A Phylogenetic Perspective on the Individual Species-Area Relationship in Temperate and Tropical Tree Community

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Species-area relationships (SARs)

How individual species structure diversity in tropical forests

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Individual species-area relationships (ISARs)

The roles of species

- species diversity accumulator
- species diversity repeller
- neutral species

Wiegand et al. 2007, PNAS, 104 (48): 19029-19033
Introduction

Species area relationships (SARs)

Individual species area relationships (ISARs)

A limitation of the SAR and ISAR approaches is that all species are treated as evolutionarily independent and that a large amount of work has now shown that local tree neighborhoods exhibit non-random phylogenetic structure given the species richness.
Introduction

Species area relationships (SARs)

Individual species area relationships (ISARs)

Individual phylogenetic area relationships (IPARs)

The roles of species

- phylogenetic diversity accumulator
- phylogenetic diversity repeller
- neutral species
Methods

Nine tropical and temperate forest dynamics plots in five countries
<table>
<thead>
<tr>
<th>Forest Dynamics Plot</th>
<th>Country</th>
<th>Forest Type</th>
<th>Latitude</th>
<th>Area (ha)</th>
<th>Total Species Richness</th>
</tr>
</thead>
<tbody>
<tr>
<td>Edoro – 1</td>
<td>Democratic Republic of Congo</td>
<td>Tropical Rain Forest</td>
<td>1.437° N</td>
<td>10</td>
<td>315</td>
</tr>
<tr>
<td>Edoro – 2</td>
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<td>Tropical Rain Forest</td>
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<td>10</td>
<td>300</td>
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<tr>
<td>Korup</td>
<td>Cameroon</td>
<td>Tropical Rain Forest</td>
<td>5.074° N</td>
<td>50</td>
<td>494</td>
</tr>
<tr>
<td>Barro Colorado Island</td>
<td>Panama</td>
<td>Tropical Moist Forest</td>
<td>9.154° N</td>
<td>50</td>
<td>299</td>
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<tr>
<td>Xishuangbanna</td>
<td>China</td>
<td>Tropical Rain Forest</td>
<td>21.612° N</td>
<td>20</td>
<td>468</td>
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<tr>
<td>Ailaoshan</td>
<td>China</td>
<td>Subtropical Moist Forest</td>
<td>24.322° N</td>
<td>6</td>
<td>76</td>
</tr>
<tr>
<td>Wabikon Lake</td>
<td>U.S.A.</td>
<td>Temperate Deciduous Forest</td>
<td>45.551° N</td>
<td>25</td>
<td>36</td>
</tr>
</tbody>
</table>
Methods

Individual species-area relationships

The method is developed by Wiegand *et al.*, 2007

- To quantify whether individuals of a species have more or less species richness surrounding them than expected by chance.
- Heterogeneous Poisson null model using an Epanechnikov kernel with a 50 m bandwidth, 9999 simulations for each target species’s individual
ISAR, all individuals $\geq 1$ cm dbh

Results
Results: ISARs

Proportion of species diversity accumulators, repellers and neutral species for the species having $\geq 70$ individuals $\geq 1$ cm dbh
Results: ISARs

Proportion of species diversity accumulators, repellers and neutral species for the species having \( \geq 70 \) individuals \( \geq 10 \) cm dbh
Methods

Individual phylogenetic-area relationships

**Phylogenetic tree construction:** Phylomatic (Webb & Donoghue, 2005), Angiosperm Phylogeny Group III

**Phylogenetic diversity:** Phylocom (Webb *et al*., 2008)

**Null model:** shuffling the names of species across the tips of the phylogeny 999 times
Proportion of phylogenetic diversity accumulators, repellers and neutral species for the species having >= 70 individuals >= 1 cm dbh
Proportion of phylogenetic diversity accumulators, repellers and neutral species for the species having \( \geq 70 \) individuals \( \geq 10 \) cm dbh.
Methods

Phylogenetic distribution of species diversity accumulators, repellers and neutral species

- D statistic (Fritz and Purvis, 2010)
- R package ‘Caper’ (Orme et al., 2012)
The phylogenetic signal of species diversity accumulators and repellers on each scale from 0–50 m in the nine forest dynamics plots, using D statistic developed by Fritz and Purvis (2010).
Conclusions

- The results indicate no clear trend in ISARs and IPARs from the temperate zone to the tropics.
- Phylogenetic diversity surrounding the individuals of species is generally only non-random on very local scales.
- Species diversity accumulators and repellers have phylogenetic signals across latitude.
Take-home message

- Non-neutral processes (e.g. competition and facilitation) may leave a detectable signature at small-scale spatial patterns of species diversity but result in stochastic patterns at larger scales.
- Past evolutionary history is important in dictating the ecological interactions we presently observe.
Acknowledgements

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Dr. Robert Howe, Dr. Amy Wolf, Wabikon lake plot

Dr. Thorsten Wiegand, ISAR software

Hundreds of field-workers
Thank you for listening!
Comments and questions?