Dissertation Notes

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April 4, 2012

Dissertation Requirements Timeline

- **April 2012** Assessment, prospectus review and course plan approval

  Bio form 5 - PhD Program Form

  Bio form 10 - Progress/Funding Assessment

  Bio form 13 - Teaching requirement documentation

  Bio form 14 - Scientific paper presentation documentation

- **Feb 2013** Prospectus defense and oral exam

  Bio form 7 - Written exam results

  Bio form 10 - Progress/Funding Assessment

  Bio form 8 - Oral exam results REPORT

  Bio form 8.11a - Oral exam assessment/questionaire

  Bio form 9 - Prospectus approval form

  Bio form 11 - Oral exam results

  Bio form 10 - Progress/Funding Assessment

- **May 2014** Final dissertation defense

  Dissertation draft

  Dissertation Defense Scheduling Form

  Graduate college final oral exam form (can only be accessed by advisor)

Committee

0.1 Requirements

1. At least four members
2. At least one external member
3. Majority from within the department (must have voting status; this includes emeritus faculty)
4.

1 The Evolution of Interaction Networks

1.1 Stability of Communities and Evolution

MacArthur 1955

1. Assuming that:
   (a) the ammount of energy entering the community does not vary with time
   (b) the length of time that energy is retained by a species doesnt' change with time
   (c) the population of each species varies directly with available food energy
2. These assumptions imply that the population of each species tends to a specific constant (example Linderman 1942)
3. p_{ij} = the proportion of energy transfered from species i to j
4. As long as all energy transfers are shown/quantified, then $\sum_j p_{ij} = 1$
5. > "This equation shows that the food web considered as an energy transformer is what is known in probability theory as a Markov chain (Feller 1950)."
   >
   > Given the assumptions, the species' populations should tend toward a constant.
   >
   > However, since populations fluctuate in nature, at least one of the assumptions must not hold.

Community Stability = the constancy of species' abundances over time

Stability can arise in two ways:

(a) Patterns of interactions among species

(b) Properties intrinsic to each species

Stability (S) increases with the number of pathways (p_i), as $S = -\sum p_i log(p_i)$

There are several interesting properties of stability:

(a) stability increases with the total number of links

(b) stability will increase with richness (given the number of prey per species remaincs constant)

(c) Given 1 and 2, stability can be achieved by a large number of species with a restricted diet or a few species with a large number of prey

(d) Maximum stability for m species is achieved by m trophic levels with every species eating all species in lower trophic levels

(e) Minimum stability would arise with one species eating all others in a single lower trophic level

2 How does genetic variation influence ecological network structure?

- Does genetic variation within a foundation species lead to modularity in co-occurrence patterns of associated species?
- Approach:
  1. Use Lonsdorf's simulation to generate communities
  2. Model communities as bipartite graphs using relative abundances
  3. Generate structural statistics (including modularity and nestedness)
  4. Look for relationship with genetic variability
  5. Add layers to simulation, such as interactions among arthropods (e.g. intransitivity)

3 How does genetic variability contribute to the structure of plant-herbivore (and predator) networks?

- Does the modular structure of plant-herbivore interaction networks arise from crosstype or genotype variability?
- Approach:
  1. Gina's, Art's, Sharon's and Dave's arthropod data
  2. Reduce to just known herbivores (and maybe omnivores) and analyze for modularity
  3. Use herbivore and predator co-occurrences to generate herbivore-predator (and maybe parasite) networks and analyze for network structural similarity among crosstypes/genotypes

4 How does genotypic variability influence the structure of lichen species interactions?

- How do lichen co-occurrence patterns vary among genotypes?
- Approach:
  1. Collect co-occurrence data for bark lichen associated with cottonwood individuals of known genotype
  2. Model co-occurrence patterns using standard co-occurrence methods and network modeling algorithms
  3. Test for the effect or similarity of genotypes with respect to lichen co-occurrence structure
  4. Analyze the structural patterns that are changing among genotypes
  5. Analyze the individual species responses

5 How does genotypic variation influence the structure of modifier-inquiline interactions?

- How does host genotype directly and indirectly influence the interaction between leaf-modifiers and inquilines associated with their modification structures?

- Approach:
  1. Survey the abundance of leaf-modifiers in the wild along a hybridizing system
  2. Survey leaf-modifiers and their inquilines in the common garden
  3. Create artificial leaf-modifications that mimic the leaf-modifier species (i.e. paper clip method used in Martinsen et al. 2000)
  4. Survey leaf modifications for inquilines
  5. Build networks for each tree using the inquiline abundance data (possibly separate out known herbivores from predators)
  6. Analyze networks for structural similarity among genotypes
  7. Analyze for individual species responses (locations in networks)

6 How does plant facilitation influence the co-occurrence patterns of associated plant species?

- Are there phylogenetic patterns in the effect of nurse plant on associated species co-occurrences?
- Approach:
  1. Cleanup Alpine Pals' global community dataset
  2. Get phylo-stats from Brad
  3. Model co-occurrence networks using distance based method
  4. Look for correlation between phylo-stats and co-occurrence network structure
  5. Explore to find the source of the phylogenetic patterns
- How does intraspecific variation influence inter-plant interactions?
- Approach:
  1. Get Lamit's plant data
  2. Model as a bipartite graph
  3. Analyze for modularity