

# New records of hemiepiphytes provide insight into the evolution of fern habit

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*Being a plant is hard enough — Epiphytes have real problems*





**Aroids**



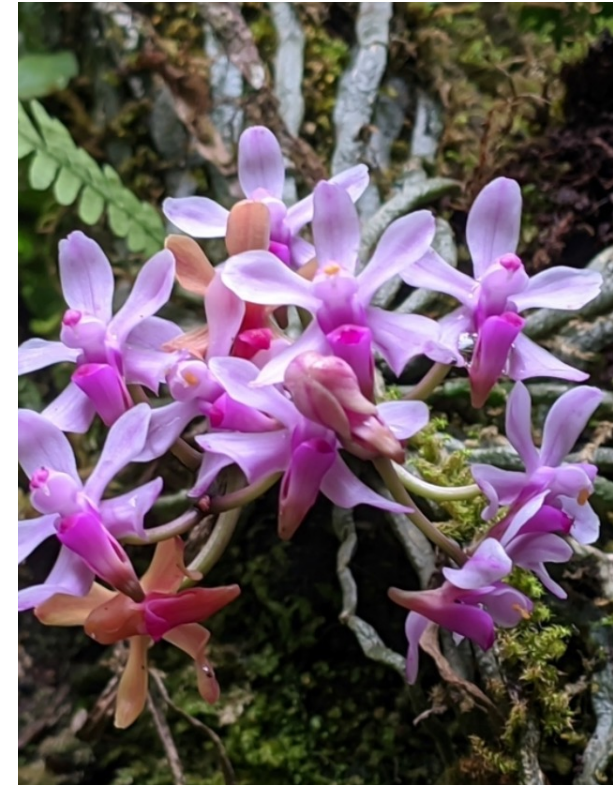
**Bromeliads**



**Gesneriads**



**Orchids**



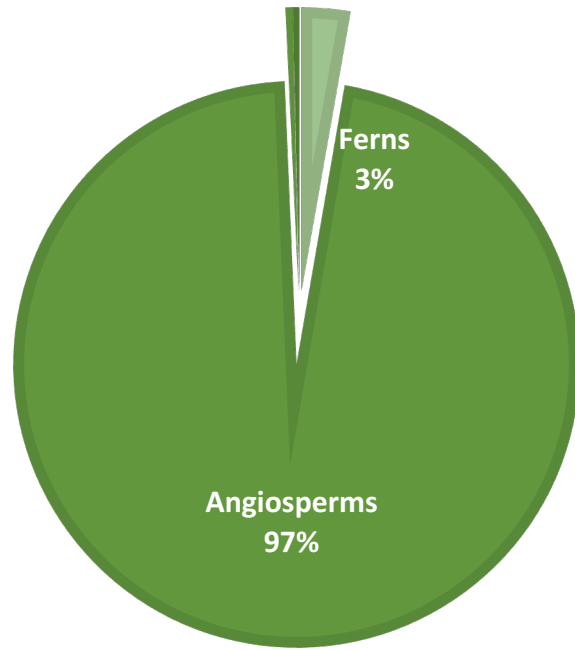




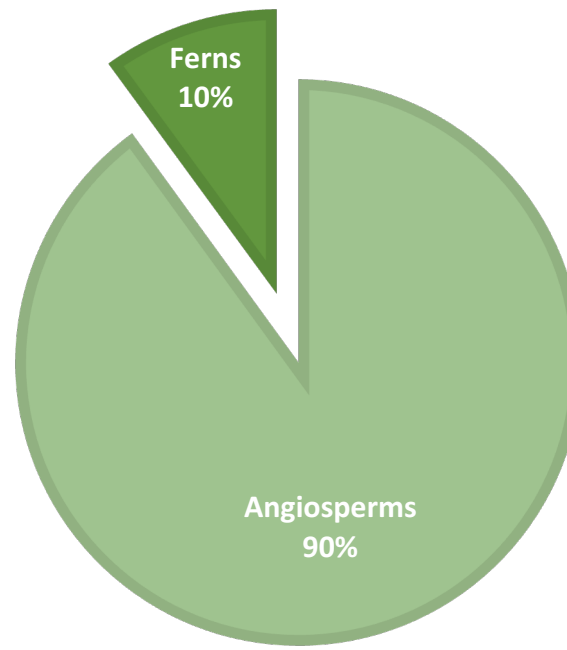
*Ferns prosper in the epiphytic niche!*



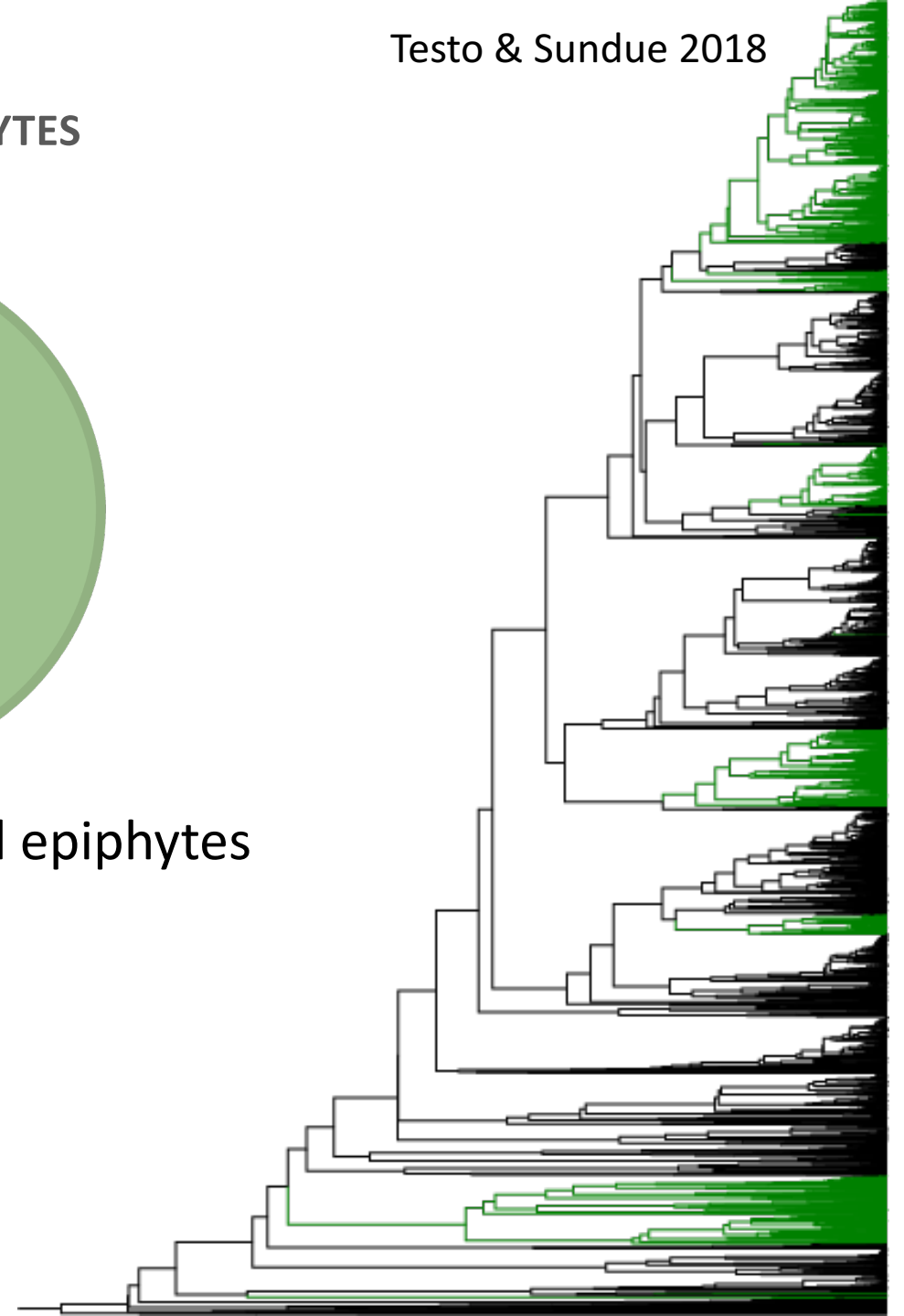
## VASCULAR PLANT DIVERSITY



## PROPORTION EPIPHYTES



Ferns are only 3% of all vascular plants – but 10% of all epiphytes





# Epiphytic ferns in space and time



*Hopetedia praetermissa* – 250 ma



*Hymenophyllum axsmithii* – 55 ma



## *Other habits of ferns in trees*



### Epiphytes

Attached to host  
without soil contact



### Root climbers

Start on ground and  
Climb host with adhesive roots



### Hemiepiphytes

Start on host and then connect to  
Ground via long roots



# Documenting Hemiepiphytes

S. E. Fawcett



Establish on trees



Roots later head downward



Roots contact soil



Plants are never seen terrestrially









Dorsiventral rhizomes



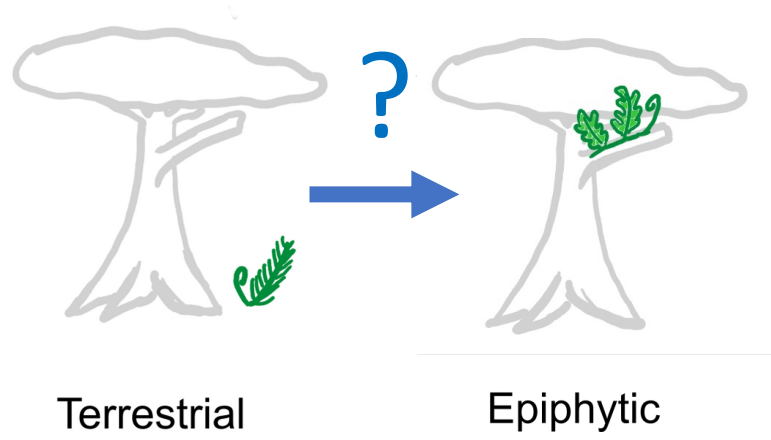
Short 'clasping' roots



Long 'feeding' roots

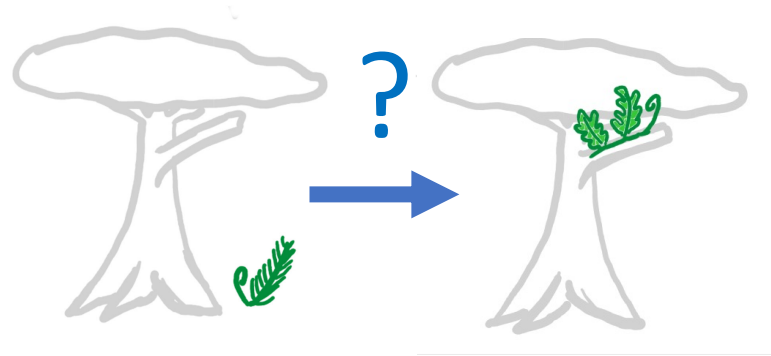


# Evolution of habits





# Evolution of habits



Terrestrial

Epiphytic



R.E. Holttum

Epiphytes

*Elaphoglossum*



Root climbers

*Lomagramma etc.*



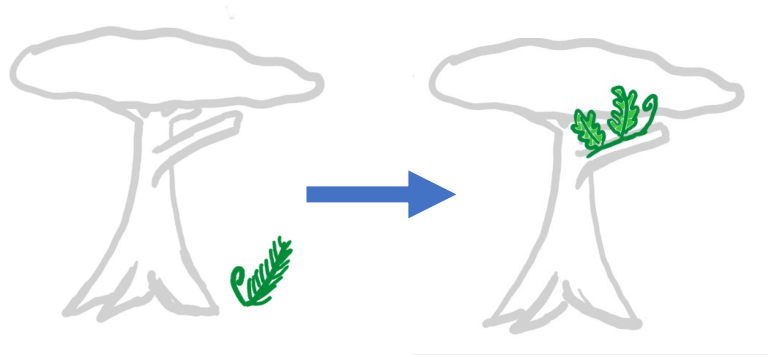
Terrestrials

*Bolbitis*





# Evolution of habits



Terrestrial

Epiphytic



R.E. Holttum



R.C. Moran

Epiphytes

*Elaphoglossum*



Root climbers

*Lomagramma etc.*



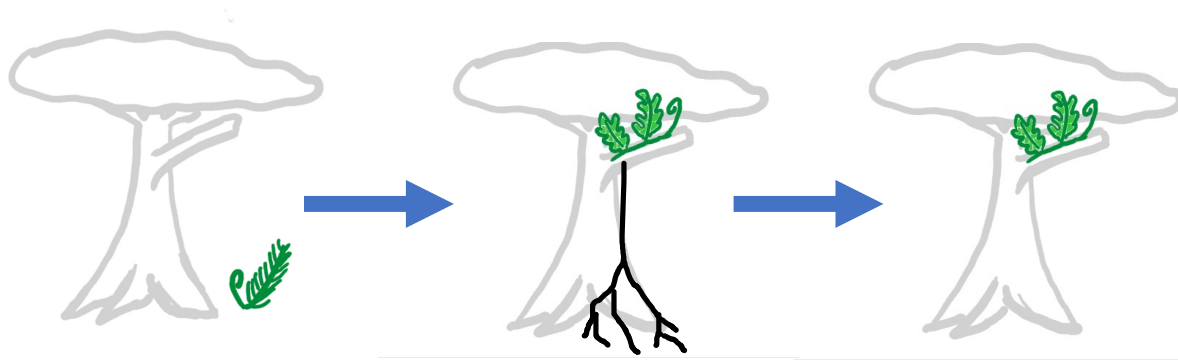
Terrestrials

*Bolbitis*





# Evolution of habits



Terrestrial

Epiphytic

Epiphytic



*Elaphoglossum  
amygdalifolium*



L.P. Lagomarsino

A.L. Grusz

Epiphytes

*Elaphoglossum*

Hemiepiphytes

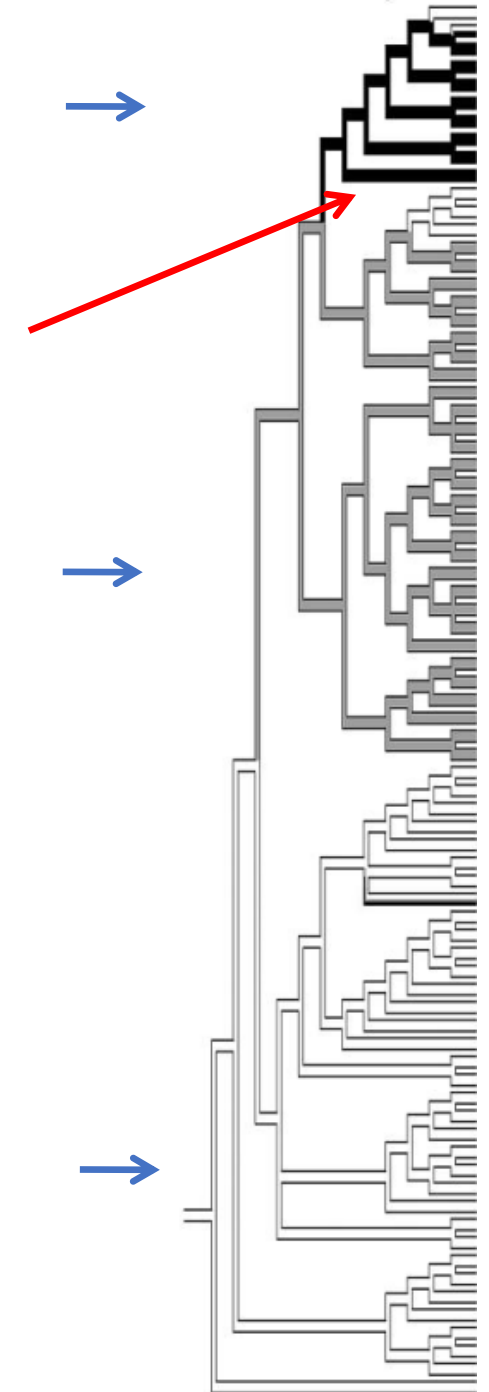
*E. amygdalifolium*

Root climbers

*Lomagramma etc.*

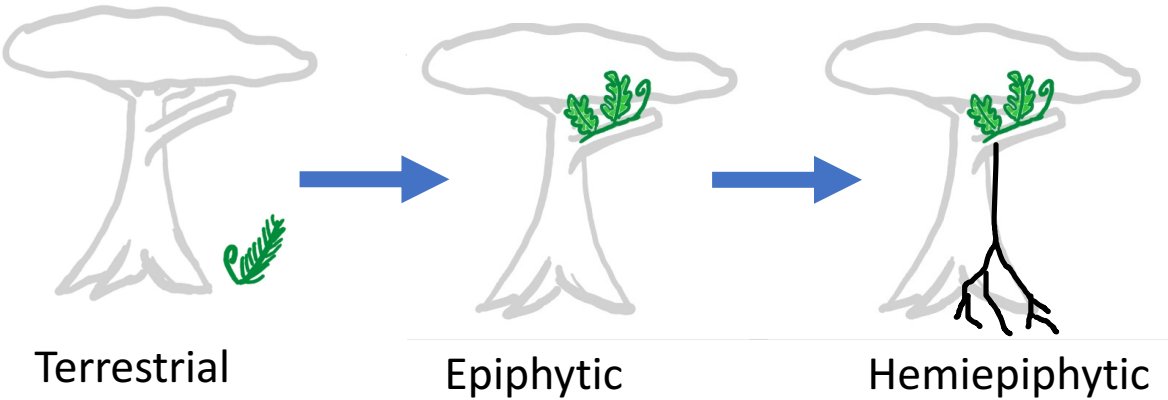
Terrestrials

*Bolbitis*





# A reversal!

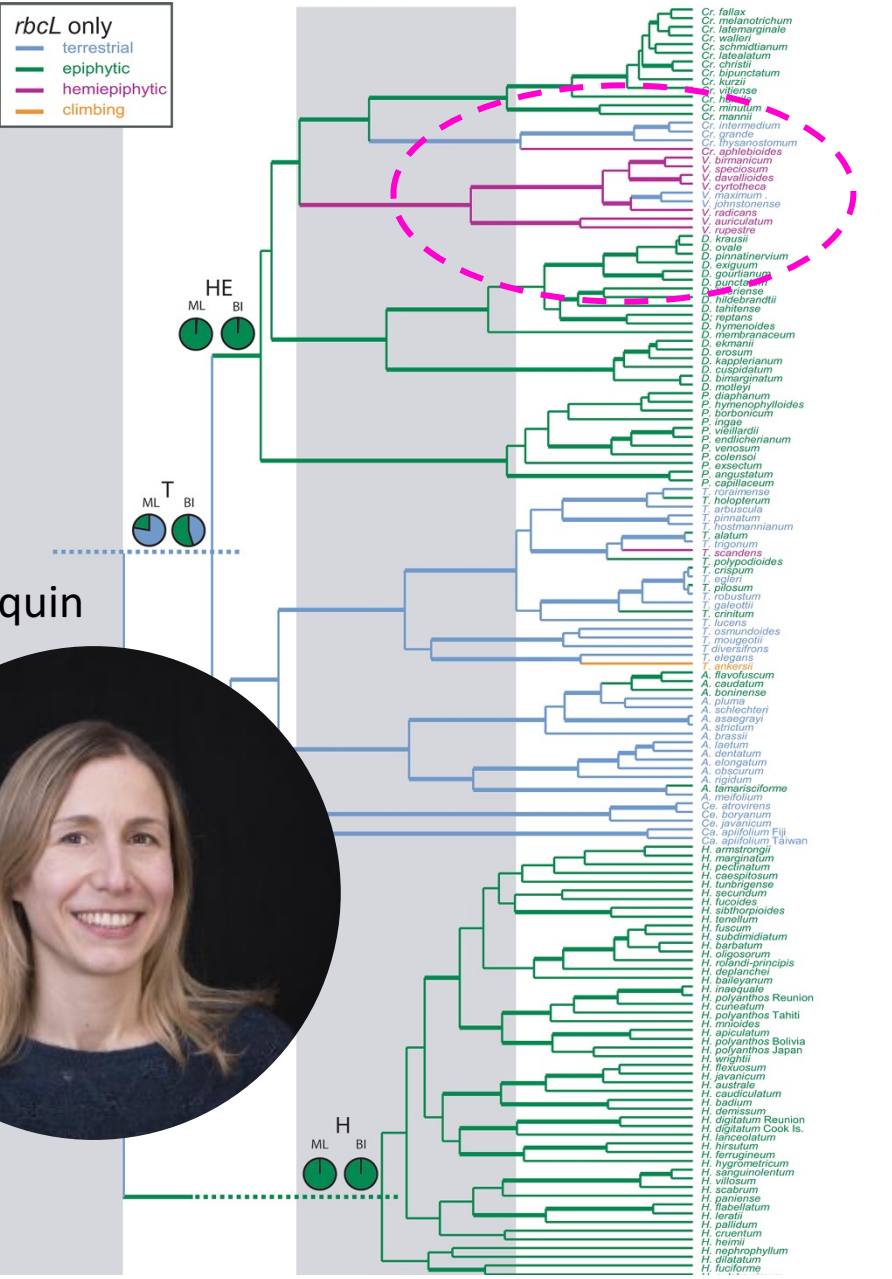


J.H. Nitta



*Vanderboschia collariata*

# Vanderboschia nested In epiphytic clades



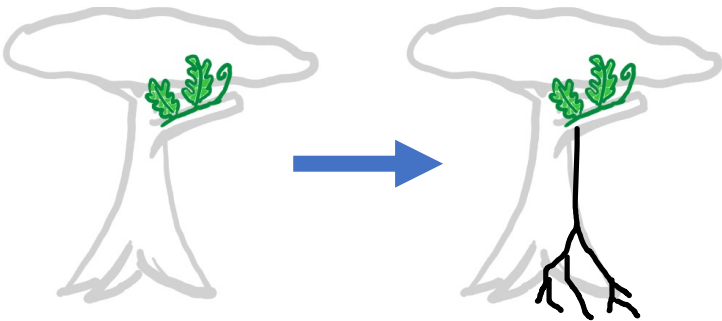
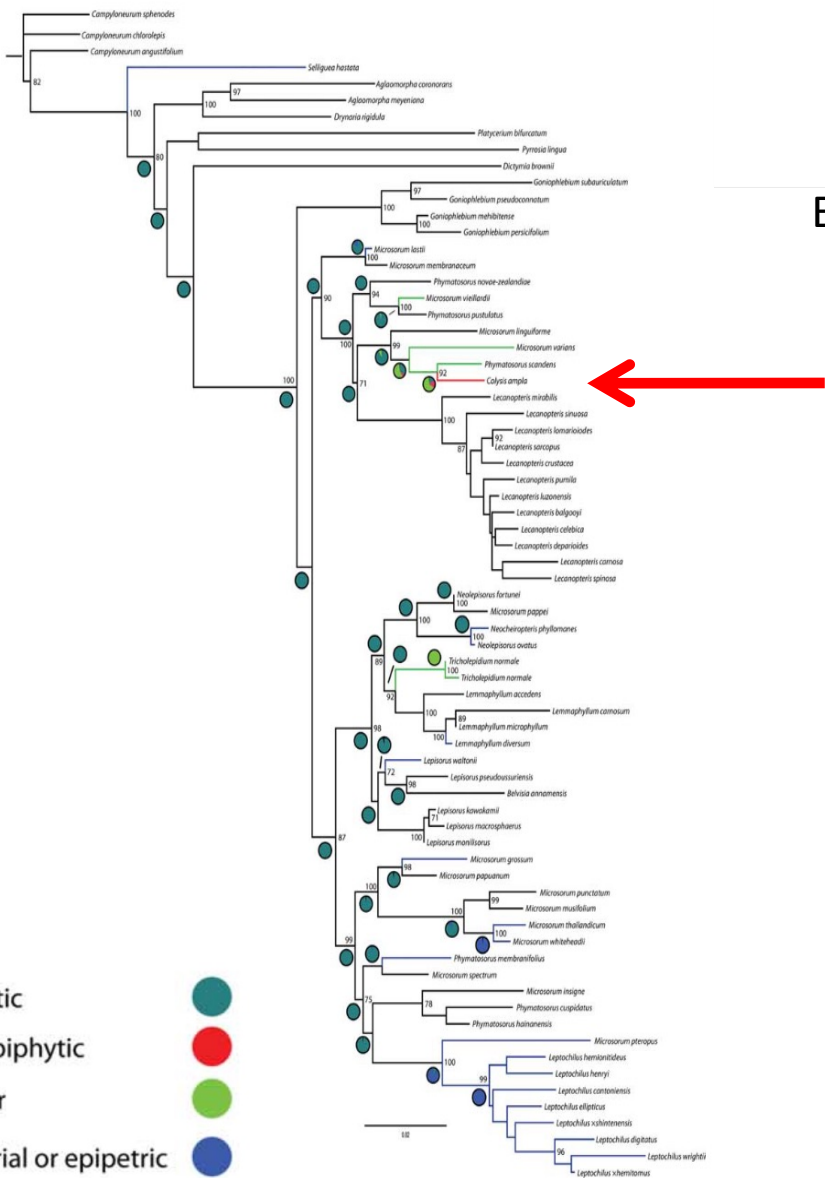
S. Hennequin





# More reversals...

W. L. Testo



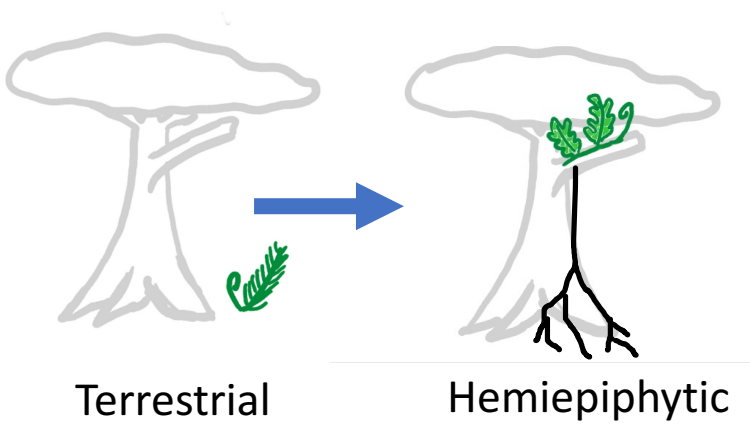
Epiphytic

Hemiepiphytic





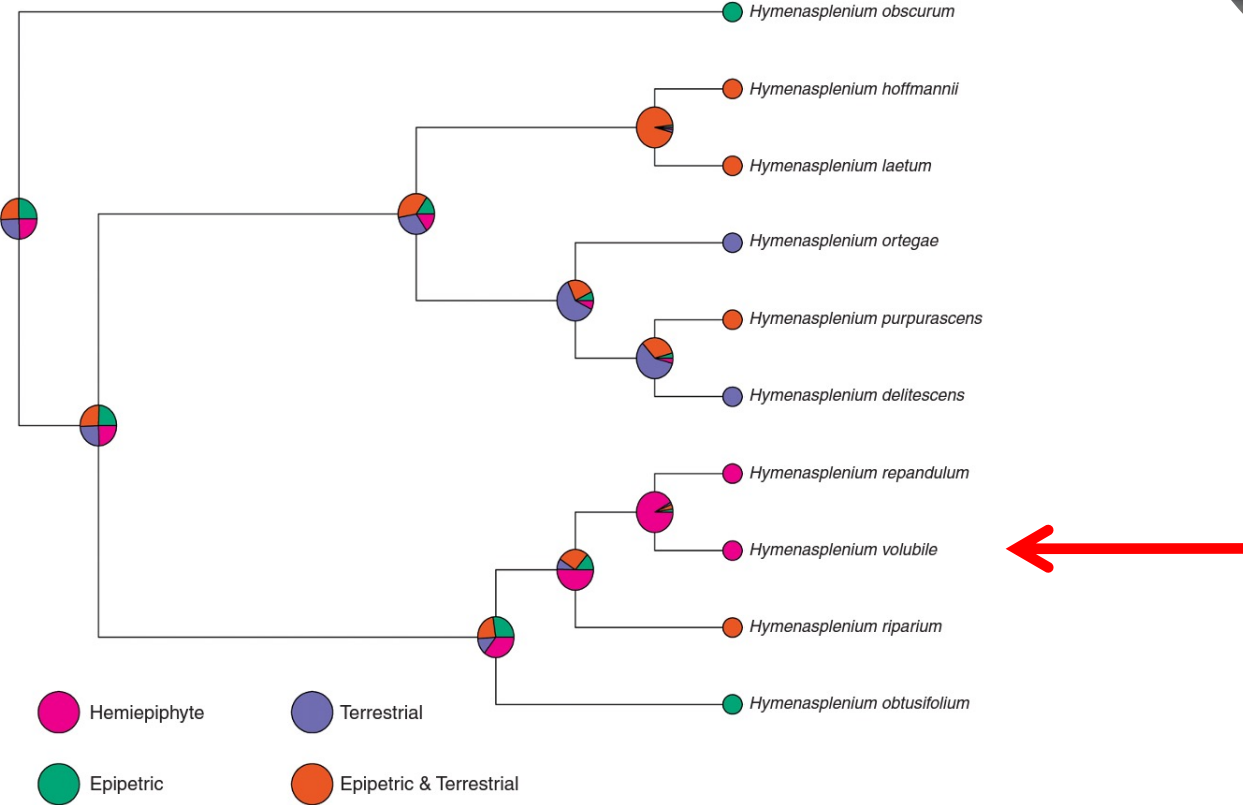
Yet another scenario...



J. L. Watts



J.E. Watkins





We need more plants!



Kore Maraia, PhD student







*If you go: Order the Megapode eggs boiled in a volcanic hot spring*





# Methods





# Results



**319 Collections**

**206 Species**

**15 Hemiepiphytic species**

**12 New hemiepiphytic records**

**7 Documented sufficiently to publish**

*~7% of the species inventoried had  
a hemiepiphytic habit*

Species distributed in:

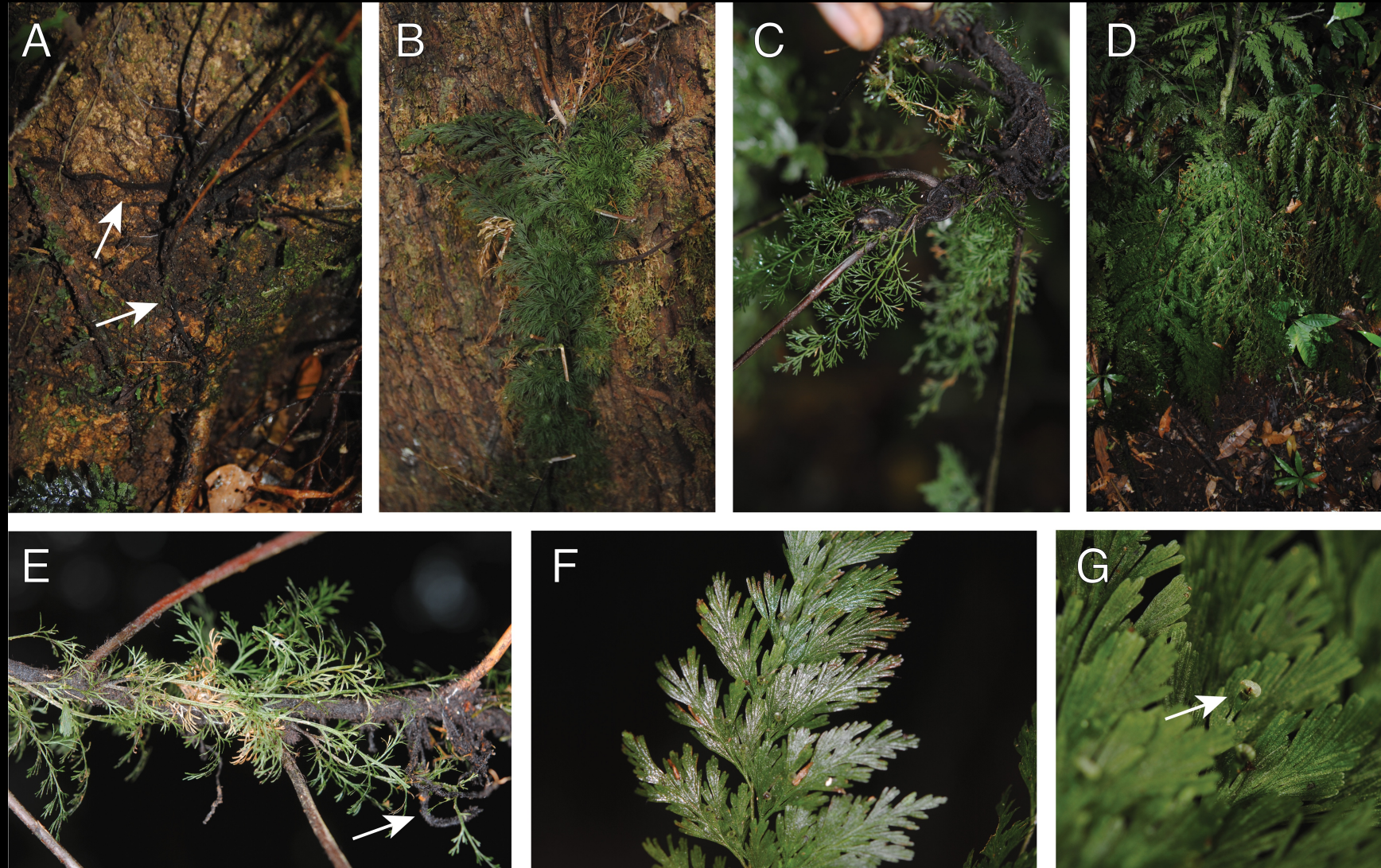
- *Aspleniaceae*
- *Hymenophyllaceae*
- *Lindsaeaceae*
- *Polypodiaceae*
- *Tectariaceae*
- *Thelypteridaceae*



## Results:

New lineages and  
Further evidence for  
morphological convergence

- Dorsiventral rhizome
- Long and short roots



***Crepidomanes*  
*aphlebioides***



## Results:

Many new records of *Asplenium* indicating the entire *A. scandens* clade (~6 spp.) is hemiepiphytic



***Asplenium scandens***



Results:

A Thelypteridaceae!

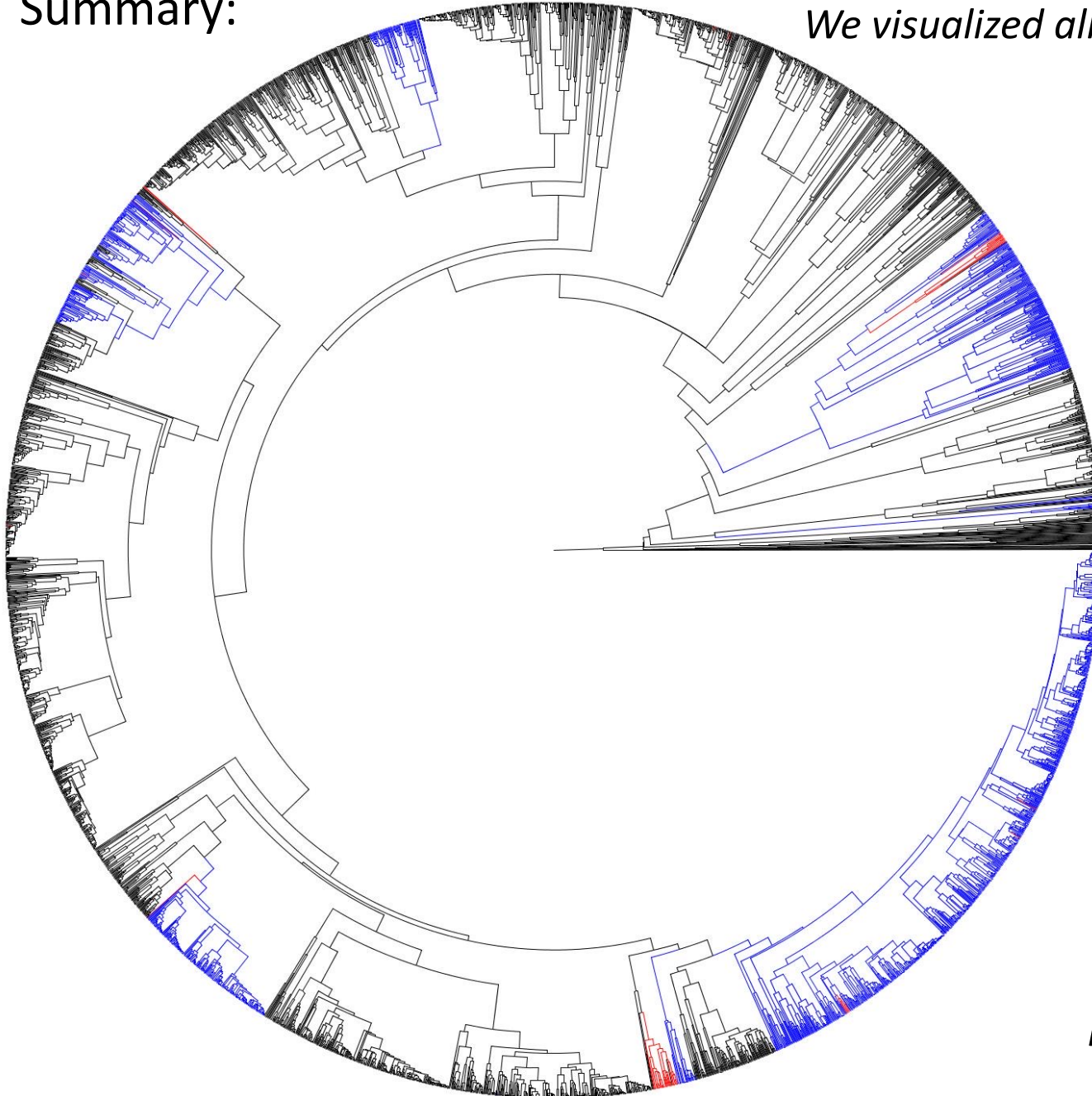


**Sphaerostephanos  
scandens**



## Summary:

*We visualized all known epiphytes and hemiepiphytes onto a 4k-tip tree*



- Epiphytes
- Hemiepiphytes

- **Most hemiepiphytes evolve within epiphytic clades**
- **A minority evolve within terrestrial or epipetric clades**
- **Many hemeipiphytes are one-offs, but there are small radiations:**
  - *Lomariopsis*
  - *Vandenboschia*
  - The *Trichomanes Lacostea* clade
  - The *Asplenium scandens* clade

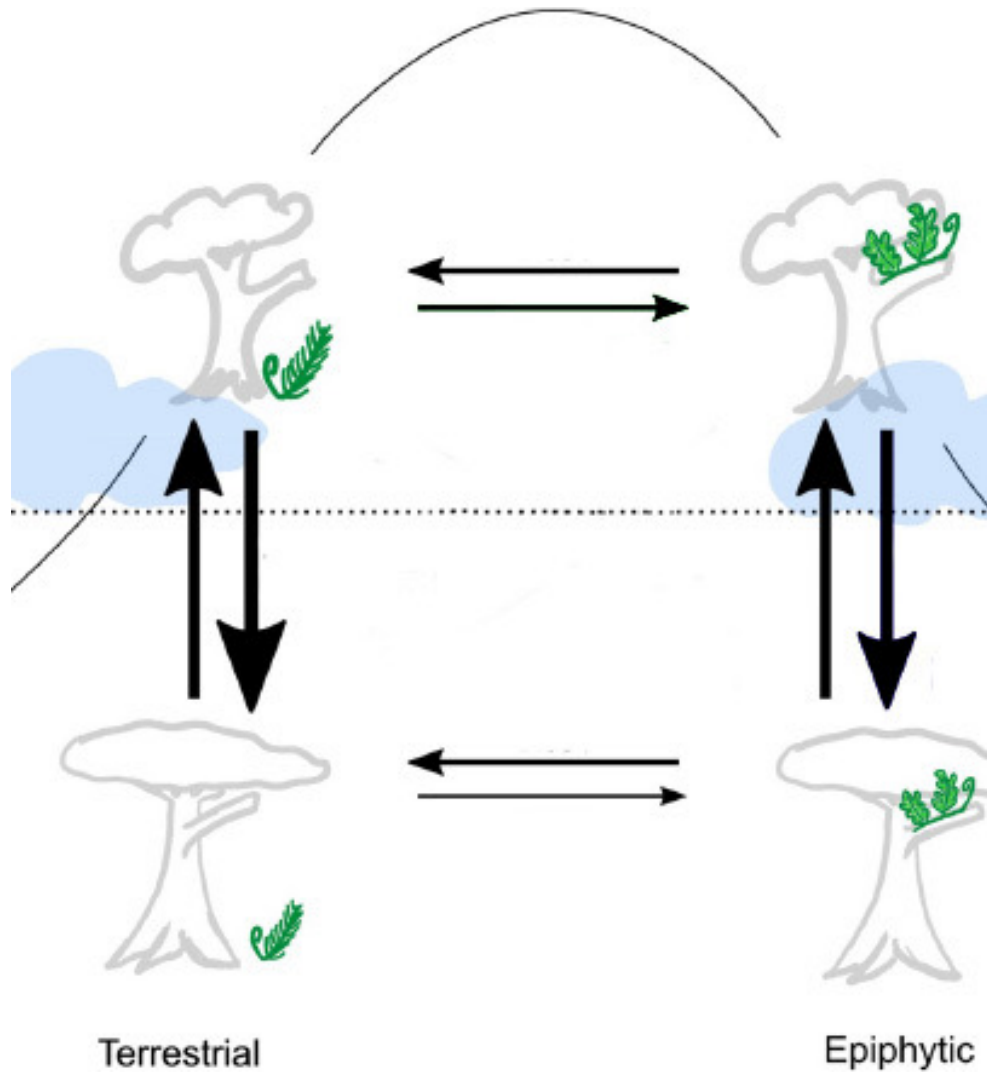
*How else can we use these data?...*







## *Future directions...*

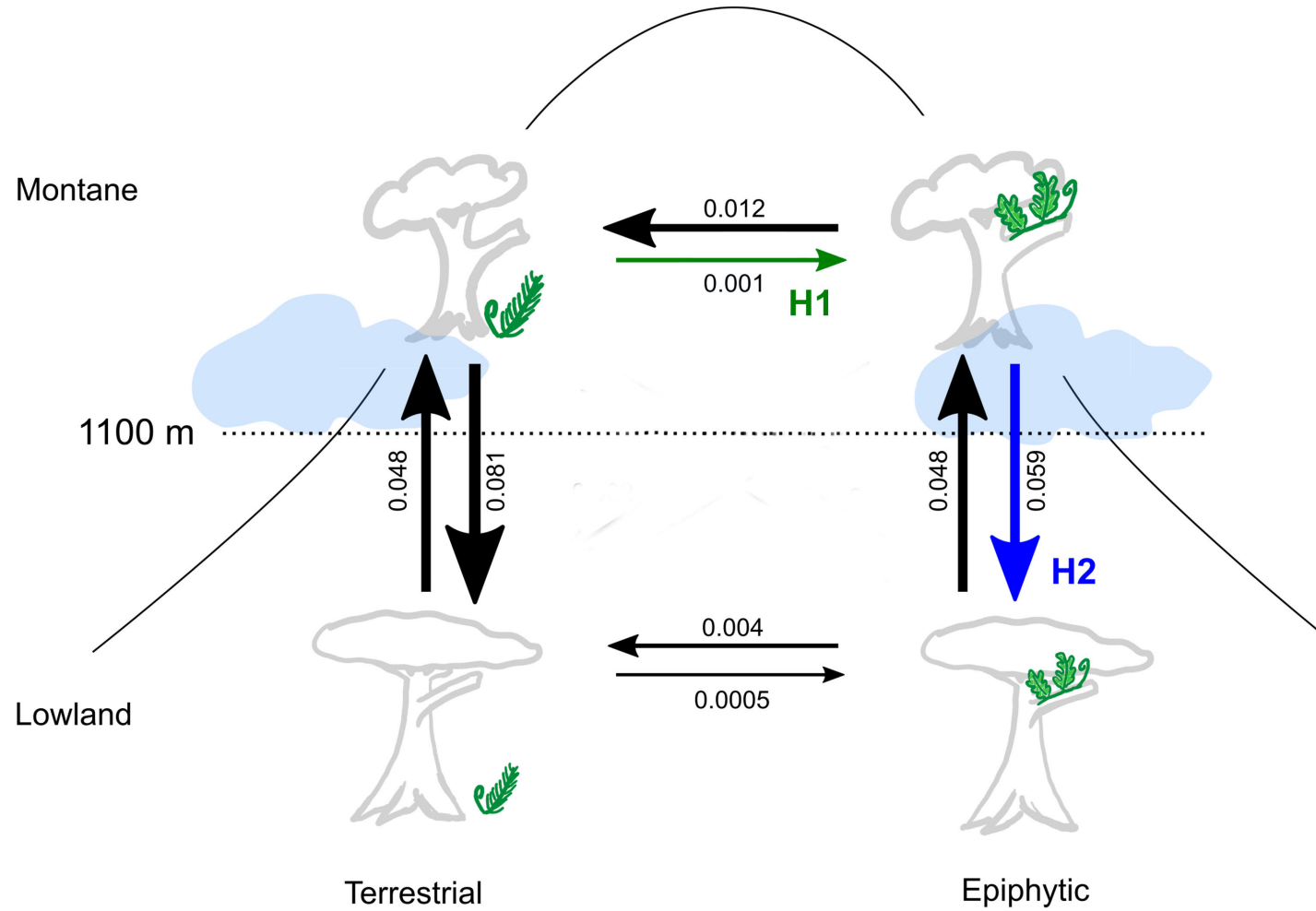


Sarah Noben

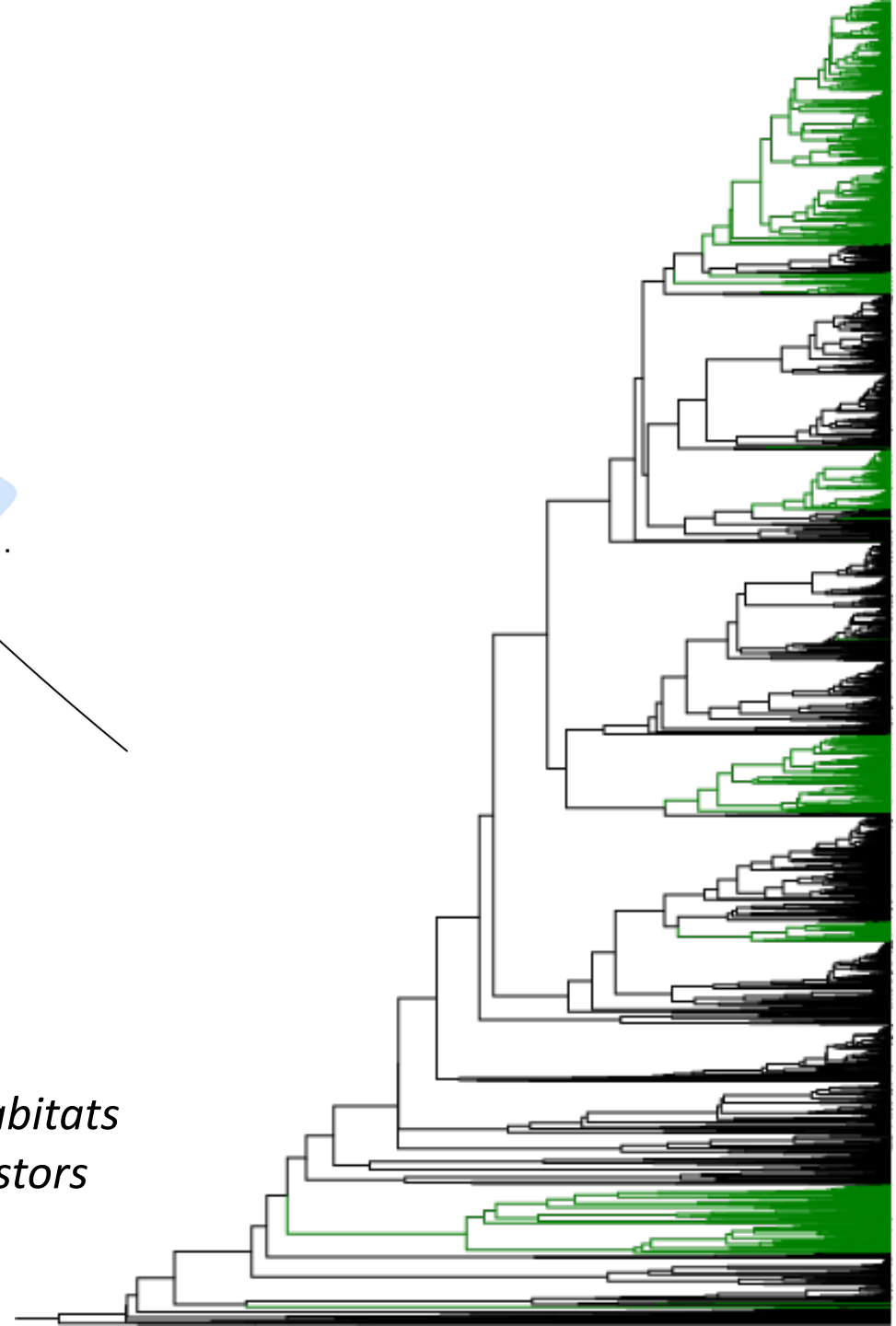
Michael Kessler



## Preliminary results...



- *Transitions to epiphytism are 2x more likely in cloud forest habitats*
- *The primary route for lowland epiphytes is from upland ancestors*





# Acknowledgments

Robbin Moran – For spending 20 years of his life talking about ferns with me!

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Susana Vega Betancur

Weston Testo

Kimberlie Sasan

