# Spatial distribution and association patterns in a tropical evergreen broad-leaved forest of North-Central Vietnam

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# Outlines

- Ecological questions
- Study site: Aluoi district, Thuathienhue province
- Methods: Spatial point pattern analysis
- Results
- Conclusions
- References

We asked:

- What are the prevailing types of intra-specific spatial distributions, inter-specific association patterns
at <u>species</u> and <u>life stage</u> levels of trees in a tropical rainforest?

- Which ecological processes could structure these patterns?

- Possible processes including dispersal limitation, self-thinning, facilitation and competition between species and life stages (Wright 2002).

In 2012, we designed:

- A 2-ha temporary plot (200 m × 100 m)

- In a tropical broad-leaved forest at 16˚08.35'N and 107˚16.68'E , belonging to Aluoi district, Thuathienhue province

- With little human disturbances.

- Elevation ranges from 625 m to 660 m a.s.l, with an average slope of 25 degrees
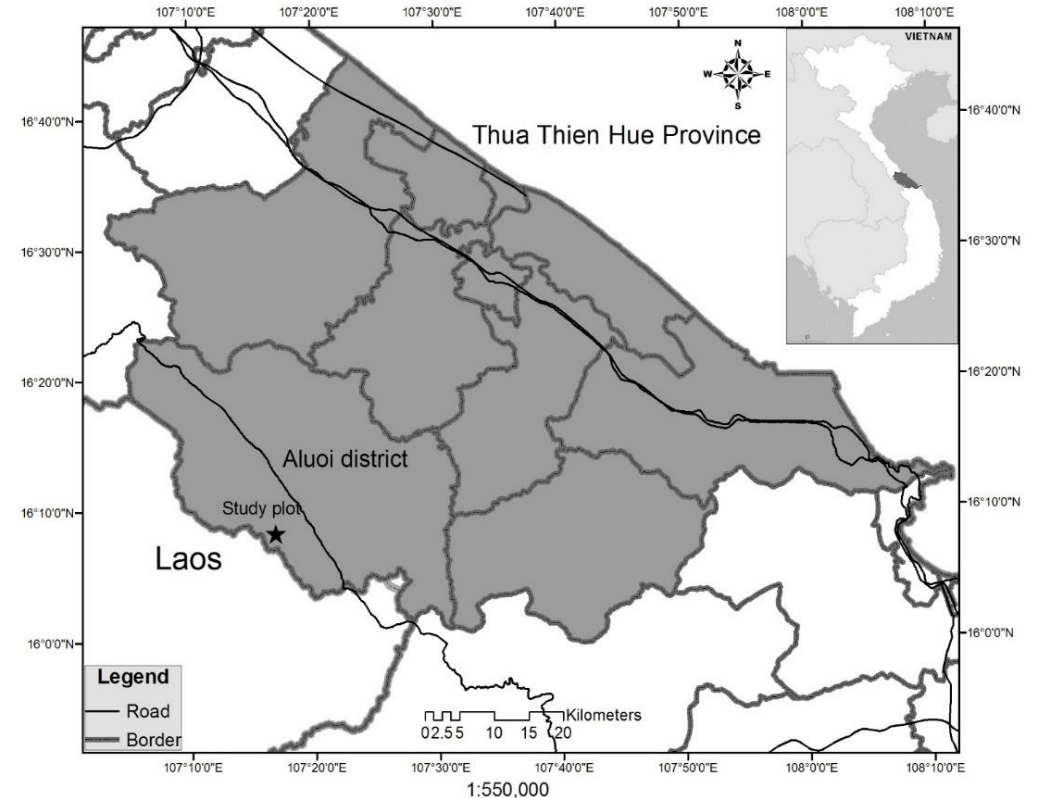
**Data collection:**

- Mapped and recorded all trees with dbh ≥ 2.5 cm and their characteristics (species and dbh).

- Coordinates (*x*, *y*) of each tree recorded via a grid system of subplots (10 m × 10 m) by using a laser distance measurer (Leica Disto D5) and compass.

- If trees were multi-stemmed, each stem considered a separate tree if the branching occurred below breast height (1.3 m).

- All tree individuals classified into three life stages: sapling (dbh < 6 cm), pole (6 cm ≤ dbh ≤ 15 cm), and adult (dbh > 15 cm).

**Functions and software:**

- Pair correlation functions $g(r)$ describe the density between pairs of points (e.g. $(x,y)$ coordinates of trees) at various distances

- $g(r)$ is the derivative of the Ripley's $K$-function: $g(r) = K'(r)/(2\pi r)$.

- Univariate and bivariate pair-correlation functions: $g_{11}(r)$, $g_{12}(r)$

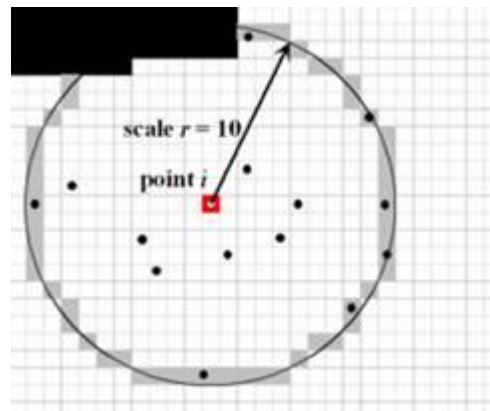- Significant patterns: out of confidence envelopes
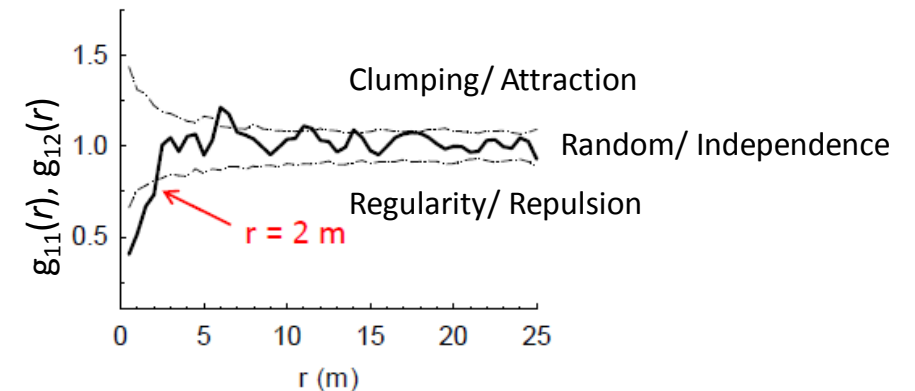


Fig.: Wiegand & Moloney 2004



Fig.: S. Getzin

**Simulation and evaluation:**

- The heterogeneous Poisson process (HP) as null model with bandwidth R= 30 m.

- First, approximate 95% confidence envelopes generated from the 5th lowest and 5th highest values of 199 Monte Carlo simulations

- Second, to evaluate significant departures from the null models, we used a Goodness-of-fit test (Loosmore & Ford 2006) for a distance interval of 0-30 m.

- Take into account if the observed $p$-value < 0.05.

- All point pattern analyses performed with the grid-based software Programita (Wiegand & Moloney 2014)

**Data analysis:**

***Analysis 1: Intra-specific spatial distributions***

- $g_{11}(r)$ to analyze intra-specific patterns of (1) each of 18 species and (2) their life stages.

- HP null model, bandwidth $R = 30$ m and a spatial resolution of 1 m

***Analysis 2: Inter-specific spatial associations***

- $g_{12}(r)$ to analyze: (1) inter-specific associations and (2) life stage associations.

- Null model as the locations of trees in pattern 1 remained fixed, while the locations of trees in pattern 2 randomized using HP with bandwidth $R = 30$ m and a spatial resolution of 1 m .

- Used $g_{12}(r)$ and $g_{21}(r)$, because we do not know whether biotic interaction is symmetric or not

(1) Sixteen of 18 species had aggregated patterns at various scales,
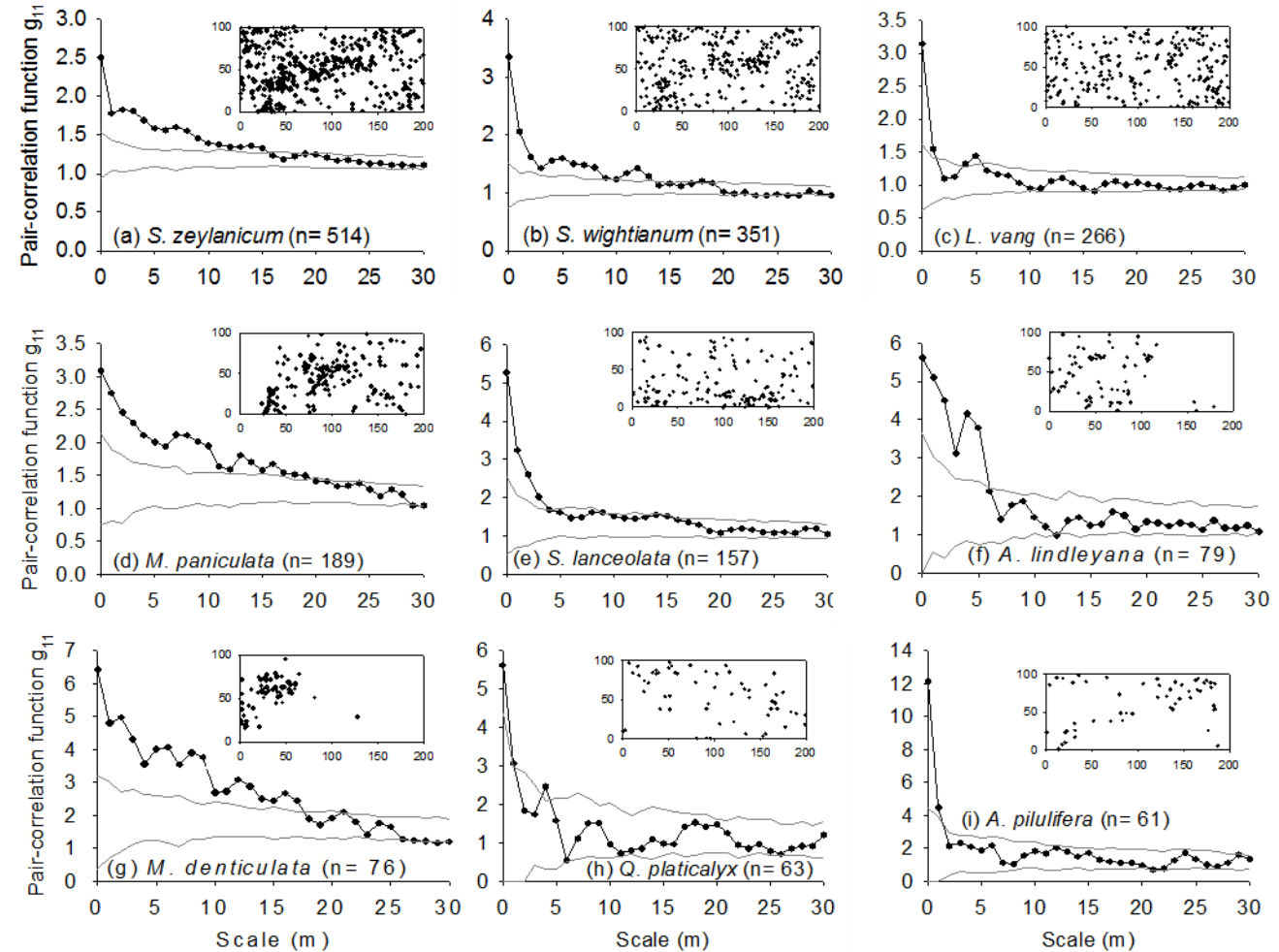
And regardless of their abundance.

Fig. The insets show the species distribution maps.
Observed patterns (dark line) lying beyond
the simulation envelopes (grey lines),
*n* gives the number of individuals.

(2) Significant and aggregated patterns were found in 64% of all same life stages.

(3) In different life stage associations, attractions (81%) predominated over repulsions (19%) at small scales of up to 15 m.
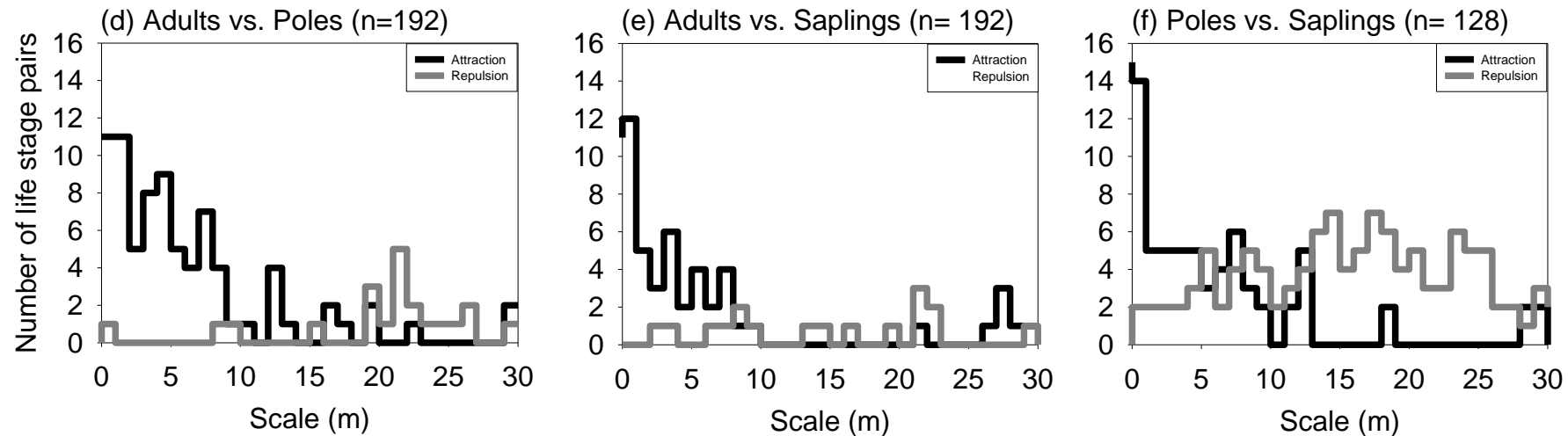


Fig. Number of significant spatial associations,
 analyzed by the bivariate pair-correlation functions $g_{12}$ for different life stages (Analysis 2).

(4) At scales up to 15 m, only 12.4% species pairs showed significant associations, Among that 71% spatial attractions, 5% spatial repulsions and 24% non-essential interactions.
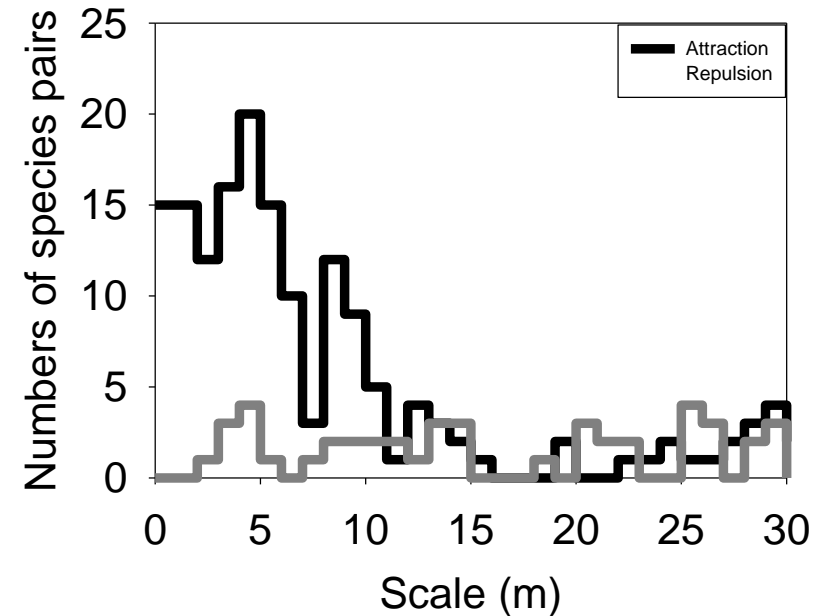


Fig.  Number of significant inter-specific associations analyzed by the bivariate pair-correlation function $g_{12}$ (Analysis 2).

- Dispersal limitation may regulate the spatial patterns of tree species.

- Positive spatial associations between tree species and life stages suggest the presence of species herd protection and/or facilitation.

- A very late onset or even absence of self-thinning.

- Habitat heterogeneity plays an important role for species distribution patterns,

- The spatial segregation occurs at a scale around 15 m in this forest.

**Spatial distribution and association patterns in a tropical evergreen broad-leaved forest of north-central Vietnam**

Hong Hai Nguyen, Jaime Uria-Diez & Kerstin Wiegand

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# Thanks for your attention!

- Failed to use tag tree numbers from last census in 2010: a lots of missing, inconsistence of tree species classification and measured data.

- Expect having data from several censuses of trees: species, dbh, height, biological features (sex, shade tolerant/intolerant), and environmental data: soil nutrients, soil humidity, . .

- Visions in spatial point pattern analysis: individual species-area relationship, phylogenetic pattern of tree species