Lincoln University
Te Whare Wānaka o Aoraki
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Ecology of epiphytic lichens

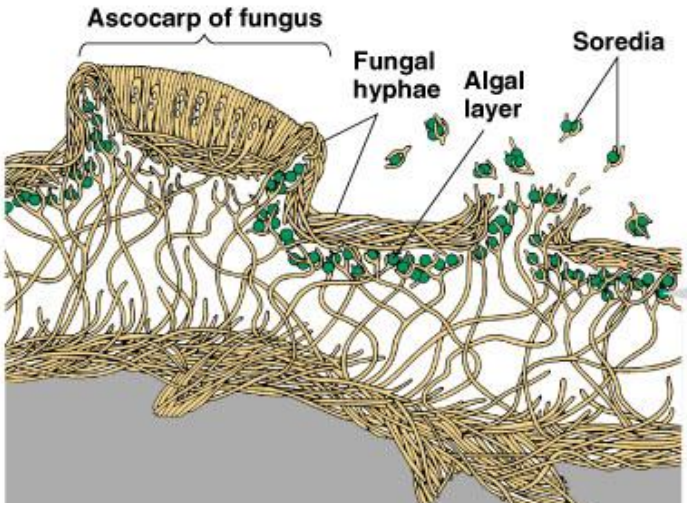
Dr. Hannah Buckley
Department of Ecology, Lincoln University

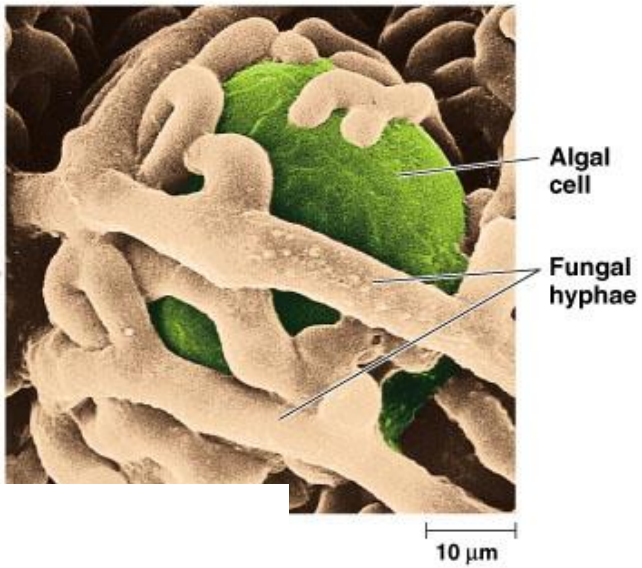
My research interests

- 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

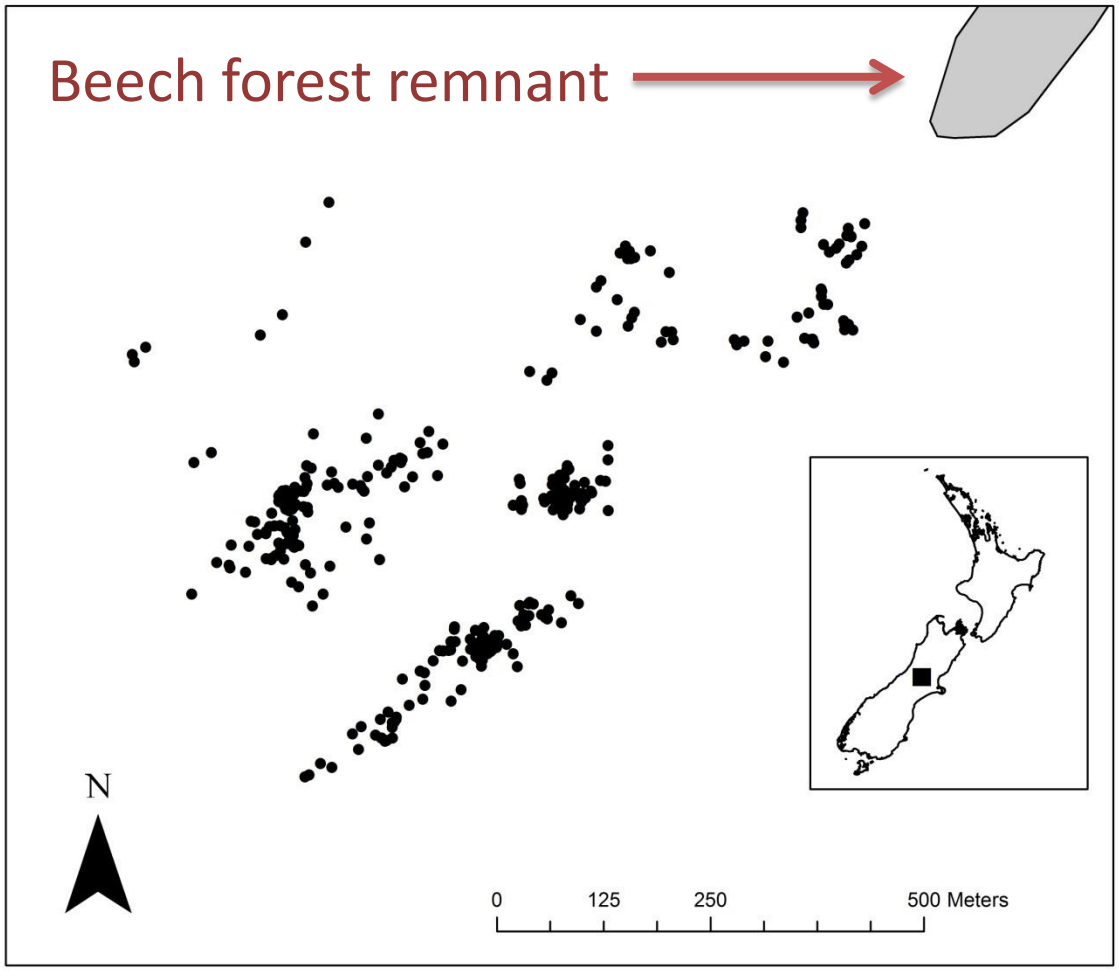
Question: What determines the structure of epiphytic lichen communities?

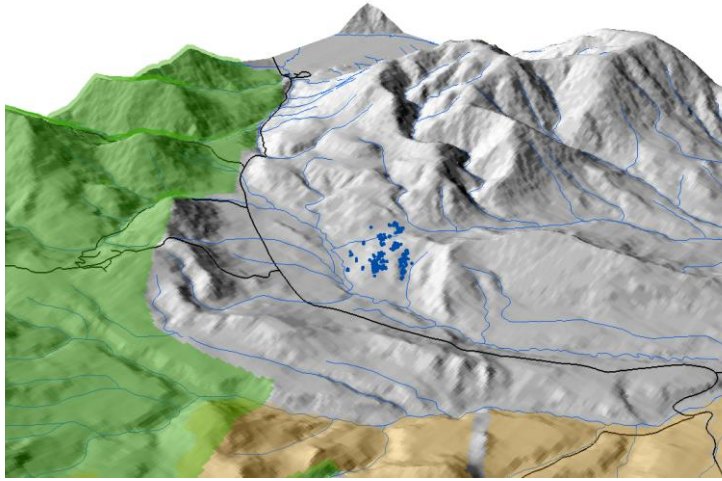
- Habitat preferences
- Species interactions
- Population dynamics (e.g., dispersal)



The Flock Hill study system

- Colonisation-dominated community assembly
- Shorter, isolated trees
- Less complex communities of lower species richness





Methods

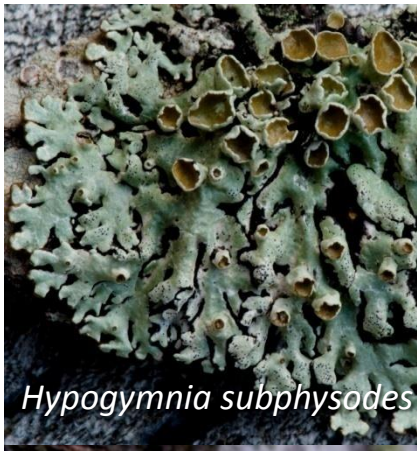
- Approx. 48 ha study area
- Sampled 374 trees
- Collected lichen specimens up to 2m
- Environmental variables recorded



Habitat conditions and distance from source affected species richness

Total richness = 56 lichens on 374 trees

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


Hypogymnia subphysodes


Ramalina celastri


Teloschistes velifer

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

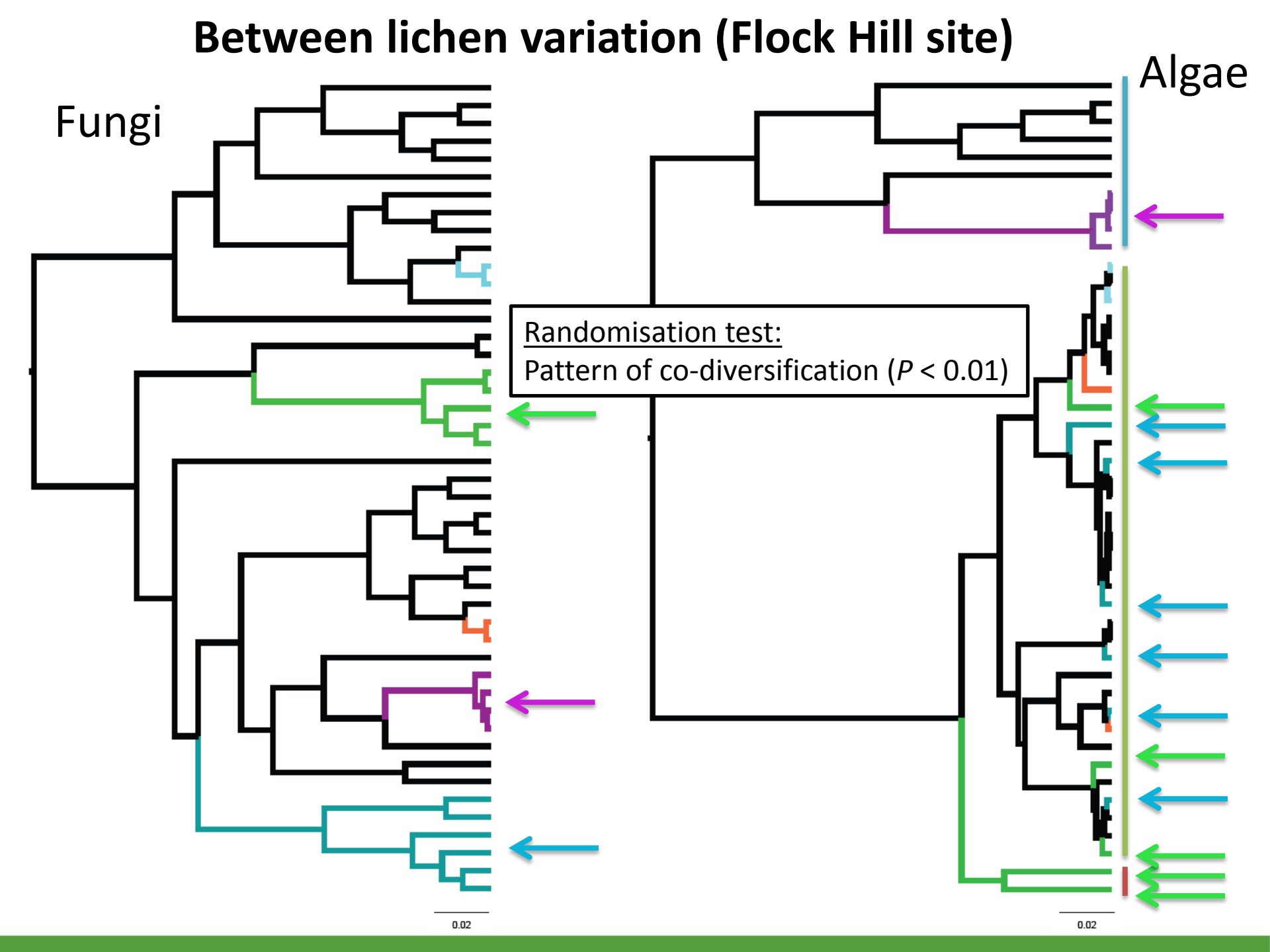
- Between lichen variation:
  - A range of lichen taxa from Flock Hill (N = 43*)
- Within site variation:
  - *Usnea* specimens from Flock Hill (N = 86)
- Between site variation:
  - *Usnea* specimens from sites around NZ (N = 25*)

* Preliminary dataset; more samples to be added

At each scale:

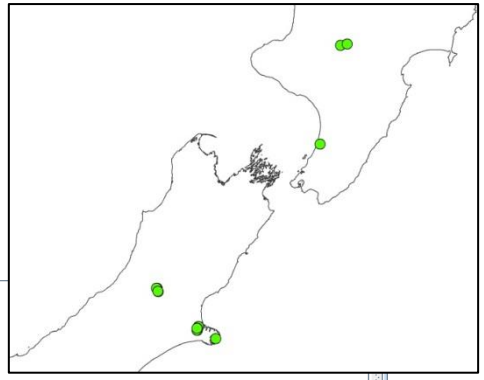
- Sequenced DNA (internal transcribed spacer region: ITS) from both fungal and algal partners
- Built separate Bayesian phylogenetic trees for each partner
- Used randomisations to test for consistency in associations between partners (co-diversification)

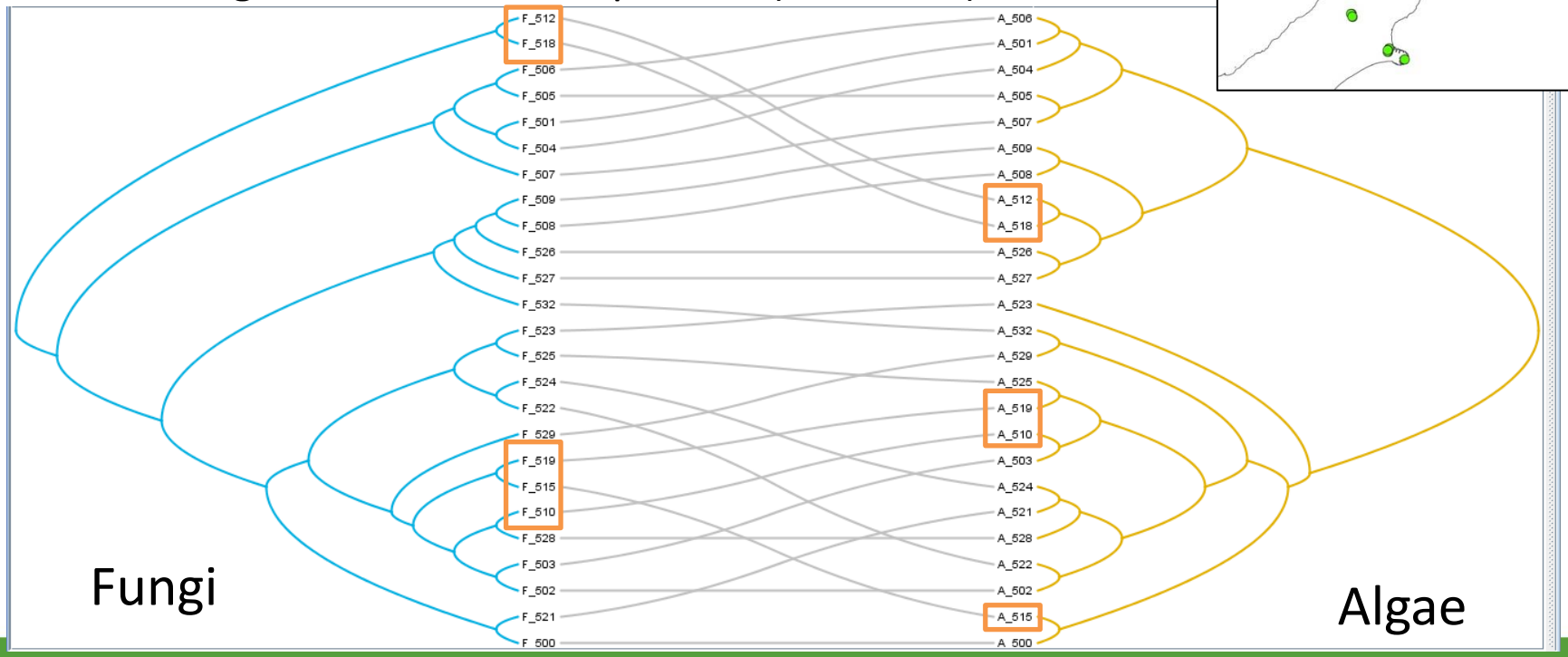
Between lichen variation (Flock Hill site)



Usnea spp only

- 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)

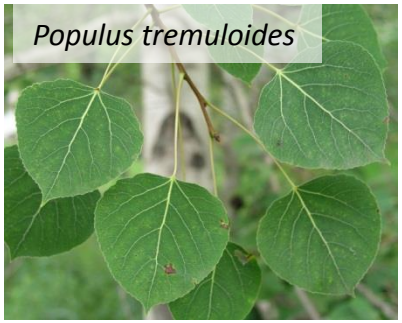
Ongoing research using epiphytic lichens

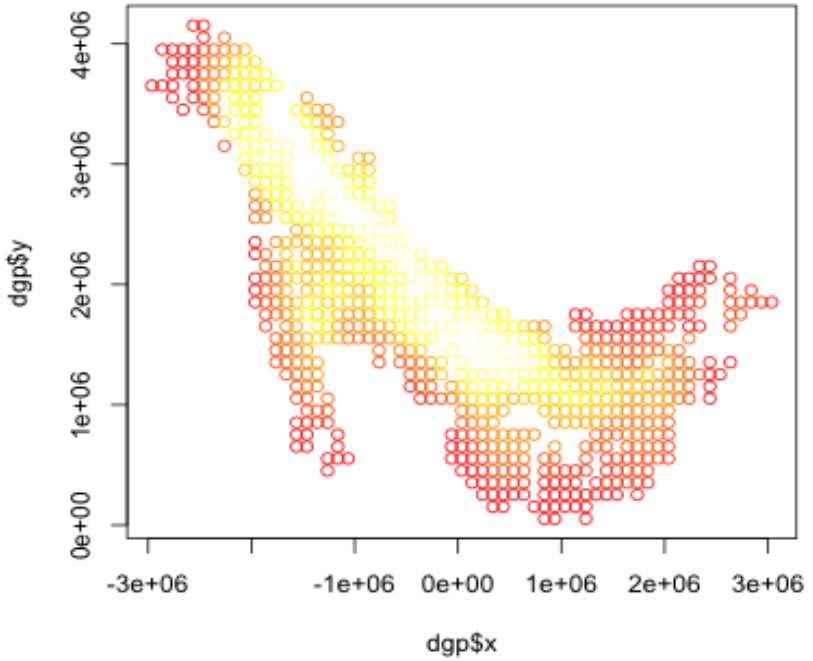
Spatial patterns in community structure

- 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

Dent, JM., Curran, TJ., Rafat, A., Buckley, HL. *Submitted*. Microhabitat variation in *Usnea* spp. biomass on mountain beech in Nina Valley, New Zealand. *New Zealand Journal of Botany*.

Buckley, HL. 2011. Isolation affects tree-scale epiphytic lichen community structure on New Zealand mountain beech trees. *Journal of Vegetation Science* 22: 1062–1071.

Buckley, HL. 2002a. Vascular plant and epiphytic lichen communities in Canadian aspen parkland: scale-dependence of species-area relationships. *Community Ecology* 3(1): 59-67.

Buckley, HL. 2002b. Vascular plant and epiphytic lichen communities in Canadian aspen parkland: determinants of species richness. *Community Ecology* 3(1): 69-78