

EISI Plant-Pollinator Networks 2017

1. Jane S. Huestis

Phylogenetics of plant-pollinator networks

1. Andrew N. Guide

Pollinator preferences

1. Elaina G. Thomas

Beta diversity in montane meadows

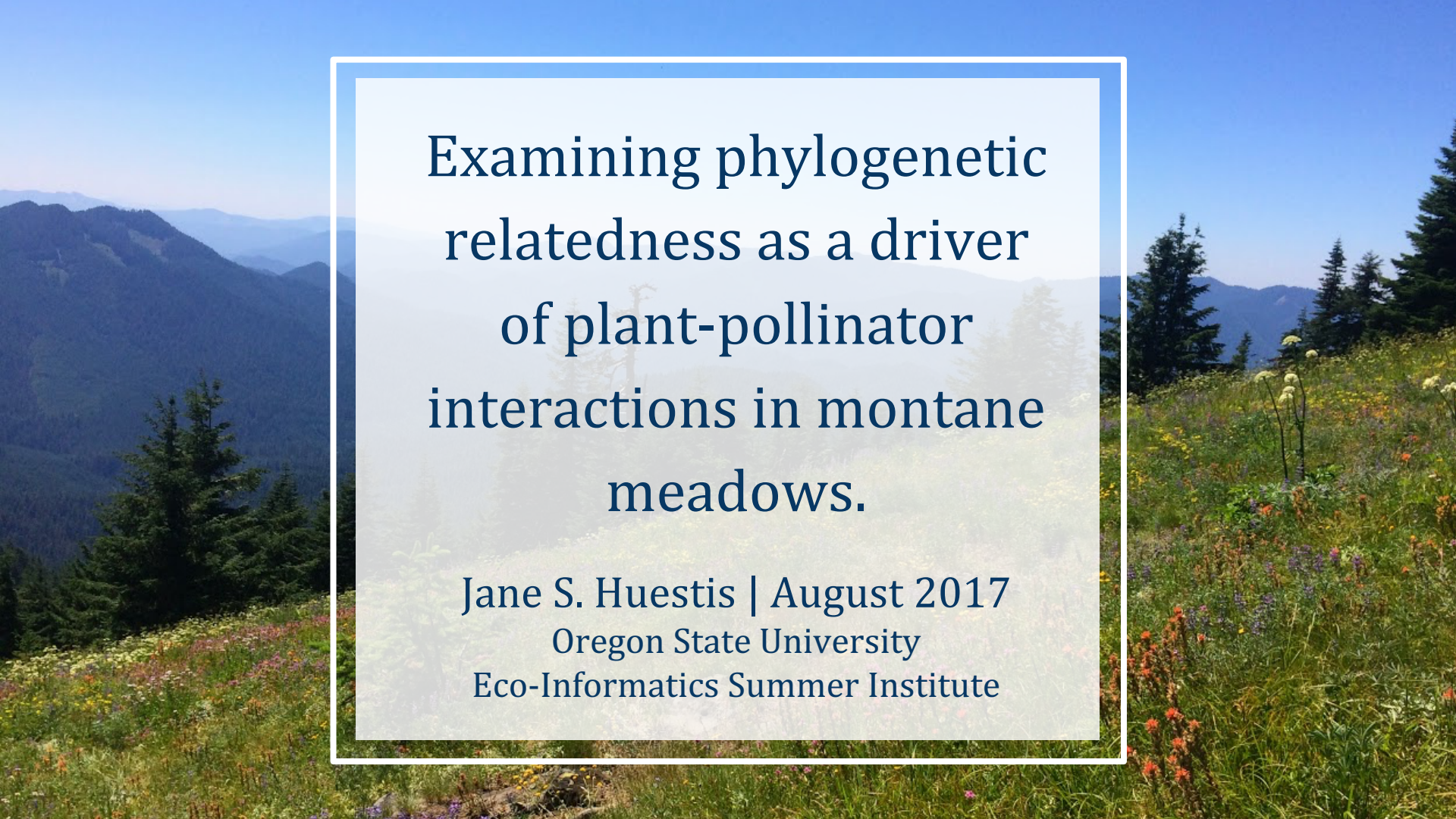
1. Lydia S. Miller

Modularity of plant-pollinator networks

1. Joshua B. Griffin

Modeling bee behavior





Examining phylogenetic relatedness as a driver of plant-pollinator interactions in montane meadows.

Jane S. Huestis | August 2017
Oregon State University
Eco-Informatics Summer Institute

Introduction

HJ Andrews Experimental Forest

- Blue River, OR
- LTER estd. 1948
- “a center for forest and stream ecosystem research in the Pacific Northwest” (AND LTER)

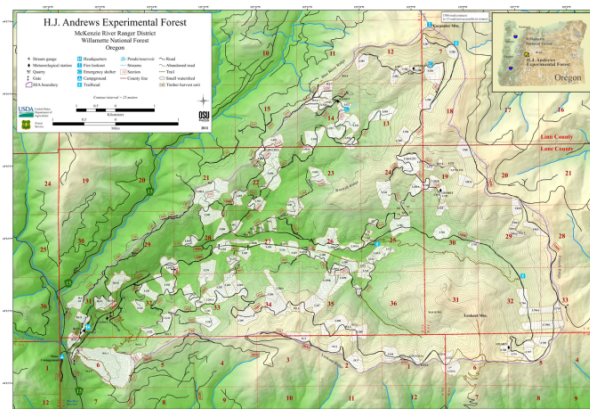


Plant-Pollinator Networks

- Agricultural significance
- Integral to healthy ecosystems

Phylogeny

- No existing phylogeny for plant or pollinators observed as part of the EISI program at HJ Andrews
- Minimal literature
- Phylogeny may inform conservation insights & practices



Map courtesy of Andrews LTER



How does phylogenetic relatedness of plant families correlate with frequency of interactions by members of the same pollinator families?

STUDY GOAL

Field Methods

Meadows & Plots

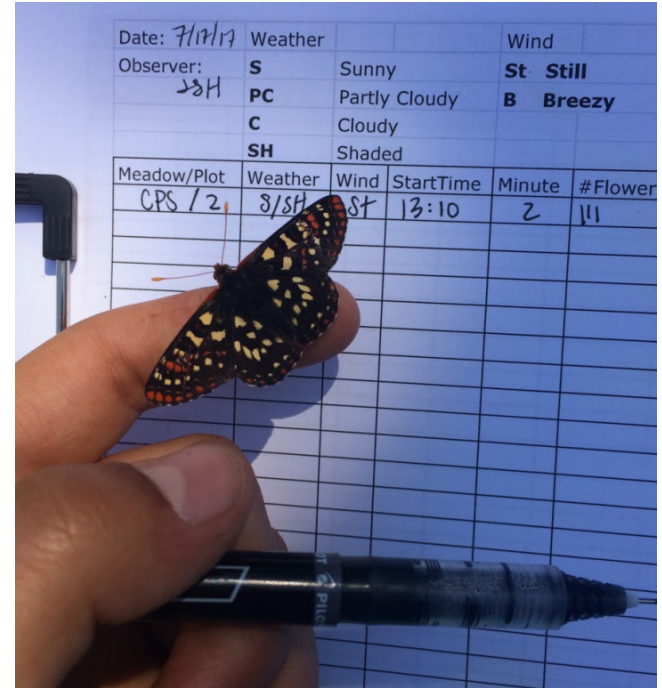
- 3 meadow complexes
- 4 meadows per complex, 10 plots per meadow
- 120 total plots surveyed

Anthesis

- Count number of stalks & flowers per stalk
 - Every species in anthesis in the plot

Interactions

- 15 minute watch period
- All plant-pollinator interactions (successful or otherwise) recorded



Phylogenetic Methods

Pollinators

- Bug Guide (Iowa State University Dept. of Entomology)
- American Insects 2nd Edition

Plants

- National Center for Biotechnology Information (NCBI) Taxonomy Browser
- USDA Natural Resources Conservation Service PLANTS Database

Tree Building & Visualization

- phyloT & NCBI
- Interactive Tree of Life (iTOL)

Distance Metrics (Plants)

- Distance matrix

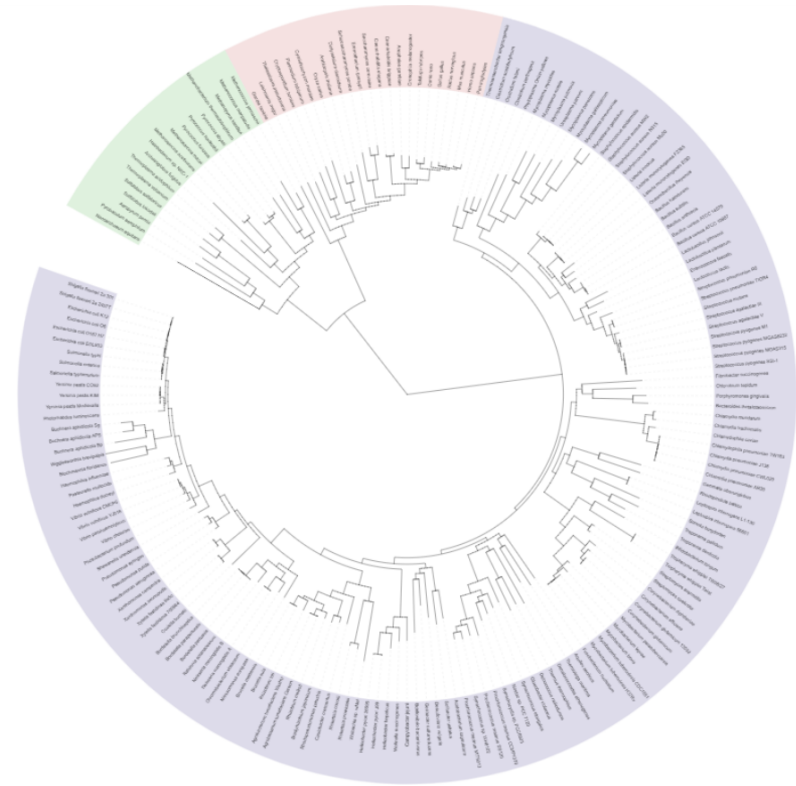


Image courtesy of iTOL

Analytical Methods

Jaccard Index

- Pairwise comparison between plant families
- Intersection & union of sets
 - Percent of shared pollinator families

Scatterplot

Linear Regression

RStudio

	Cyperaceae	Liliaceae	Orchidaceae	Iridaceae	Ranunculaceae	Berberidaceae	Santalaceae	Portulacaceae
Cyperaceae	1.00000000	0.07407407	0.33333333	0.00000000	0.09523810	0.33333333	0.00000000	0.08333333
Liliaceae	0.07407407	1.00000000	0.07407407	0.00000000	0.37142857	0.07407407	0.03703704	0.26666667
Orchidaceae	0.33333333	0.07407407	1.00000000	0.00000000	0.09523810	1.00000000	0.00000000	0.18181818
Iridaceae	0.00000000	0.00000000	0.00000000	1.00000000	0.04761905	0.00000000	0.00000000	0.09090909
Ranunculaceae	0.09523810	0.37142857	0.09523810	0.04761905	1.00000000	0.09523810	0.04761905	0.28000000
Berberidaceae	0.33333333	0.07407407	1.00000000	0.00000000	0.09523810	1.00000000	0.00000000	0.18181818
Santalaceae	0.00000000	0.03703704	0.00000000	0.00000000	0.04761905	0.00000000	1.00000000	0.00000000
Portulacaceae	0.08333333	0.26666667	0.18181818	0.09090909	0.28000000	0.18181818	0.00000000	1.00000000
Polygonaceae	0.04347826	0.43137255	0.04347826	0.02173913	0.31372549	0.04347826	0.02173913	0.21276596
Caryophyllaceae	0.08333333	0.31034483	0.18181818	0.09090909	0.18518519	0.18181818	0.00000000	0.46666667
Saxifragaceae	0.08333333	0.41666667	0.08333333	0.04166667	0.32352941	0.08333333	0.00000000	0.29629630
Crassulaceae	0.07407407	0.42105263	0.07407407	0.00000000	0.37142857	0.07407407	0.03703704	0.31034483
Brassicaceae	0.14285714	0.36666667	0.14285714	0.00000000	0.34615385	0.14285714	0.07142857	0.31578947
Onagraceae	0.08333333	0.26666667	0.18181818	0.00000000	0.33333333	0.18181818	0.00000000	0.29411765
Rosaceae	0.04878049	0.54545455	0.04878049	0.02439024	0.34782609	0.04878049	0.02439024	0.26829268
Fabaceae	0.08000000	0.40540541	0.08000000	0.04000000	0.35294118	0.08000000	0.04000000	0.33333333
Clusiaceae	0.10526316	0.39393939	0.10526316	0.00000000	0.33333333	0.10526316	0.05263158	0.30434783
Violaceae	0.25000000	0.11111111	0.66666667	0.00000000	0.14285714	0.66666667	0.00000000	0.27272727

```
RStudio
File Edit Code View Plots Session Build Debug Profile Tools Help
Go to file/function
Addins
phylomatrix2.R
pmatrix
Source on Save
Run
Source
4
5 plantfam <- levels(family[,2])
6 pnfam <- levels(family[,3])
7
8
9
10 myArray <- array(0, dim = c(length(plantfam),length(pnfam)), dimnames = list(plantfam,pnfam))
11
12
13 for(i in 1:dim(family)[1]){
14   myArray[family[i,2],family[i,3]] = 1
15 }
16
17 num_sets <- choose(dim(myArray)[1],2)
18
19 idx_sets <- generate_idx_sets(myArray[,1])
20
21 myDimnames <- generate_dimnames(idx_sets,plantfam)
22
23 perc_arr <- array(NA, dim = c(1,num_sets),dimnames = list("Intersection/Union %",myDimnames[]))
24
25
```


Results | Phylogenies

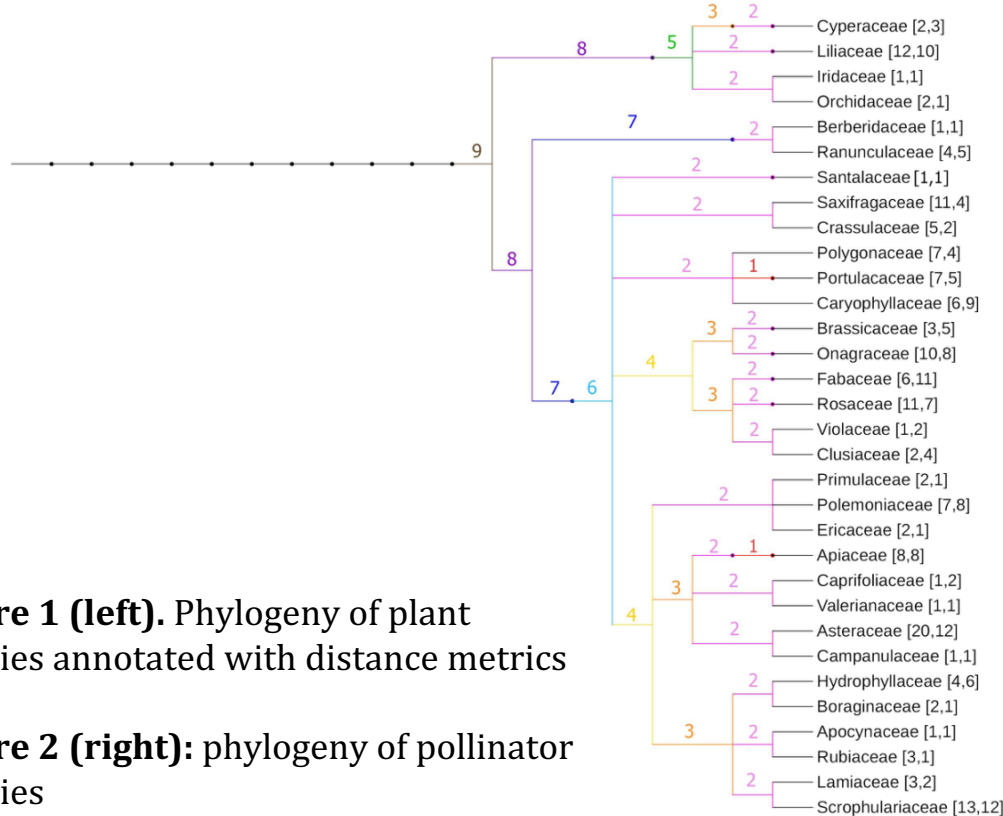
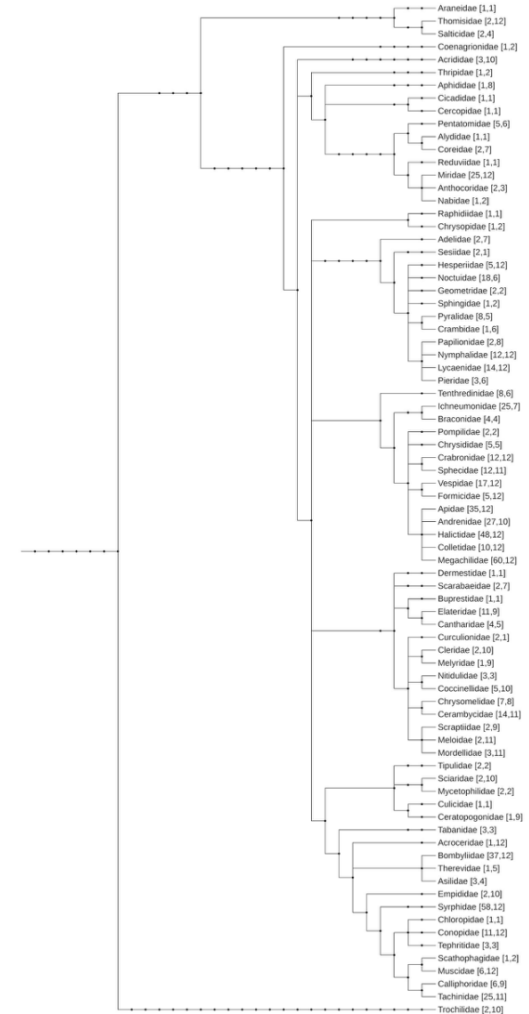


Figure 1 (left). Phylogeny of plant families annotated with distance metrics

Figure 2 (right): phylogeny of pollinator families



Results | Phylogenetic distance versus shared pollinators

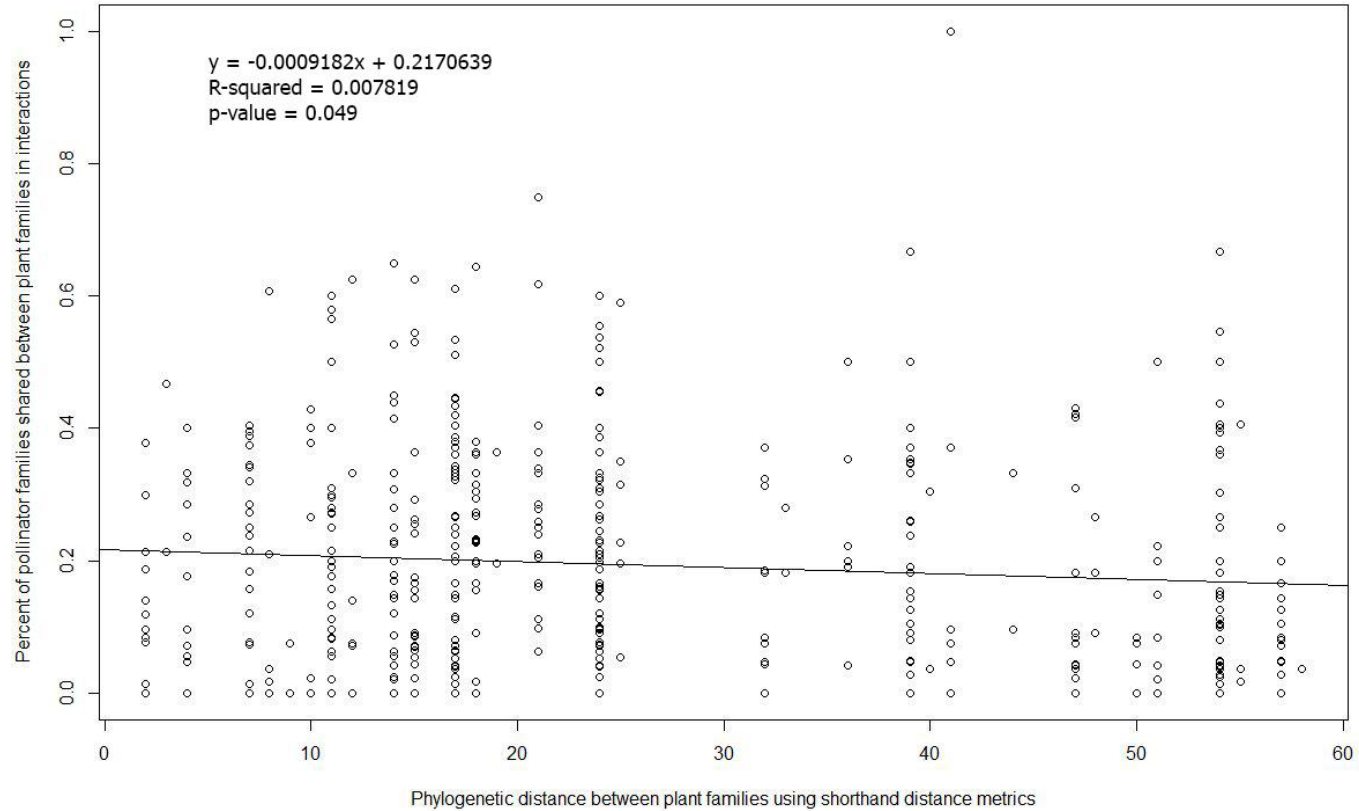


Figure 3. Relationship of shared pollinator family interactions as a function of phylogenetic distances between pairwise comparisons of plant families.

Results | Points of interest

Plant families compared	Percent of pollinator families shared	Phylogenetic distance
Berberidaceae x Orchidaceae	75	41
Violaceae x Orchidaceae	66.7	54
Boraginaceae x Orchidaceae	66.7	54
Berberidaceae x Violaceae	66.7	39
Boraginaceae x Berberidaceae	66.7	39
Polemoniaceae x Polygonaceae	66.9	14
Apiaceae x Polygonaceae	64.5	18

Table 1. Points of interest due to their high percentage of pollinator families shared.

Plant families compared	Phylogenetic distance	Percent of pollinators shared
Iridaceae x Orchidaceae	2	0
Berberidaceae x Ranunculaceae	2	9.5
Caryophyllaceae x Polygonaceae	2	21
Crassulaceae x Saxifragaceae	2	38
Polemoniaceae x Ericaceae	2	8.3
Polemoniaceae x Primulaceae	2	14
Ericaceae x Primulaceae	2	30
Campanulaceae x Asteraceae	2	1.4
Valerianaceae x Caprifoliaceae	2	7.7
Apocynaceae x Rubiaceae	2	0
Scrophulariaceae x Lamiaceae	2	12
Hydrophyllaceae x Boraginaceae	2	19

Table 2. Percent of pollinators shared between plant families with low phylogenetic distance.

Discussion & Conclusions

Goal

How is phylogenetic relatedness of plant families correlated with frequency of visits by the same pollinator families?

Key Findings

Slight negative correlation between phylogenetic distance & shared pollinator families

Further Directions

Flower morphology



Acknowledgments

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