

Changes in Collembola diversity along a Neotropical elevation gradient

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Elevation - Diversity Patterns

- Biogeographical trends have been studied by ecologists wanting to understand how environmental factors influence species occurrence
- Patterns in diversity have been observed across large distances along latitudinal gradients
- However similar patterns are observed along elevation gradients, at a smaller spatial scale

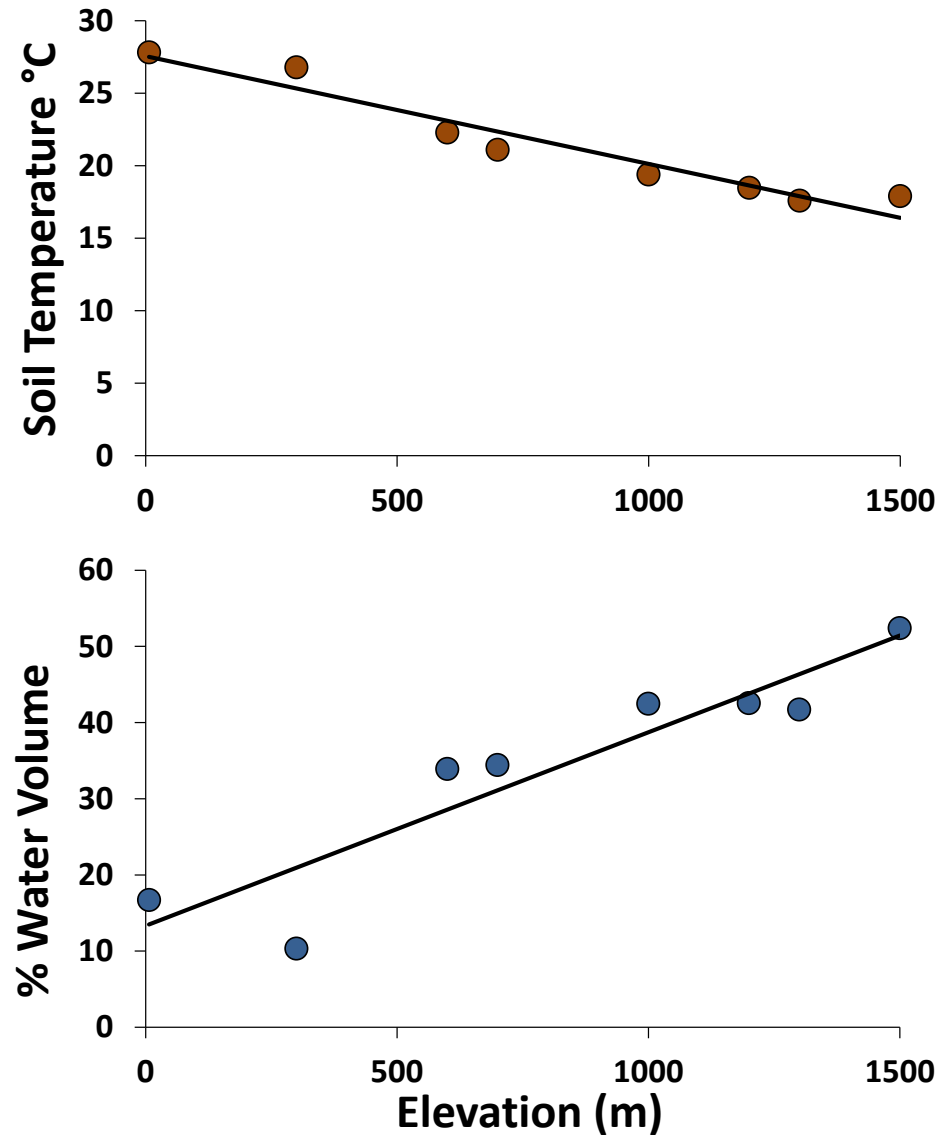


Greg Meredith

Abiotic Factors and Elevation

As elevation increases:

- Soil temperature decreases and becomes less variable
- Mean annual precipitation and % water volume of the soil increases



Abiotic Factors Summary

- Large change in abiotic factors over a 30 km distance
- Forest composition changes as elevation increases
- Expect that these changes will have an effect on Collembola diversity



Collembola

Habitat:

- Leaf litter, soil, vegetation
- Found in most ecosystems

Important in the ecosystem:

- Prey for predatory arthropods
- Assist in decomposition

Sensitive to environmental conditions that change along elevation gradients:

- At risk of desiccation
- Influenced by temperature



Symphypleona



Poduromorpha

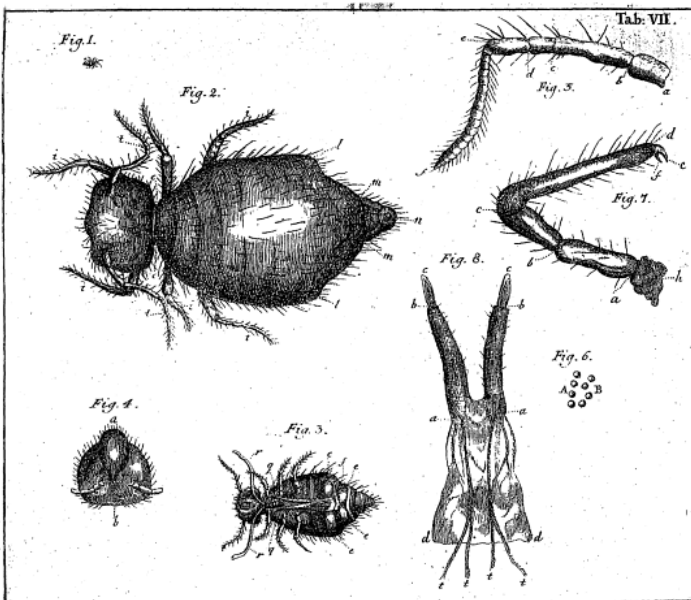


Entomobryomorpha



Neelipleona

Taxonomic Impediment



De Geer (1743)

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PLOS ONE

Cryptic Diversity in the Ubiquist Species *Parisotoma notabilis* (Collembola, Isotomidae): A Long-Used Chimeric Species?

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Abstract

Parisotoma notabilis is the most common species of Collembola in Europe and is currently designated as ubiquitous. This species has been extensively used in numerous studies and is considered as well characterized on a morphological ground. Despite the homogeneity of its morphology, the sequencing of the barcoding fragment (5' end of COI) for several populations throughout Europe and North America revealed four distinct genetic lineages. The divergence found between these lineages was similar to the genetic distance among other species of the genus *Parisotoma* included in the analysis. All four lineages have been confirmed by the nuclear gene 28S. This congruence between mitochondrial and nuclear signals, as well as the geographical distribution pattern of lineages observed in Europe, supports the potential specific status of these lineages. Based on specimens from the type locality (Hamburg), the species name was successfully assigned to one of these lineages. This finding raises several problems as *Parisotoma notabilis* has been widely used in many ecological studies. Accumulation of new data for the different lineages detected, especially ecological information and life history traits, is needed to help resolve this situation.

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Objectives

Diversity Pattern

- Differences between morphological and molecular based analyses

Phylogenetic structure

- Indication of possible environmental filtering



Diversity Measurements

- **Morphospecies Richness**
- MOTU Richness
- Faith's Phylogenetic Diversity
- Nearest Taxon Index

Morphospecies 1:



Morphospecies 2:



Diversity Measurements

- Morphospecies Richness
- **MOTU Richness**
- Faith's Phylogenetic Diversity
- Nearest Taxon Index

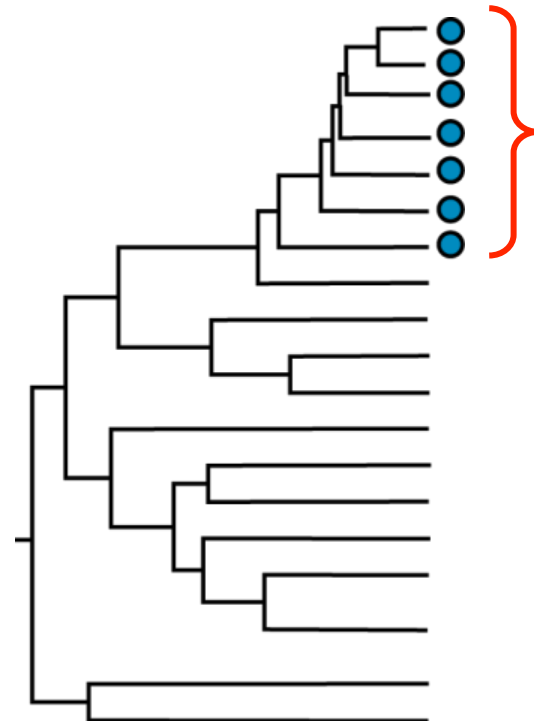
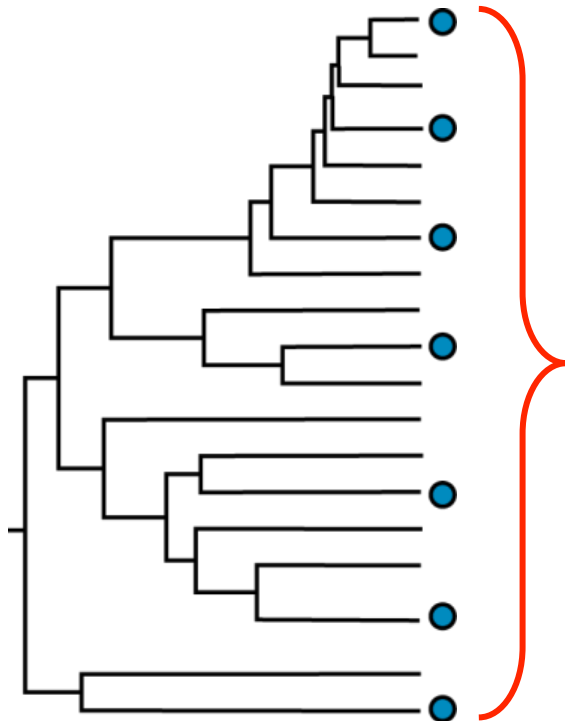
2% divergence

MOTU 1: ATAGTAGGAACTGCTTTT **A** G...

MOTU2: ATAGTAGGAACTGCTTTT **C** G...

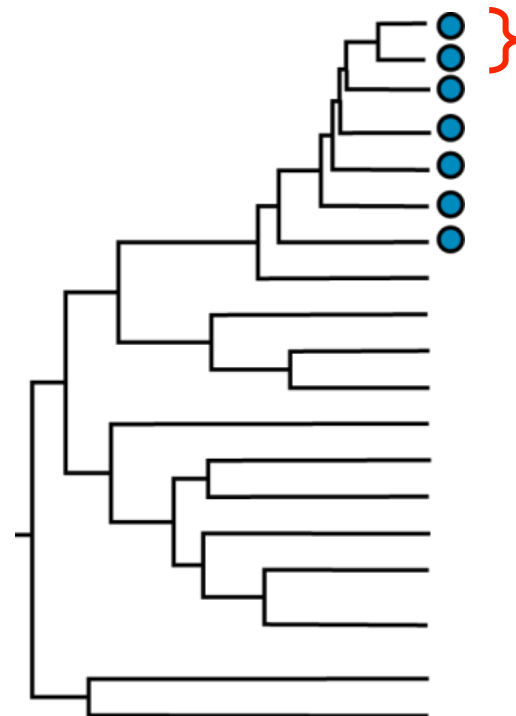
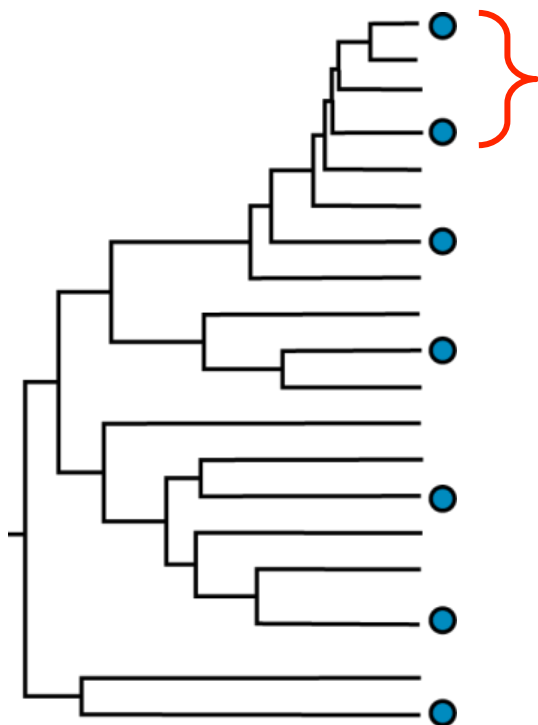
Diversity Measurements

- Morphospecies Richness
- MOTU Richness
- **Faith's Phylogenetic Diversity**
- Nearest Taxon Index



Diversity Measurements

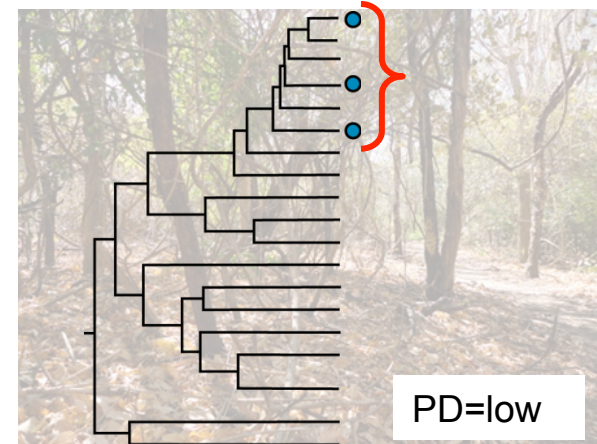
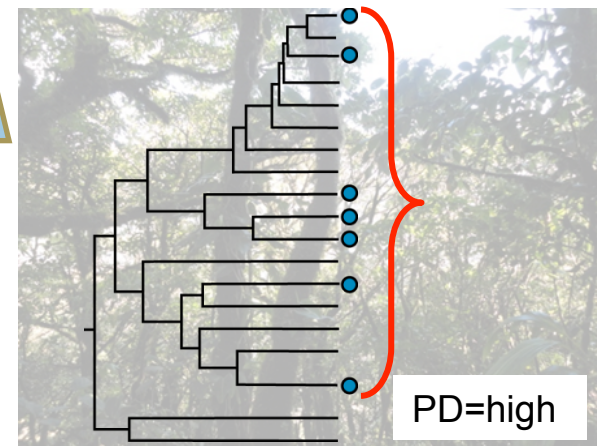
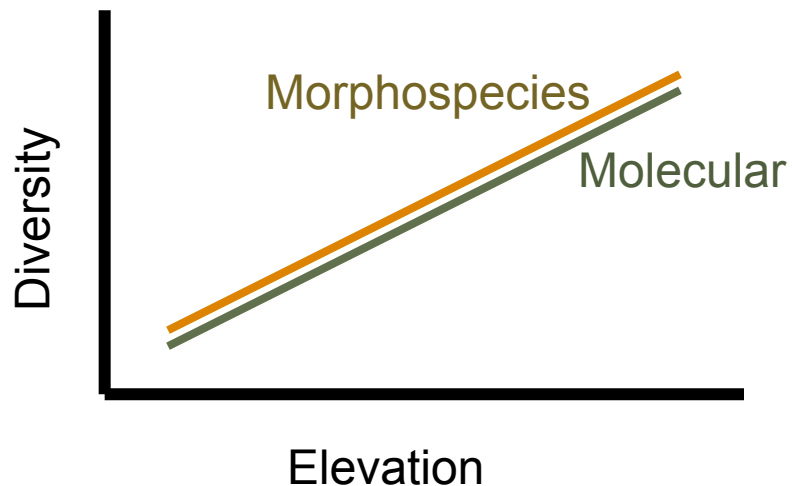
- Morphospecies Richness
- MOTU Richness
- Faith's Phylogenetic Diversity
- **Nearest Taxon Index**



Hypotheses and Predictions

Diversity Pattern

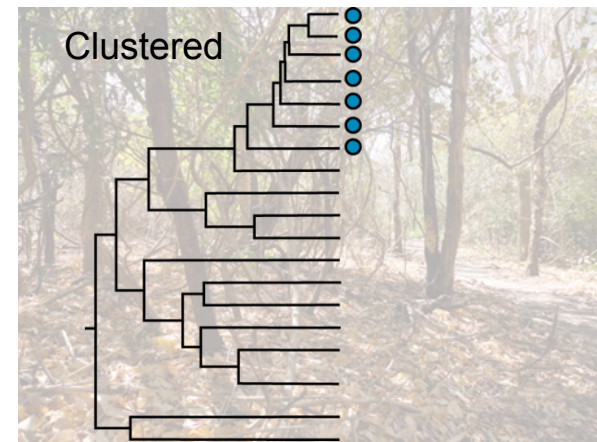
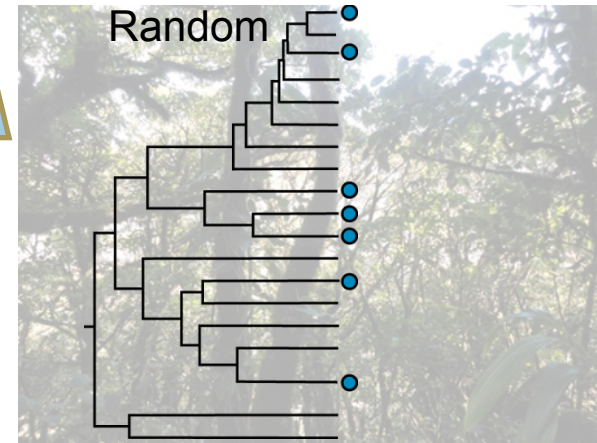
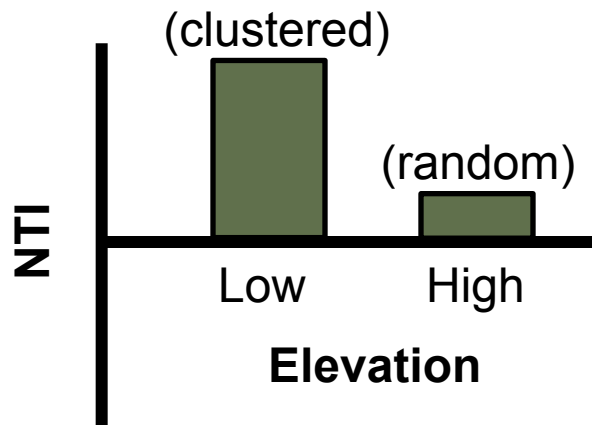
- If Collembola have difficulty persisting in hot dry areas, then Collembola diversity will increase with elevation.



Hypotheses and Predictions

Phylogenetic Structure

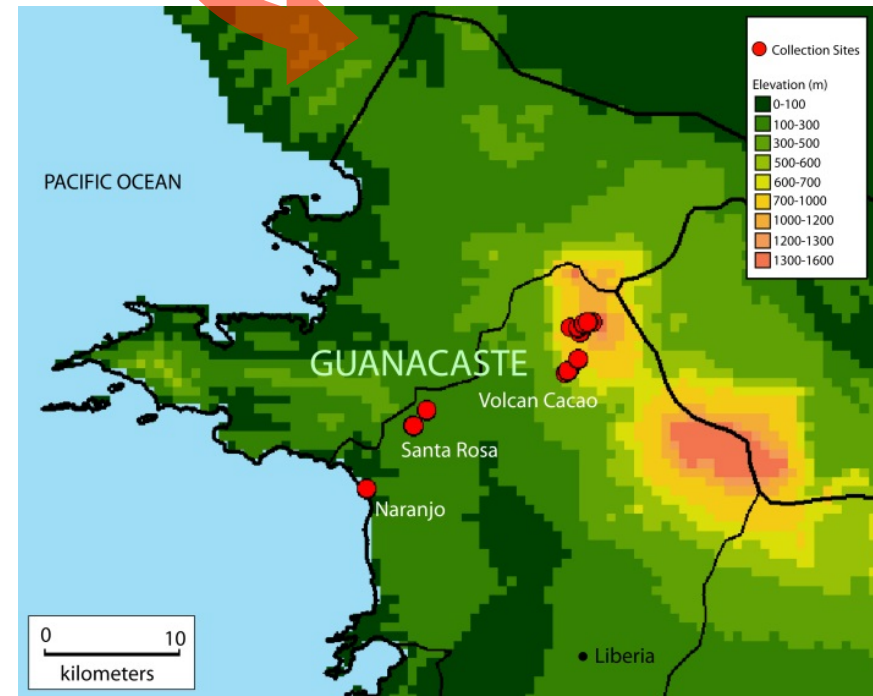
- If specialized traits are needed to exploit dry environmental, then areas at low elevations will be phylogenetically clustered.



Collections

Collected along Volcán Cacao in the Área de Conservación Guanacaste, Costa Rica at eight elevations using standardized protocols

- Sampled during dry and wet seasons from 2008-2014



Specimen Identification

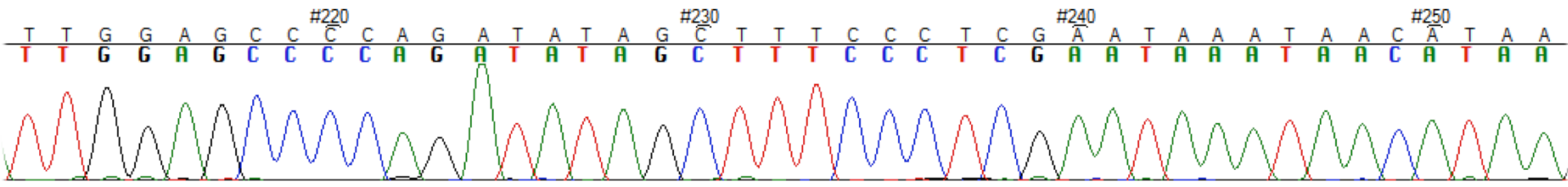
Morphospecies

- Interim proxy for formal species names
- Based on morphological characteristics



MOTUs

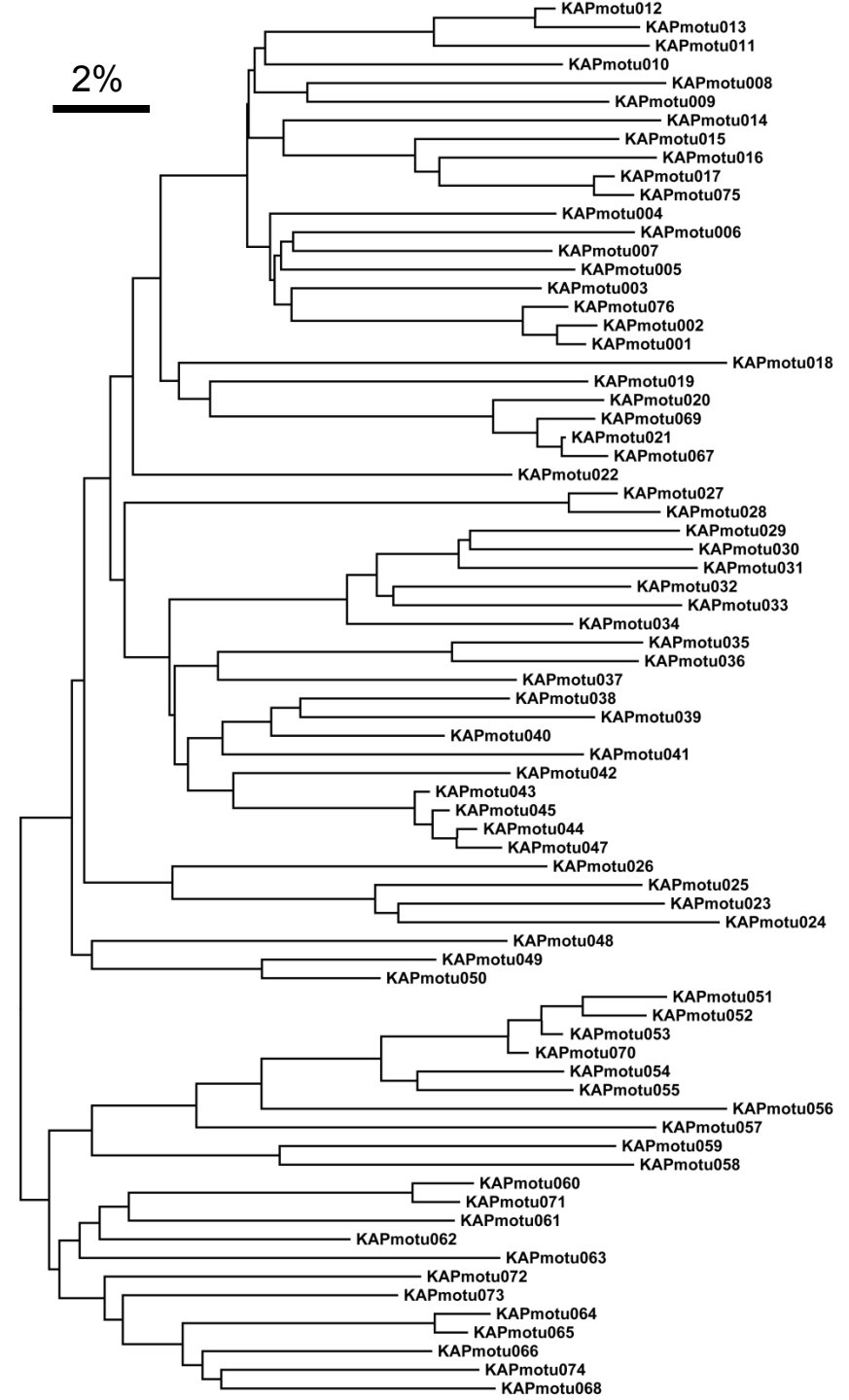
- COI = 5' COI mitochondrial gene
- Concatenated = 18S & 28S & COI



Diversity Analysis

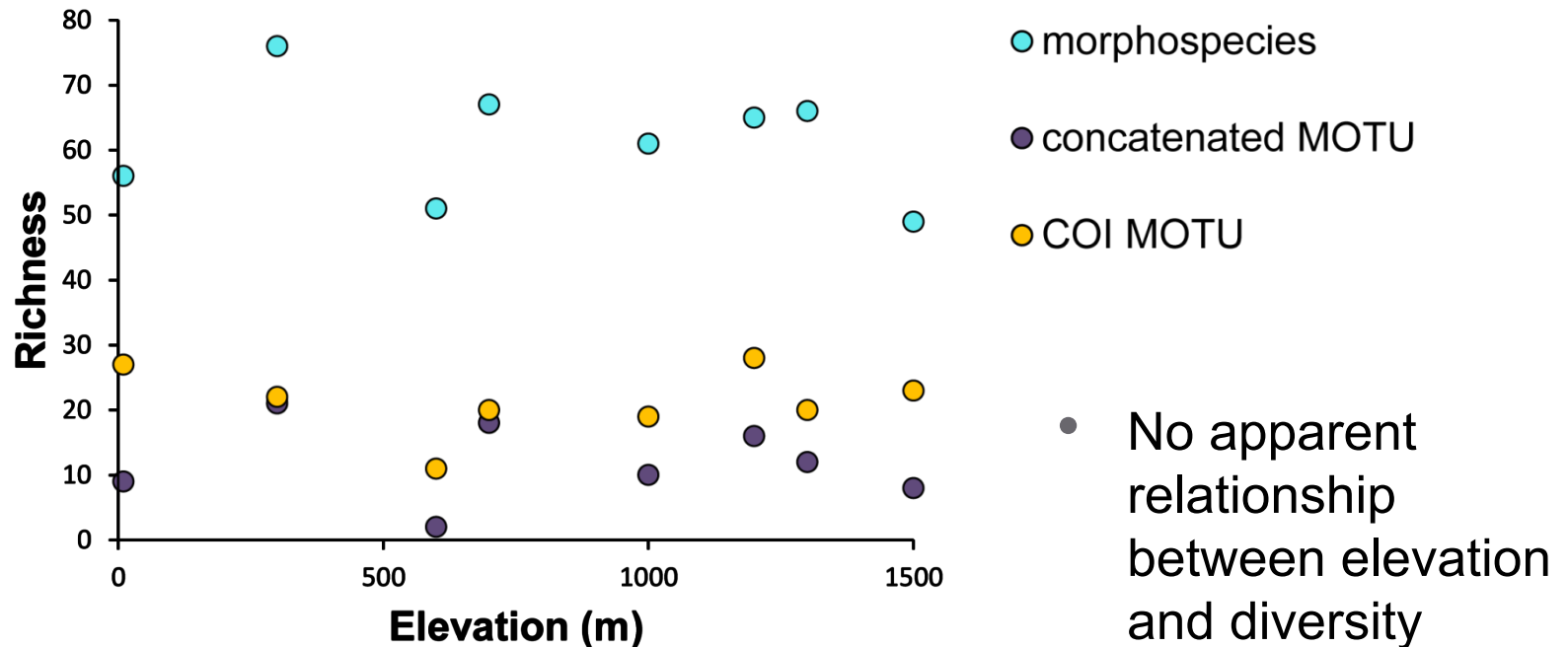
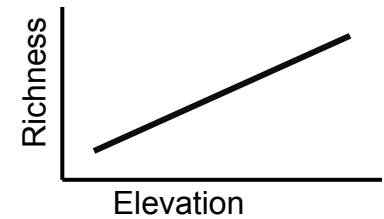
For PD and NTI estimates:

- Neighbor-Joining tree
 - K2P distances
 - Pairwise deletions
- Maximum Likelihood
 - K2P distances
 - Partial deletions



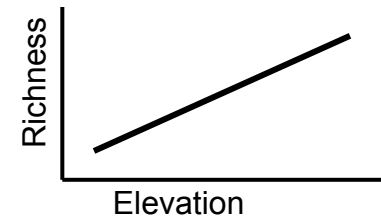
Morphospecies and MOTU Richness

Diversity Pattern

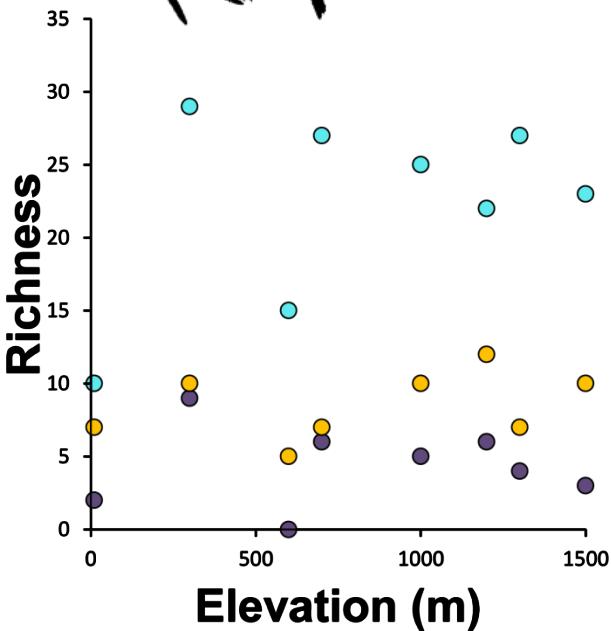


Morphospecies and MOTU Richness

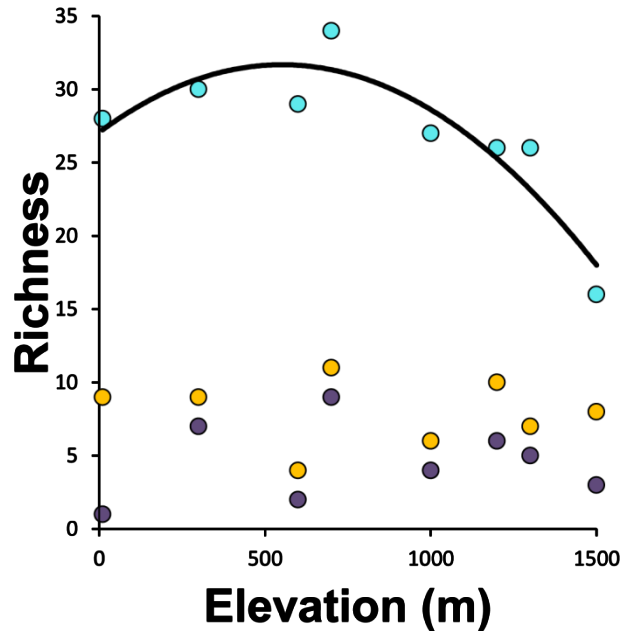
Diversity Pattern



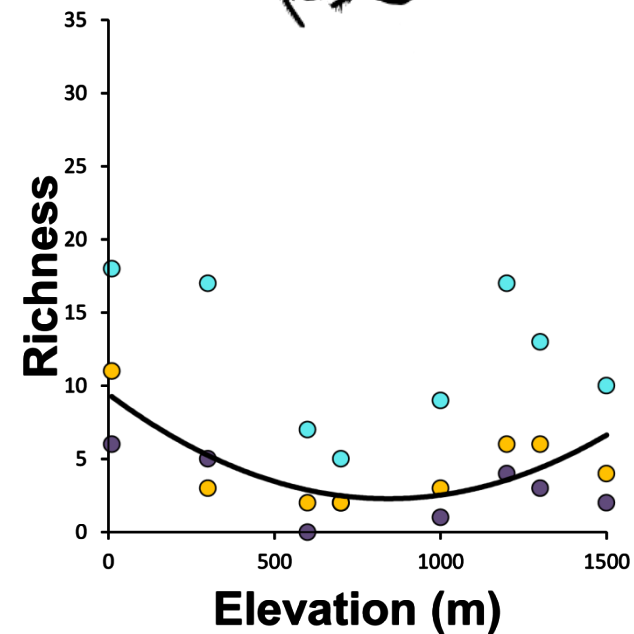
Entomobryomorpha



Poduromorpha



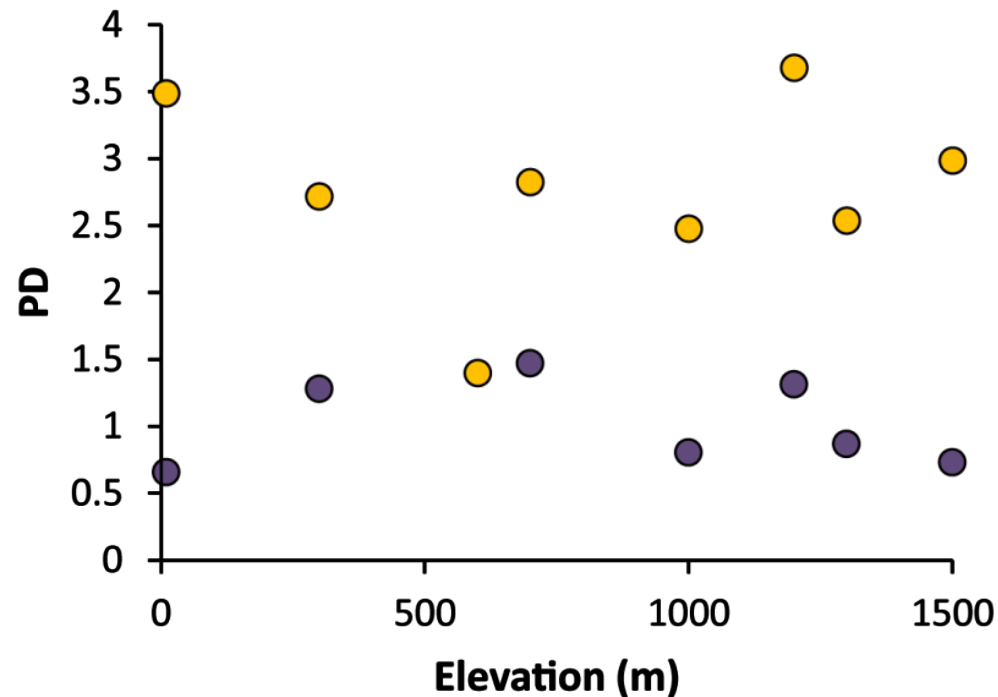
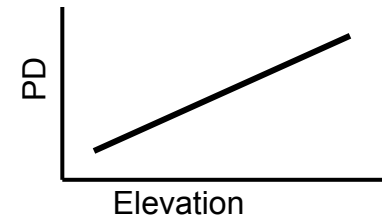
Symphyleona



$p < 0.05$

Phylogenetic Diversity

Diversity Pattern



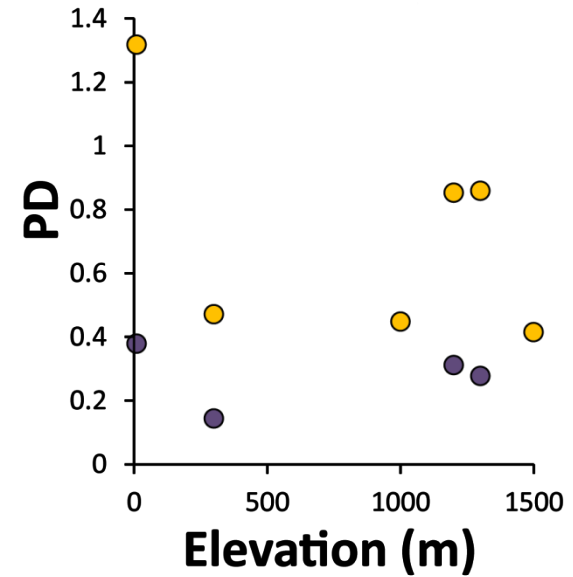
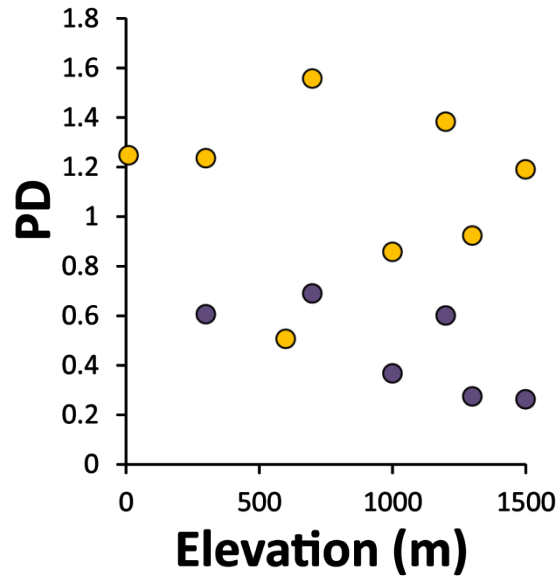
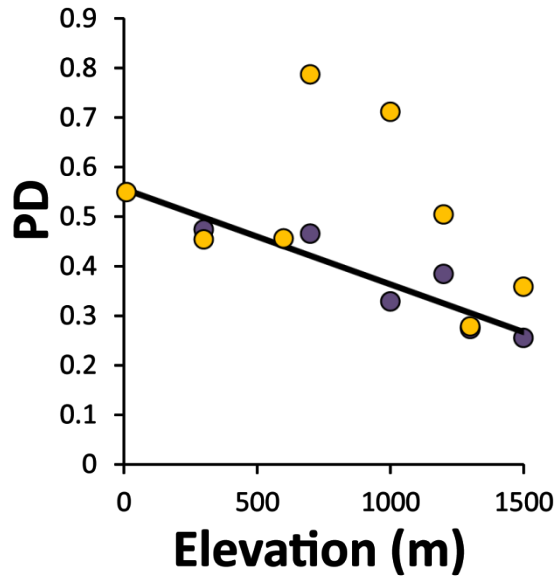
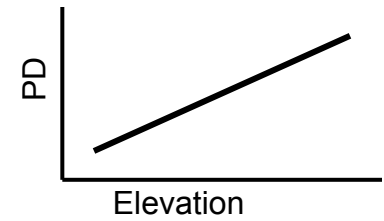
● concatenated sequences

● COI sequences

• No apparent relationship between elevation and diversity

Phylogenetic Diversity

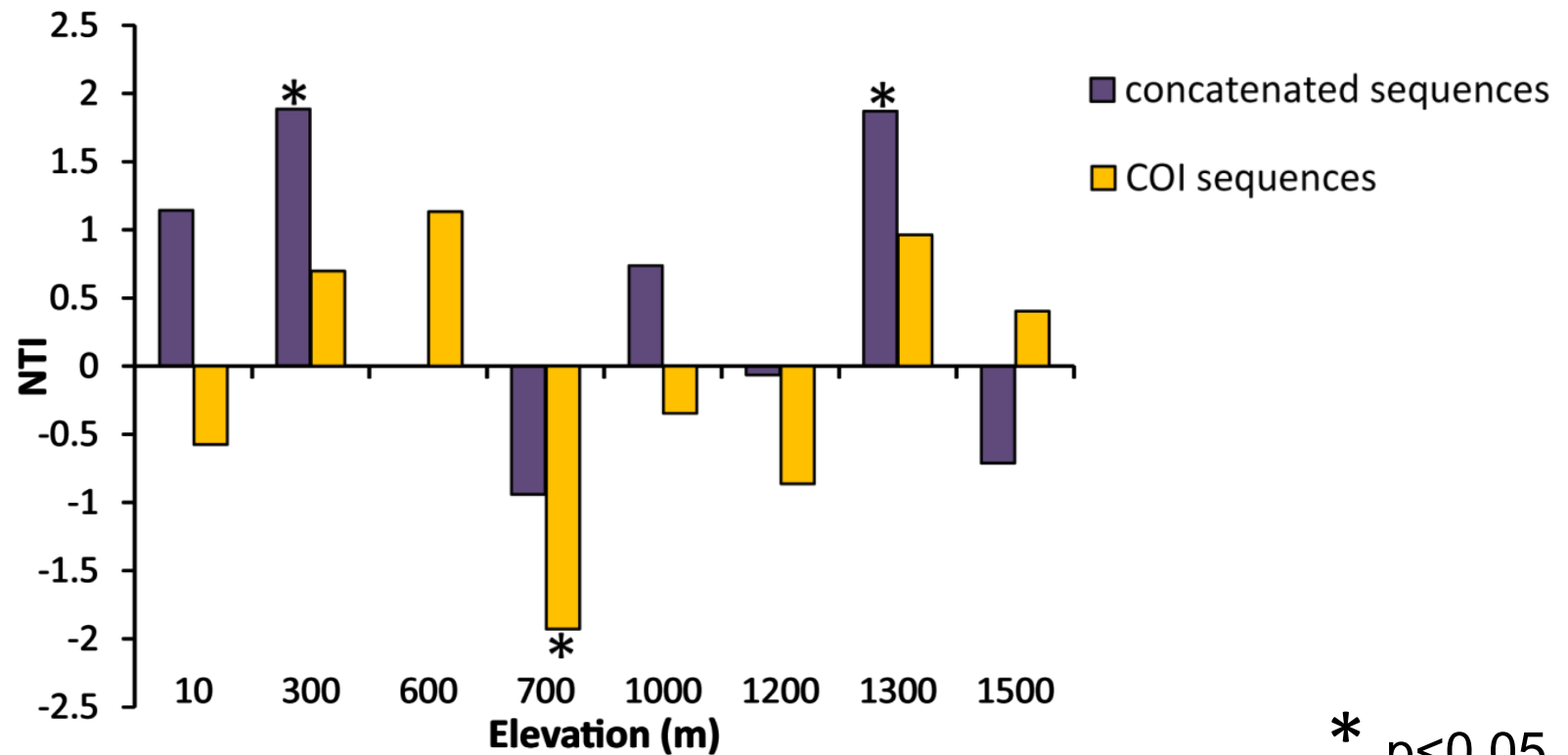
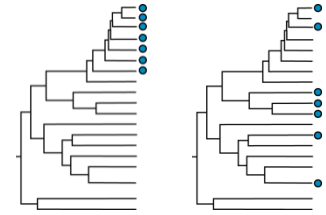
Diversity Pattern



$p < 0.05$

Phylogenetic Structure

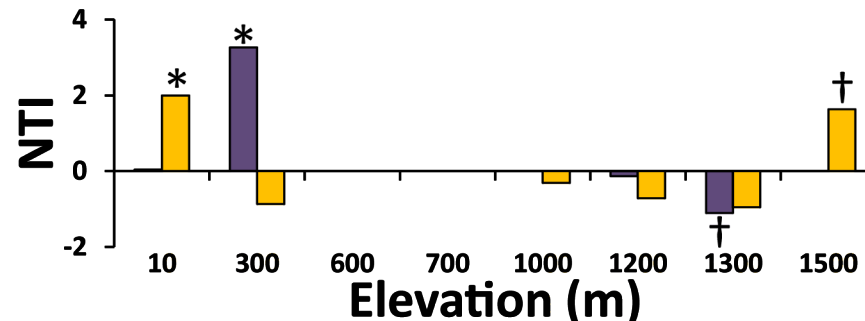
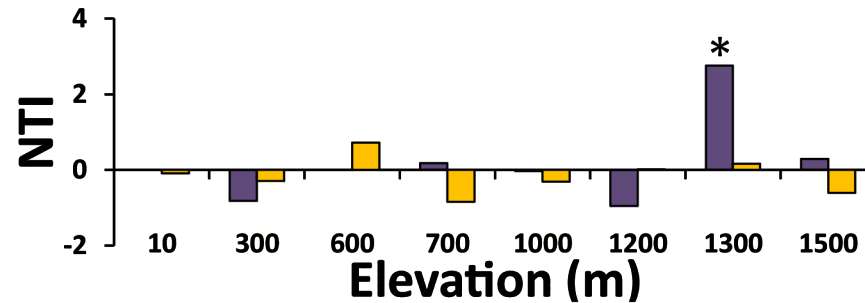
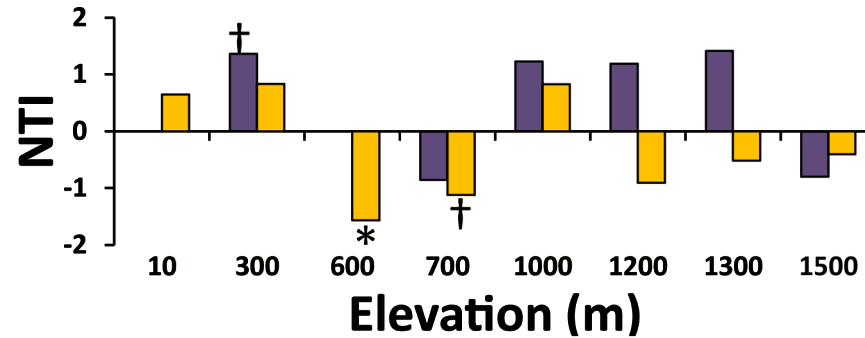
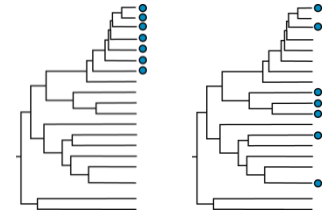
Phylogenetic structure



* $p < 0.05$

† $0.05 < p < 0.1$

Phylogenetic Structure



Summary

Diversity

- Lack of a diversity-elevation trend
 - Abiotic factors as measured do not reflect the conditions Collembola experience
 - Collembola may be able to exploit microhabitats that shelter them from the impacts of moisture and temperature gradients



Summary

Phylogenetic Structure

- No evident difference between phylogenetic structure of low and high elevations
 - Specific site effects influencing non-random phylogenetic structure

Ordinal differences

- Orders differ in their response to elevation gradients both in terms of morphospecies richness, COI MOTU richness, PD and NTI
 - Reflects the different habitat niches orders fill



Acknowledgments

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- The Arthur D. Latornell Graduate Research Travel Grant and Scholarship that paid for field work
- We emphatically and gratefully acknowledge the support of the ACG parataxonomist team in maintaining traps throughout the year, and Area de Conservación Guanacaste for preserving the forests in which they live



Questions?

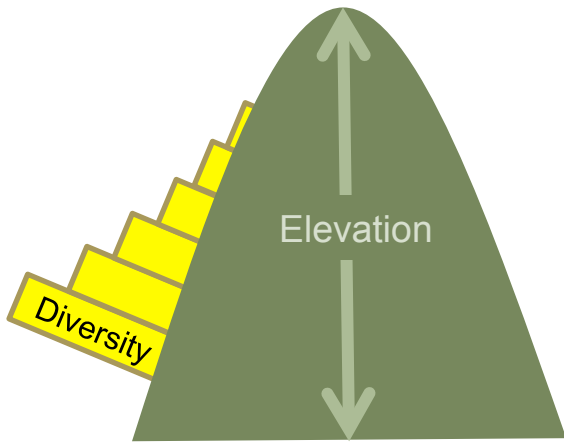


@kat_pare

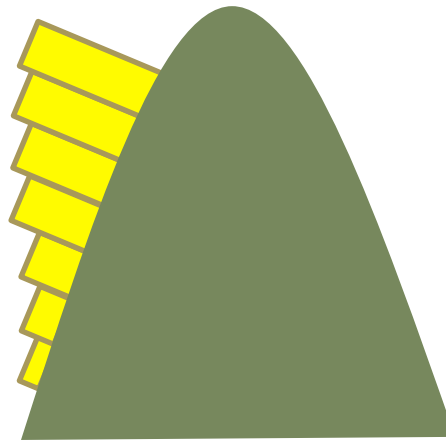
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Elevation - Diversity Patterns

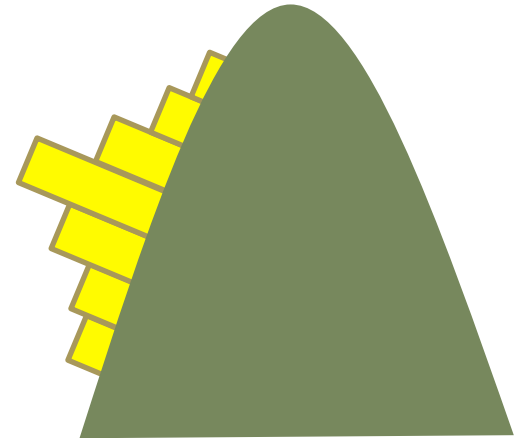
Decrease



Increase

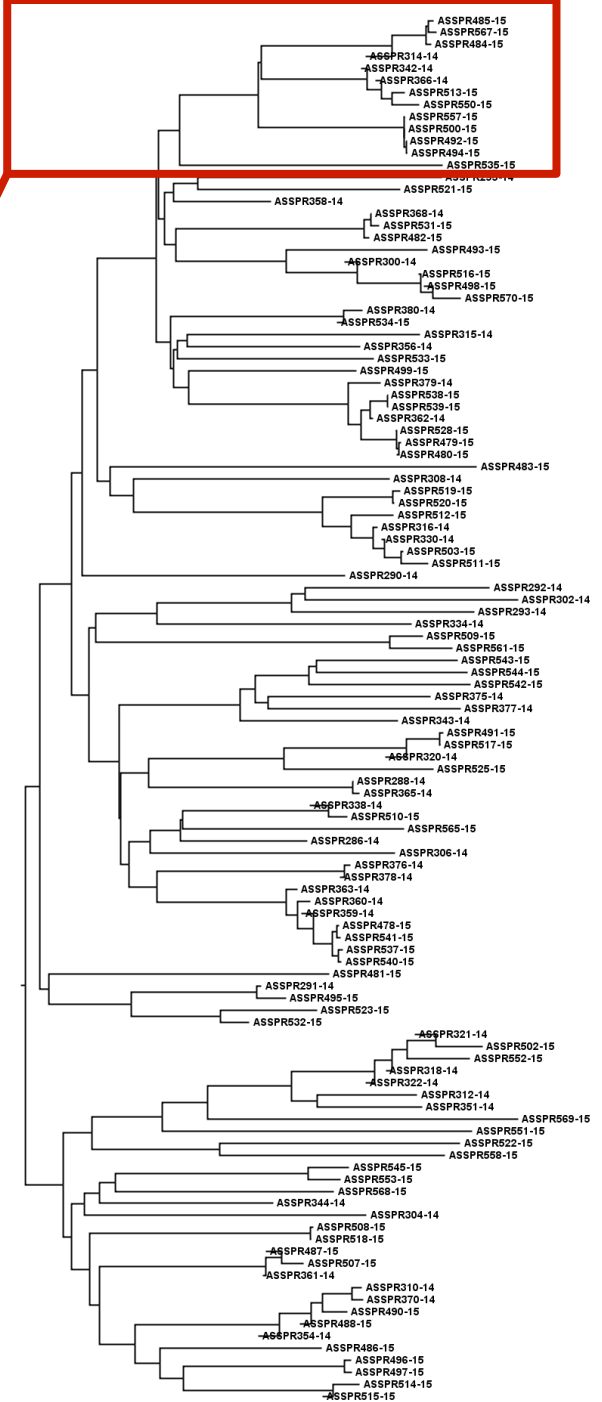
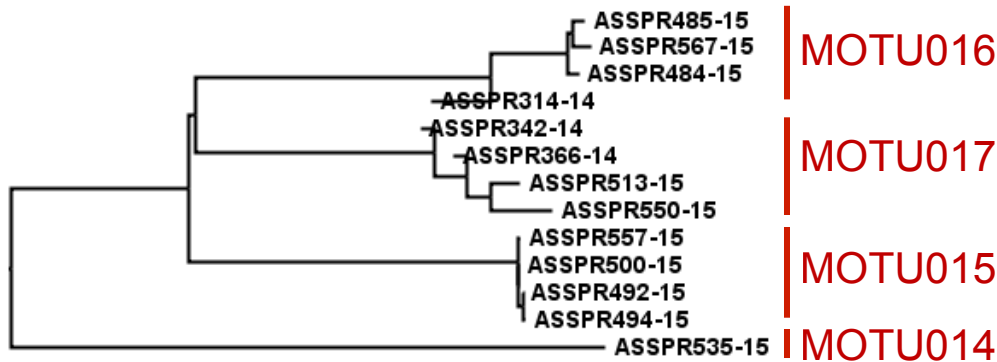


Mid-elevation peak



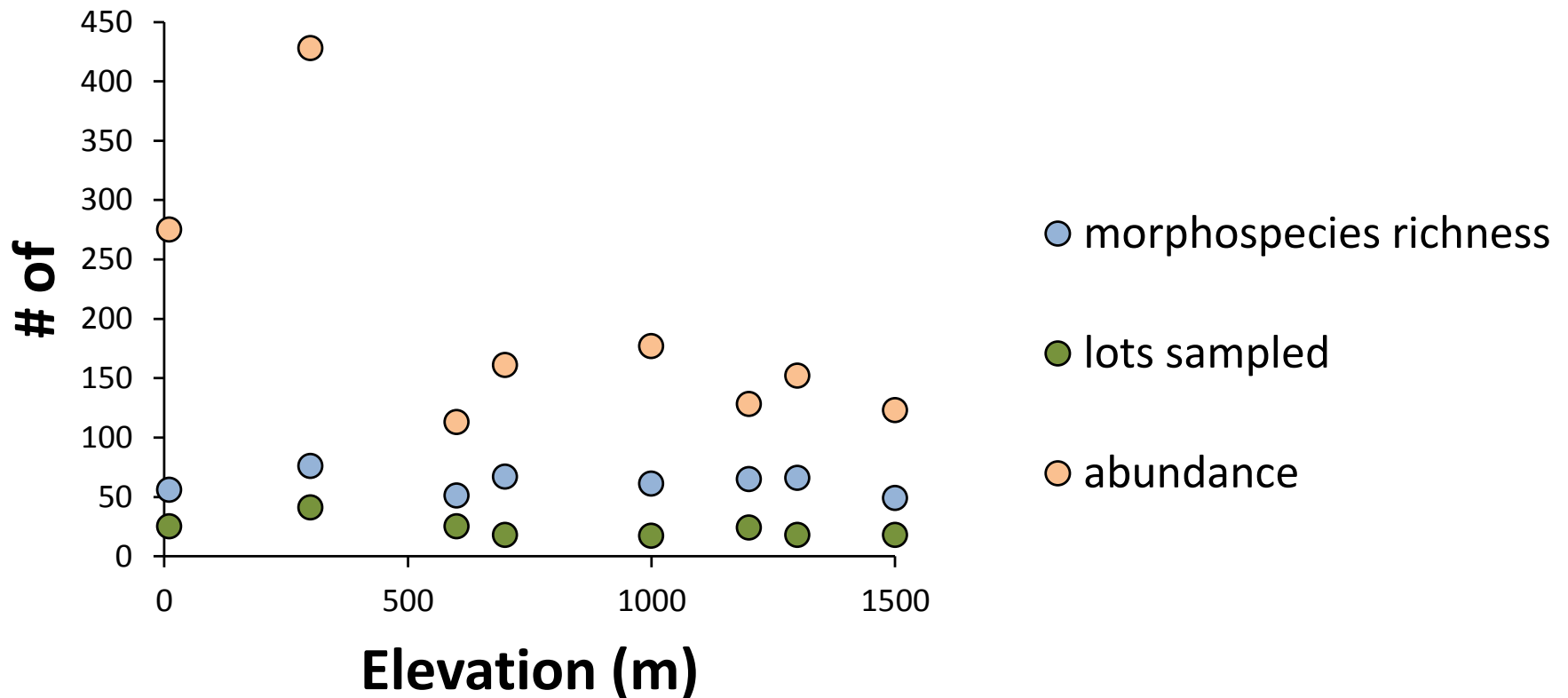
Diversity Analysis

- MOTU Richness
 - COI
 - Concatenated (18S & 28S & COI)



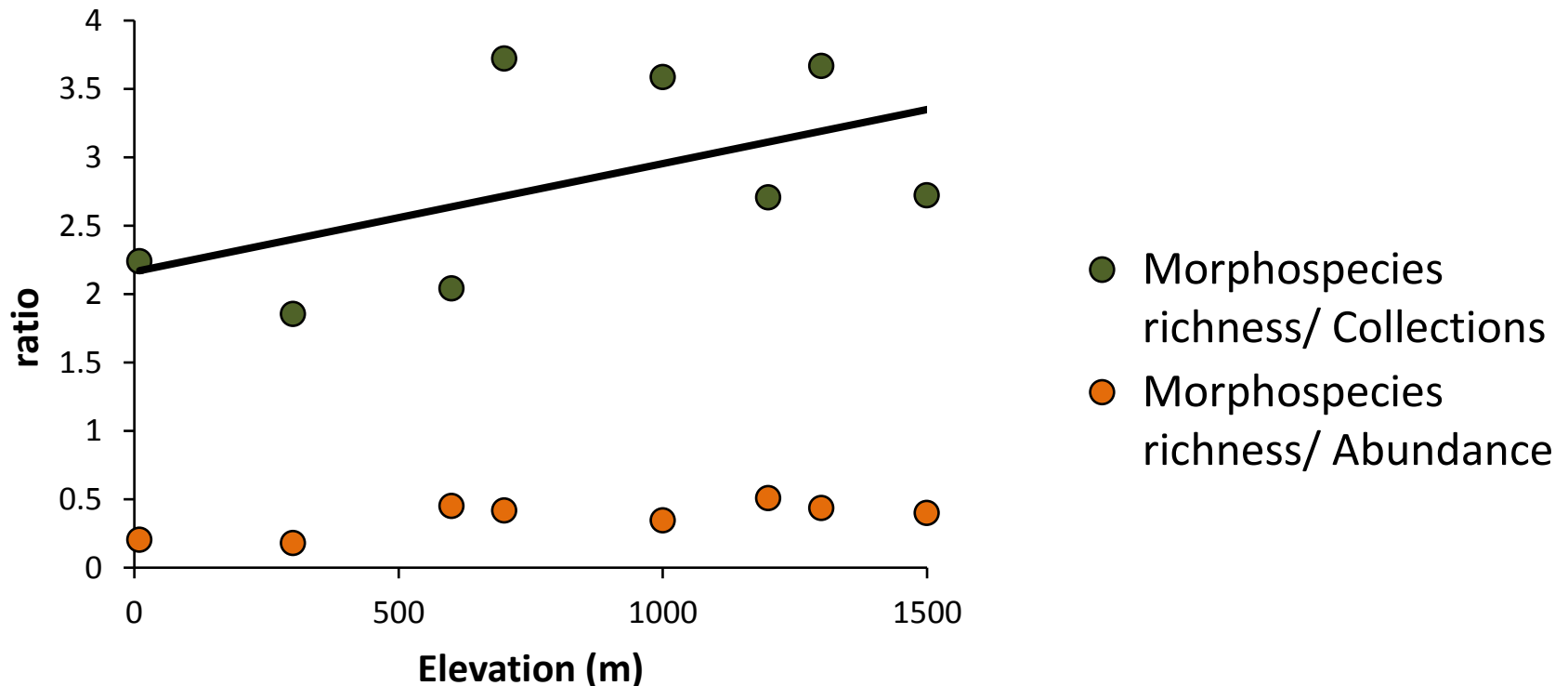
Sampling Effort (Morphospecies)

- Abundance
- Number of collection units sampled per elevation



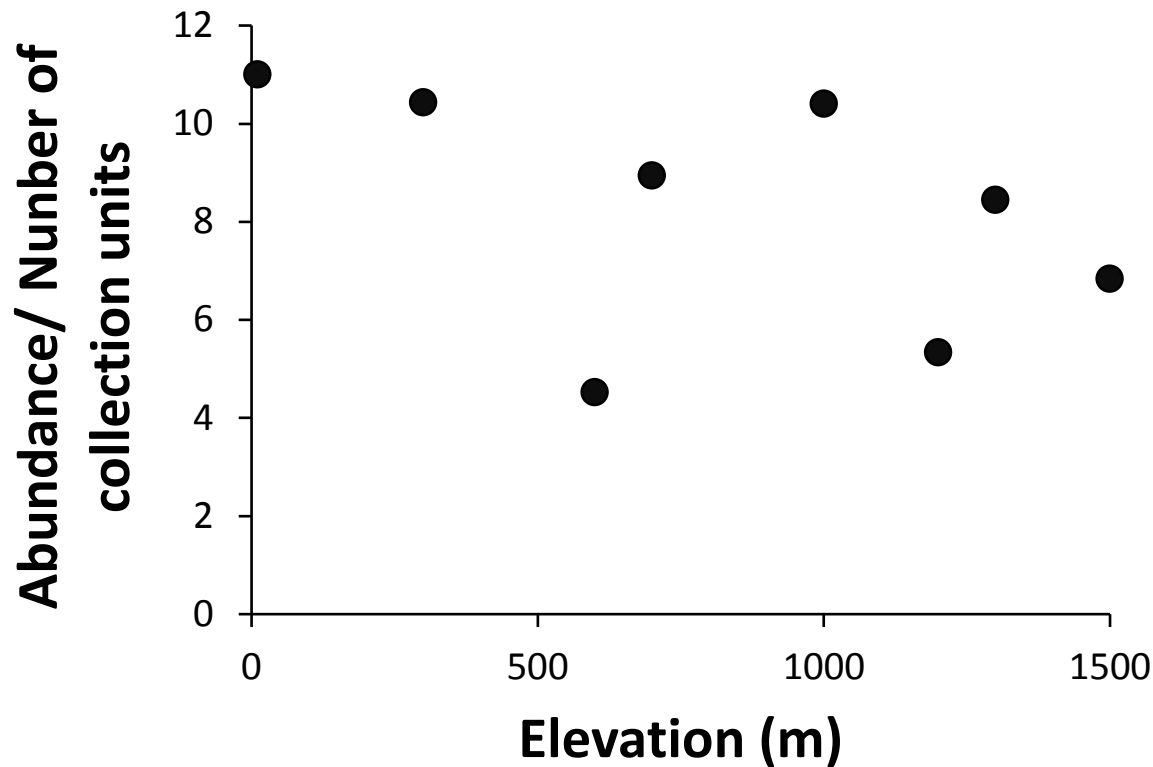
Sampling Effort (Morphospecies)

- Controlling the effect of differing abundance and collection units



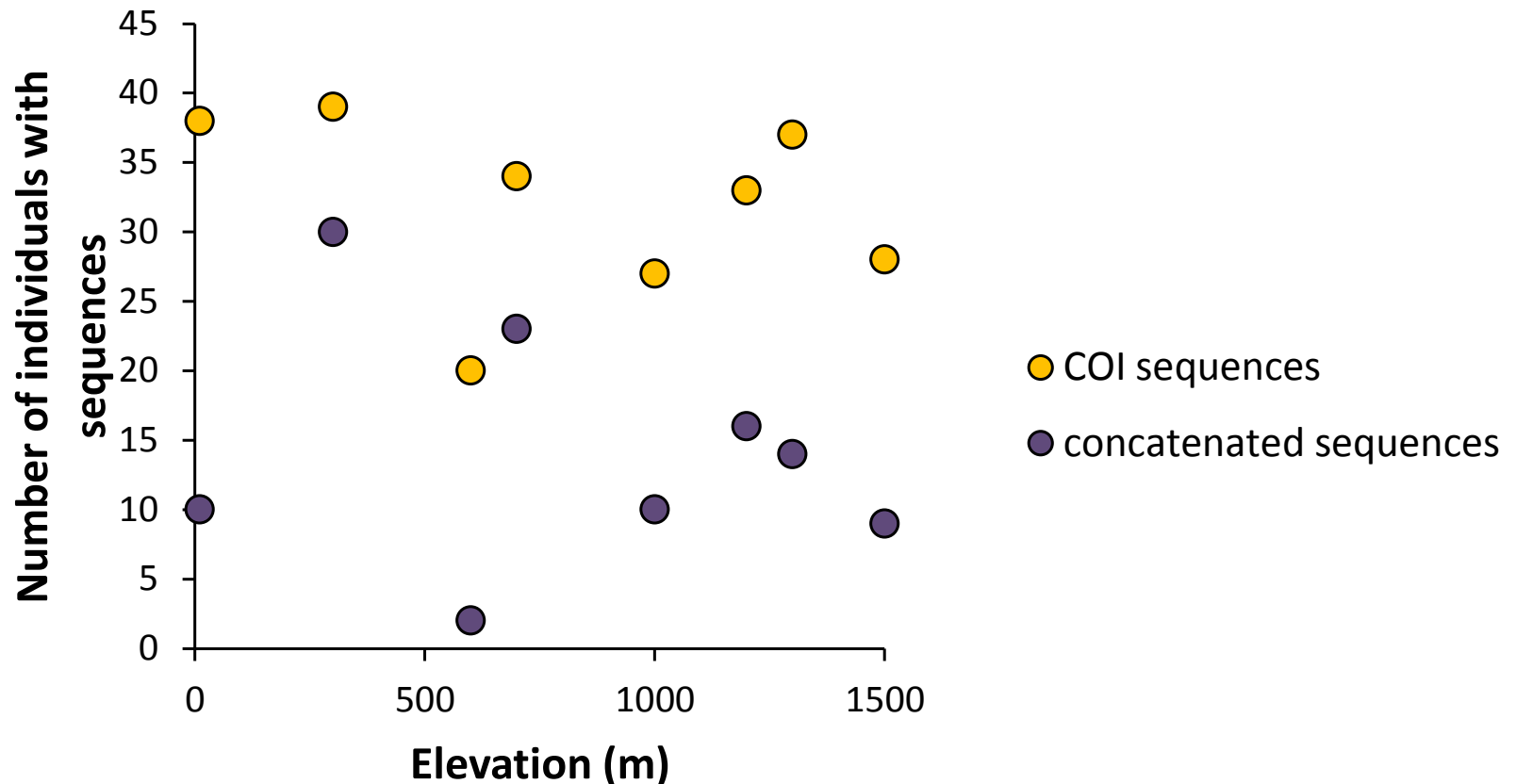
Sampling Effort (Morphospecies)

- However, evidence that abundance decreases independently of the number of collection units



Sampling Effort (Molecular Sequences)

- Number of individuals with COI and concatenated sequences



Sampling Effort (Molecular Sequences)

- Number of individuals with COI and concatenated sequences

