

# Range Size and Local Demography in Neotropical Trees

## Large Plots Combined with Wide-Scale Collections

Richard Condit<sup>1</sup>



Smithsonian Tropical Research Institute

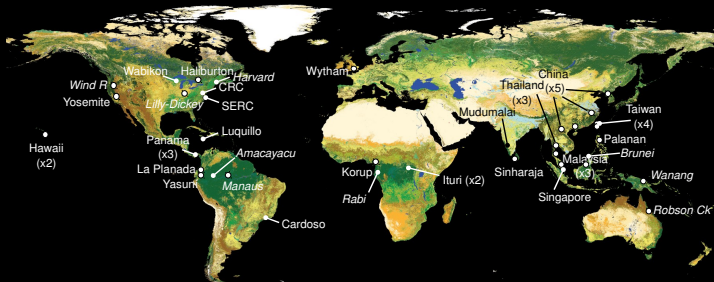
<sup>1</sup>SIGEO & Center for Tropical Forest Science

## Local dynamics and geographic range determined by species characteristics

- Wide-scale ranges correlated with local abundance
- Weedy pioneers have wider ranges
- Specialists have narrower ranges

# Center for Tropical Forest Science: Smithsonian & Harvard

SIGEO-CTFS: A network of forest censuses following common methods



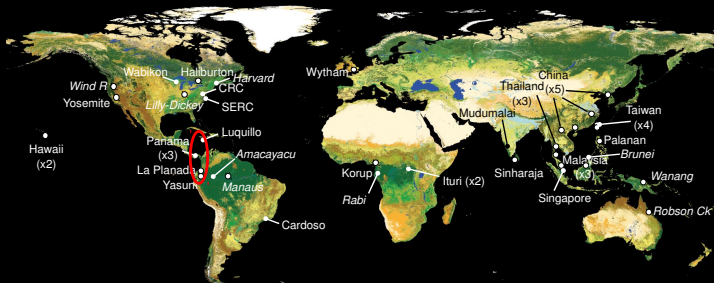
33 completed plots have data in a common database format on one of 4 servers

-- 3,802,654 trees (ie  $3.80 \times 10^6$ )

-- 9,073,531 measurements (ie  $9.07 \times 10^6$ ) in 89 plot censuses

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SIGEO-CTFS: A network of forest censuses following common methods



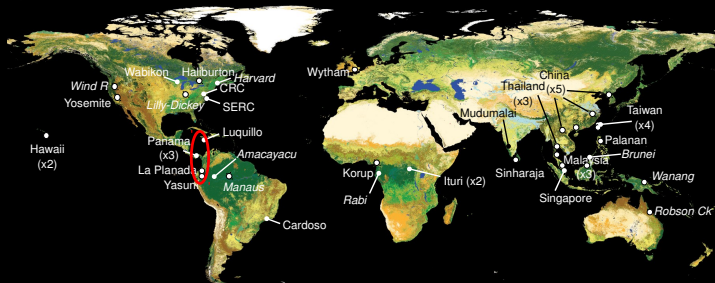
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SIGEO-CTFS: A network of forest censuses following common methods



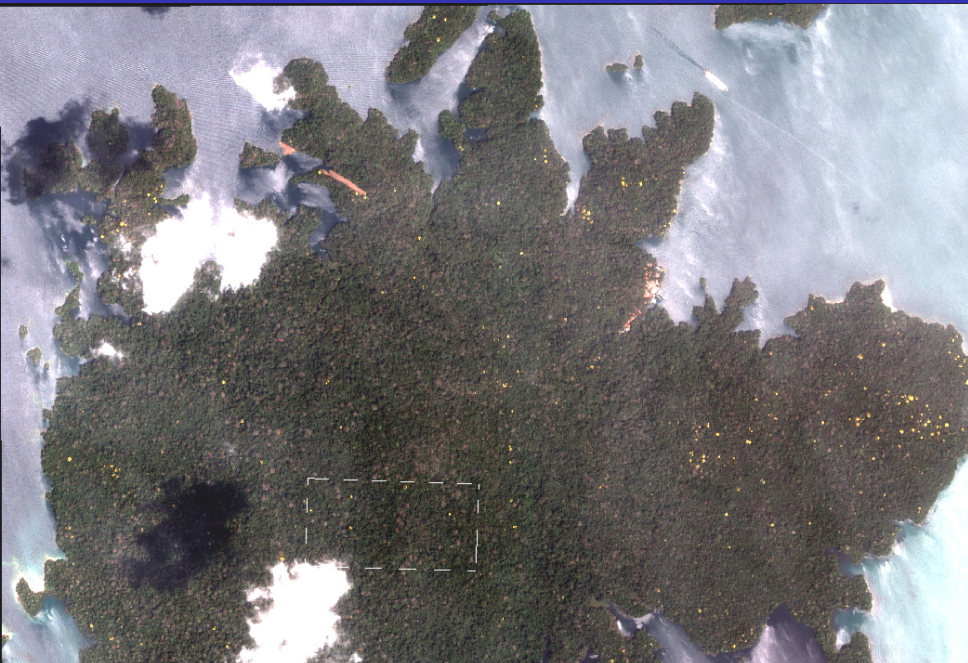
Yasuni: Renato Valencia et al.

Luquillo: Jess Zimmerman et al.

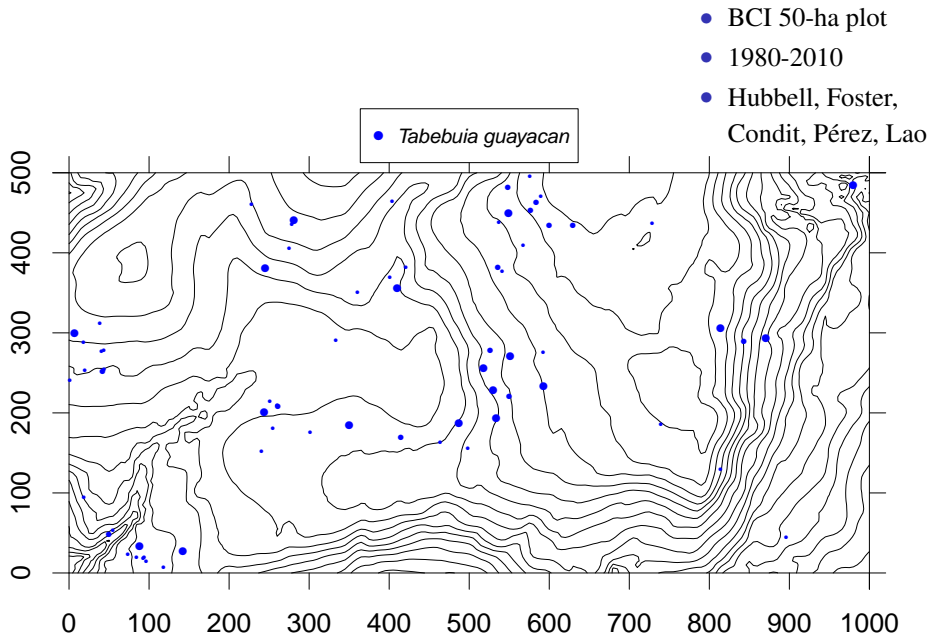
La Planada: Cristian Samper et al.

BCI: Hubbell & Foster et al.

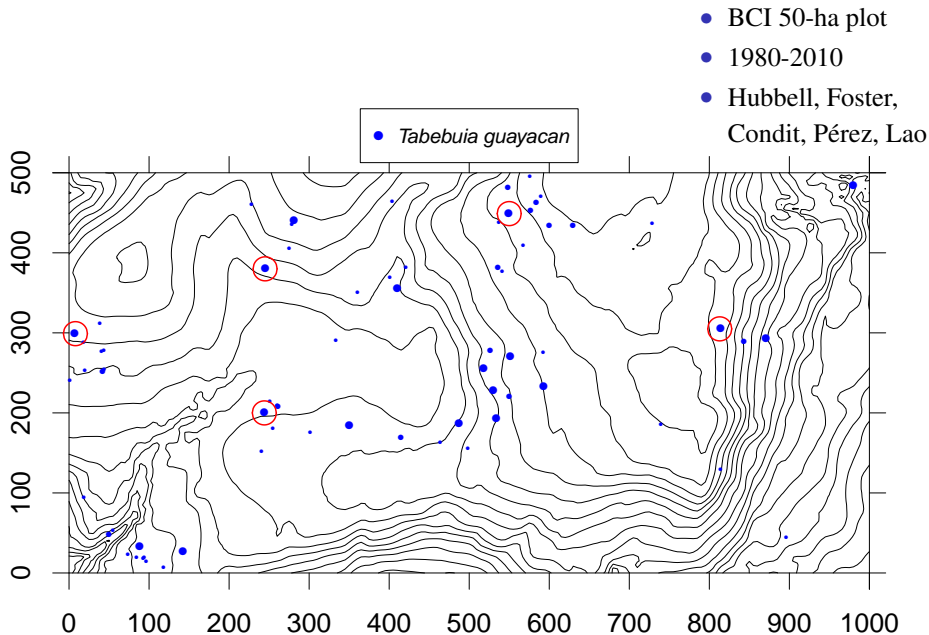
# CTFS forest census plots



# Barro Colorado census plot



# Barro Colorado census plot





# BIEN: Botanical Information for Ecology Network

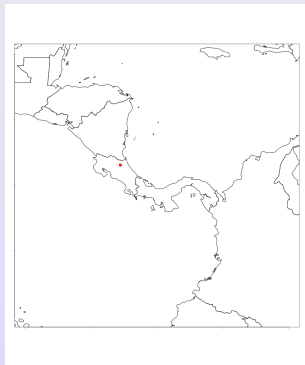
BIEN is a group of botanists interested in broad-scales in ecology and seeking ecoinformatic solutions



# BIEN: Botanical Information for Ecology Network

BIEN is a group of botanists interested in broad-scales in ecology and seeking ecoinformatic solutions

- seeking very large collections of plot and specimen data publicly available
- harmonizing the format and the taxonomy in order to maximize the records available
- offering convenient access



- B. Enquist (Arizona)
- P. Jørgensen (Missouri)
- B. Boyle (Arizona)
- S. Dolins (Bradley)
- R. Condit (STRI)
- M. Schildauer (NCEAS)
- R. Peet (N. Carolina)
- ... and more



## 1 CTFS plot network

## 2 BIEN Working Group

## 3 Local species

Species with very few records

Species with very localized records

## 4 Predictions from Macroecology

Abundance and range size

Demographic characters and range size

## 5 Conclusions

Macroecology

Poorly-known species

- 12 million occurrences in a single table



*Faramea occidentalis*

- 12 million occurrences in a single table
  - Abundances for a single species from a single plot
  - Herbarium specimens with locations (e.g. Missouri)



*Faramea occidentalis*

- 12 million occurrences in a single table
- 11.2 million occurrences in the Americas



*Faramea occidentalis*

- 11.2 million occurrences in the Americas
- 6.6 million have precise coordinates



*Faramea occidentalis*



- 11.2 million occurrences in the Americas
- 6.6 million have precise coordinates
- The taxonomy challenge
  - 9.4 million records have a verifiable Latin binomial
  - 5.6 million have coordinates as well



*Faramea occidentalis*

- 550,000 distinct Latin binomials in 12 million records
  - Many incorrect
  - Many spelling 'variants'
- 260,000 names can be matched to authoritative list (Missouri)
- 191,566 names in the Americas



*Symphonia globulifera*  
(plant photos Rolando Pérez)

# Very seldom-seen species

BIEN database occurrence records

191,566 valid names in the Americas:



*Palicourea guianensis*

# Very seldom-seen species

BIEN database occurrence records

191,566 valid names in the Americas:

- 80,027 have no records with coordinates
  - 34,810 with just one record
  - 65,333 occur in only one country
  - one-third are synonyms and thus not valid species (based on sample of 100 re-checked at Tropicos)



*Palicourea guianensis*

# Very seldom-seen species

BIEN database occurrence records

191,566 valid names in the Americas:

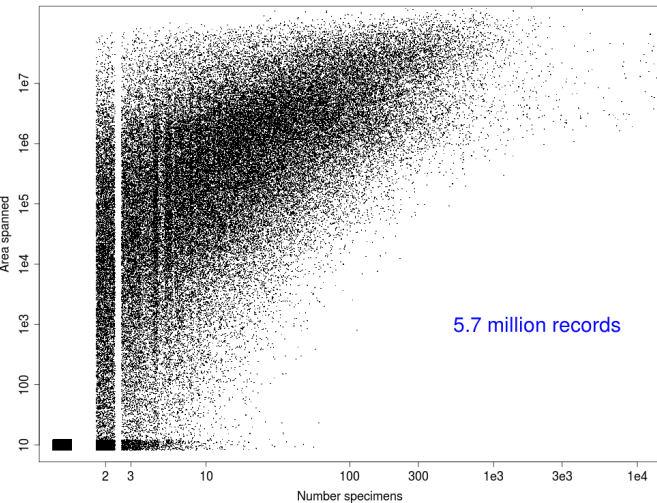
- 80,027 have no records with coordinates
- 111,540 have records with coordinates



*Palicourea guianensis*

# Range size based on coordinates

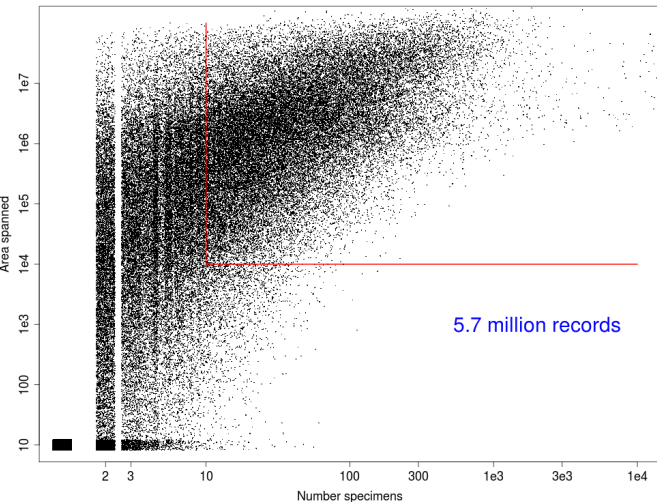
Observations and range size



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# Range size based on coordinates

Observations and range size

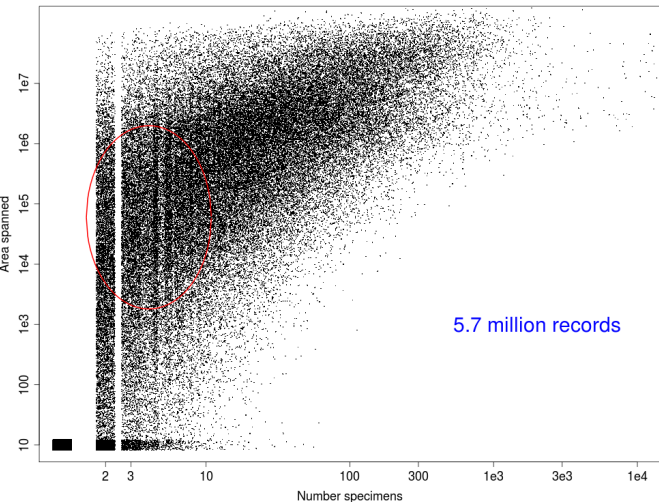


111,540 species:

- 55K have >10 records spanning >  $10^4$  km<sup>2</sup>

# Range size based on coordinates

Observations and range size



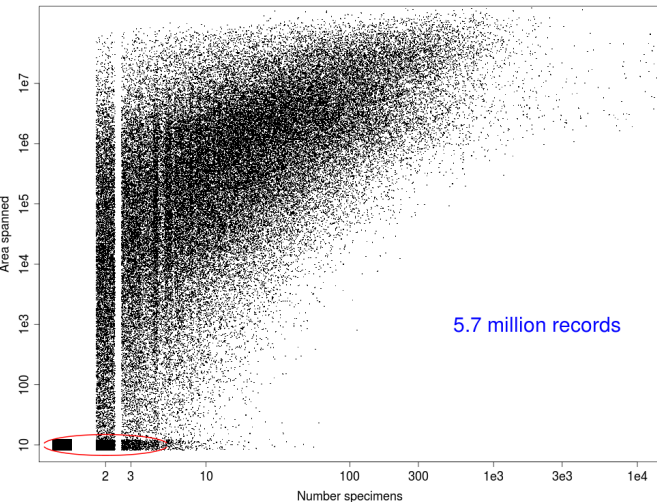
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# Range size based on coordinates

Observations and range size



111,540 species:

- 55K have >10 records spanning >  $10^4$  km<sup>2</sup>
- 14K have <10 records spanning >  $10^3$  km<sup>2</sup>
- 27K have <10 records spanning < 10 km<sup>2</sup>





# Local species and tree plots

Trees censused in plots are seen far more often than average

The 55,000 species known over  $< 10$  km represent over a third of the species with sufficient records to judge, but  $< 3\%$  of plot species:

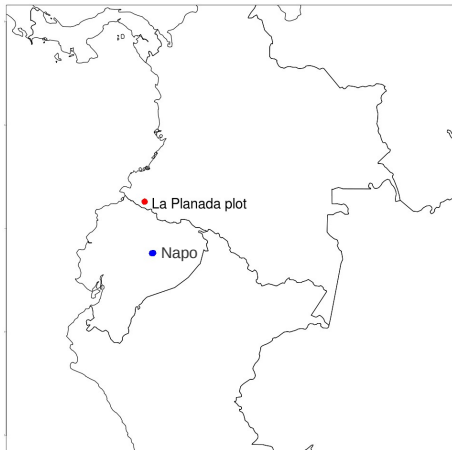
Plot	Species	%Narrow	%Wide
BCI	294	0.00	100.00
La Planada	150	2.67	97.33
Luquillo	129	2.33	97.67
Yasuní	738	0.27	99.73
Total	152783	36.26	63.74

- Narrow: range spans  $< 10$  km
- Wide: range spans  $\geq 10^4$  km<sup>2</sup>

Cases where the very local species do appear in a tree plot  
(La Planada)

Species	Plot	Records	LatLong
<i>Clavija laplanadae</i>	46	3	1
<i>Daphnopsis anomala</i>	91	1	1
<i>Miconia laetivirens</i>	248	8	3
<i>Ocotea hirtostyla</i>	211	10	10

- Plot: number of individuals in 25 ha plot
- Records: all specimen records
- LatLong: specimen records with coordinates



*Ocotea hirtostyla* was known from 10 records Napo in Ecuador

211 individuals 25 ha plot at La Planada

*Clavija laplanadae* has 3 records near La Planada and 46 individuals in 25 ha

Potential predictors of range size  
according to macroecological theory

## Potential predictors of range size according to macroecological theory

- ① Abundance: trees  $\text{ha}^{-1}$ , 1191 species at 4 plots



## Potential predictors of range size according to macroecological theory

- ② Shade-tolerance: response of recruitment to light  
233 species at BCI

## Potential predictors of range size according to macroecological theory

- 3 Soil response: abundance and soil phosphorus  
199 species in plots around Panama

## Potential predictors of range size according to macroecological theory

- 4 Climate response: abundance and dry season moisture  
405 species in plots around Panama

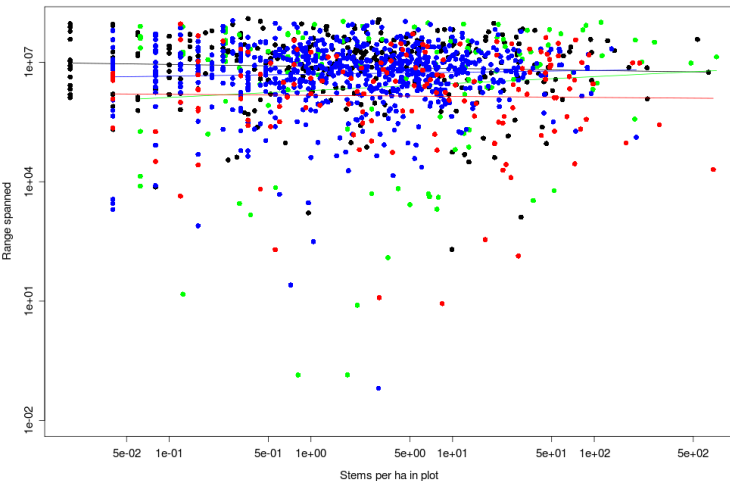
## Potential predictors of range size according to macroecological theory

- 5 Demographic rates: growth, mortality rates  
1029 species in 4 plots [results not shown]
- 6 Population status: change in abundance through time  
1029 species 4 plots over 6-25 years [results not shown]

## Potential predictors of range size according to macroecological theory

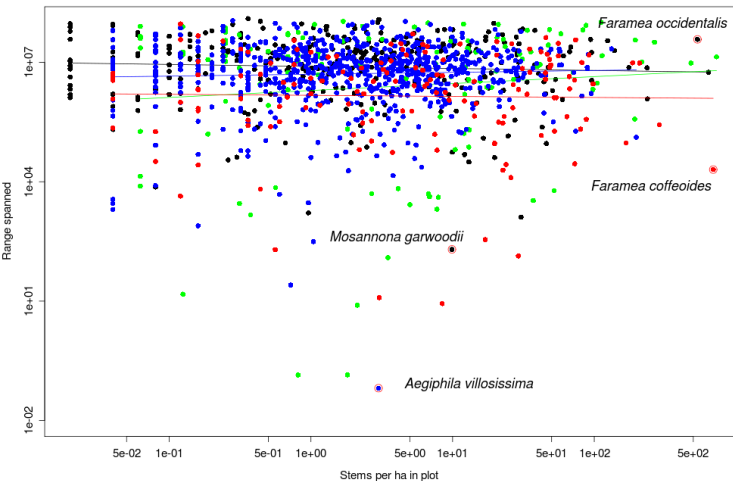
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# 1) Local abundance and range size



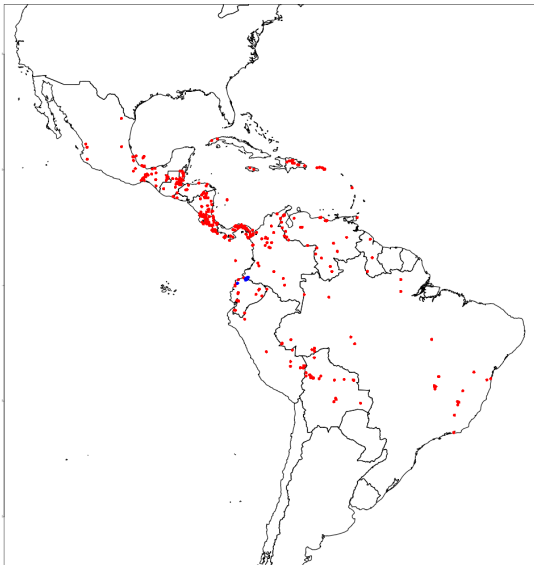
- BCI
- Luquillo
- La Planada
- Yasuni

# 1) Local abundance and range size



- BCI
- Luquillo
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## Two abundant understory species



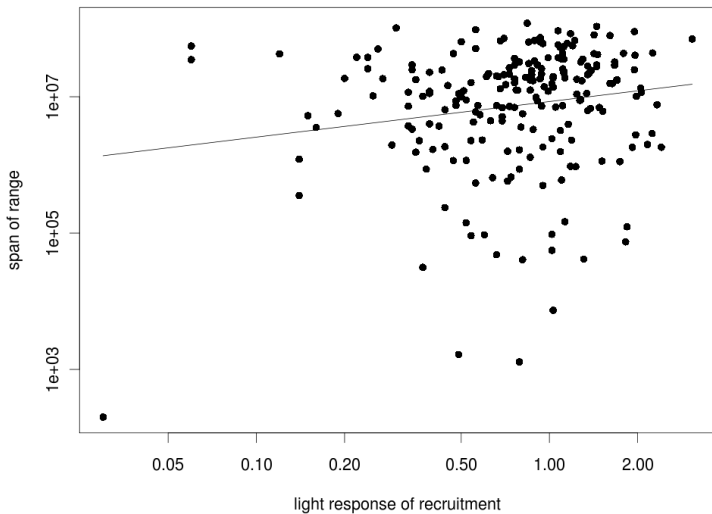
*Faramea* often abundant,  
whether a narrow endemic  
or widespread

*F. occidentalis*

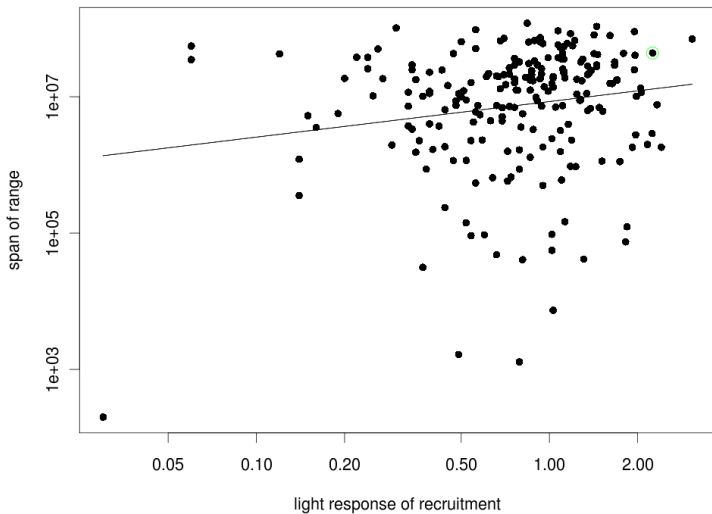
*F. coffeoides*



## 2) Shade-tolerance and range size

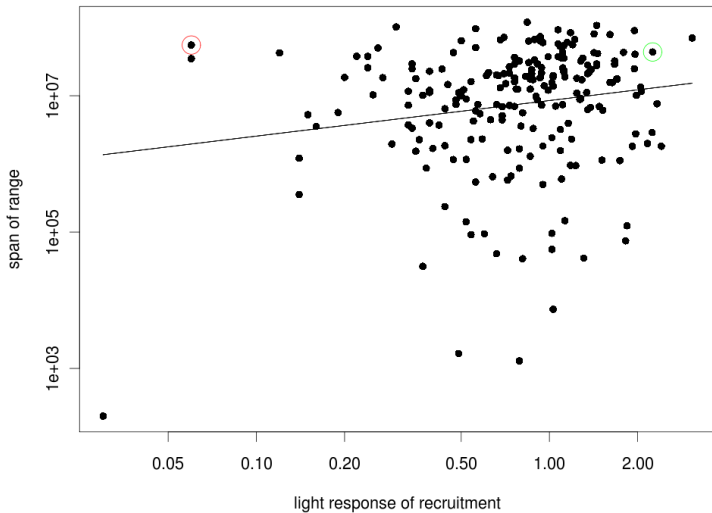


## 2) Shade-tolerance and range size



● *Palicourea guianensis*

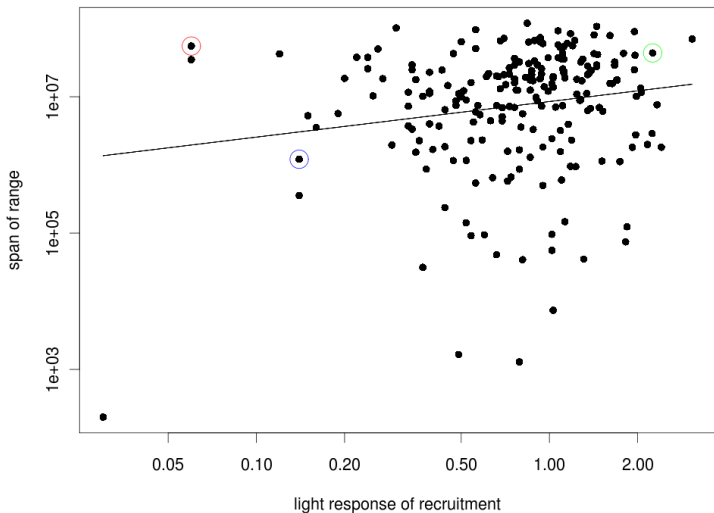
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● *Palicourea guianensis*

● *Symphonia globulifera*

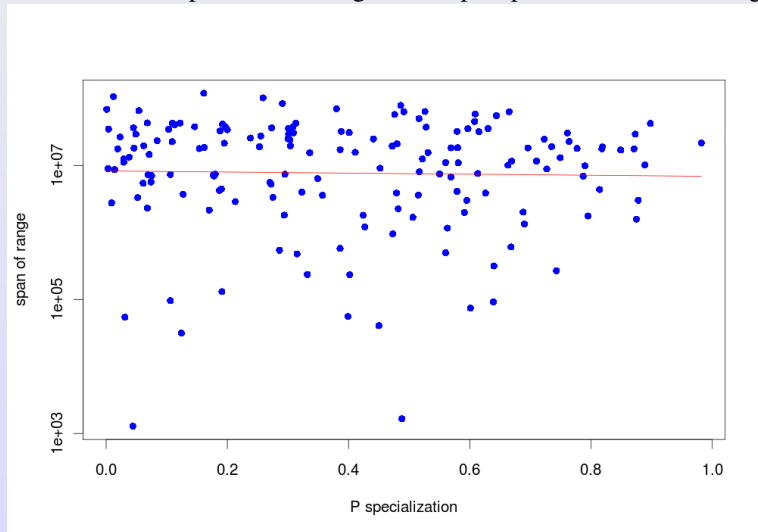
## 2) Shade-tolerance and range size



- *Palicourea guianensis*
- *Symphonia globulifera*
- *Desmopsis panamensis*

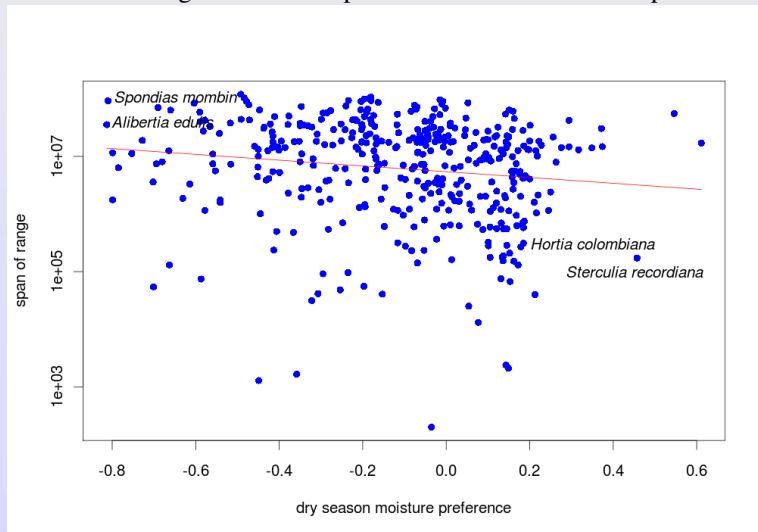
### 3) Phosphorus specialization and range size

Generalists and specialists for high or low phosphorus had similar ranges



## 4) Climatic specialization and range size

Many species from the wet forests of the Caribbean slope of central Panama have narrow ranges relative to species of the drier Pacific slope



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# Conclusions for macroecology

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- Specialists on local soil have range sizes no different from generalists, but...

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- Very few plot species are very locally known
- Pioneer tree species have (very slightly) wider ranges than shade-tolerant species
- Specialists on local soil have range sizes no different from generalists, but...
- Species of the wet Caribbean forests in Panama had narrower ranges

Fun facts to remember:  
There is work to do!

- Many species names are barely known
- 90,000 species names lack coordinates
- 60,000 are known from essentially one location
- a third of those are probably invalid synonyms
- many or most probably occur widely

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*Ceiba pentandra*