

Rubber plantations replace forest ant species with  
habitat generalists with larger geographic distributions:  
a case study in Xishuangbanna, China, and a global  
meta-analysis

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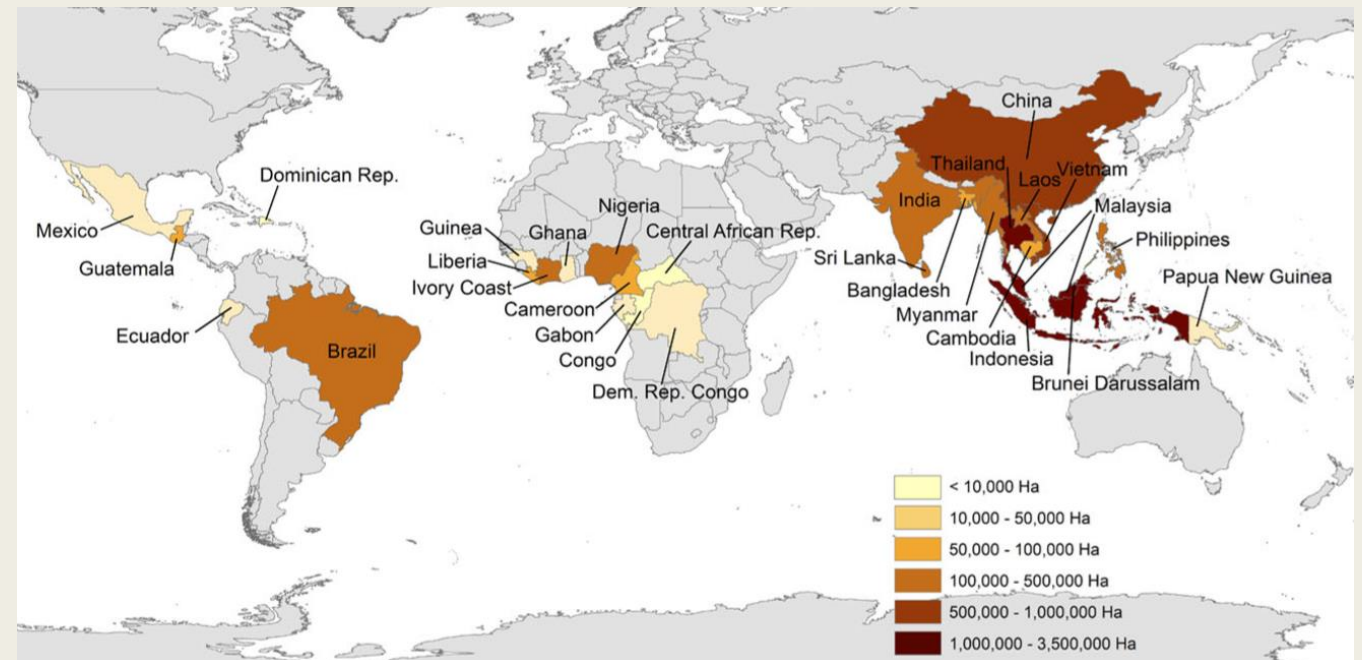
CAS Key Laboratory of Tropical Forest Ecology

Xishuangbanna Tropical Botanical Garden

Chinese Academy of Sciences

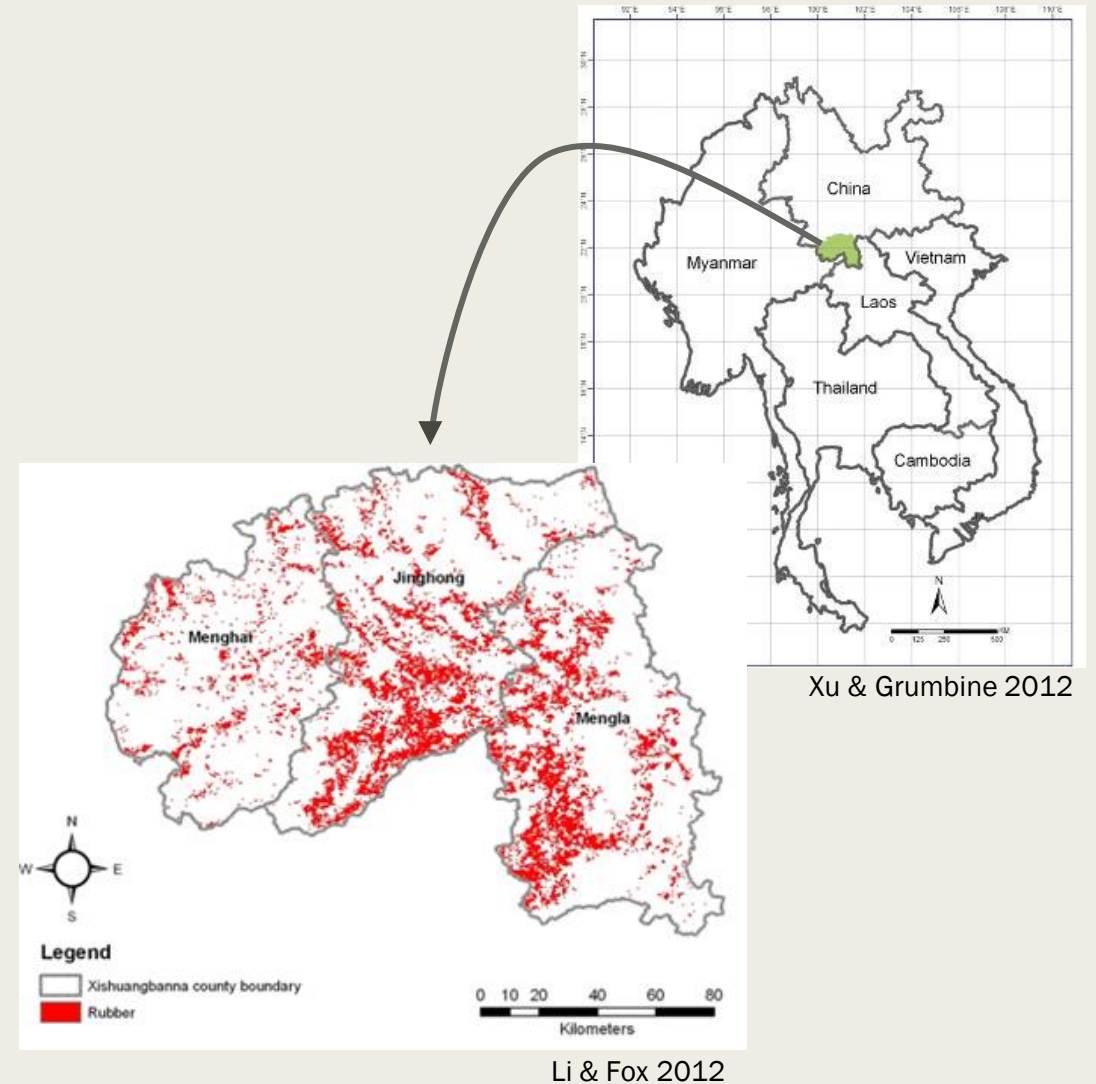
# Background

- Rubber plantations = easily one of the most dominant human-modified landscapes in the tropics (9.9M ha in 2012)
- SE Asia (including tip of SW China)= ‘epicenter’ of rubber cultivation = 84% of total global area
- Coincides with 4 biodiversity hotspots
- Biodiversity, especially of threatened species



# Background

- Xishuangbanna, SW China
- Extend up to 22° N, at elevations reaching 1400masl and on steep slopes (>20 °) (Chen 2016)
- ~2700km<sup>2</sup> by 2014 (Li *et al.* 2015)
  - 14% of land area of Xishuangbanna
- Serious environmental impacts (Wigboldus *et al.* 2017)
  - Loss of ecosystem function and services
  - Soil erosion
  - Altered hydrological systems
  - Biodiversity and local climate



# Background

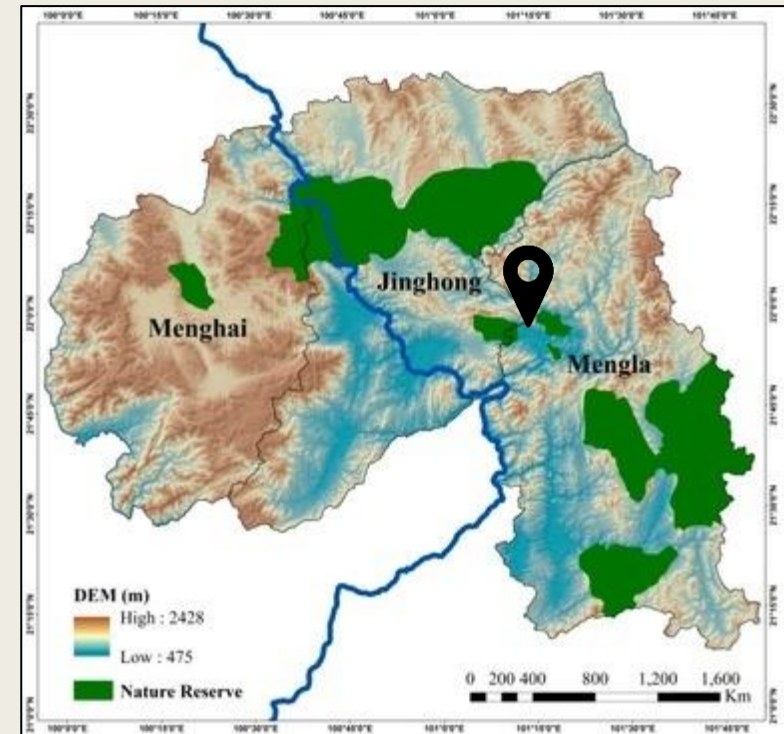
- Disturbance non-randomly selects for generalist species (Smart *et al.* 2006)
  - *Simulation suggested disturbance promotes survival of generalists and replacement of habitat specialists* (Marvier *et al.* 2004)
  - *Species in disturbed habitats can thrive in a wider variety of habitat types* (Marvier *et al.* 2004)
- Generalists ~ wider species distribution ranges (Kattan 1992; Gaston 1996)
  - *Birds* (Aratrakorn *et al.* 2006) *and lepidopterans* (Kitahara 2000; Kitching *et al.* 2000)
    - species in undisturbed sites restricted to undisturbed sites
    - species in disturbed sites in both disturbed and undisturbed sites
    - ‘wider distribution’ for species in disturbed sites
- No real systematic study comparing the extent of species geographic range of species in disturbed and undisturbed habitats

# Objectives

- **Xishuangbanna case study:** investigate ecological impacts of rubber plantations on ant fauna
  - Compared species richness and assemblage composition of ants between the three dominant habitat types in Xishuangbanna
    - *Tropical rainforest*
    - *Limestone forest*
    - *Rubber plantation*
- **Meta-analysis of 25 studies**
  - Compared the size of distribution range of ants found in forests and rubber plantations
    - *Primary forests*
    - *Secondary forests*
    - *Rubber plantations*

# Methods: Xishuangbanna ant survey

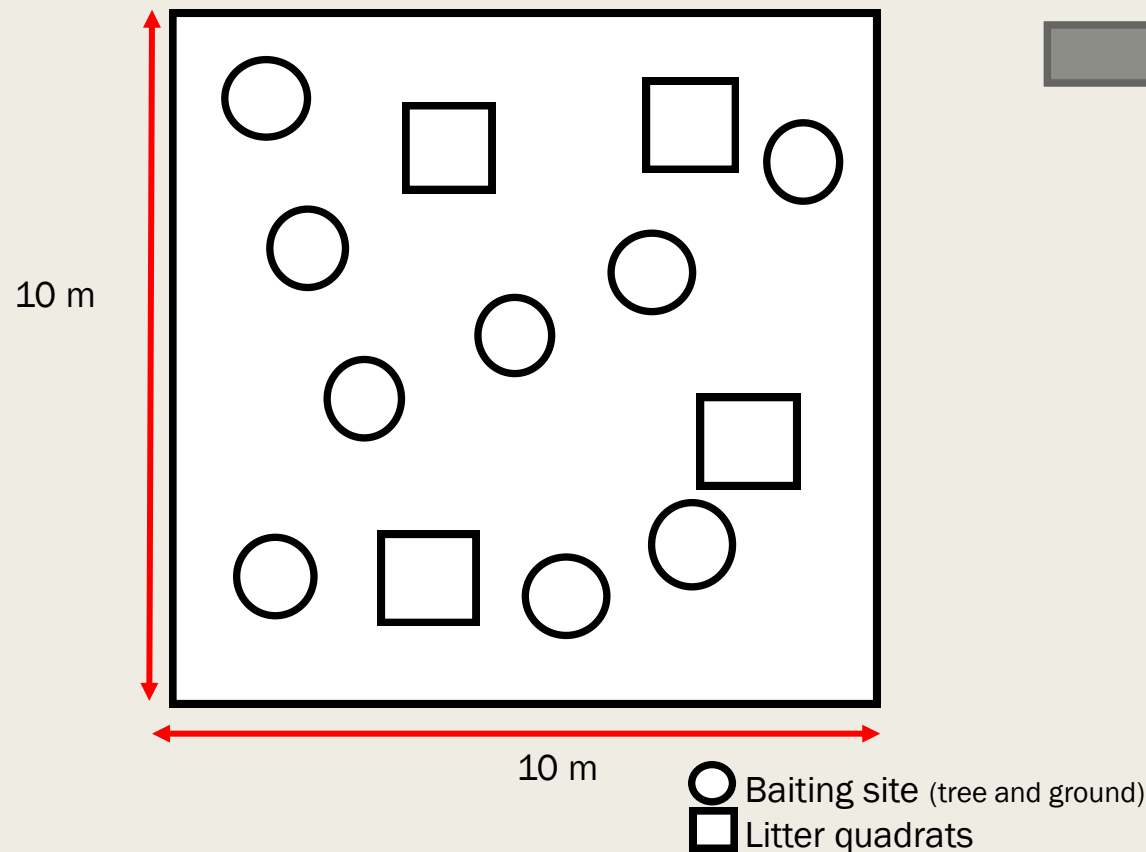
- Three habitat types within Xishuangbanna Tropical Botanical Garden (XTBG)
  - *Tropical rainforest*
  - *Limestone forest*
  - *Rubber plantation*
- Five 10x10m plots in each habitat type



# Methods: Xishuangbanna ant survey

Ants collected (Nov 2015)

1. litter extraction
2. ground and arboreal baits



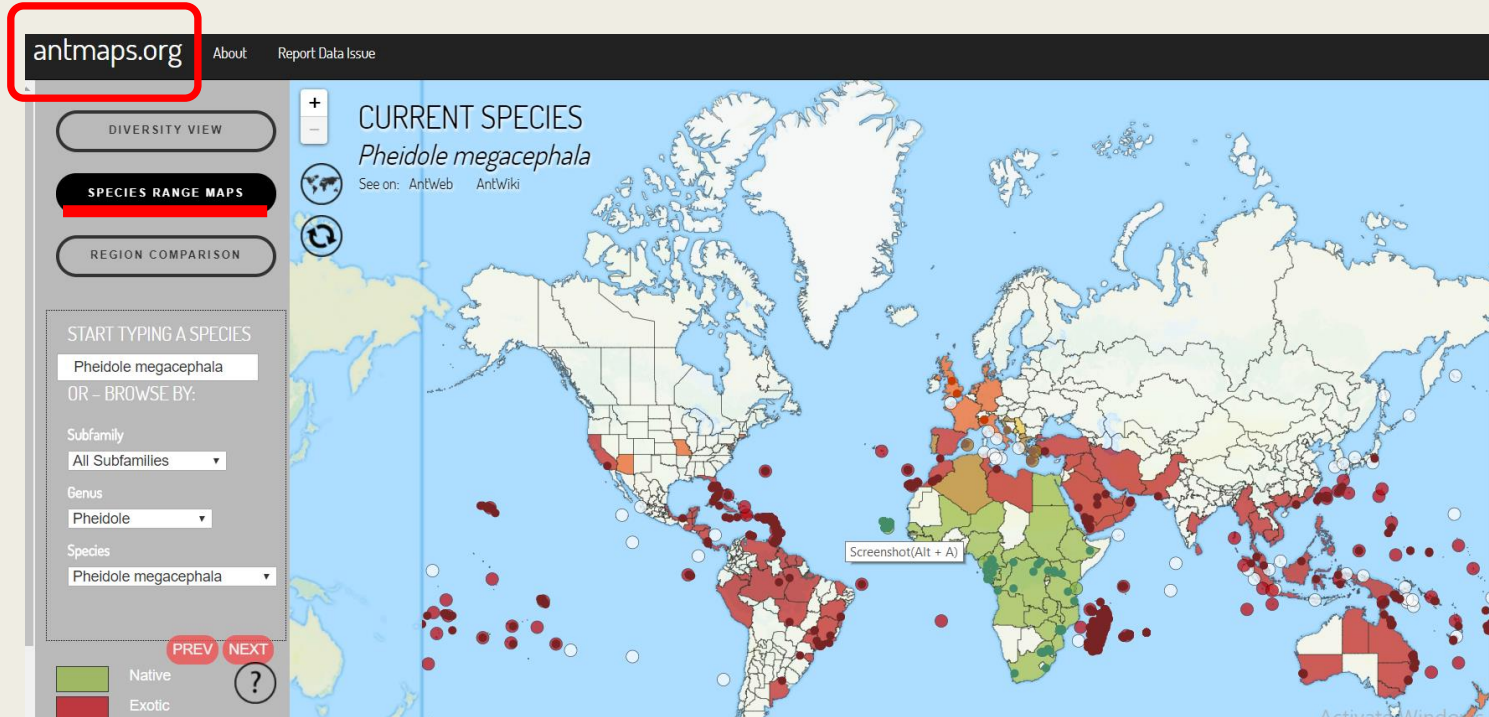
Sorted to species/morphospecies



Compared the habitats:

1. species richness
2. assemblage composition

# Methods: Xishuangbanna ant distribution range



\*input species name and it shows which regions the ant species are known to occur

\*\*individual regions:  
whole country  
province/state  
island/island group

Counted number of regions where each species occur



Proxy for breadth of distribution range



Two datasets:  
1. All species  
2. Restricted species

Compared breadth of species distribution of ants from three habitats





# Methods: Global meta-analysis – ant distribution range

Extracted species lists from 25 studies on ants in rubber plantations and forests (from Web of Science, Google Scholar and Chinese Citation Indices)

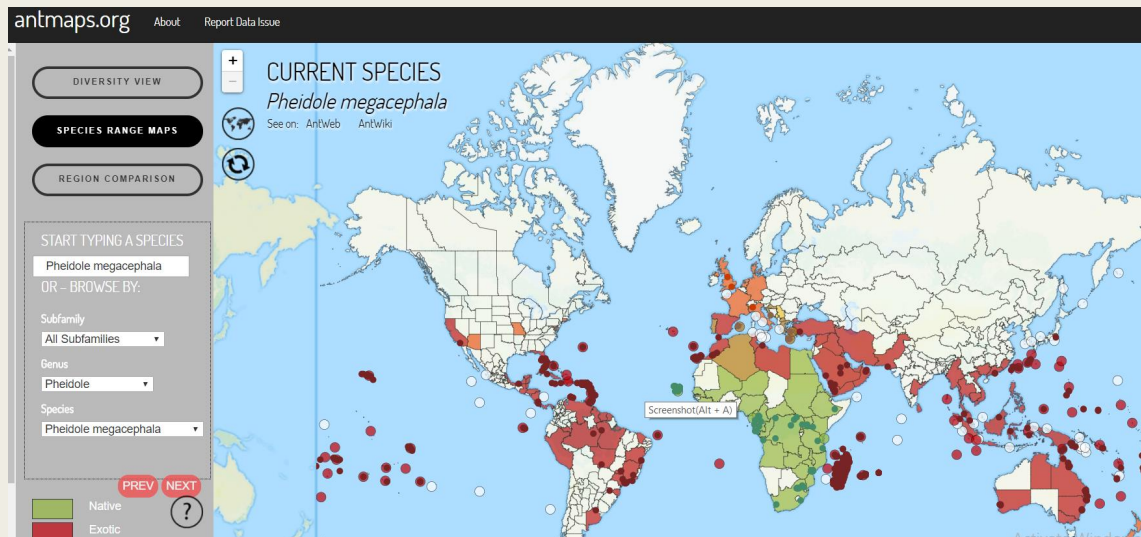


Updated each described species from all papers



Compared breadth of species distribution of ants from:

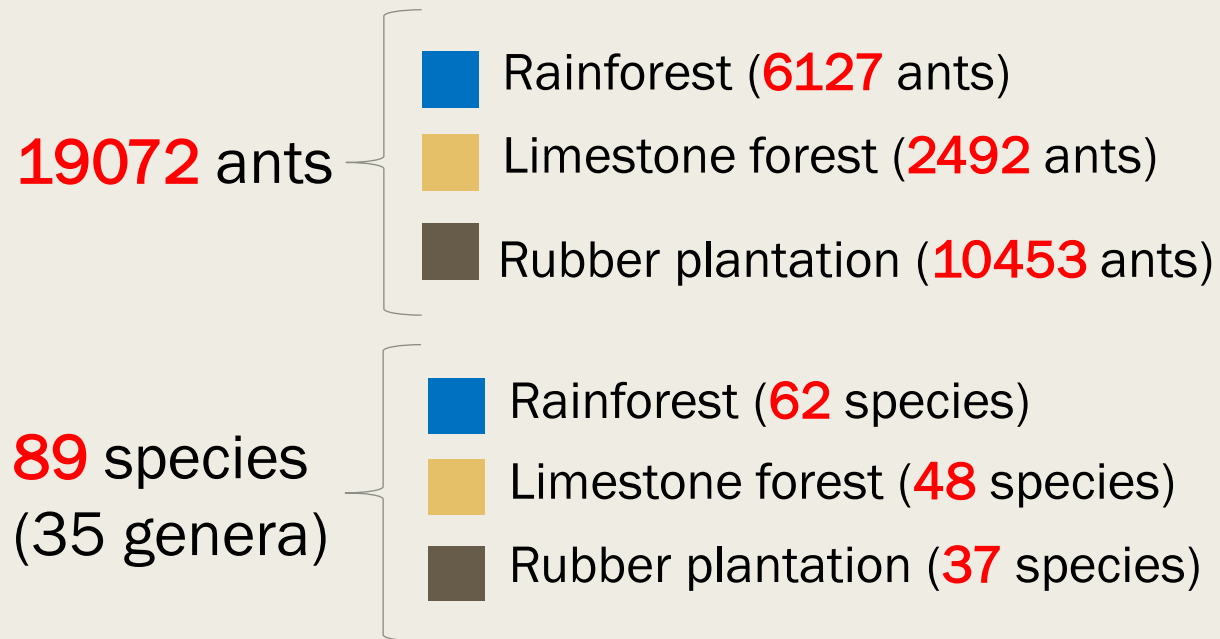
*primary forests*  
*secondary forests*  
*rubber plantations*



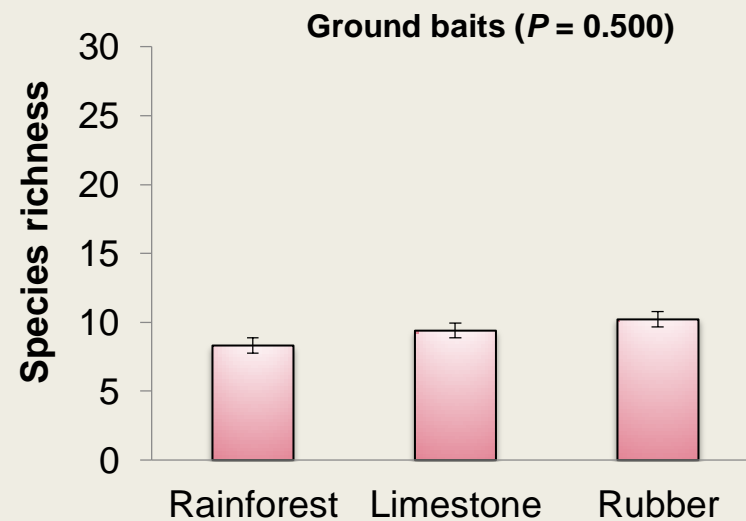
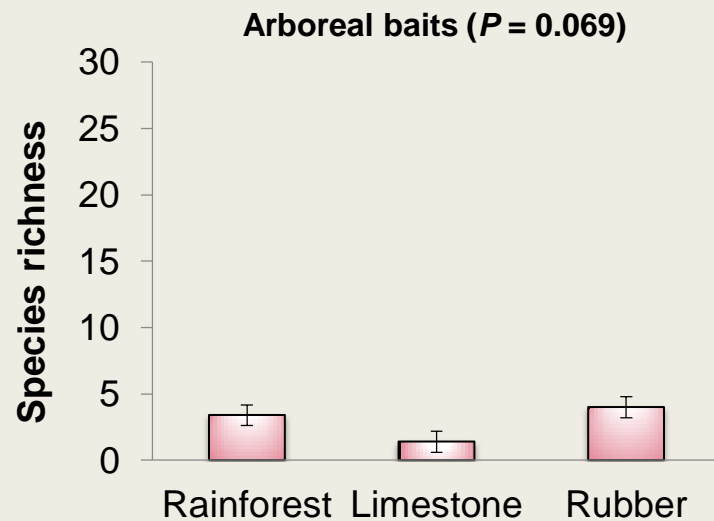
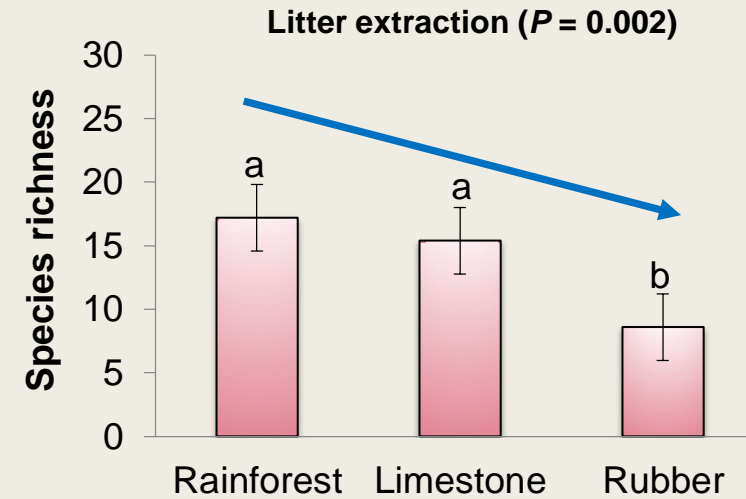
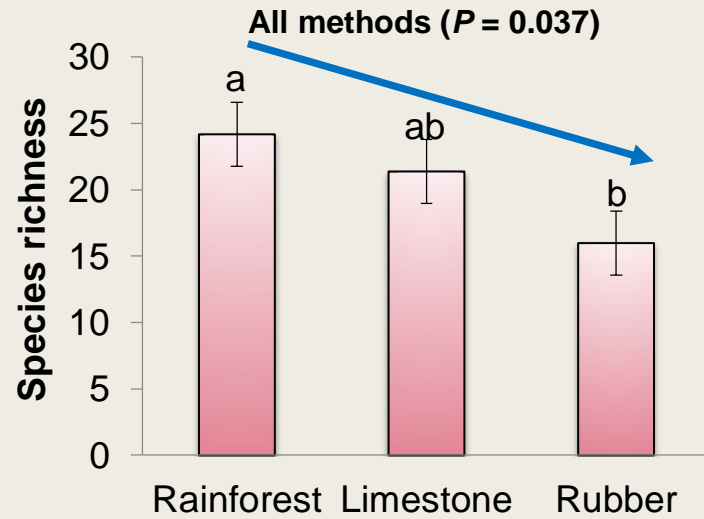
Measured species distribution range

\*additional analysis based on same number of species per given habitat

# Results: Xishuangbanna ant survey

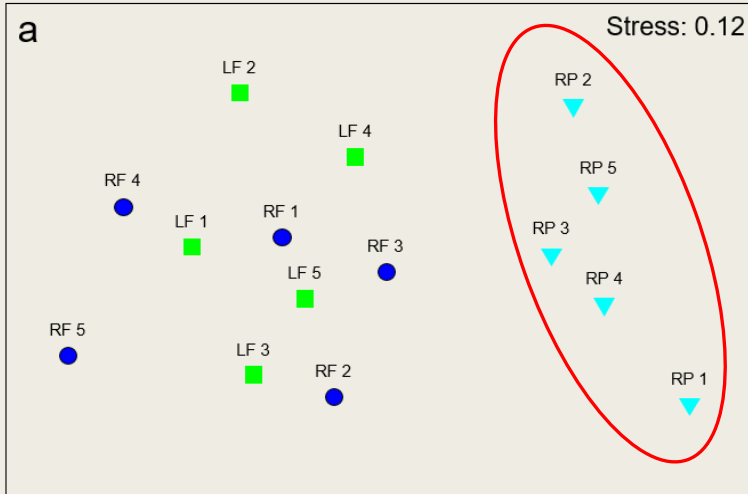


# Results: Xishuangbanna ant survey

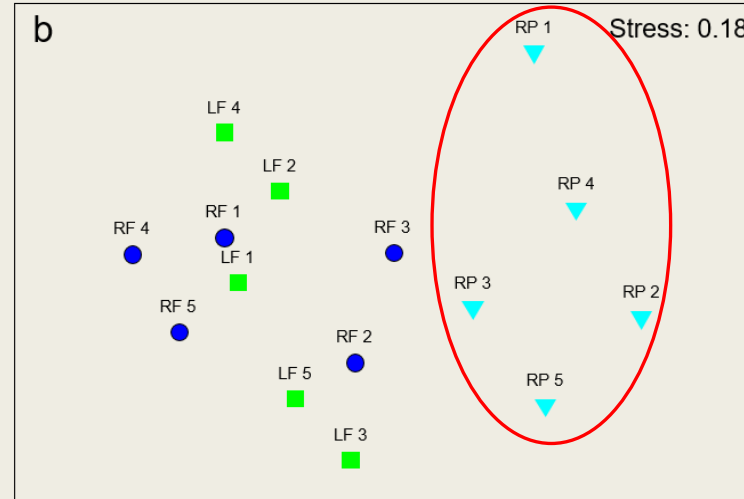


# Results: Xishuangbanna ant survey

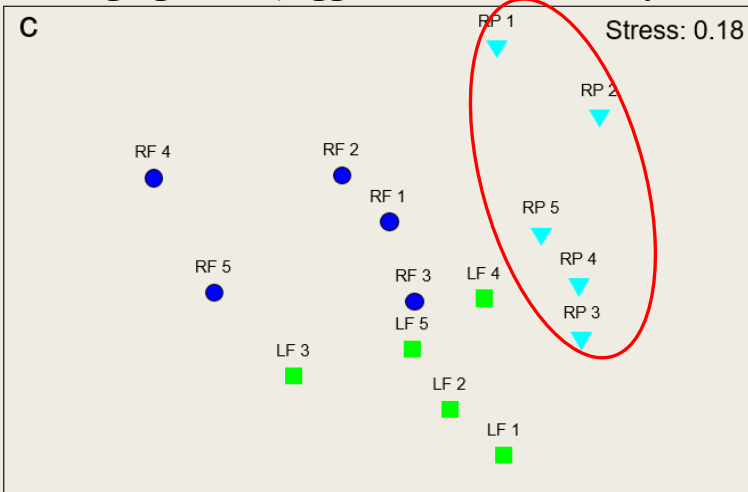
All methods (presence/absence, Sorensen)



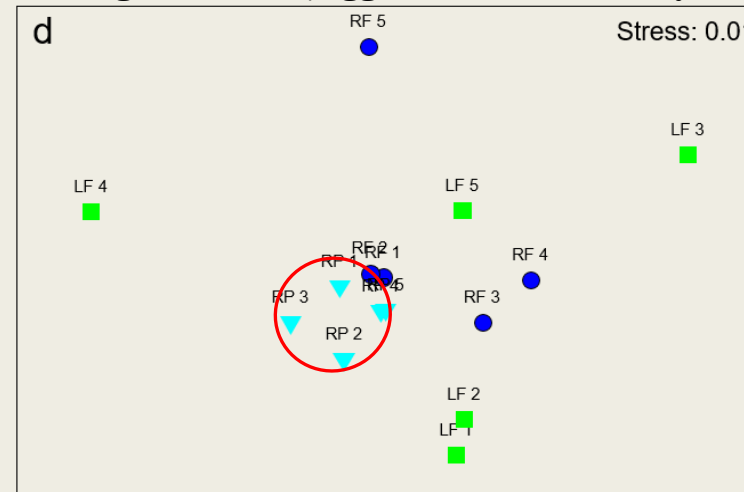
Litter extraction (logged abundance, Bray-Curtis)



Baiting - ground (logged abundance, Bray-Curtis)

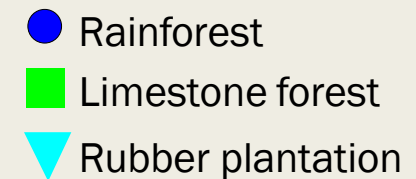


Baiting - arboreal (logged abundance, Bray-Curtis)



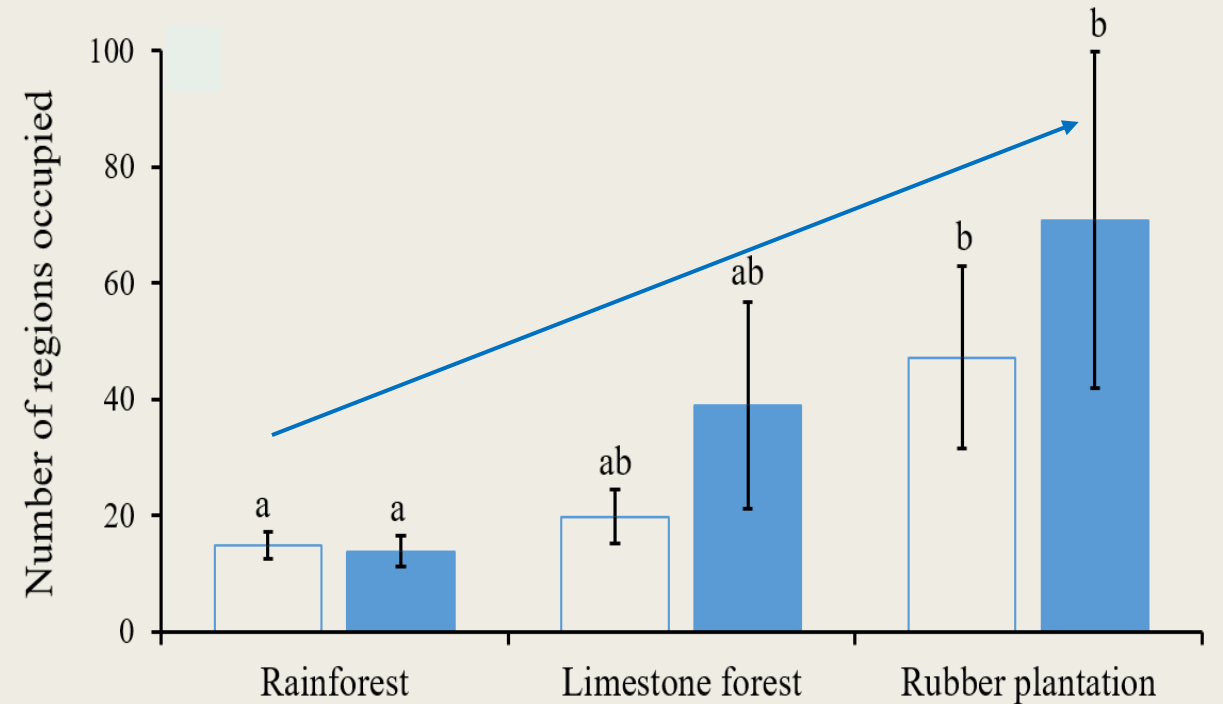
## ANOSIM

	<i>P</i> value
All methods	< 0.001
Litter ext.	0.004
Ground	0.001
Arboreal	0.001



# Results: Xishuangbanna ant distribution range

Habitat	All species	Restricted species
Primary forest	31	15
Limestone forest	21	4
Rubber plantation	14	7



Open bars: all species  
Shaded bars: restricted species

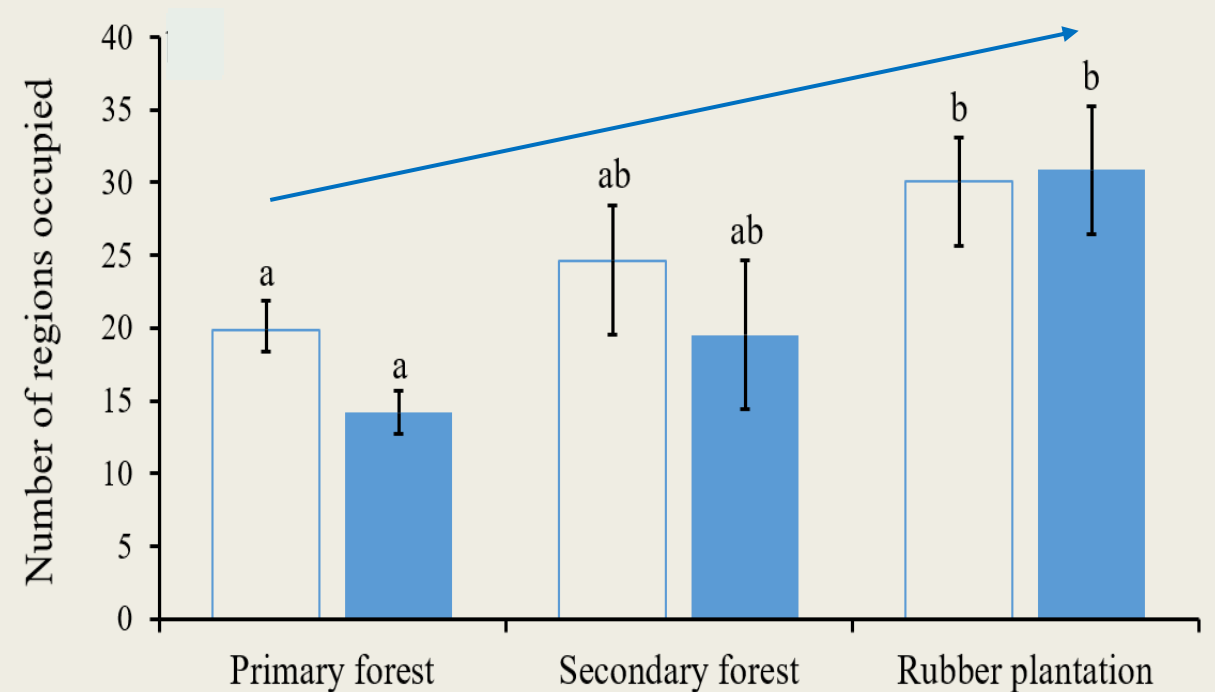
# Results: Global meta-analysis ant distribution range

Habitat	All species	Restricted species
Primary forests	232	114
Secondary forests	106	19
Rubber plantations	180	83

Subsampling *P* values:

all species: 0.488

restricted species: 0.001



Open bars: all species  
Shaded bars: restricted species

# Preliminary conclusions

- Reduced ant species richness and different assemblage composition in the rubber plantation in XTBG, China
- Wider distribution range of ants from rubber plantations than limestone forest and rainforest habitats
- Similar pattern observed in the meta-analysis:
  - *Narrowest distribution range from ants from primary forest, then secondary forest and broadest from rubber plantation ants*
  - *Most notable for restricted species between rubber plantations and primary forests*

# Thank you!

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