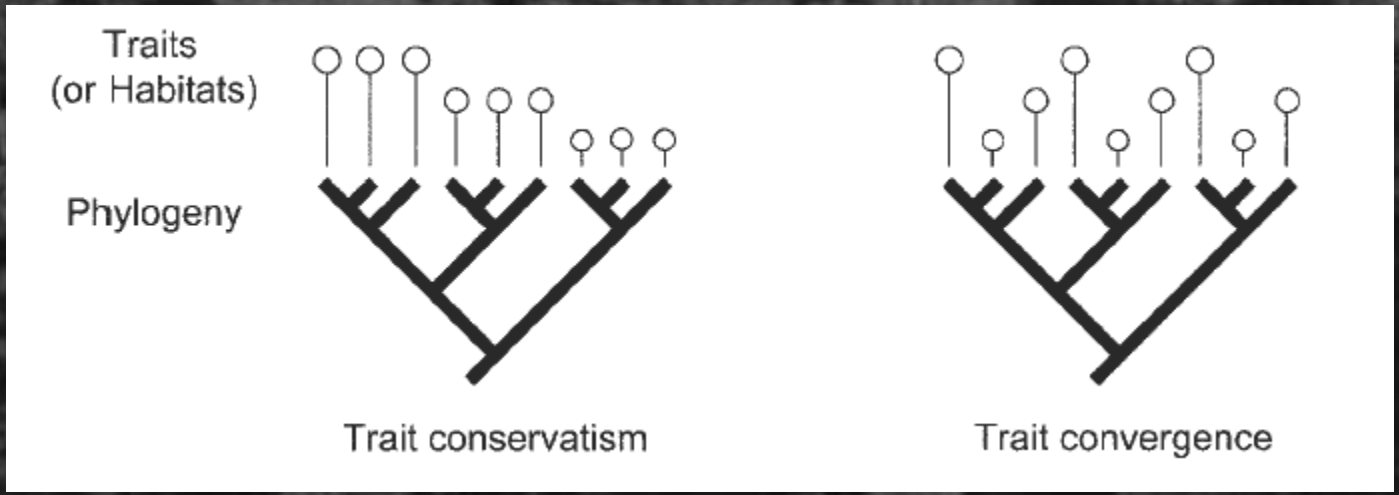


Objectives of BRIDGE WP2

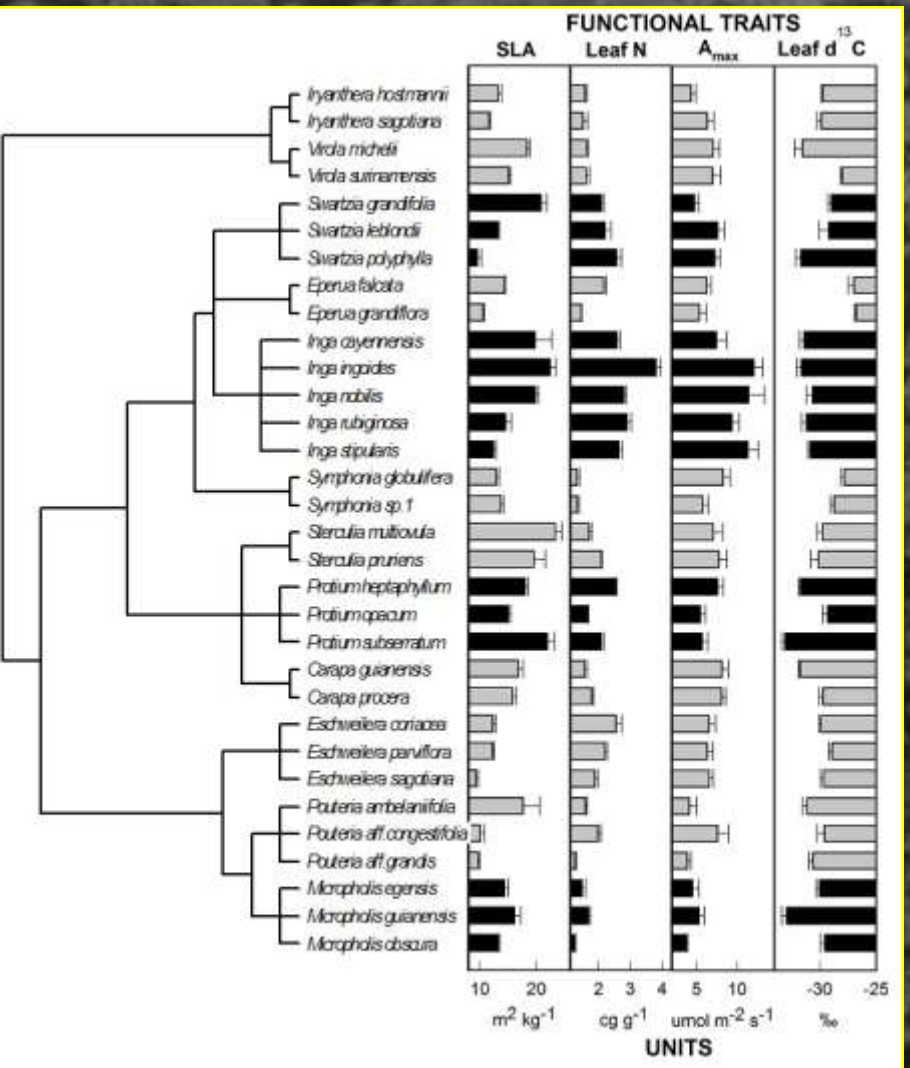


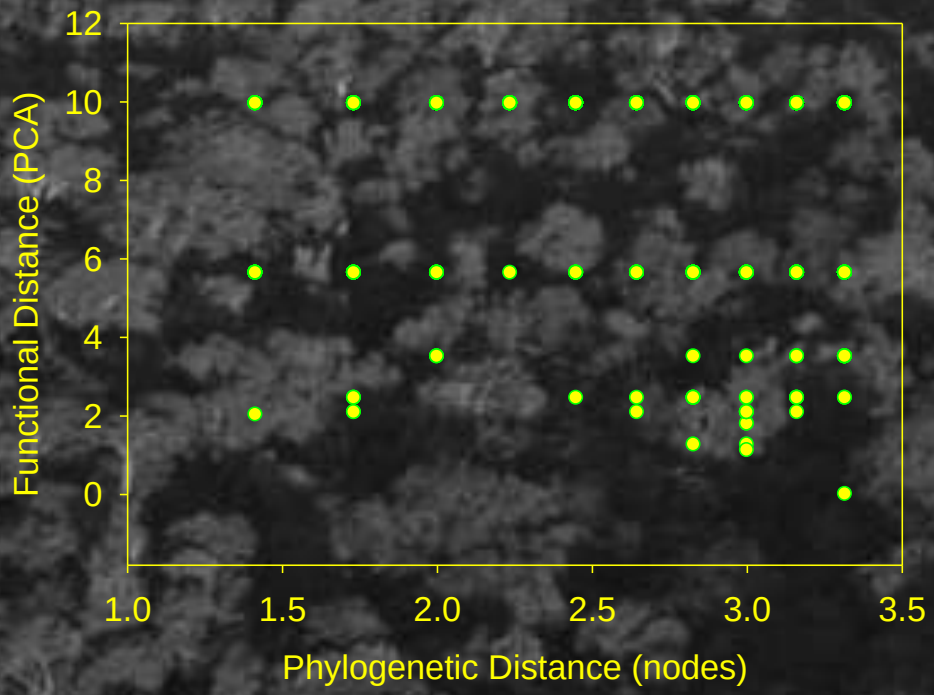
2. Test for evolutionary patterns in traits

- trait convergence at different taxonomic levels
- ancestral states

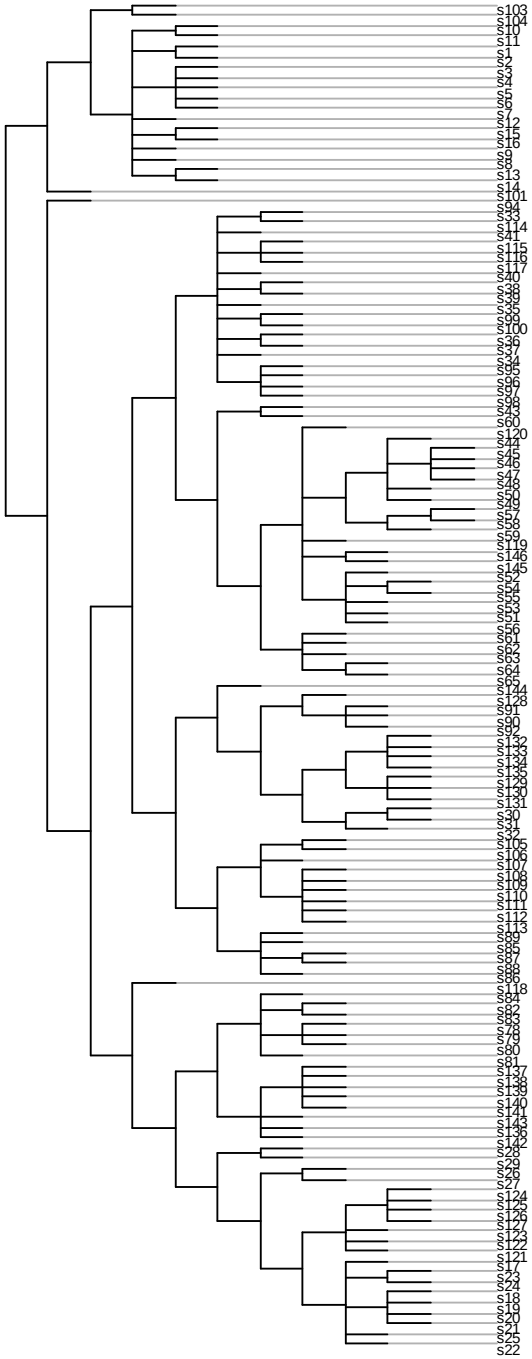


Evolutionary convergence in functional traits

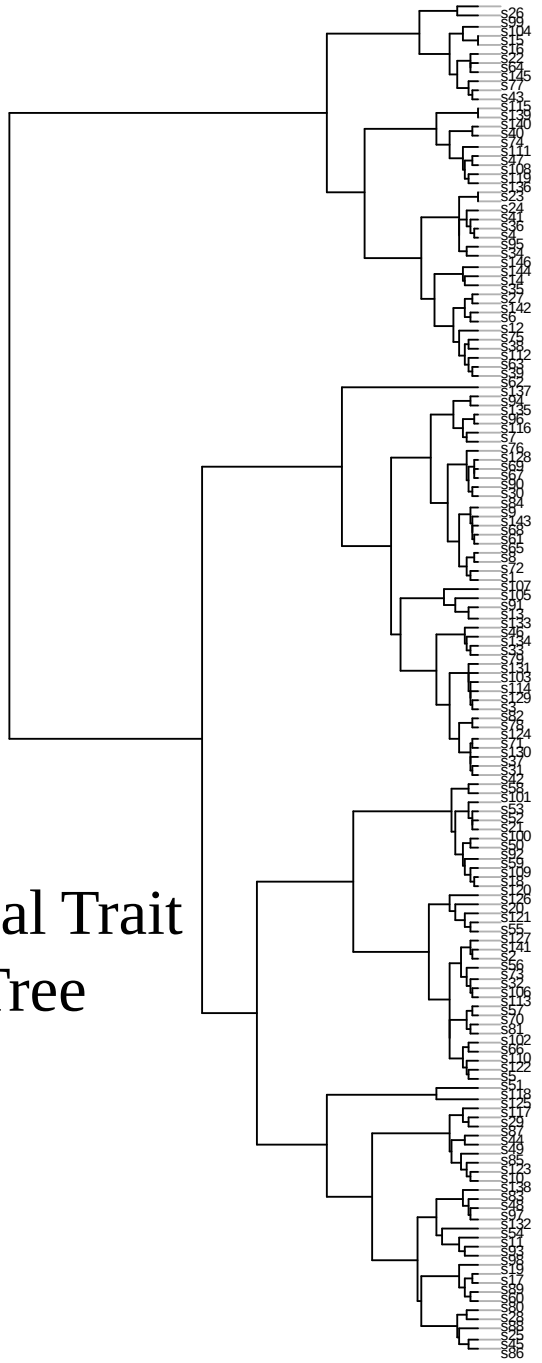




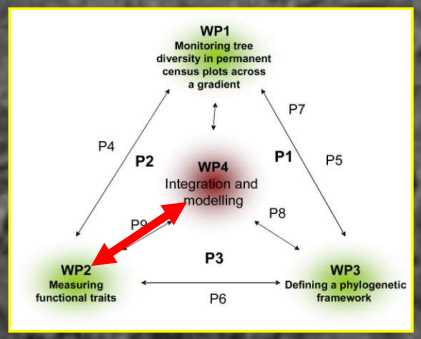
Phylogenetic
Cluster Tree



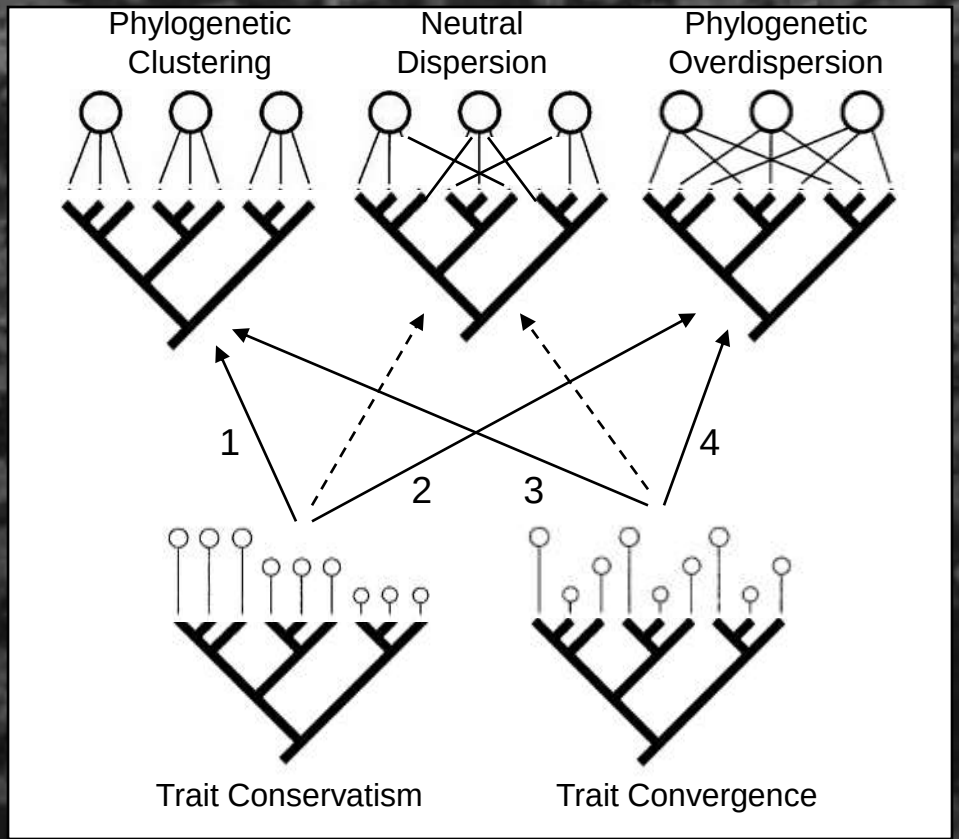
Functional Trait
Cluster Tree



Objectives of BRIDGE WP2



3. Contribute to test of niche vs. neutral vs. filtering



Which Traits, Why and How?

Resource Acquisition

- Leaf Blade Surface 2,3
- Specific Leaf Area 2,3
- Leaf Thickness 2,3
- Leaf Dry Matter Content 1
- Chlorophyll (SPAD) 1
- Leaf longevity 1
- Photosynthetic rate 1
- Stomatal Conductance 1
- Stomatal Density 2,3
- Leaf N 2,3
- Leaf P 2,3
- Leaf δ13C 2,3
- Leaf δ15N 2,3
- Root:Shoot 1
- Hydraulic Conductance 1

Defense

- Leaf toughness 2,3
- Leaf tissue density 2,3
- Leaf C:N 2,3
- Leaf phenols 1
- Leaf terpenes 1
- Wood density 1
- Wood anatomy 1
- Wood chemistry 1

Life History

- Seed size
- Cotyledon Morphology
- RGR_{max}
- DBH_{max}
- $Height_{max}$
- Phenology
- Fruit biomass
- Archit/syndromorph

Limitations

1 – Financial/Practical

2 – Individual Size/Age effect

3 – Environmental effect

Leaf Sampling Protocol - Field

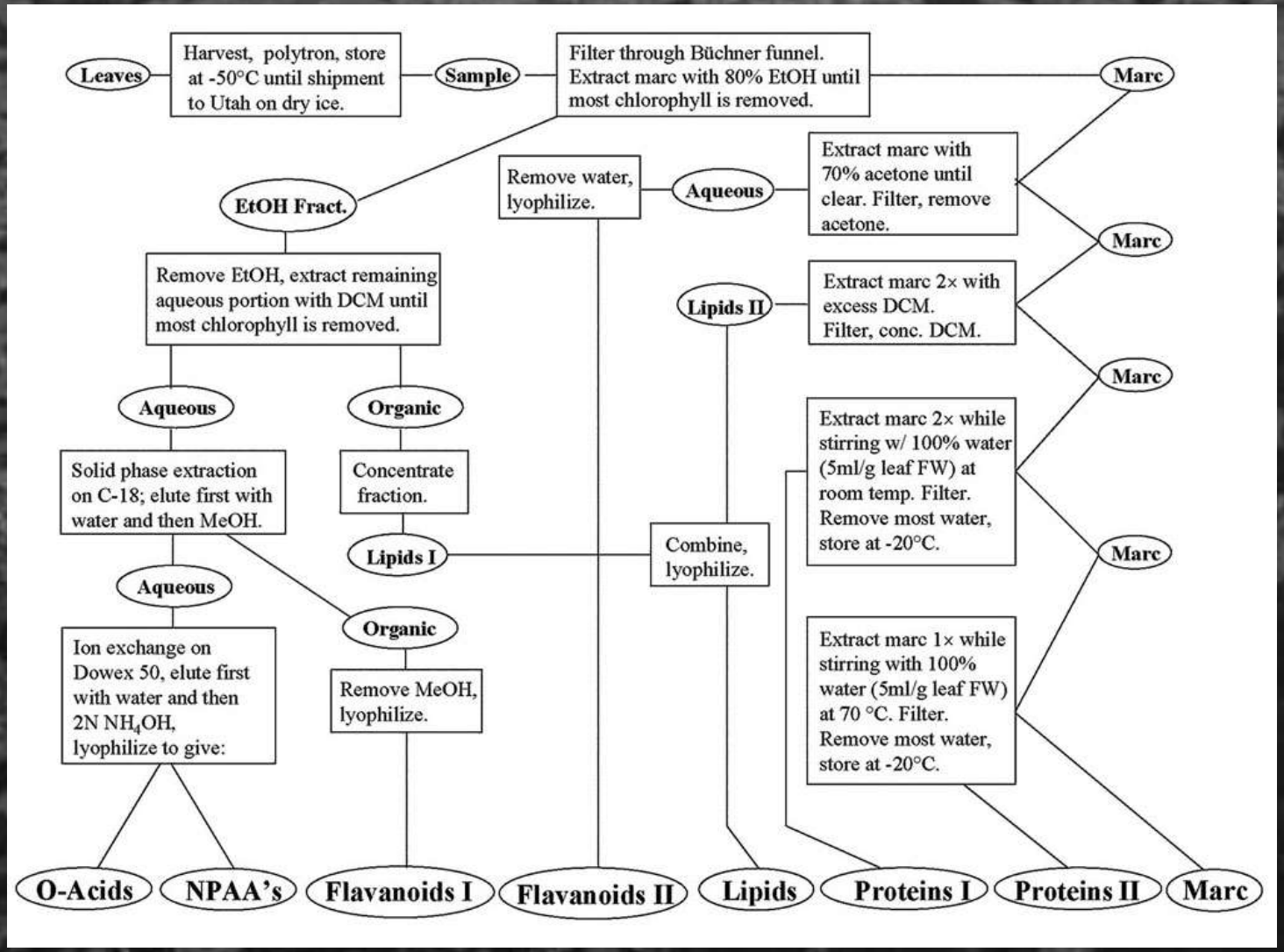
- Separate campaign for wood cores (?)
- One team for ALL leaf sampling (DNA, taxonomy, traits)
  - With tree ID inventory, 3-5 persons
- WP1 team will measure DBH, height
- Measure ALL individuals in ALL plots (?)
- Shoot or climb to get recent ‘sun’ leaves
- Note Dawkins Index for sample *and* individual
- Mark both sample and collection bag
  - 3 blades per individual for phys. traits (A,B,C)
  - 4-5 blades for defense traits in silica gel
- Separate sample for DNA and herbarium vouchers
  - if in 0.25 ha subplot for barcoding
  - if species identity is not 100%
  - if fertile and not very common taxon
  - fruit and seed collections separately if fertile
- Measure surface, thickness and toughness in field camp
- Prepare herbarium vouchers in field camp (with WP1 team)

Leaf Sampling Protocol - Lab

- Store Defense Samples separately
- Dry phys. samples to constant mass at 45 C
- Weigh three blades independently
- Initially, limit subsequent analyses to samples with twig DI > 2?
- Cut and varnish samples for stomatal density. Label and store.
- Grind three blades independently
  - tube with 500 mg for leaf P
  - tube with rest for storage
  - from storage, weigh 3mg sample in tin for C,N, isotopes

Leaf Sampling Protocol – Lab

Coley Lab Defense Assays



Wood Sampling Protocol

- Separate campaigns after first inventory?
  - make use of taxonomic ID, DBH and maps for individual selection (these already exist in many of the plots)
- Cores with chain-corer – permanent damage?
- Separate samples with core depth?
- Separate samples for chemistry and anatomy/density?
- Samples to CIRAD Lab for analyses of anatomy/density
- Samples to CNRS Lab for analyses of chemistry

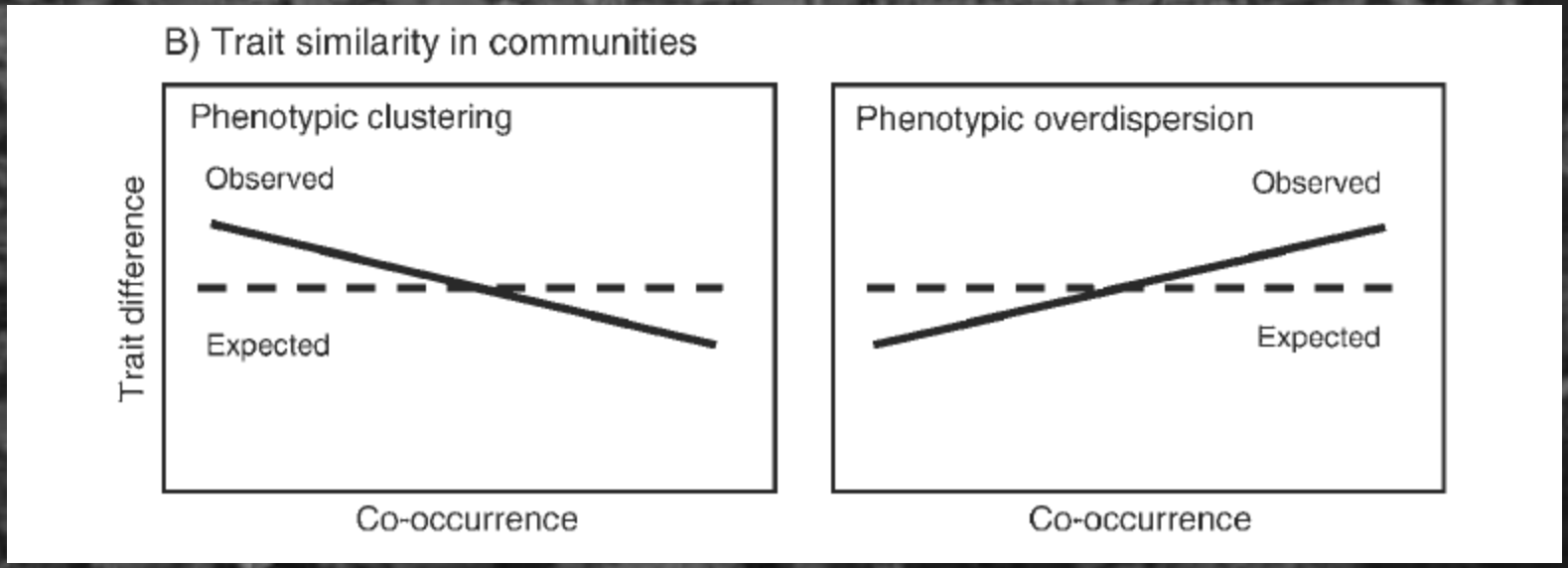
Database considerations

- Links to individual especially for taxonomic ID
  - Sample Labels Extremely Important
- Taxonomic Identification
  - must note who applied name, when and based on what criteria (especially give reference voucher number or specialist name and date)
- Identify needs in *Mariwenn* for life history traits
  - Do we need phenological inventories?
  - If linking to database of Sabatier et al., we need to confirm all herbarium vouchers with *their* samples!

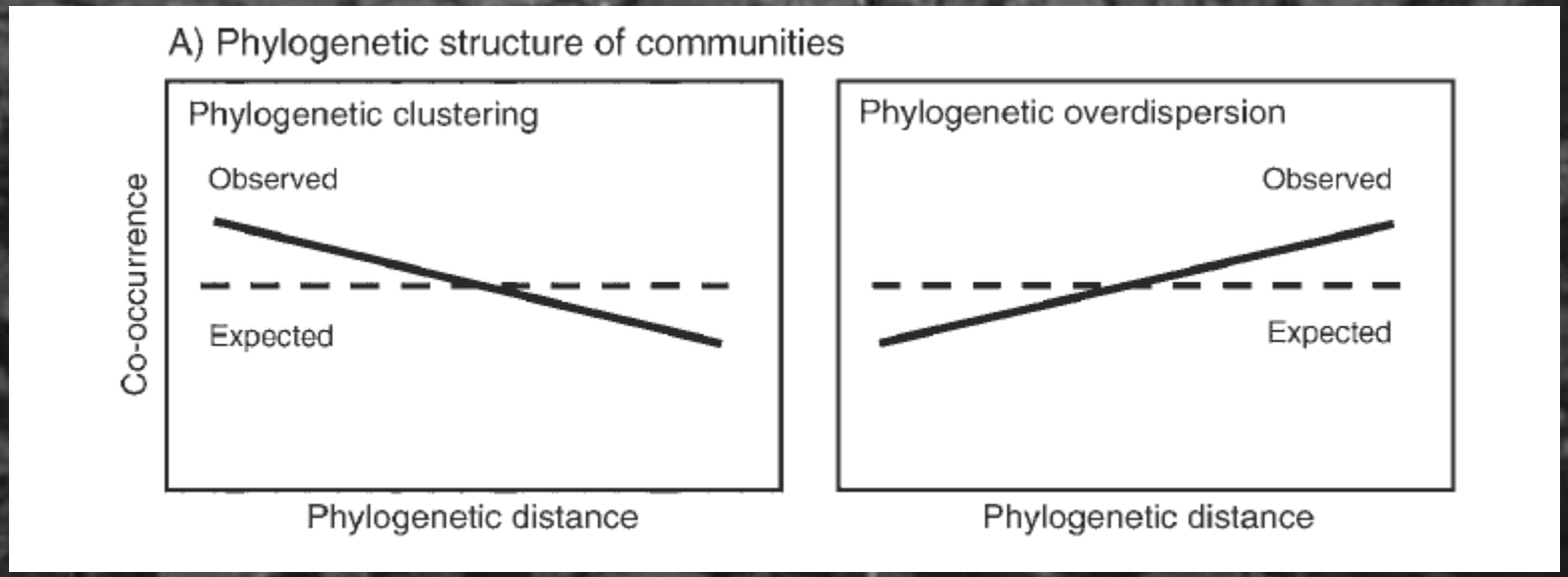
Discussion Points

- Sampling campaigns
  - separate for cores in some sites only
- Personnel and responsibilities
  - team with Botany: Petronelli, Baraloto, Goret, Engel
  - wood sampling team?
- Wood cores in permanent plots
- Wood traits for a subset
  - only for >30 cm DBH?
  - only for certain spp.?
  - only for certain plots?
- Leaf traits and environmental conditions
  - do we sample all individuals?
  - is the proposed strategy for initial anals of sun leaves OK?
  - are we missing any traits?
- Leaf defense chemistry – who? which budget?
- Other?

Measuring Phenotypic Structure



Measuring Phylogenetic Structure



Scale*Habitat and Phylogenetic Clustering vs. Overdispersion