

Phylogenetic Diversity

BOTANY 2021 VIRTUAL
iDigBio / BiotaPhy Workshop



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July 1st, 2021

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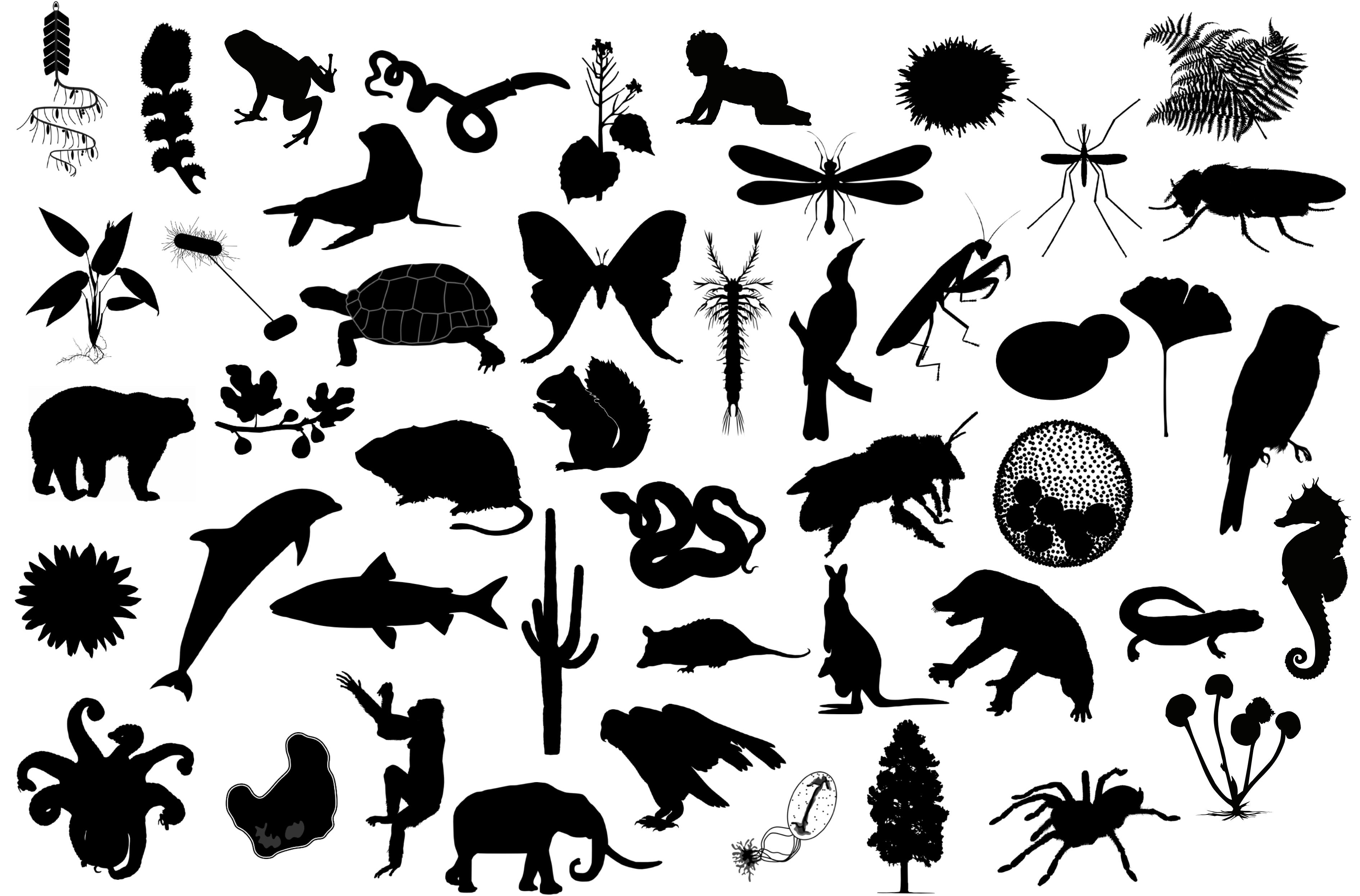
Outline

What is phylogenetic diversity?

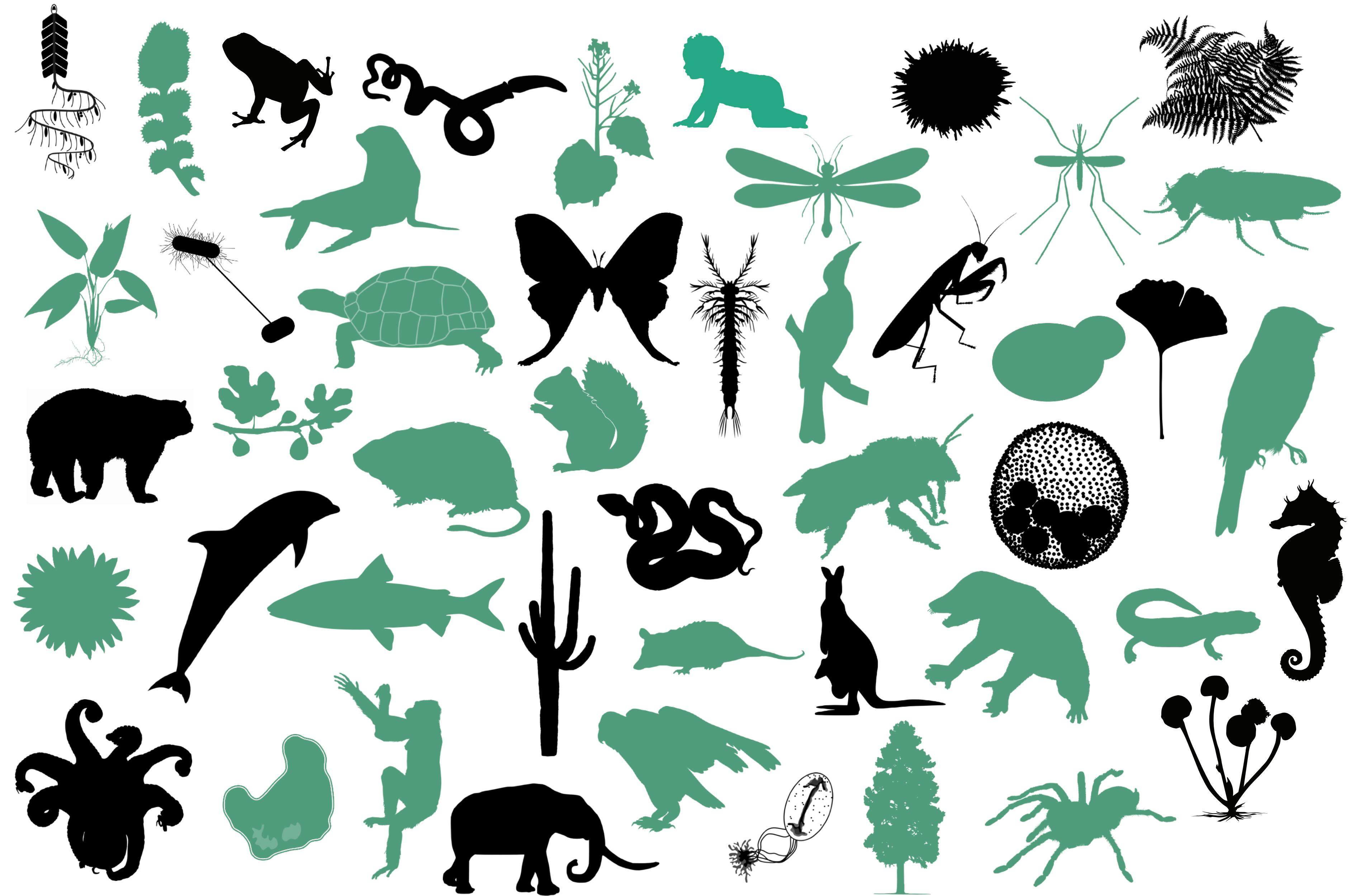
Why is phylogenetic diversity useful for biodiversity analyses?

How do we measure phylogenetic diversity?

Considerations for study design



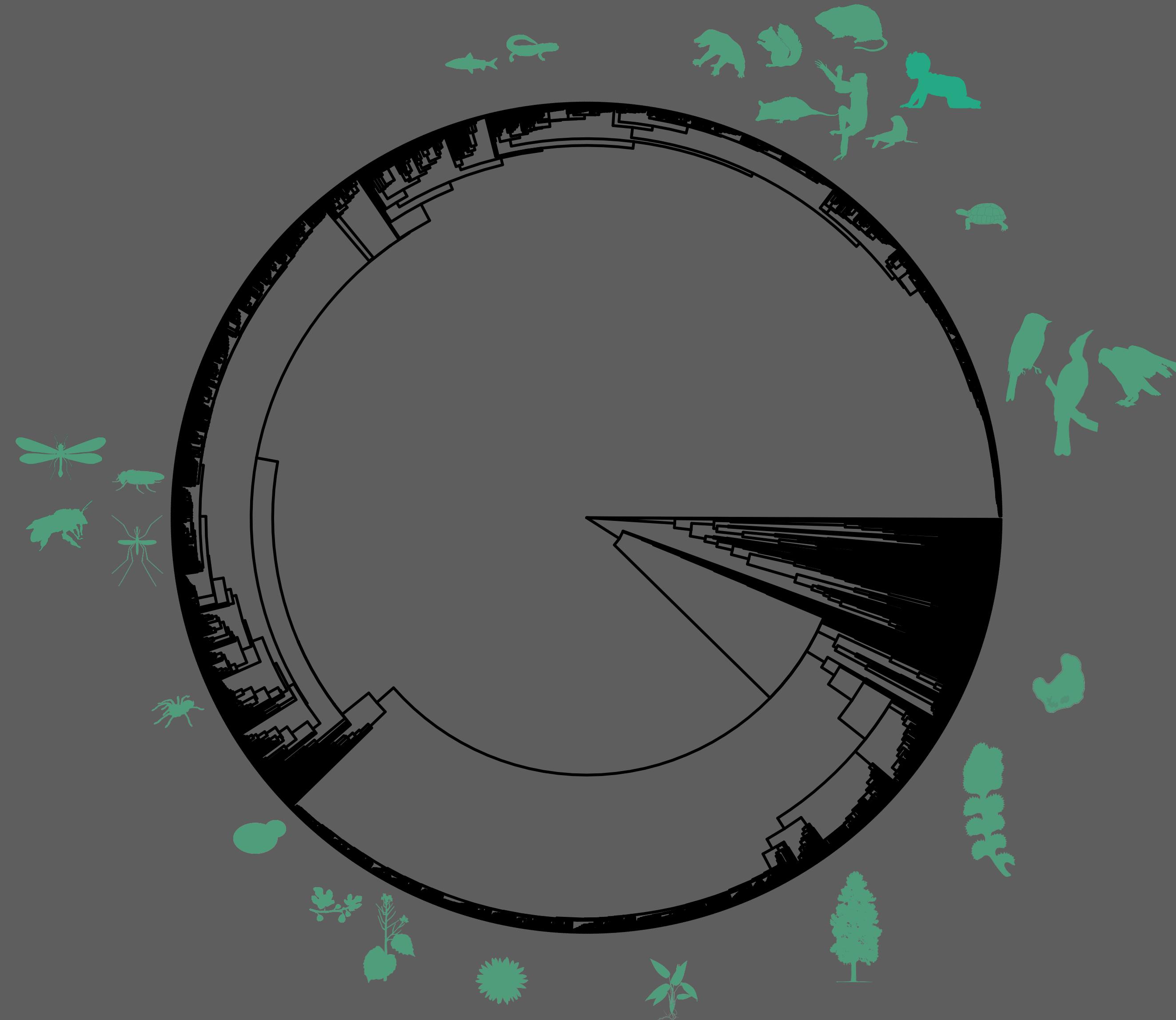
PhyloPic



PhyloPic

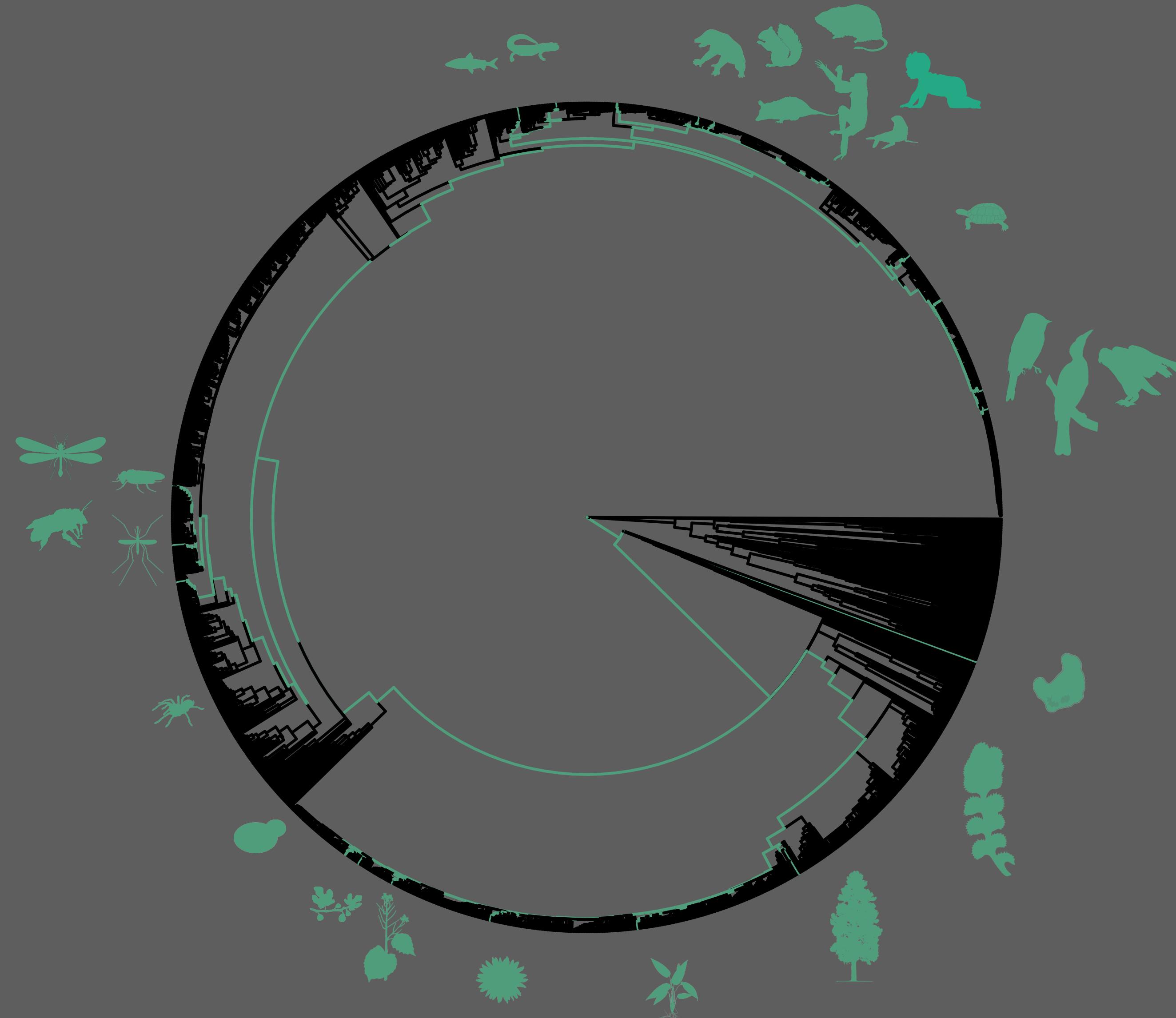
PHYLOGENETIC DIVERSITY

THE AMOUNT OF EVOLUTIONARY HISTORY THAT IS REPRESENTED IN A GIVEN AREA



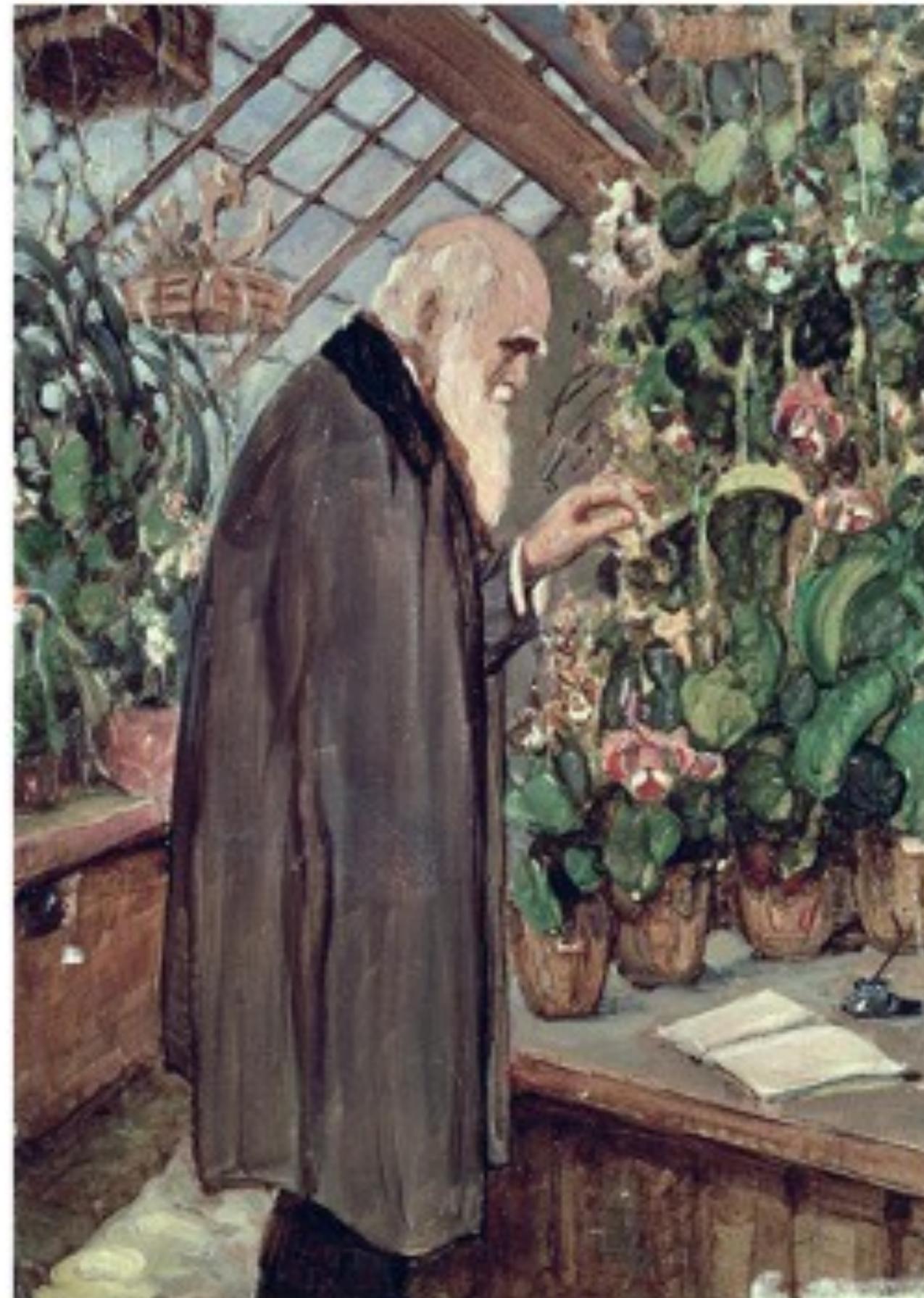
PHYLOGENETIC DIVERSITY

THE AMOUNT OF EVOLUTIONARY HISTORY THAT IS REPRESENTED IN A GIVEN AREA



What is phylogenetic diversity?

The amount of evolutionary history that is represented in a given area



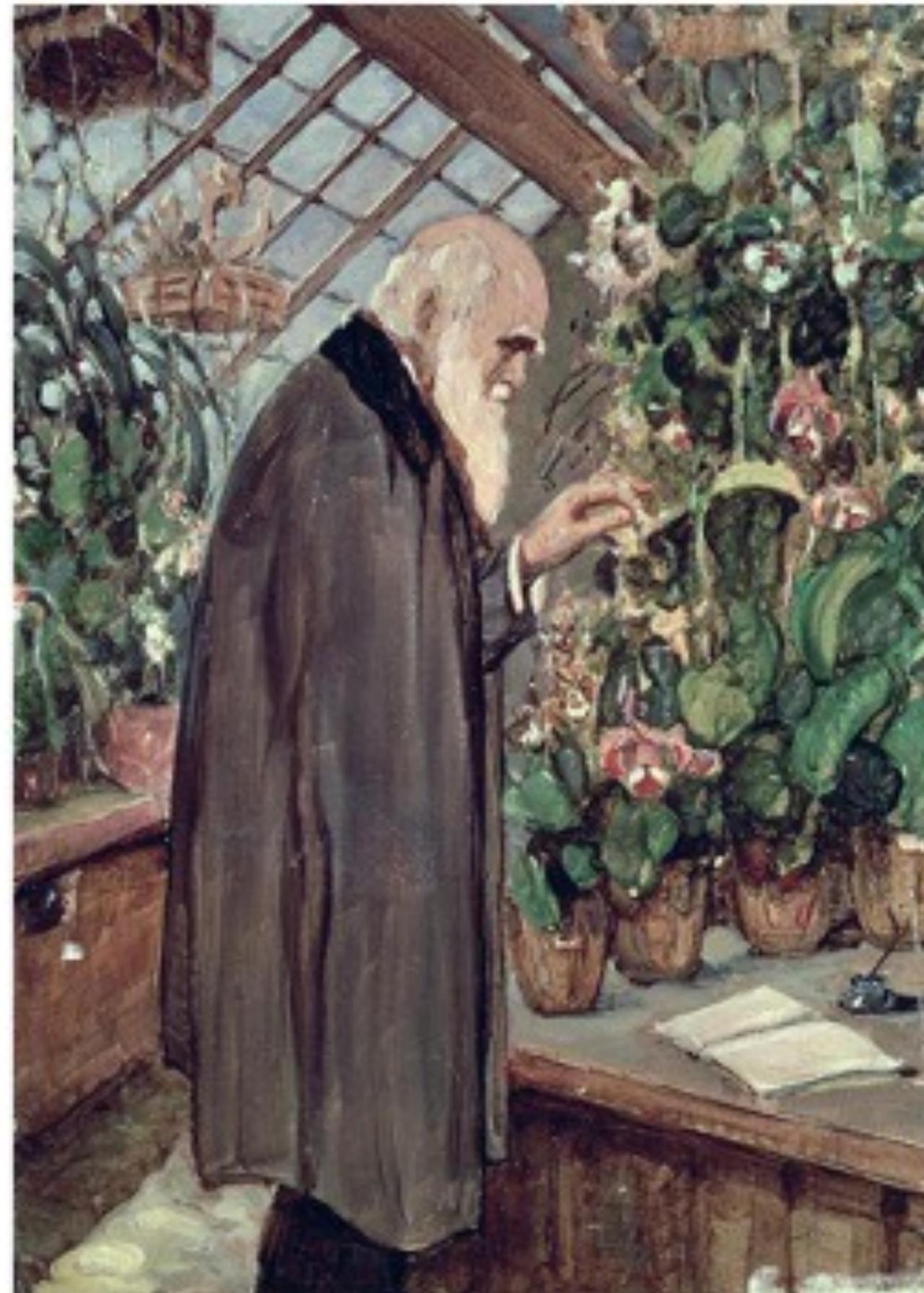
“As species of the same genus have usually, though by no means invariably, some similarity in habits and constitution, and always in structure, the **struggle will generally be more severe between species of the same genus**, when they come into competition with each other, than between species of distinct genera.”

Darwin 1859

John Collier Charles Robert Darwin (1809-82)

What is phylogenetic diversity?

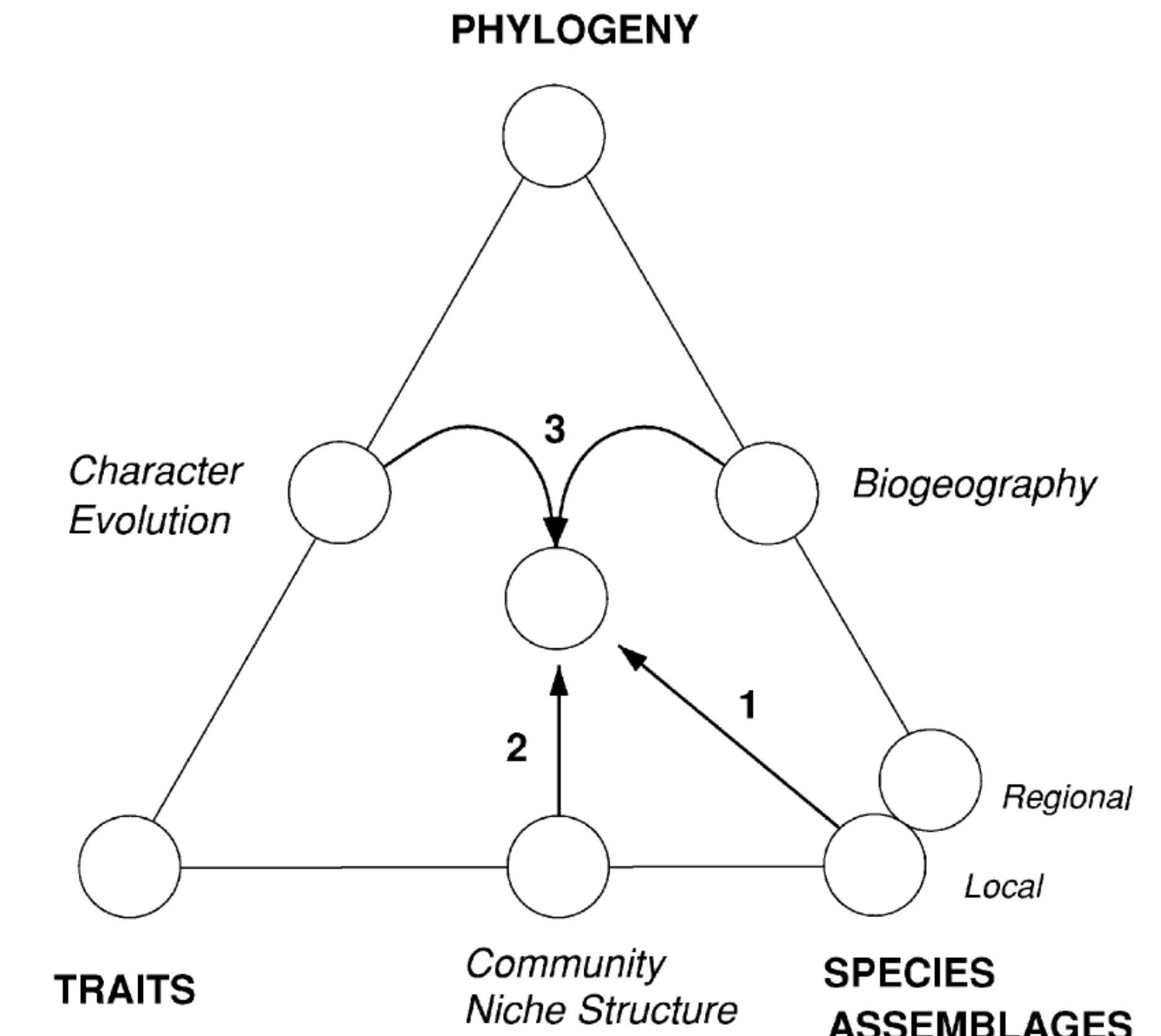
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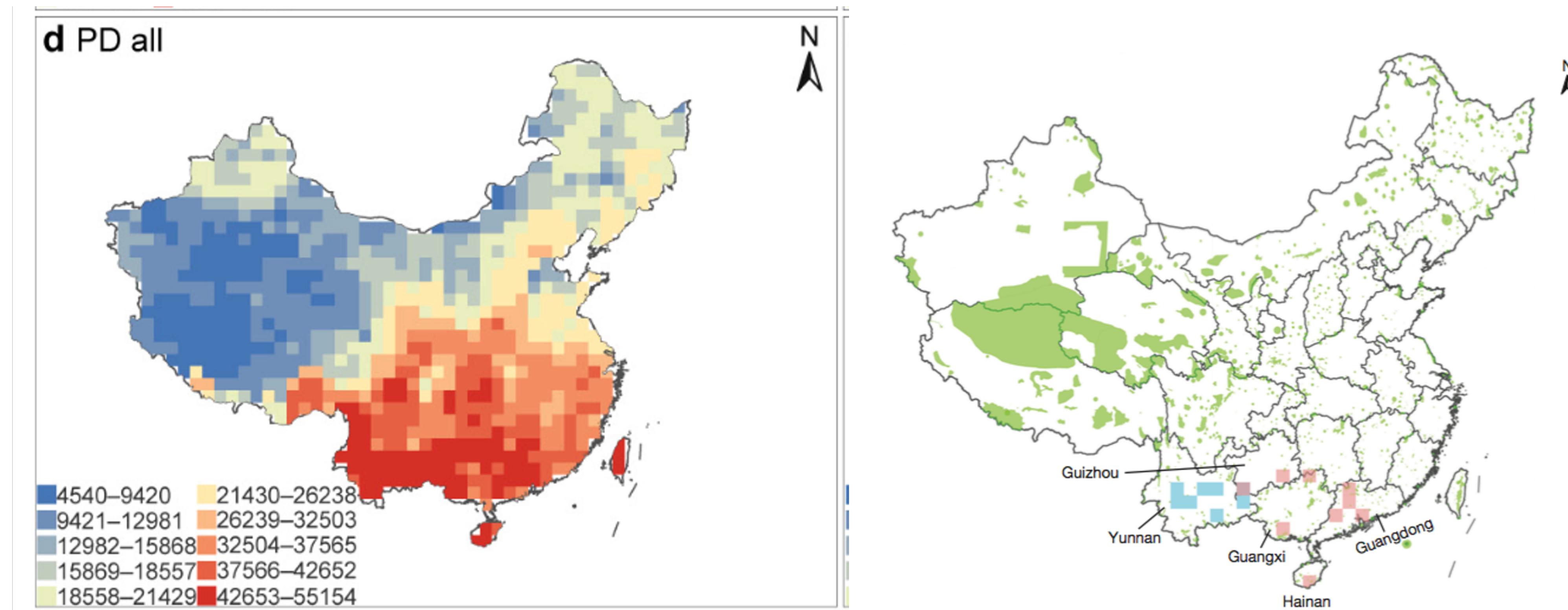


Webb et al. 2002 Ann. Rev. Ecol. Syst.

Why is phylogenetic diversity useful for biodiversity analyses?

1) Incorporate evolutionary history into conservation prioritization

Hot spots of phylogenetic diversity in China do not always overlap with conservation regions



Lu et al. 2018 Nature

Why is phylogenetic diversity useful for biodiversity analyses?

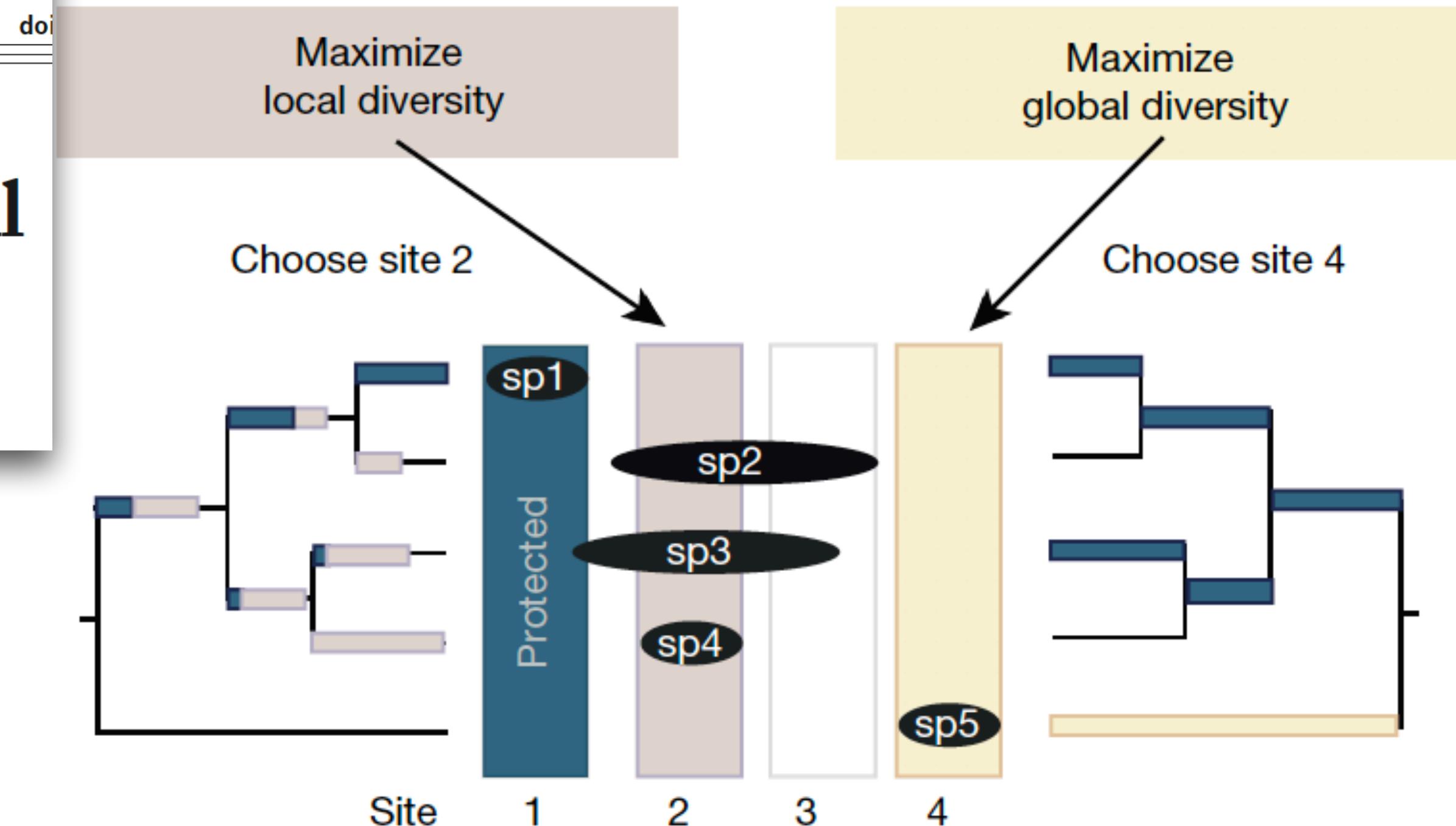
1) Incorporate evolutionary history into conservation prioritization

Phylogenetic diversity can inform different conservation priorities or objectives

LETTER

Large conservation gains possible for global biodiversity facets

Laura J. Pollock¹, Wilfried Thuiller¹ & Walter Jetz^{2,3}

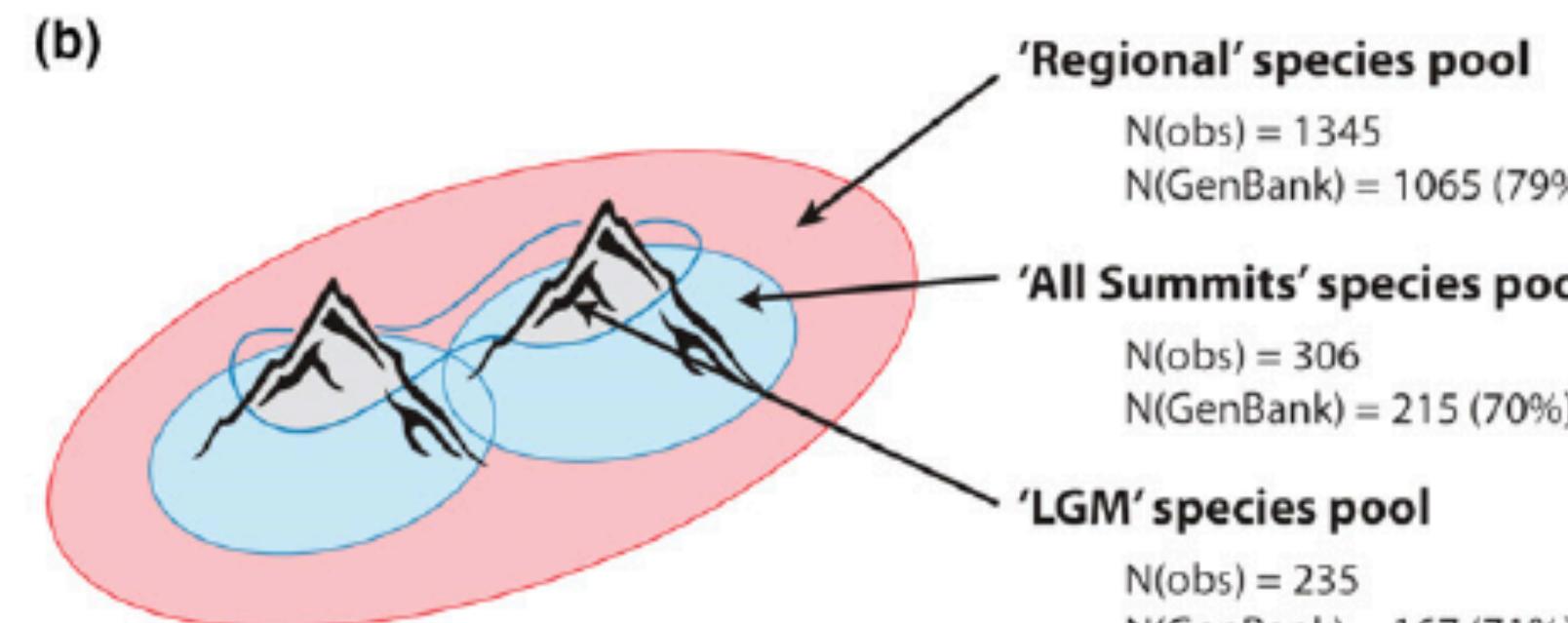
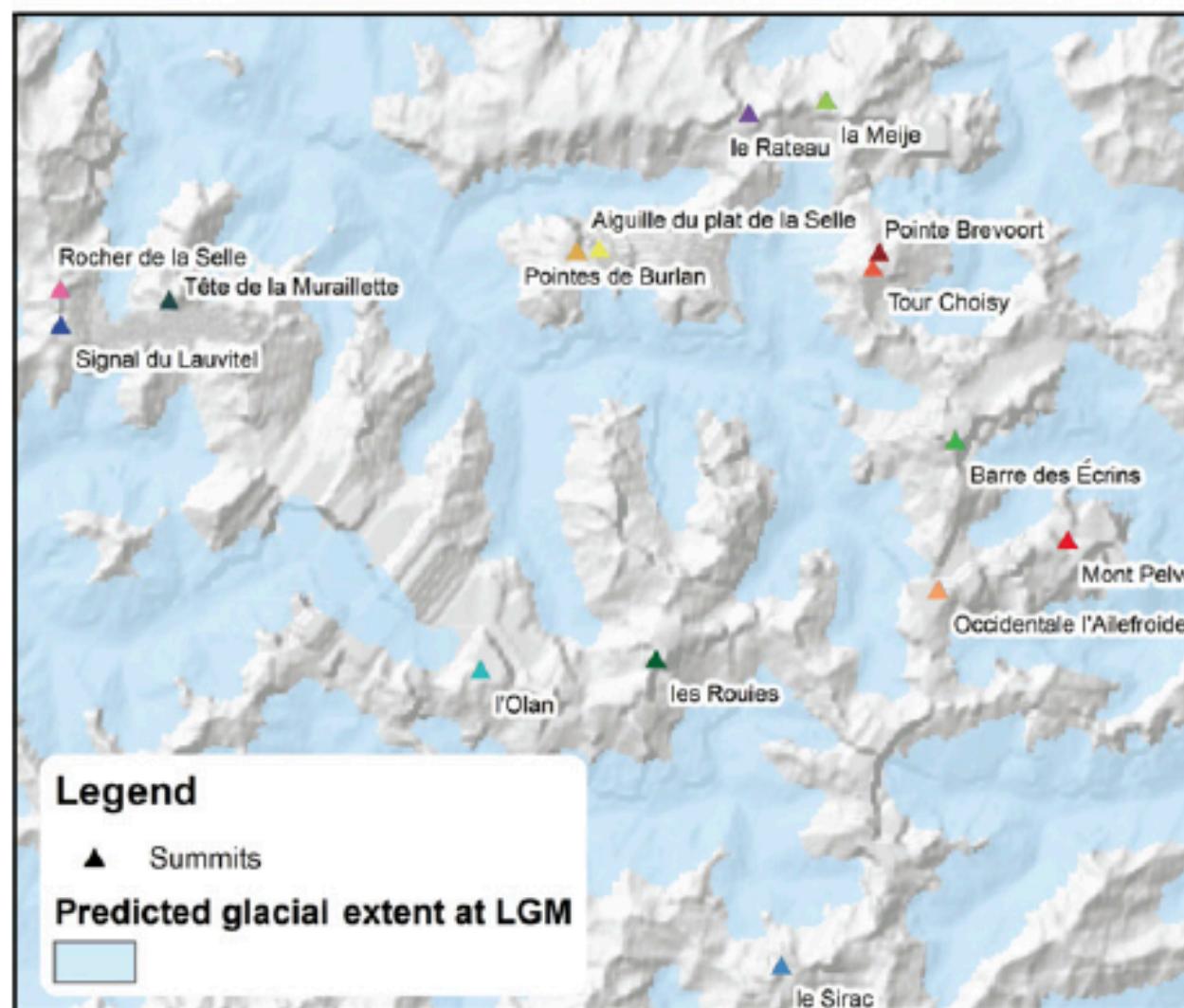


Pollock et al. 2017 Nature

Why is phylogenetic diversity useful for biodiversity analyses?

2) Provide insights into the structure and assembly of ecological communities

Evidence of phylogenetic clustering in the flora of high-alpine sky islands in France suggests environmental filtering

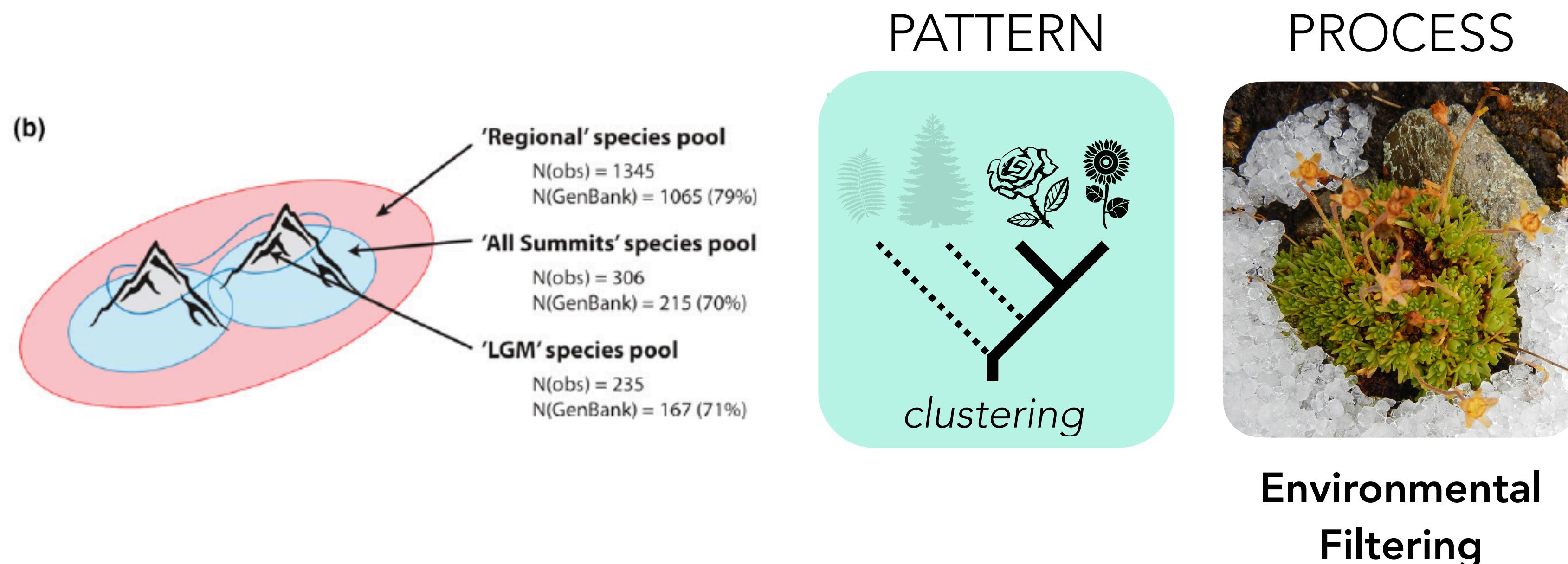
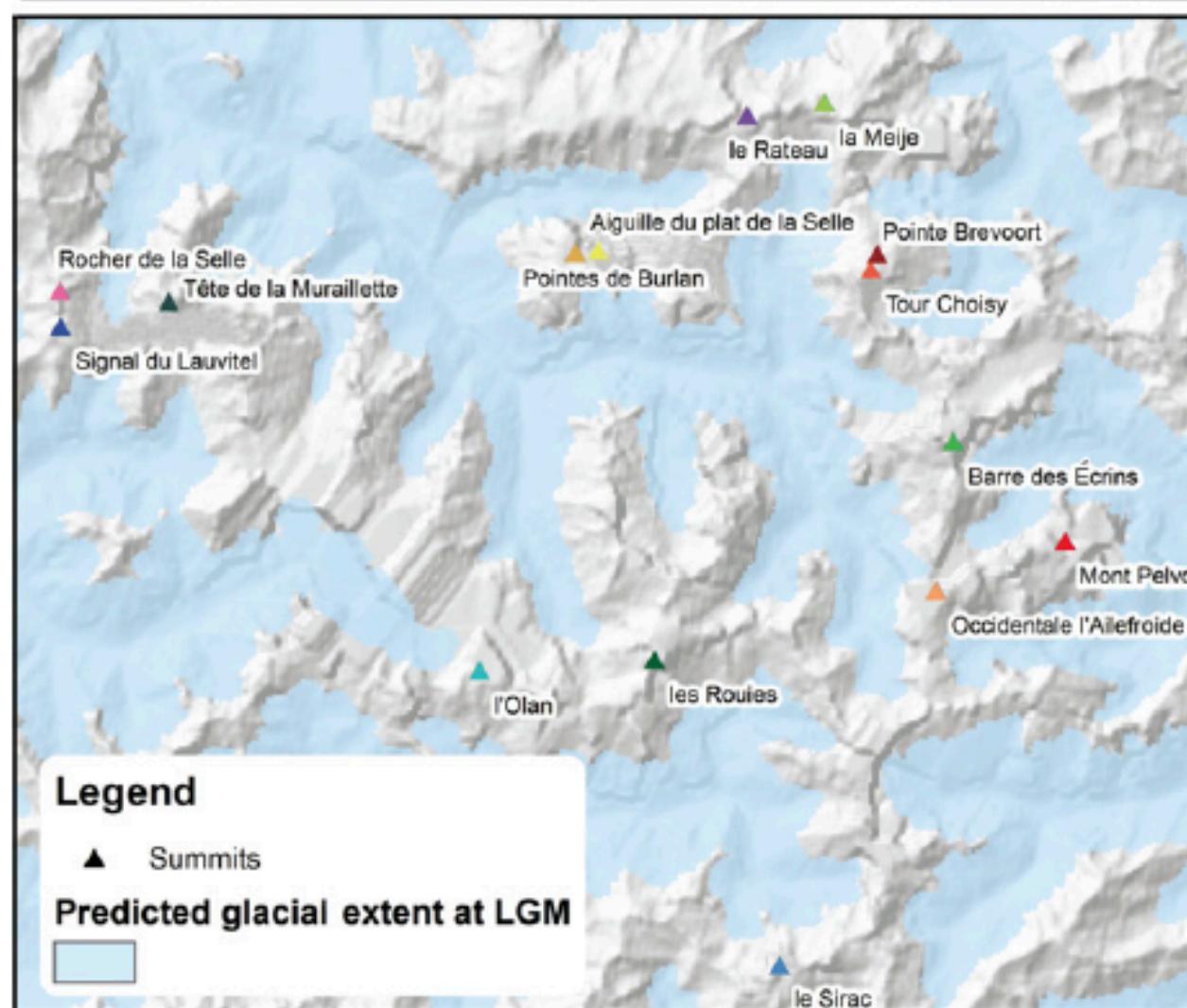


Marx et al. 2017 J Bioge

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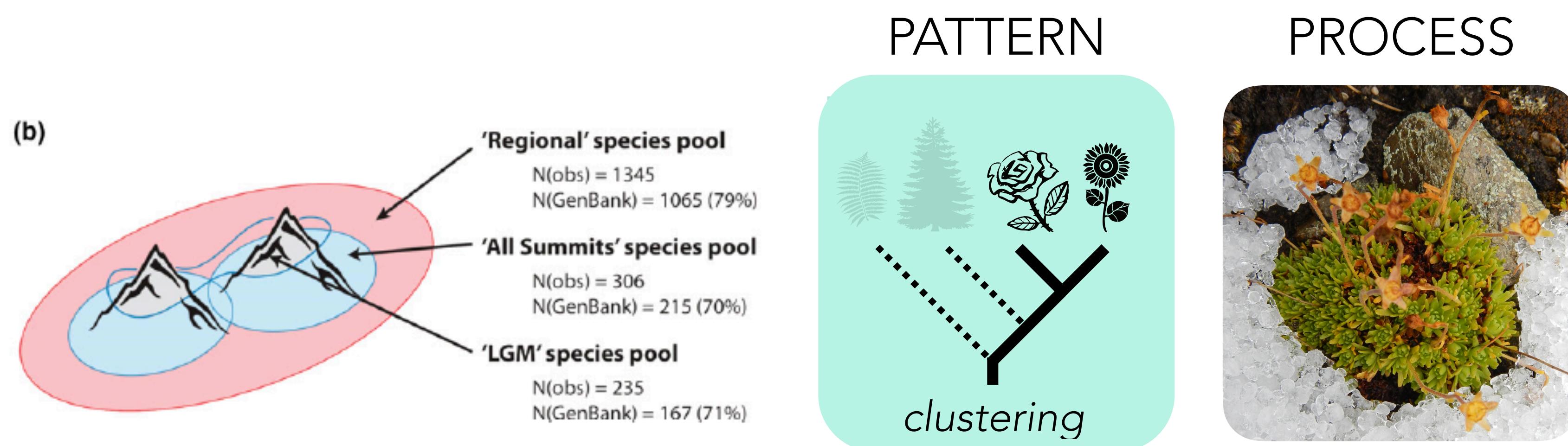
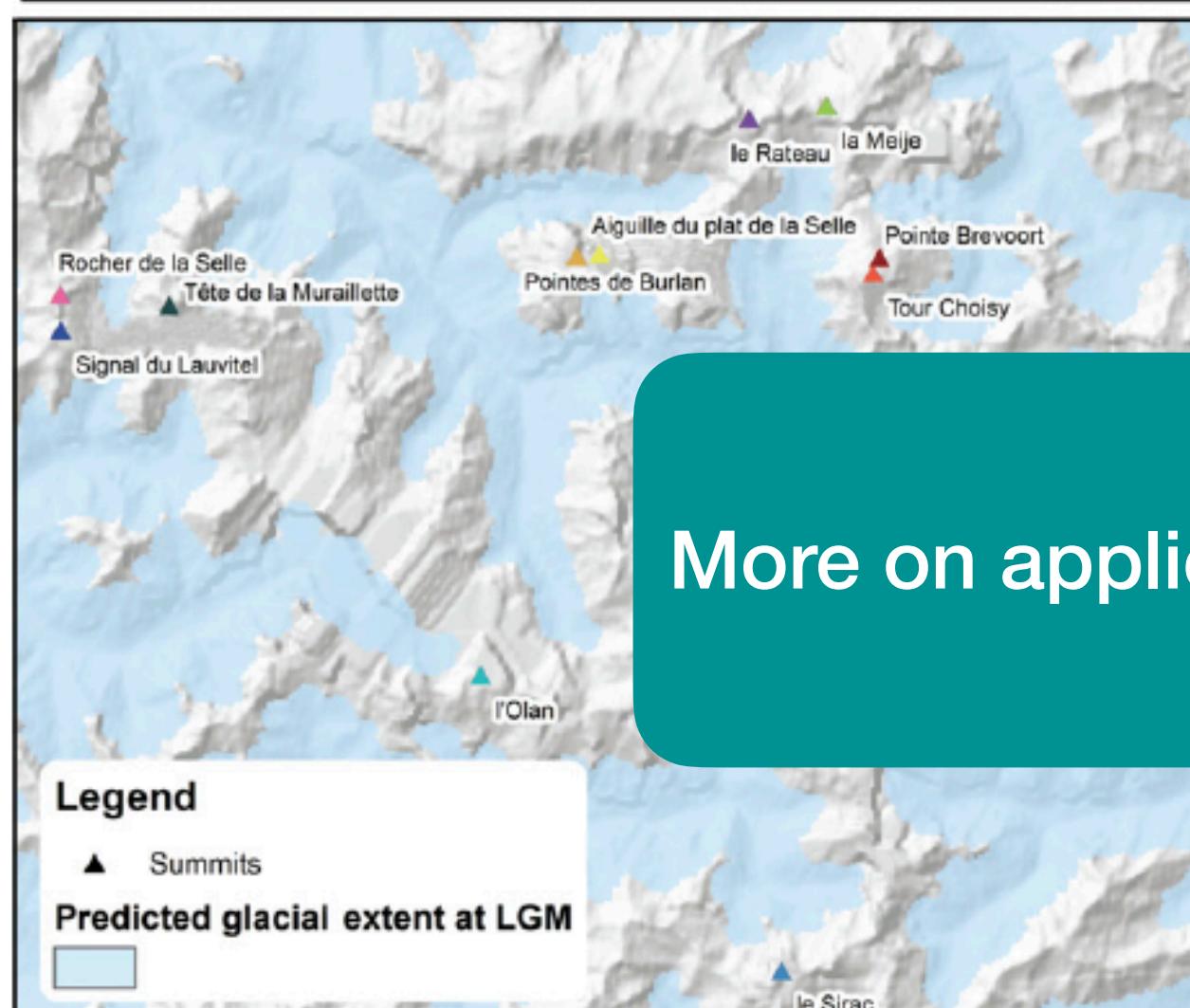
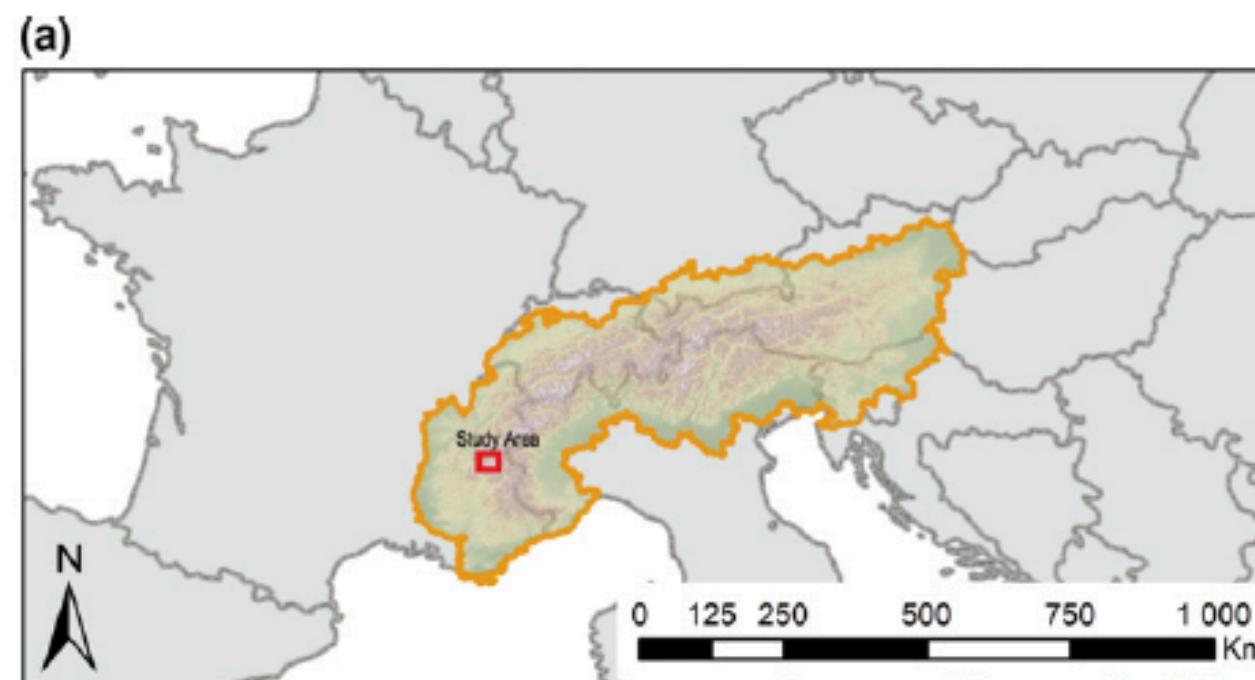


Marx et al. 2017 J Bioge

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More on applications of phylogenetic diversity in BiotaPhy later in the workshop...

Marx et al. 2017 J Bioge

Environmental Filtering

How is phylogenetic diversity measured?

The amount of evolutionary history represented in a given area

Species presence/absence
(+ abundance) within the
area(s) of interest

Species presence/absence (+
abundance) for an inclusive
“regional species pool”



Locality information from observations,
occurrence data, and/or niche models
(BiotaPhy platform)

How is phylogenetic diversity measured?

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Species presence/absence
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Inferred phylogenetic relationships
including local species & regional
species pool

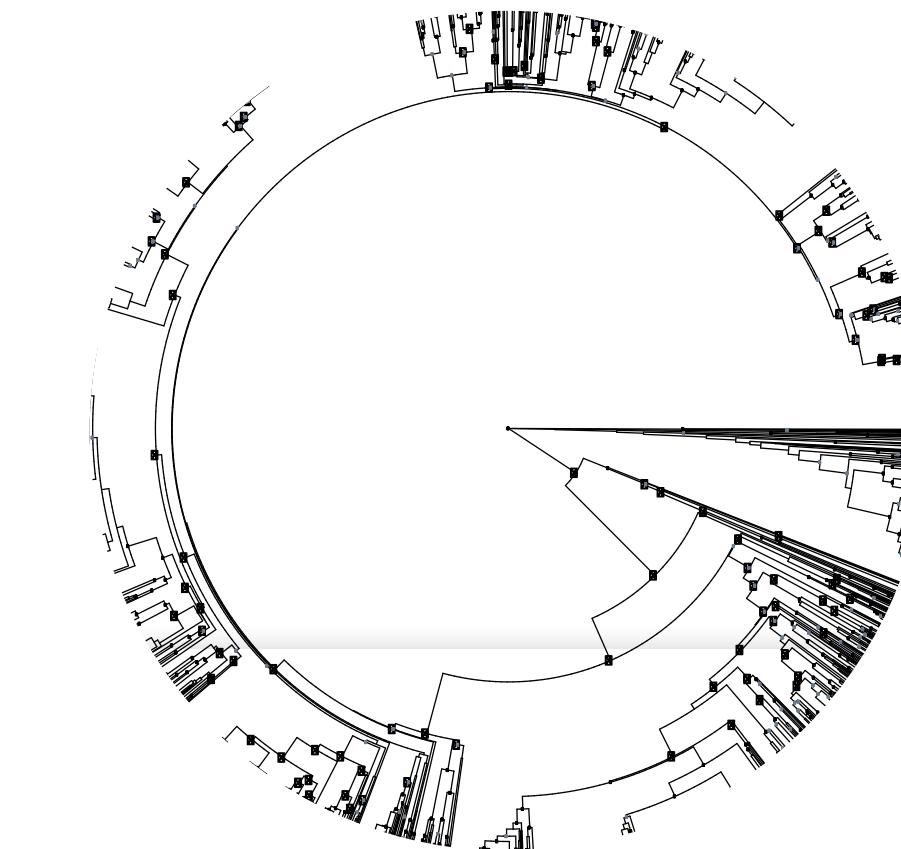


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Ecology, 100(9), 2019, e02788
© 2019 by the Ecological Society of America

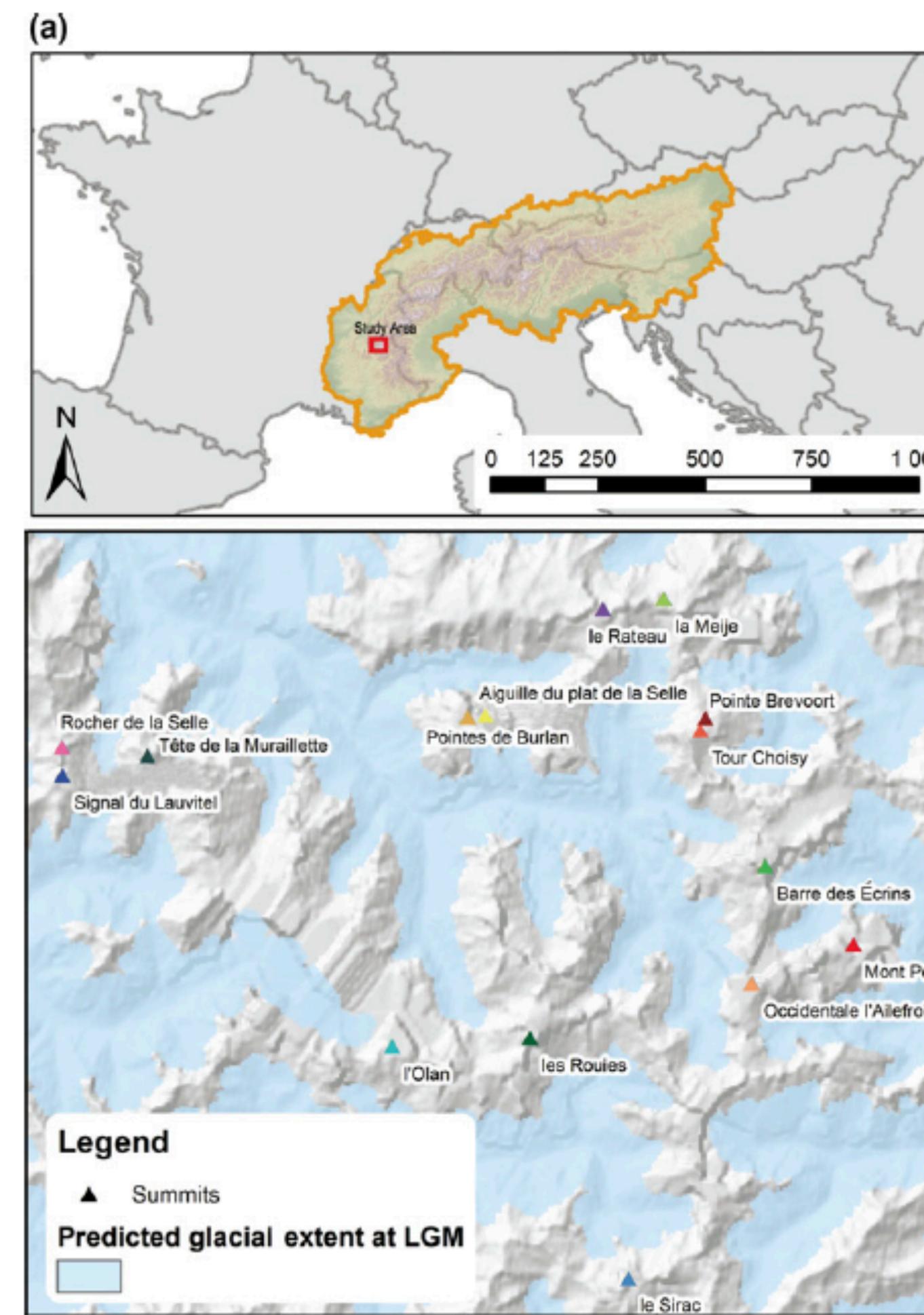
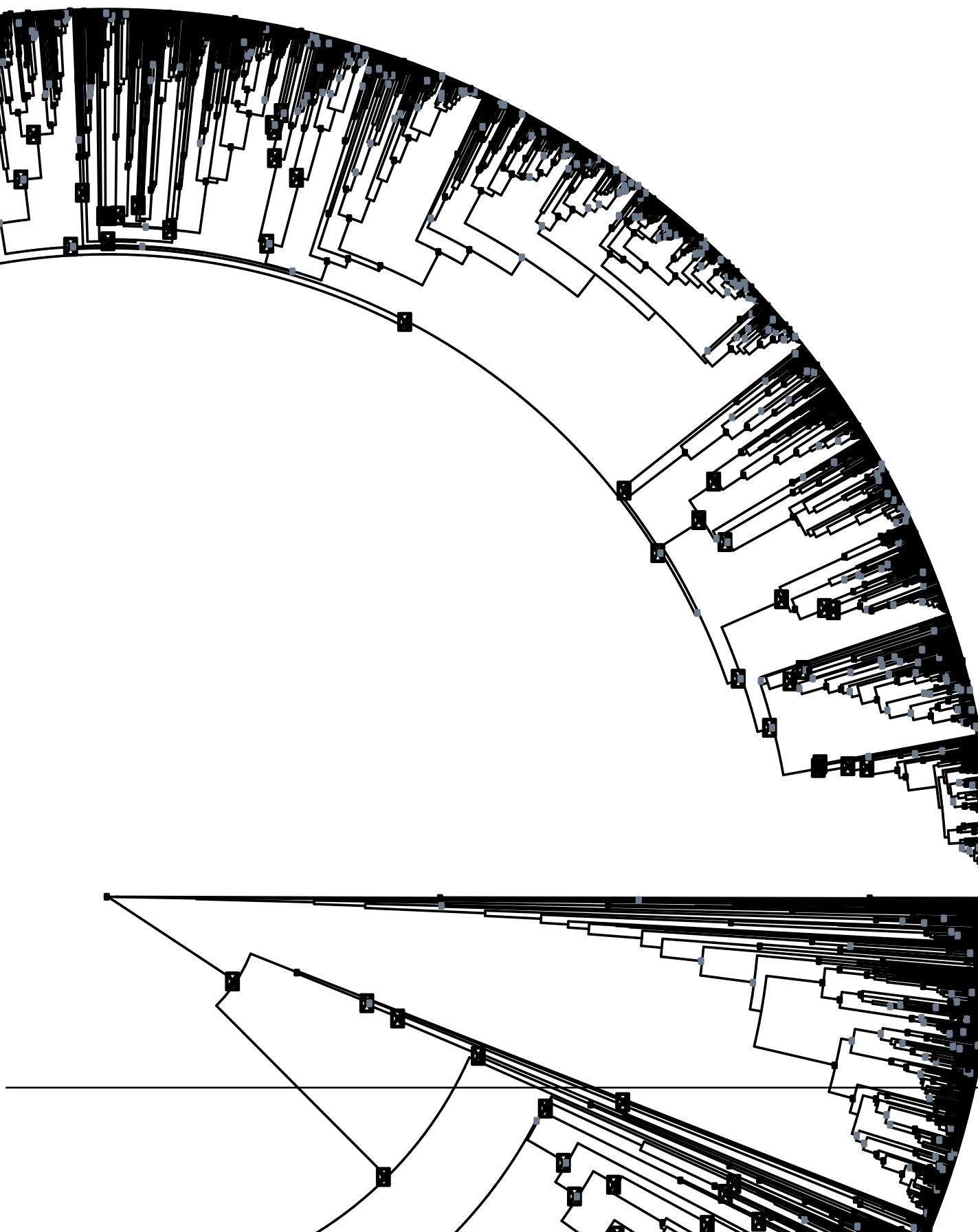
For common community phylogenetic analyses, go ahead and use
synthesis phylogenies

DAJIANG LI,^{1,5} LAUREN TROTTA,¹ HANNAH E. MARX,² JULIE M. ALLEN,³ MIAO SUN,⁴ DOUGLAS E. SOLTIS,⁴
PAMELA S. SOLTIS,⁴ ROBERT P. GURALNICK,⁴ AND BENJAMIN BAISER¹



How is phylogenetic diversity measured?

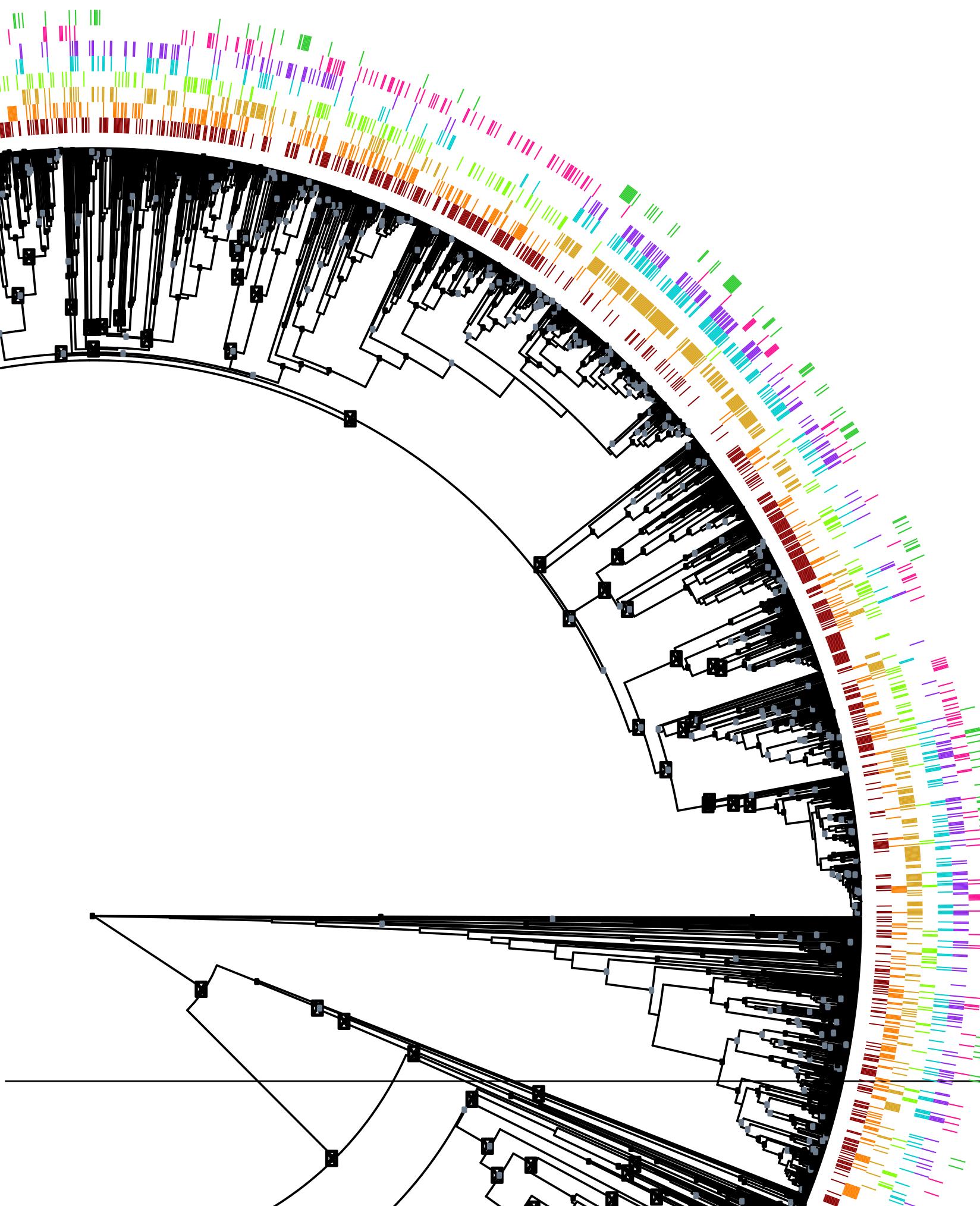
Study system: a mountain range in the Alps



How is phylogenetic diversity measured?

Study system: a mountain range in the Alps

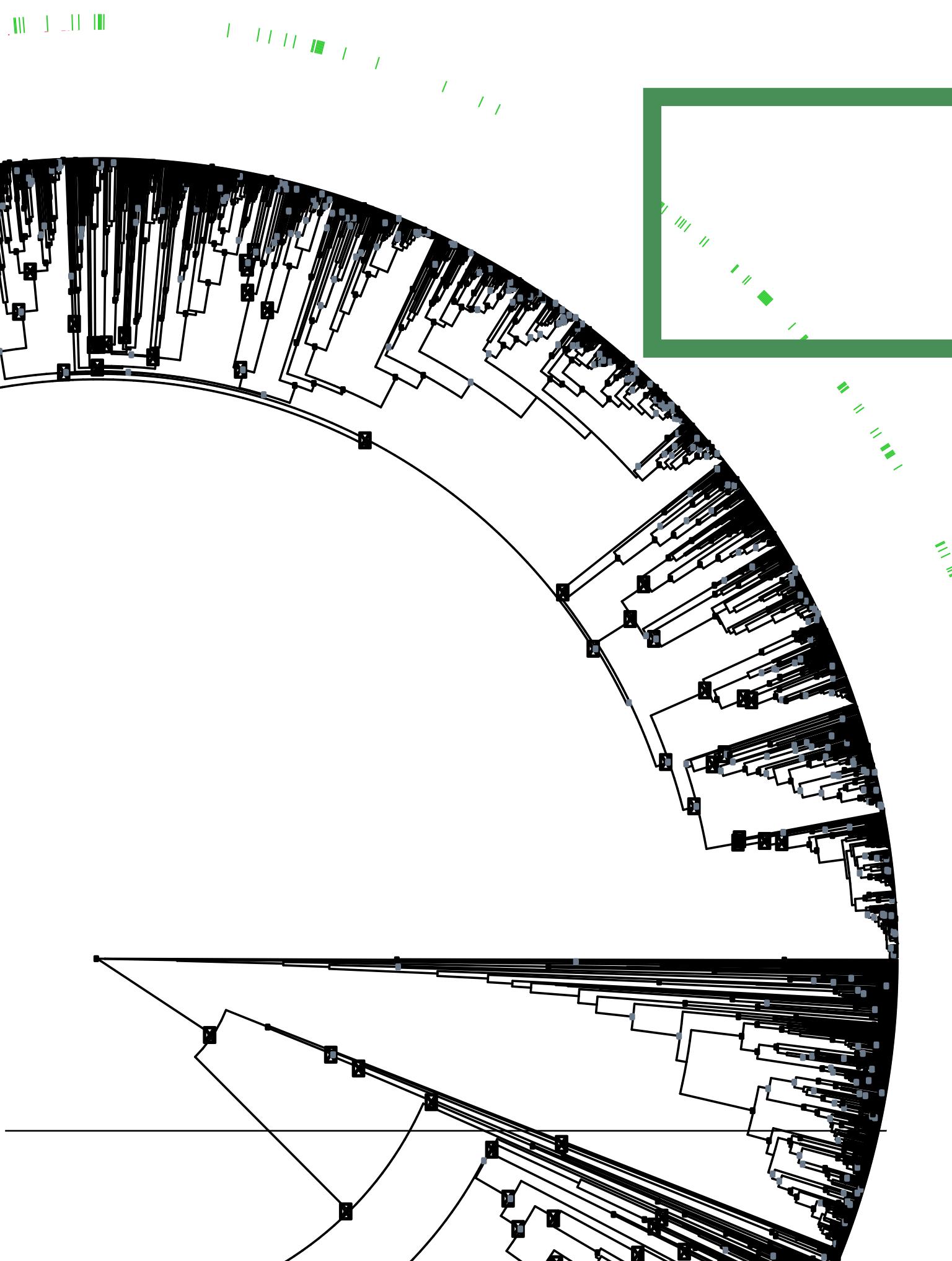
Phylogeny of regional species pool (mountain range)



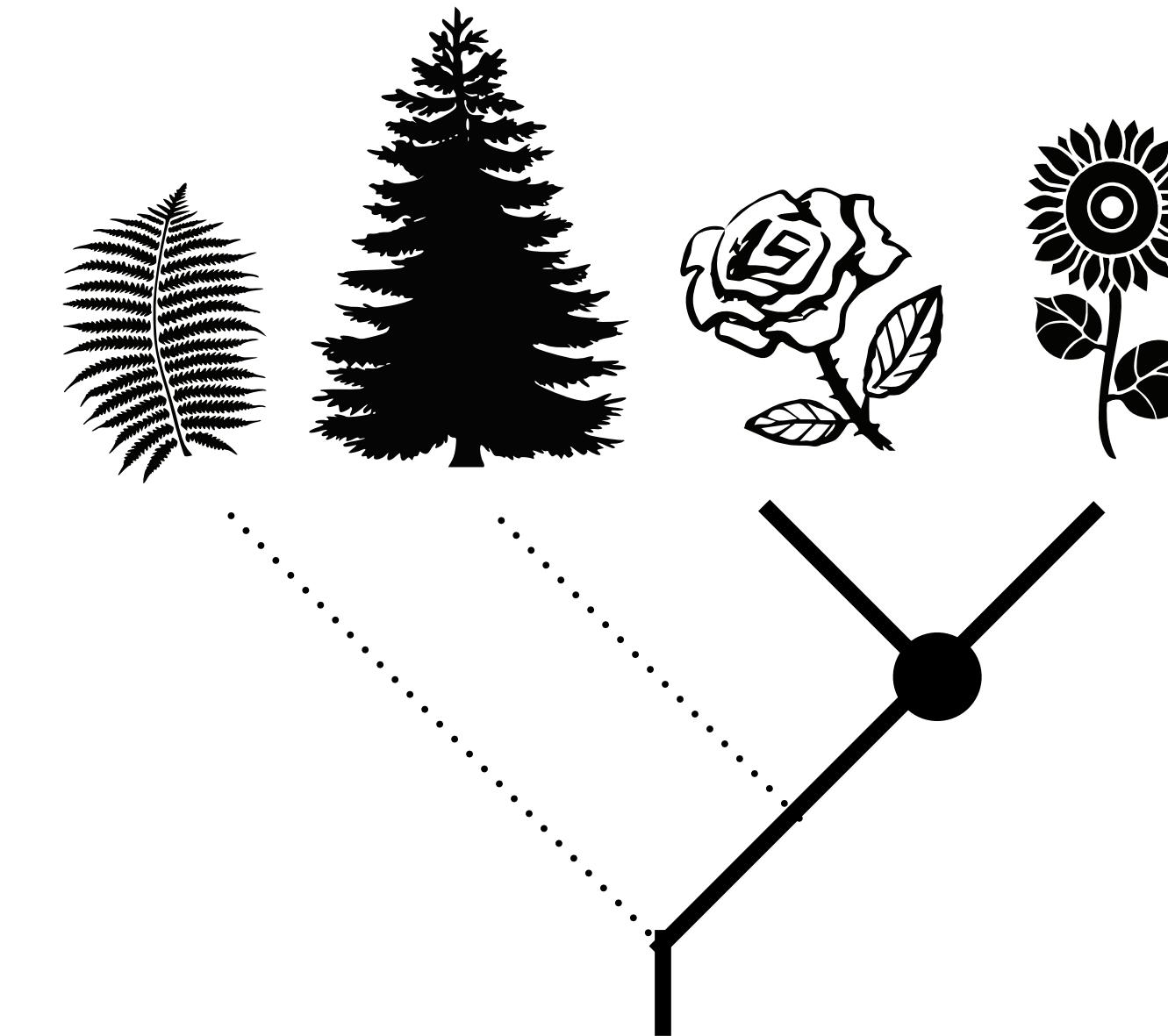
How is phylogenetic diversity measured?

Study system: a mountain range in the Alps

Phylogeny of regional species pool (mountain range)



-> Local community
(single summit)



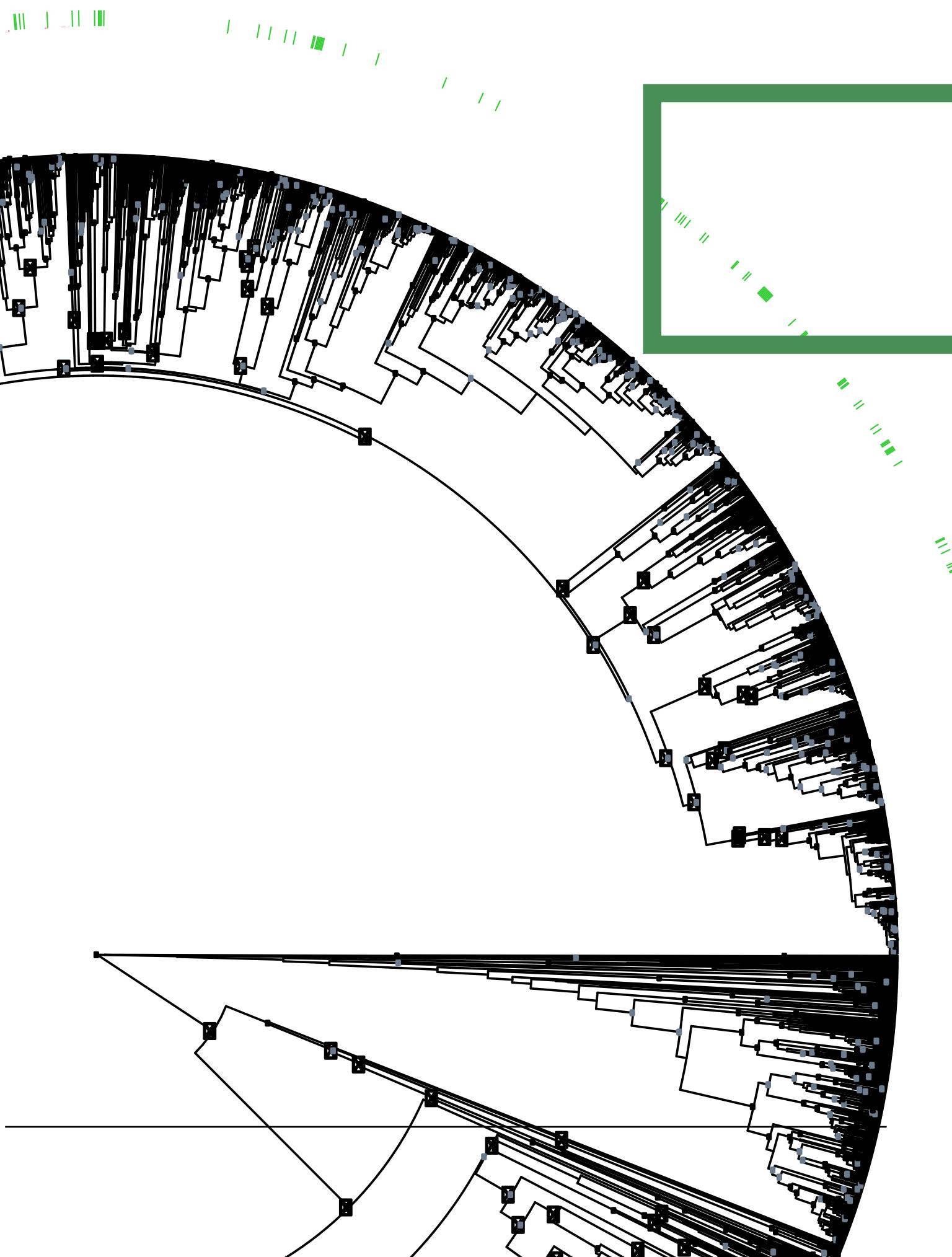
**Phylogenetic diversity (Faith's PD) =
sum of all branch lengths connecting focal set of species**

Faith 1992

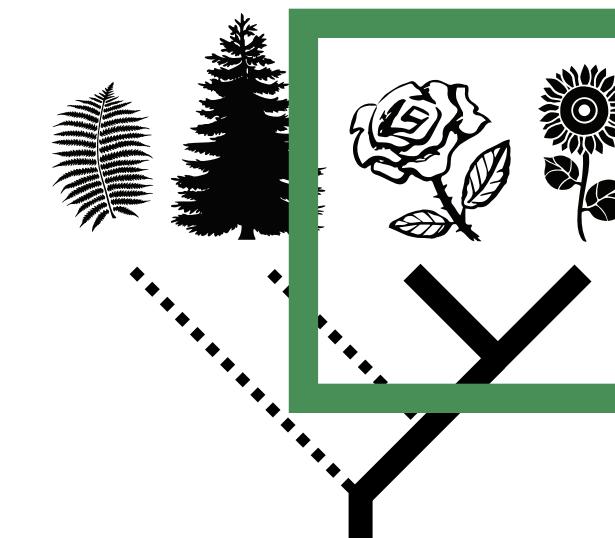
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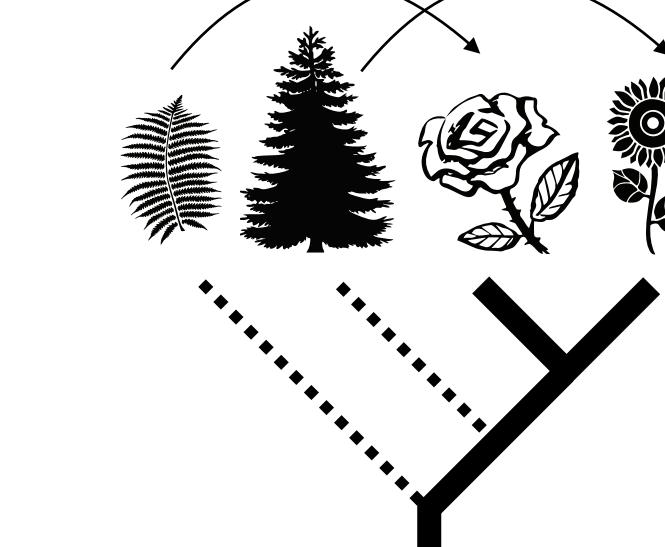
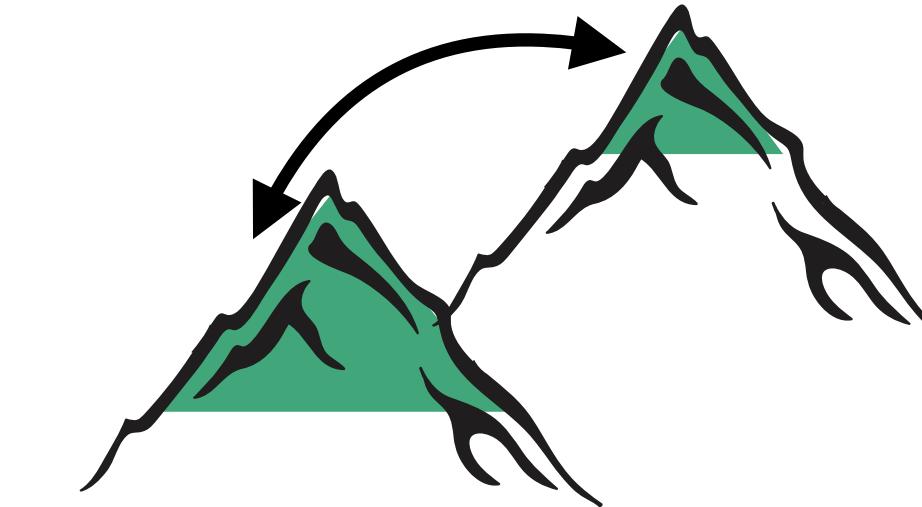
Phylogeny of regional species pool (mountain range)



-> Local community
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Observed PD



Null Expected PD

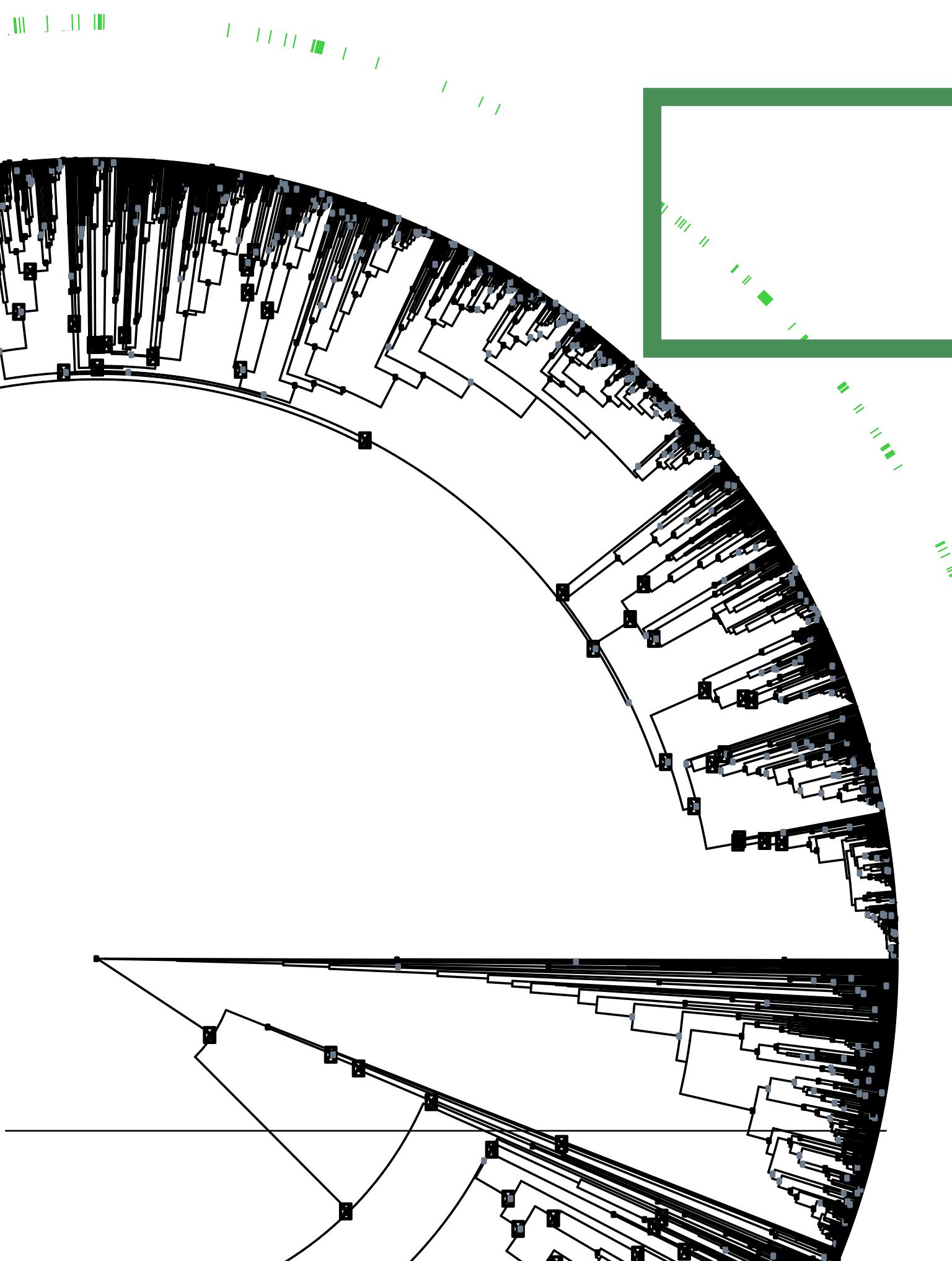
(all species equally likely to be present)

Webb 2000 Am Nat

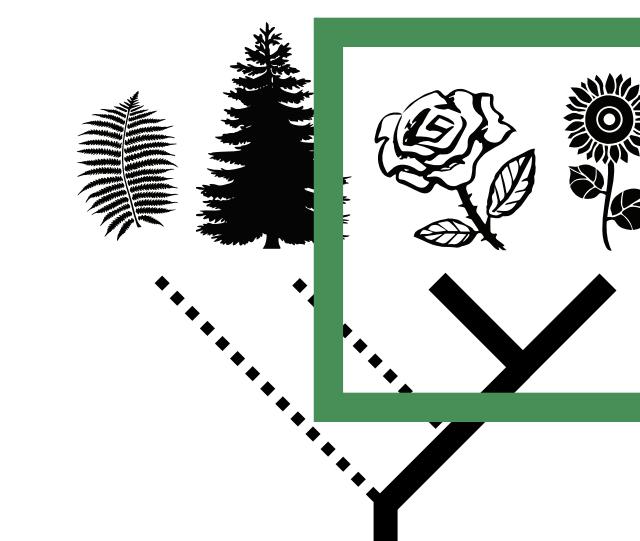
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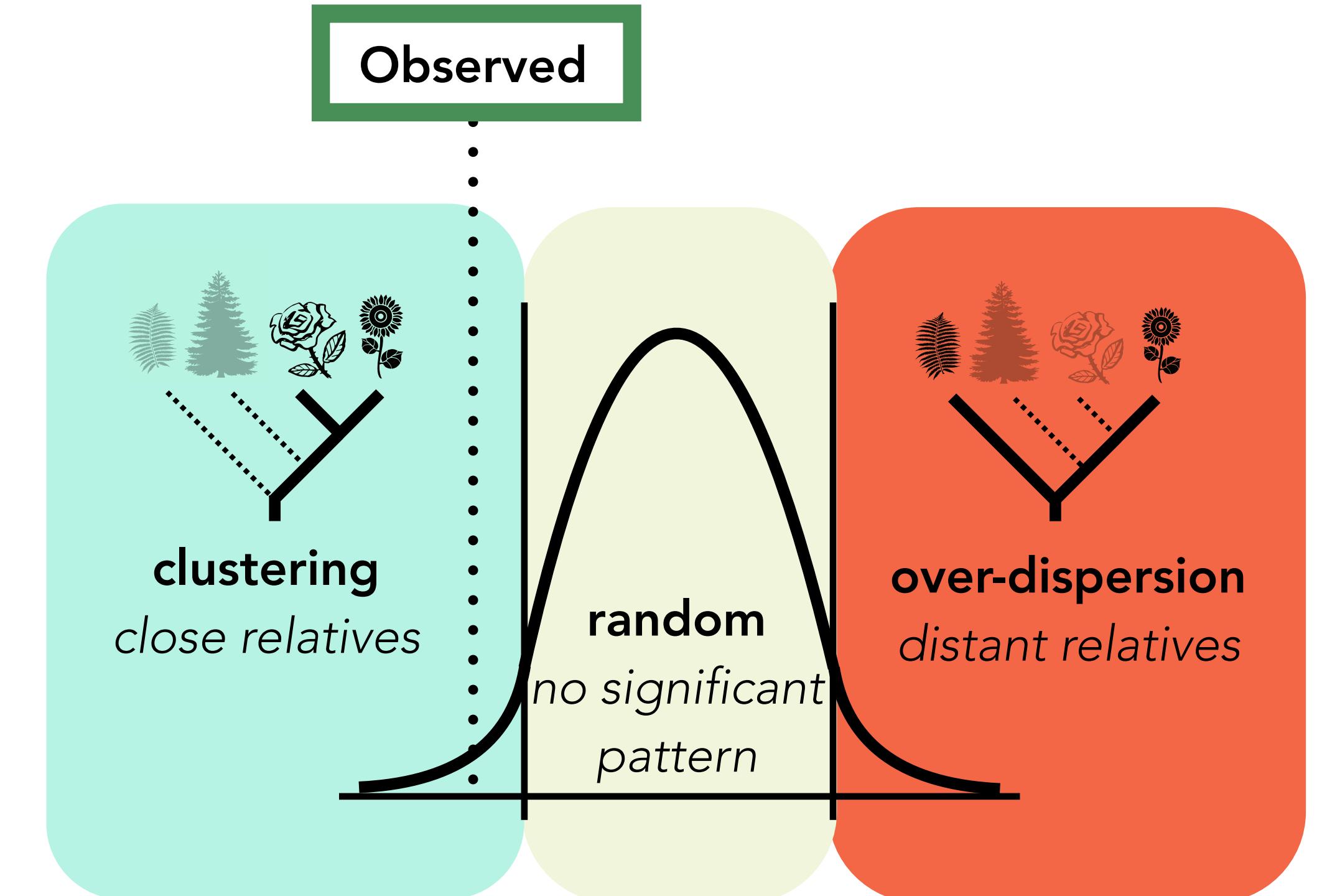


-> Local community
(single summit)



Observed PD

Observed



Standardized Effect Sizes (SES) =
(observed - mean(null)) / sd(null)

How is phylogenetic diversity measured?

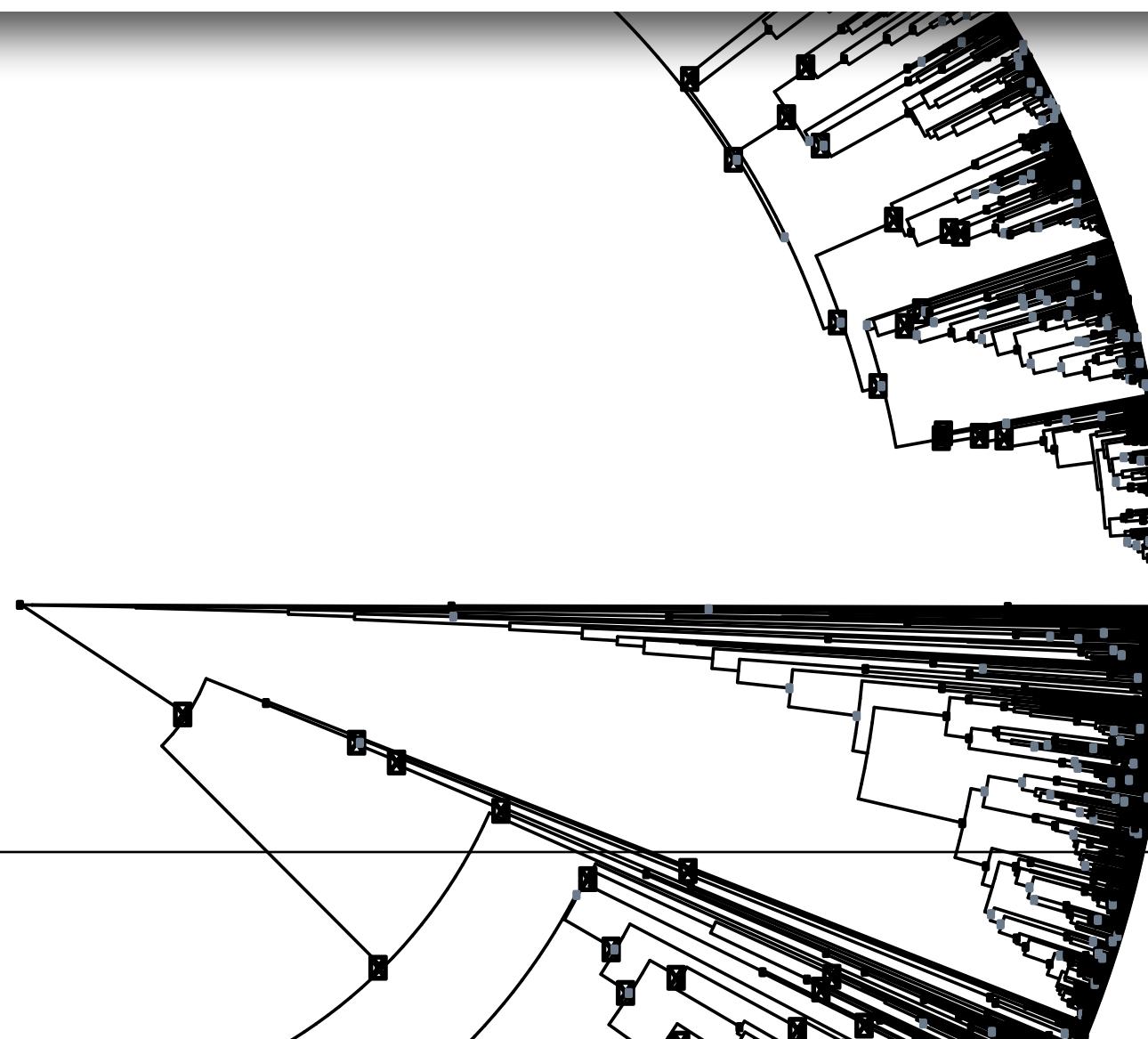
BIOLOGICAL
REVIEWS

Cambridge
Philosophical Society

1

A guide to phylogenetic metrics for conservation, community ecology and macroecology

Caroline M. Tucker^{1,*}, Marc W. Cadotte^{2,3}, Silvia B. Carvalho⁴, T. Jonathan Davies^{5,6},
Simon Ferrier⁷, Susanne A. Fritz^{8,9}, Rich Grenyer¹⁰, Matthew R. Helmus^{11,12}, Lanna S.
Jin¹³, Arne O. Mooers¹⁴, Sandrine Pavoine^{15,16}, Oliver Purschke^{17,18,19}, David W.
Redding²⁰, Dan F. Rosauer²¹, Marten Winter¹⁷ and Florent Mazel²²



Phylogenetic community structure metrics and null models: a review with new methods and software

Eliot T. Miller, Damien R. Farine and Christopher H. Trisos



ARTICLE

Received 20 Apr 2014 | Accepted 20 Jun 2014 | Published 18 Jul 2014

DOI: 10.1038/ncomms5473

Phylogenetic measures of biodiversity and neo- and paleo-endemism in Australian *Acacia*

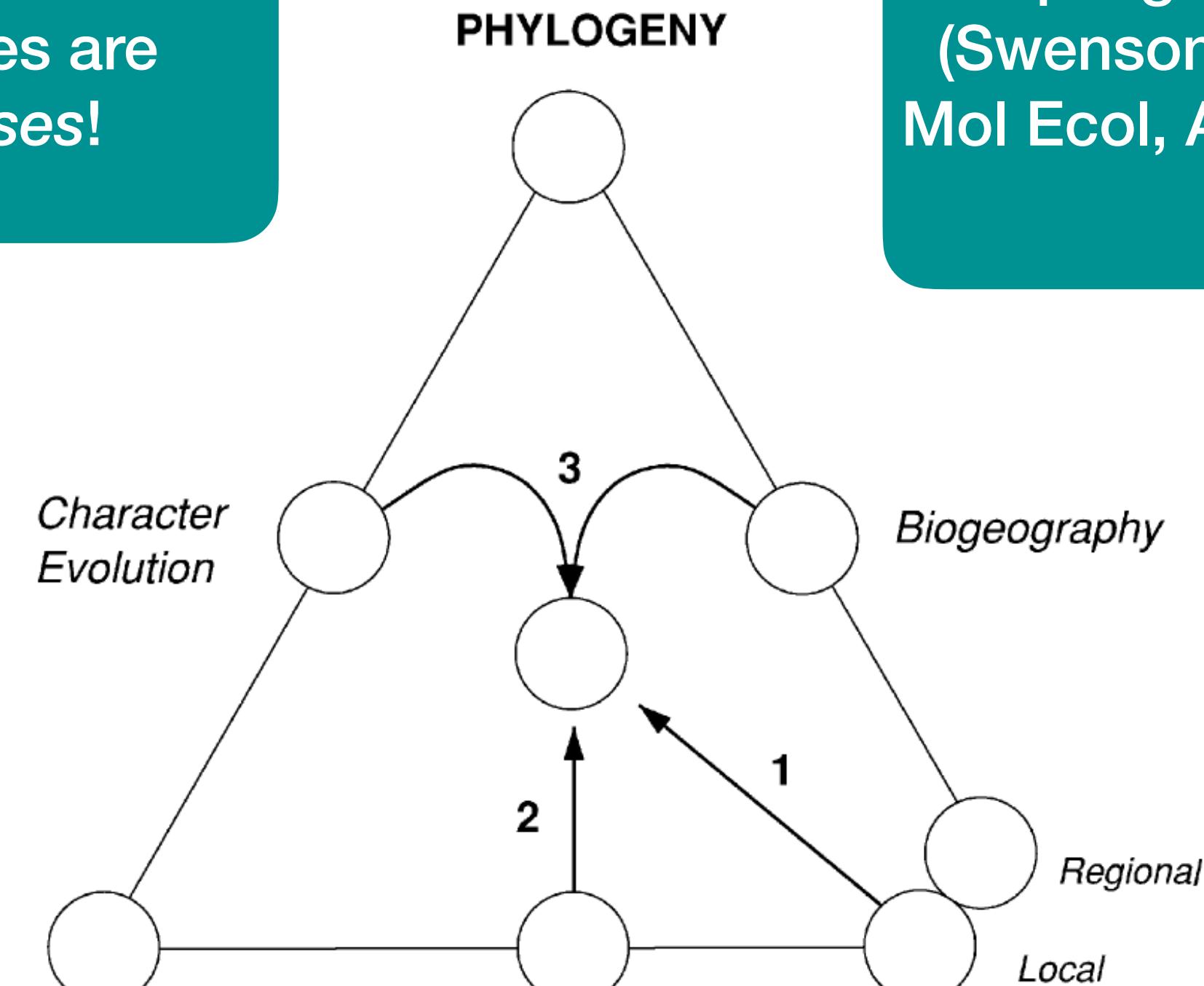
Brent D. Mishler^{1,2}, Nunzio Knerr¹, Carlos E. González-Orozco^{1,3}, Andrew H. Thornhill^{1,4},
Shawn W. Laffan⁵ & Joseph T. Miller¹

Ecography 39: 001–017, 2016
doi: 10.1111/ecog.02070
© 2016 The Authors. Ecography © 2016 Nordic Society Oikos
Subject Editor: Nate Swenson. Editor-in-Chief: Miguel Araújo. Accepted 15 March 2016

Considerations for study design

Phylogenies are
hypotheses!

Other types of data:
Phenotypes/phylogenetic
signal + environment
(Kraft et al. 2007 Am Nat)

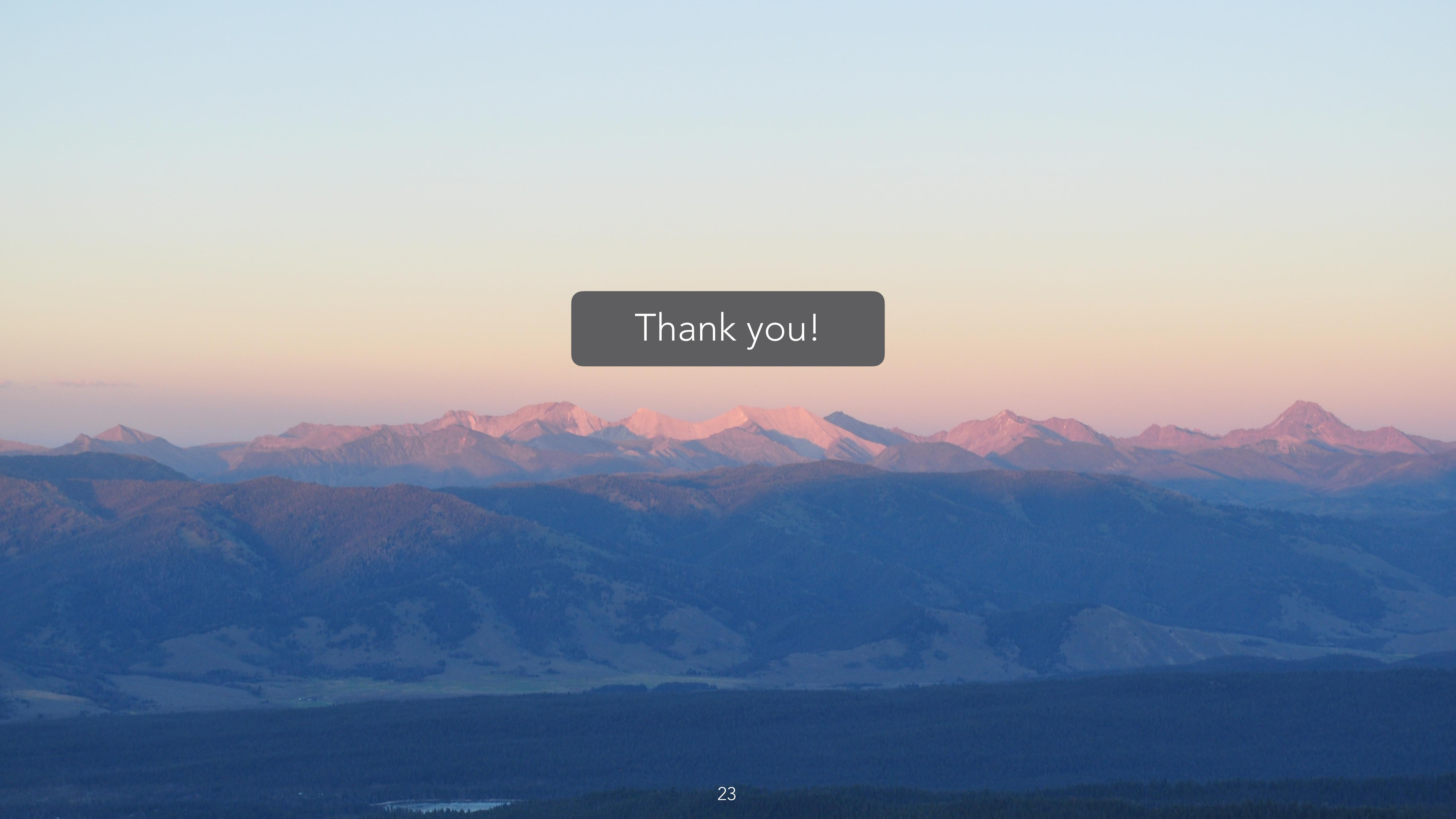


Within (alpha) and among (beta)
communities
(Leprieur et al., 2012 PlosONE)

Sampling of community/clade or phylogeny
(Swenson 2009 PlosONE, Park et al. 2017
Mol Ecol, Allen et al. 2019 iScience, Jantzen
et al., 2019 Ecol Evol)

Spatial scale: overdispersion at
smaller scales, clustering at larger
(Swenson et al. 2006 Ecology,
Vamosi et al., 2009 Mol Ecol)

Taxonomic scale: oaks vs.
angiosperms
(Cavender-Barres et al., 2004, 2006)



Thank you!

Extras

Dominant drivers of diversity on alpine summits

