# Community Phylogenetics of Lichens in the Flat Tops Wilderness Area of Colorado

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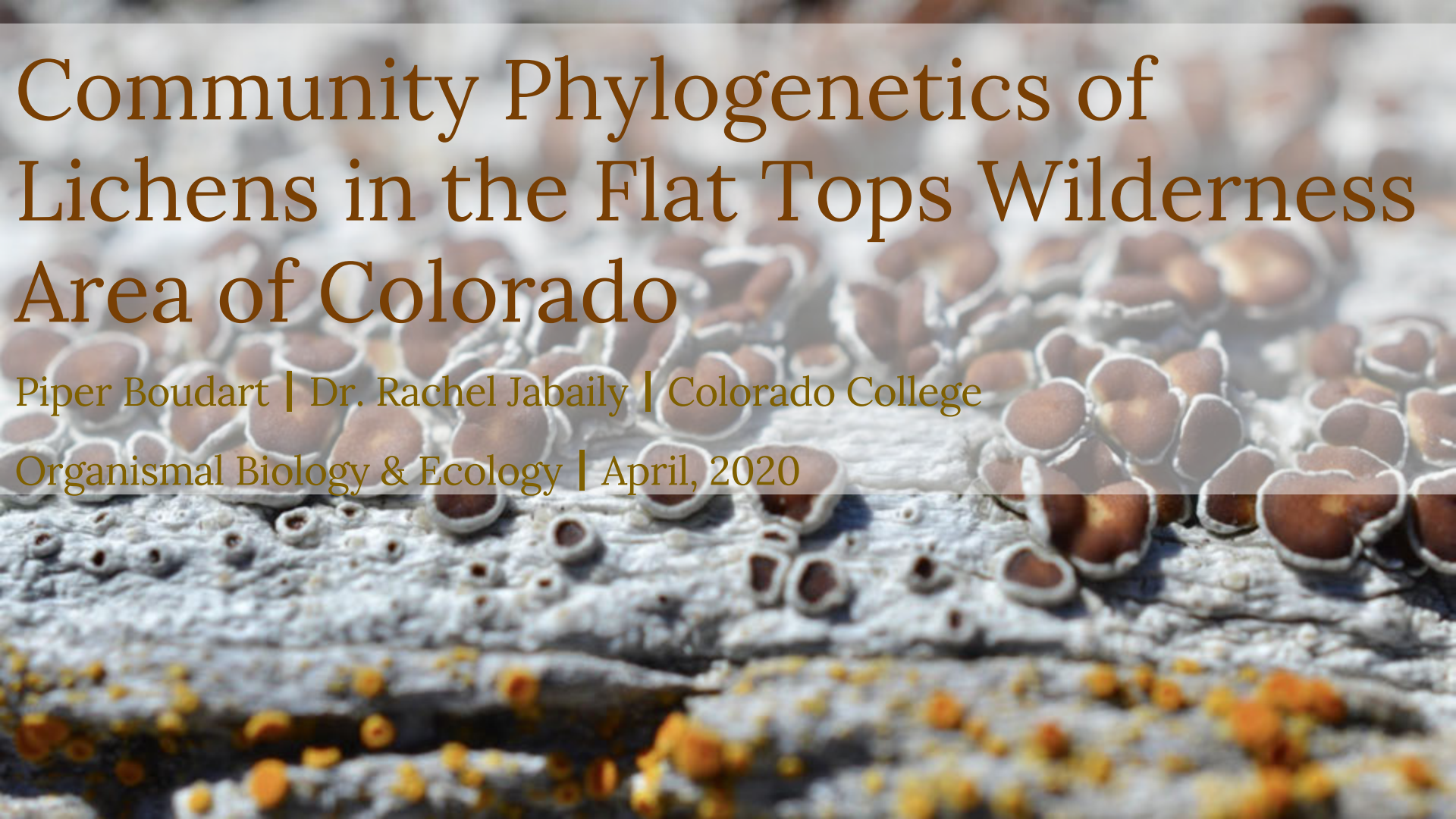
Organismal Biology & Ecology | April, 2020




01
Field Work & Specimen Collection
02
Specimen Identification & Deposition
03
Phylogeny Creation
04
Community Phylogenetic & Statistical Analyses

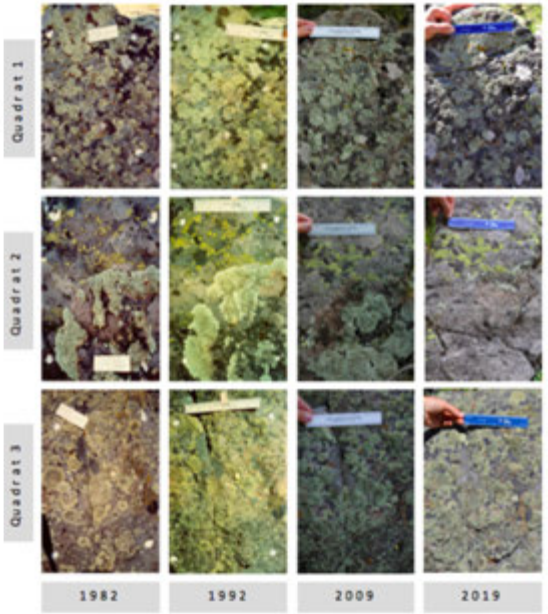
# Lichens

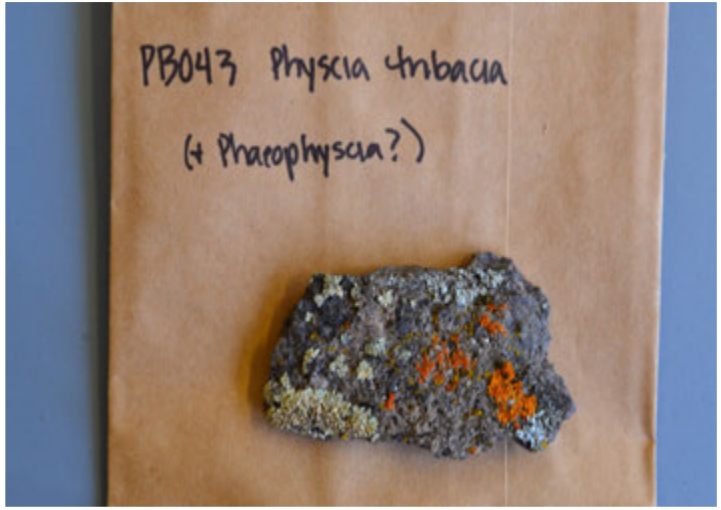
- Symbiotic relationship between fungus and algal photobiont
- Classification based on fungal symbiont
- Demonstrate substrate-specificity
  - Present study includes saxicolous species only
- Assemblages vary based on microenvironment
  - In part dictated by aspect and rock type

= Wilderness Boundary

= Inventory Site

Site 11
Site 12
Site 13
Site 14
Site 15
Site 16
Photo plots: 11 & 12
Site 10
Site 9
Site 7
Photo plots: 9 & 10
Site 8
Site 6
Site 5
Photo plot: 8
Site 17
Site 18
Site 19
Site 1
Site 3
Site 4
Photo plots: 1, 2 & 3
Site 2
Photo plots
Site 21
Site 20




PB043 Physcia tribacia
(+ Phaeophyscia?)

**Lichens of Colorado**
Flat Tops Wilderness Area

*Rhizocarpon disporum* (Naeg. F...

**Lichens of Colorado**
Flat Tops Wilderness Area

***Physcia dubia*** (Hoffm.) Lettau

**Lichens of Colorado**
Flat Tops Wilderness Area

***Lecidella carpathica*** Körb

**Lichens of Colorado**
Flat Tops Wilderness Area

***Rusavskia elegans*** (Link) S. Y. Kondr. & Kärnefelt

Det. Piper Boudart, 2019

LOCALITY: Garfield Co., Colorado: Flat Tops Wilderness Area in the White River National Forest, M. E. Hale site no. 4 (1982). Large talus field on NE side of

**Lichens of Colorado**
Flat Tops Wilderness Area

***Xanthoparmelia cumberlandia*** (Gyelnik) Hale

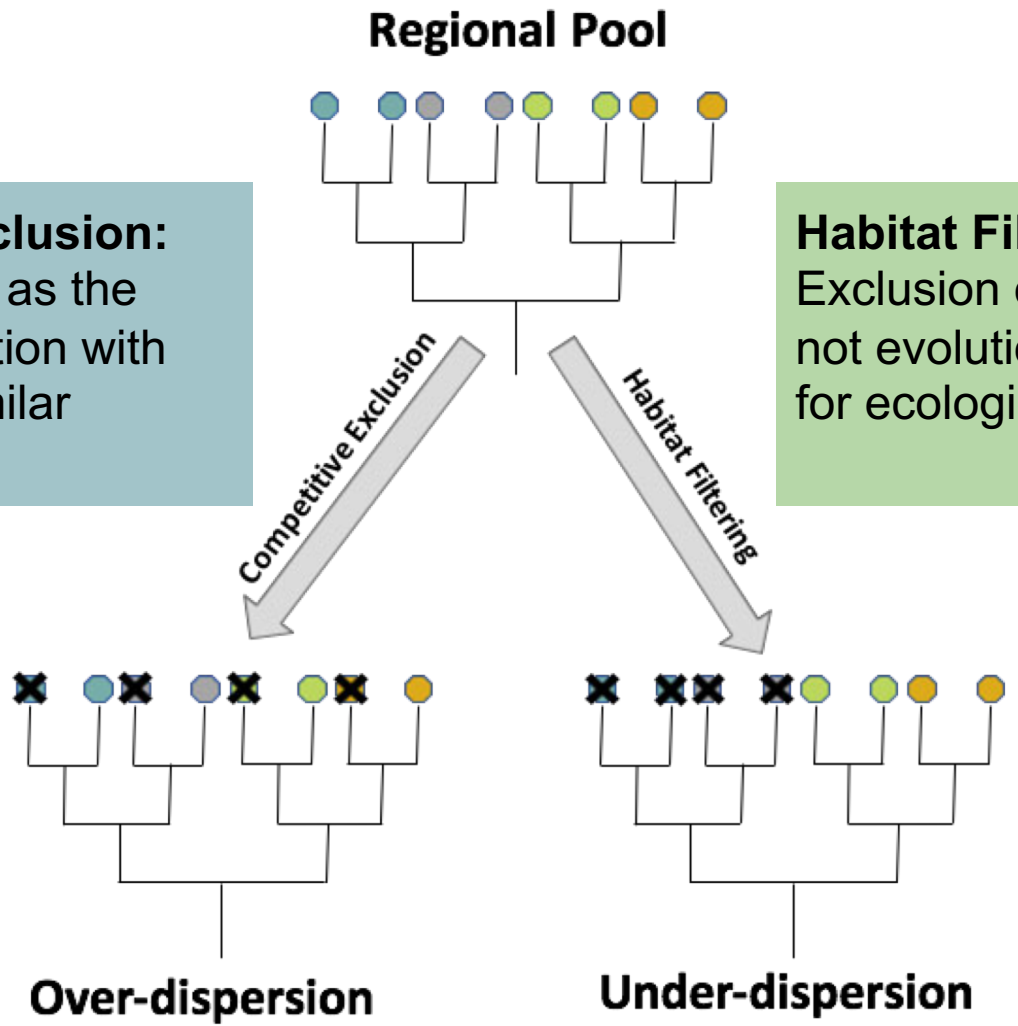
Det. Piper Boudart, 2019



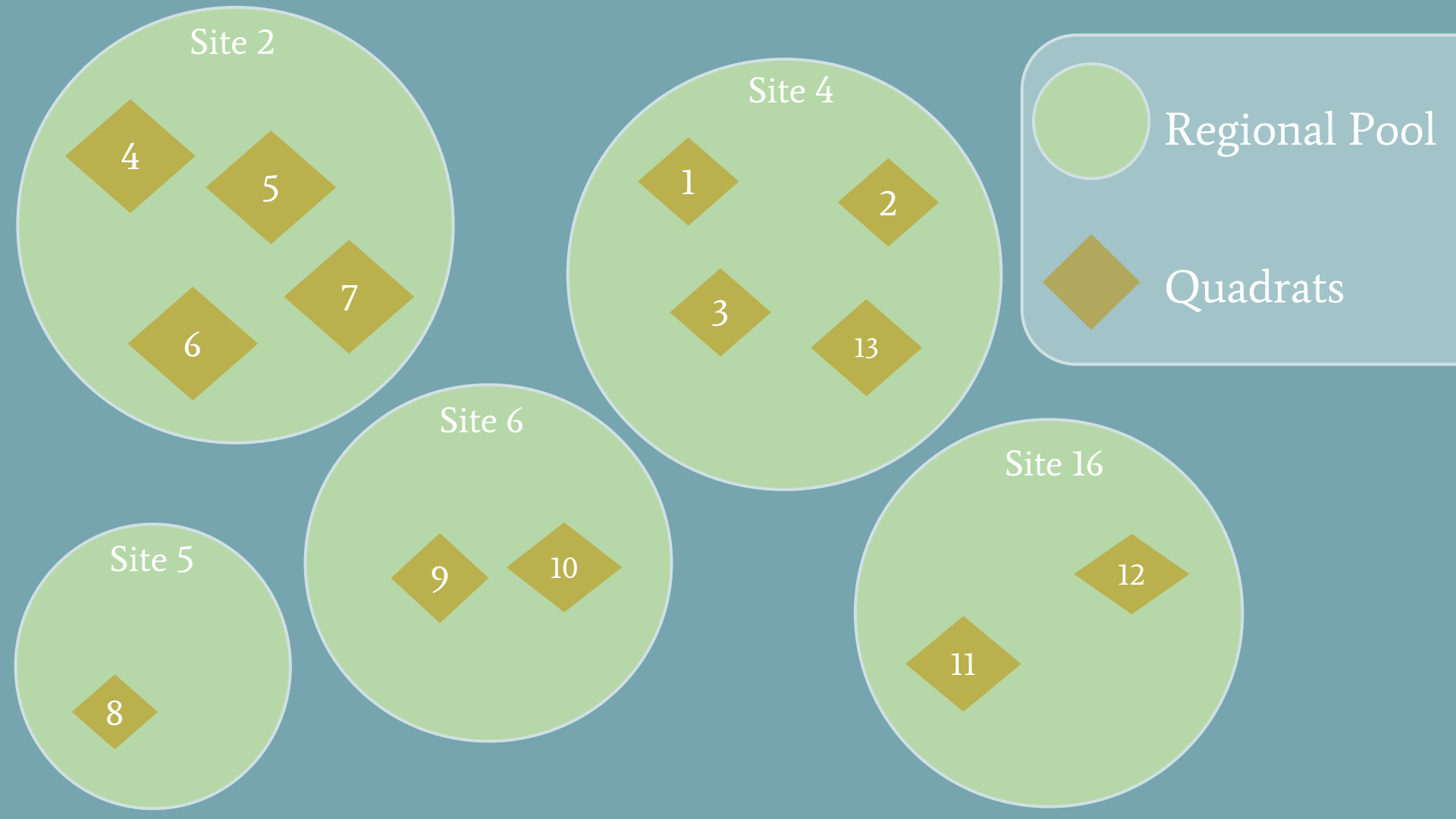

# Community Phylogenetics

- Intersection of ecology and phylogenetics
- Seeks to determine if local communities are random subsets of a broader regional species pool
- Analyzes evolutionary relationships within species assemblages
- Infers mechanisms of assemblage

**Competitive Exclusion:**
Local extinctions as the result of competition with evolutionarily similar neighbors




**Habitat Filtering:**
Exclusion of taxa that are not evolutionarily equipped for ecological conditions


Site 2
4
5
7
6
Site 4
1
2
3
13
Regional Pool
Quadrats
Site 6
9
10
Site 16
12
11
Site 5
8

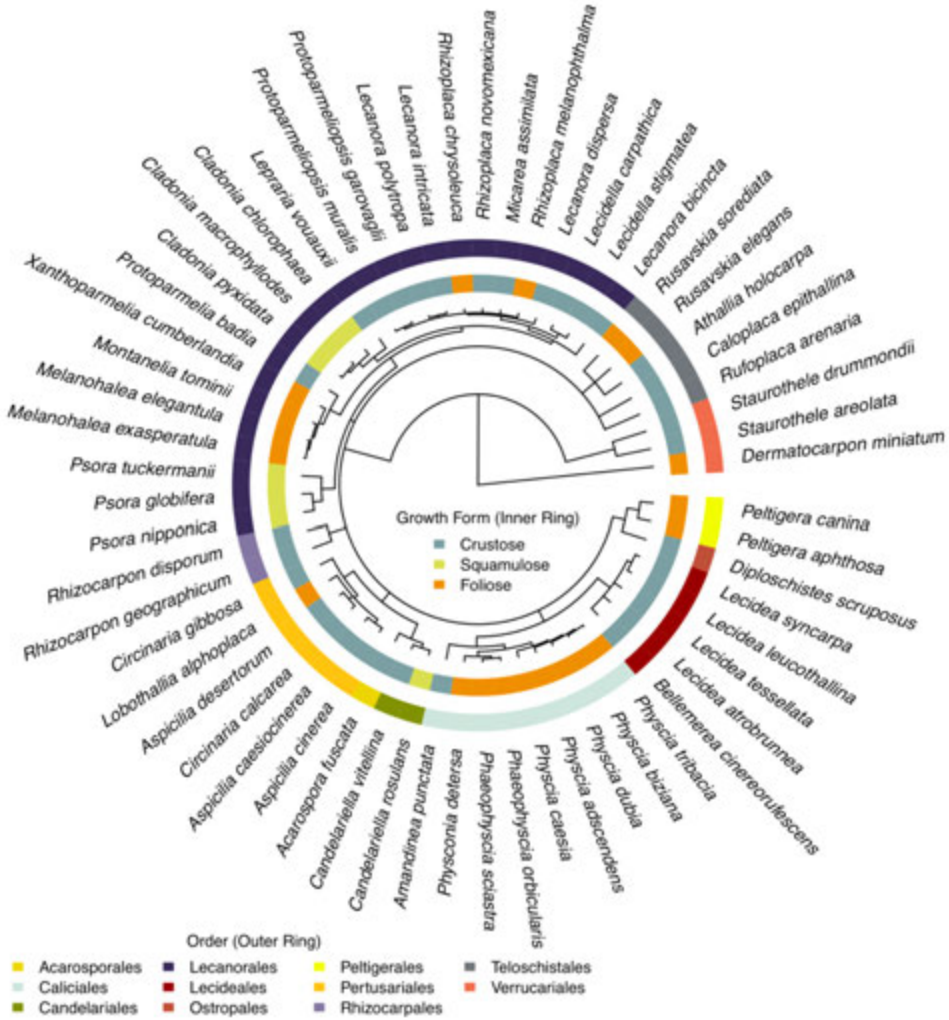



**Fig. 1** Maximum likelihood consensus tree of the regional pool used to conduct community phylogenetic analyses.

# Phylogenetic Diversity Metrics

**Faith's Phylogenetic Diversity (PD):** the sum of the branch lengths of all species in the community phylogeny

**Mean Pairwise Distance (MPD):** the mean branch length between each pair of species in community phylogeny

**Mean Nearest Taxon Distance (MNTD):** the mean branch length between each species and its nearest relative in the community phylogeny

| Quadrat+Year | SES PD | SES MPD | SES MNTD |
|---|---|---|---|
| Q1_1982 | -0.626 | -0.529 | -1.465 |
| Q1_1992 | -0.282 | -0.179 | -0.929 |
| Q1_2009 | 0.420 | 0.356 | -0.316 |
| Q1_2019 | -0.185 | 0.032 | -0.710 |
| Q2_1982 | 1.133 | 0.833 | 1.202 |
| Q2_1992 | -0.063 | 0.325 | -0.402 |
| Q2_2009 | 0.235 | 0.550 | -0.111 |
| Q3_1982 | 0.158 | 0.271 | 0.385 |
| Q3_1992 | -0.270 | 0.018 | -0.350 |
| Q3_2009 | 0.292 | 0.125 | 0.381 |
| Q3_2019 | 0.743 | 0.530 | 0.000 |
| Q4_1982 | -0.343 | -0.084 | -0.320 |
| Q4_1992 | -0.315 | -0.158 | -0.284 |
| Q5_1982 | -0.111 | -0.242 | 0.141 |
| Q5_1992 | -0.357 | -0.491 | 0.081 |
| Q6_1982 | -0.071 | -0.324 | 0.118 |
| Q6_1992 | -1.067 | -0.473 | -1.267 |
| Q7_1982 | ◆2.162 | ◆2.218 | 1.144 |
| Q7_1992 | ◆2.124 | ◇1.904 | 1.146 |
| Q8_1982 | 0.657 | 0.387 | 1.078 |
| Q8_1992 | 0.665 | 1.154 | 1.073 |
| Q8_2009 | 0.763 | 0.922 | 1.212 |
| Q9_1982 | 0.450 | 0.219 | 0.680 |
| Q9_1992 | 0.778 | 0.161 | 1.105 |
| Q9_2009 | 0.778 | 0.161 | 1.105 |
| Q10_1982 | 1.568 | 1.369 | ◆2.118 |
| Q10_1992 | 0.046 | 0.315 | -0.497 |
| Q10_2009 | -0.206 | 0.047 | -0.586 |
| Q11_1982 | ◇1.897 | 1.465 | ◇1.849 |
| Q11_1992 | 1.264 | 0.755 | 0.755 |
| Q11_2009 | ◇1.897 | 1.465 | ◇1.849 |
| Q12_1982 | 0.036 | 0.058 | -0.309 |
| Q12_1992 | 0.161 | 0.328 | -0.893 |
| Q12_2009 | -0.370 | -0.008 | -1.635 |
| Q13_2019 | 0.086 | -0.655 | 0.022 |

◆ Significantly overdispersed

◇ Marginally overdispersed

PD, MPD, and MNTD SES values for each quadrat, each inventory period

# Phylogenetic Diversity Metrics

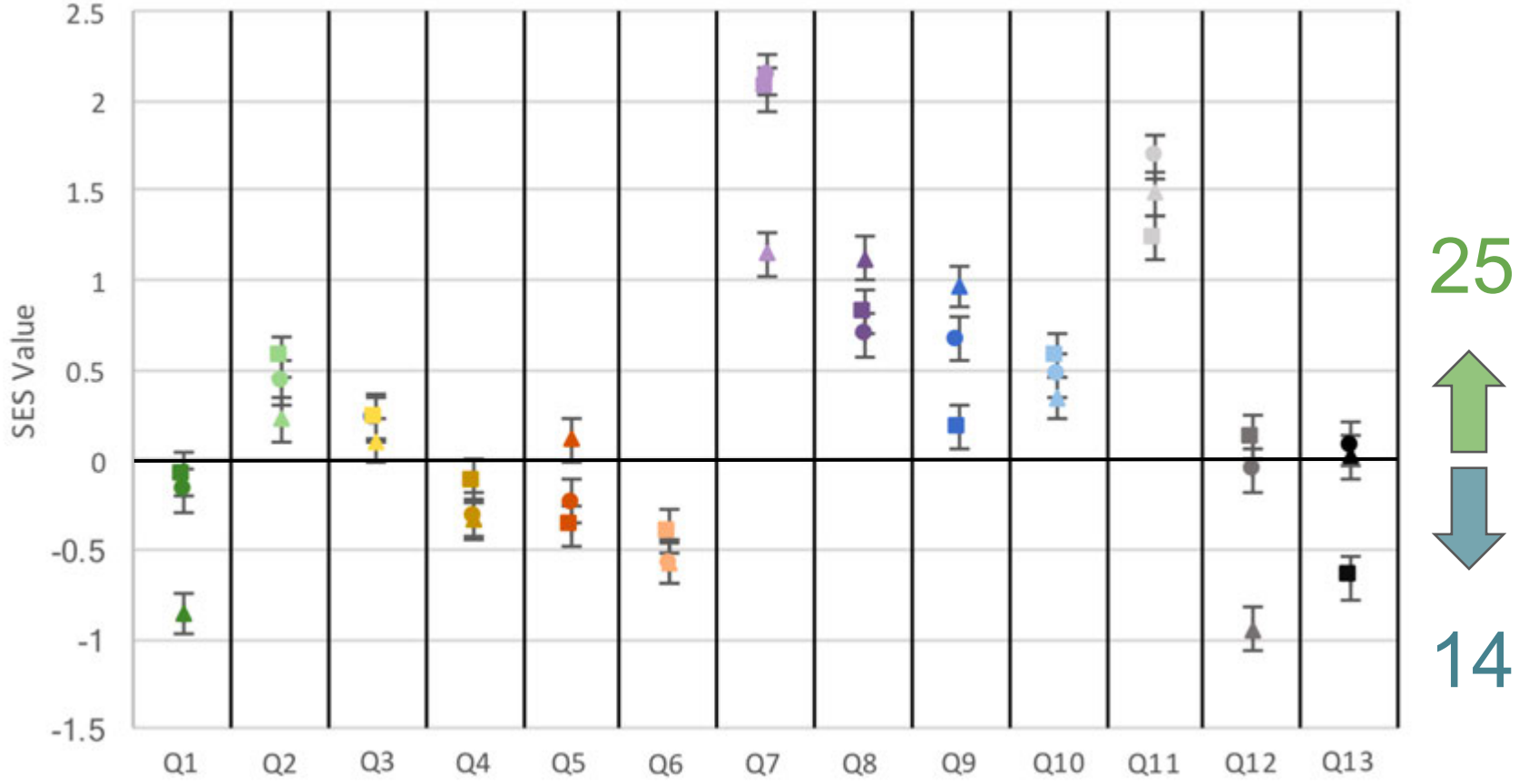



**Fig. 2** Average SES value for each quadrat over all available inventory periods with standard error. Triangles represent MNTD, squares MPD, and circles PD.

# Multivariate Analysis of Variance

**Table 1**

**Repeated-Measures MANOVA for Time, Aspect, and Rock Type on Phylogenetic and Taxonomic Diversity Measures**

| Effect | PD | MPD | MNTD | Species Richness | % Crustose |
|---|---|---|---|---|---|
| **Aspect** | | | | | |
| Aspect | 0.2208 | 0.0633* | 0.2433 | 0.6466 | 0.9143 |
| Time | 0.2612 | 0.7148 | 0.2335 | 0.1019 | 0.2877 |
| Time x aspect | 0.6637 | 0.8048 | 0.7858 | 0.6394 | 0.7626 |
| **Rock type** | | | | | |
| Rock type | 0.1945 | 0.256 | 0.2647 | 0.0695* | 0.7446 |
| Time | 0.1719 | 0.6579 | 0.2102 | 0.0441** | 0.2591 |
| Time x rock type | 0.2828 | 0.5851 | 0.6027 | 0.5194 | 0.187 |

* $P < 0.10$
** $P < 0.05$

# Analysis of Variance

**Table 2**

**ANOVA for Aspect and Rock Type on Phylogenetic Diversity Measures**

| Effect | PD | MPD | MNTD |
|---|---|---|---|
| **Aspect** | | | |
| Prob > F | 0.0072** | 0.0065** | 0.0203* |
| RSquare | 0.626951 | 0.634664 | 0.541409 |
| **Rock type** | | | |
| Prob > F | 0.2895 | 0.3290 | 0.1820 |
| RSquare | 0.10119 | 0.086622 | 0.155772 |

* $P < 0.05$
** $P < 0.01$

# Discussion

- Quadrats 7 and 10 demonstrate overdispersion
  - Indicative of competitive exclusion
- Strong correlation between quadrat aspect and phylogenetic diversity metrics
  - Most overdispersed quadrats located on horizontal rock faces flush with ground
- Significant effect of rock type on species richness

# Discussion

- Limited impact of habitat filtering
- Continued increase in species richness
  - Coupled with decrease in available space
- Phylogenetic structure likely to vary with successional stage
  - Stronger habitat filtering in earliest stages
  - Greater overdispersion in intermediate stages

# Future Directions

- Photographs provide opportunity to study lichen growth, neighbor dynamics, and successional patterns over time
- Herbarium specimens provide physical inventory and opportunities for elemental analyses
- Added time point continues legacy of Hale and provides continuity for a long-term study

# Acknowledgments

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