Ecology of epiphytic lichens

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My research interests

• Spatial patterns in community structure at multiple scales
  – Species richness
  – Species composition
  – Species’ distributions
  – Species’ traits

• Interactions between ecological and evolutionary processes
Lichens

- A symbiosis between a fungus and at least one photobiont

- Photobionts:
  - Green algae
  - Cyanobacteria

http://biology-pictures.blogspot.co.nz
Epiphytic Lichens as a Model System

• Multiple taxa in a single thallus
• Functionally and reproductively variable
• Structurally relatively simple communities
• Quick to sample
• Spatially discrete
Epiphytic lichen community ecology

**Question:** What determines the structure of epiphytic lichen communities?

- Habitat preferences
- Species interactions
- Population dynamics (e.g., dispersal)
The Flock Hill study system
• Colonisation-dominated community assembly
• Shorter, isolated trees
• Less complex communities of lower species richness

Beech forest remnant
Methods

• Approx. 48 ha study area
• Sampled 374 trees
• Collected lichen specimens up to 2m
• Environmental variables recorded
Habitat conditions and distance from source affected species richness

Total richness = 56 lichens on 374 trees

<table>
<thead>
<tr>
<th>Variable</th>
<th>Estimate (Std. Err.)</th>
<th>LRT</th>
<th>P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Trunk diameter (linear term)</td>
<td>0.74 (0.04)</td>
<td>285.9</td>
<td>&lt; 0.001</td>
</tr>
<tr>
<td>Trunk diameter (quadratic term)</td>
<td>-0.08 (0.01)</td>
<td>58.8</td>
<td>&lt; 0.001</td>
</tr>
<tr>
<td>Percent cover of sooty mould</td>
<td>-0.11 (0.02)</td>
<td>22.3</td>
<td>&lt; 0.001</td>
</tr>
<tr>
<td>Distance to forest</td>
<td>-0.08 (0.02)</td>
<td>16.0</td>
<td>&lt; 0.001</td>
</tr>
<tr>
<td>Dracophyllum spp. presence within 2m radius of tree</td>
<td>0.18 (0.05)</td>
<td>11.5</td>
<td>&lt; 0.001</td>
</tr>
<tr>
<td>Tree density within 5m radius of tree</td>
<td>-0.05 (0.02)</td>
<td>4.6</td>
<td>0.032</td>
</tr>
<tr>
<td>Percent rough bark on trunk below 2m</td>
<td>0.06 (0.03)</td>
<td>4.0</td>
<td>0.046</td>
</tr>
</tbody>
</table>

Variables included in the analysis:
- **Teloschistes velifer**
- **Ramalina cestri**
- **Hypogymnia subphysodes**
Molecular ecology

• How do ecological and evolutionary factors interact to determine symbiosis structure?
  – Fungal specificity and selectivity

• How are lichen symbiont populations structured spatially?
Fungal specificity across taxonomic and spatial scales

• **Between lichen** variation:
  – A range of lichen taxa from Flock Hill (N = 43*)

• **Within site** variation:
  – *Usnea* specimens from Flock Hill (N = 86)

• **Between site** variation:
  – *Usnea* specimens from sites around NZ (N = 25*)

* Preliminary dataset; more samples to be added
At each scale:

- Sequenced DNA (internal transcribed spacer region: ITS) from both fungal and algal partners
- Built separate Bayesian phylogenetic trees for each partner
- Used randomisations to test for consistency in associations between partners (co-diversification)
Between lichen variation (Flock Hill site)

Randomisation test:
Pattern of co-diversification ($P < 0.01$)
Within site variation (Flock Hill *Usnea*)
- Geographic location was important
- Even after accounting for this, there was still a co-diversification pattern \((P < 0.001)\)

Between site variation (NZ *Usnea*)
- Geographic location wasn’t important
- Strong co-diversification pattern \((P < 0.001)\)
Conclusions

• Both studies show that spatial effects (e.g., habitat effects and dispersal) are important for lichen ecology, from a single thallus to the community level

• The structure of the lichen symbiosis appears to also be the result of evolutionary processes (co-diversification)
Ongoing research using epiphytic lichens

Spatial patterns in community structure
- Functional trait patterns

Macroecology
- North American epiphytic lichens

Molecular Ecology
- Genetic structuring at multiple spatial scales
- Free living vs. obligate symbionts
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Related publications


