Generating databases of 3D leaf structure for living collections of grapevines

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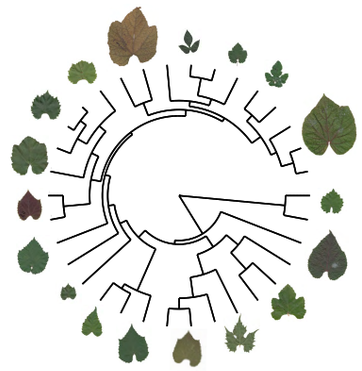
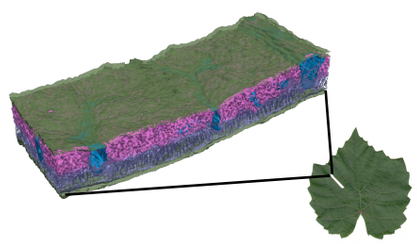
Outline

I. The importance of living collections to ecological and evolutionary studies

II. Evolution of climatic tolerances in grapevine:
integration of anatomical and physiological traits



III. Building a database of 3D leaf structure for grapevine:
generating new methods and tools for research and outreach



I. Importance of Germplasm Collections

Germplasm: living genetic resources such as seeds or tissues maintained for the purpose of breeding, preservation & other research uses *(including adaptation to changing climates)*

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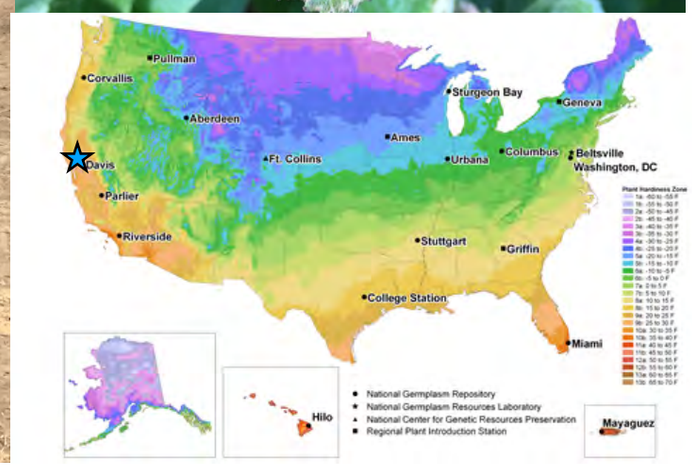
USDA National Genetic Resources Program
National Plant Germplasm System

- ~500,000 accessions of plants covering 10,000 species and over 200 plant families
- economically important cultivars, varieties, & wild species
- acquire, preserve, evaluate, document & distribute crop germplasm

Wolfskill Experimental Orchards

Winters, CA

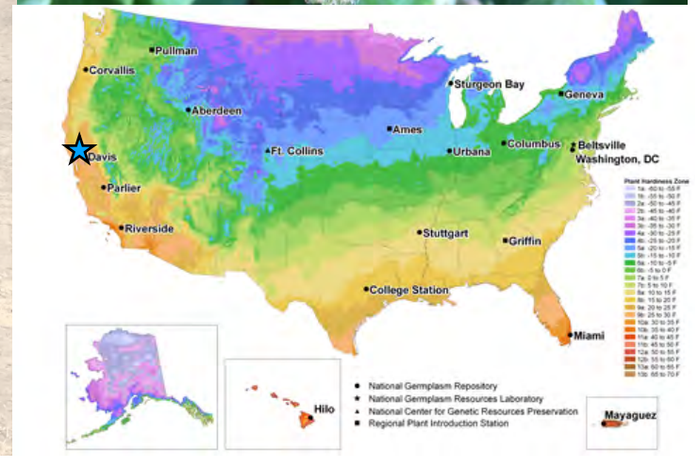


Wolfskill Experimental Orchards — Winters, CA

Donated to the University of California in1934 by the Wolfskill family, and currently managed and maintained by the UC and USDA

Contains the largest collection of grapevine cultivars in North America (~3,000 accessions)

Contains the largest known collection of wild grapevine (*Vitis*) in the world (~ 30 spp.)

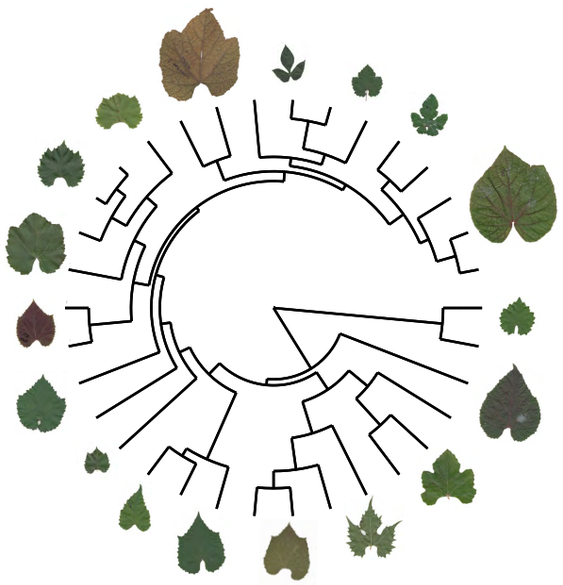


"It is quickly apparent to any practical vineyardist, that the chief material structure of American Viticulture must necessarily be, —

The Native Grapes of America.

Without these we cannot secure adaptability, endurance and resistance to disease."

T.V. Munson, 1908, ***Foundations of American Grape Culture***



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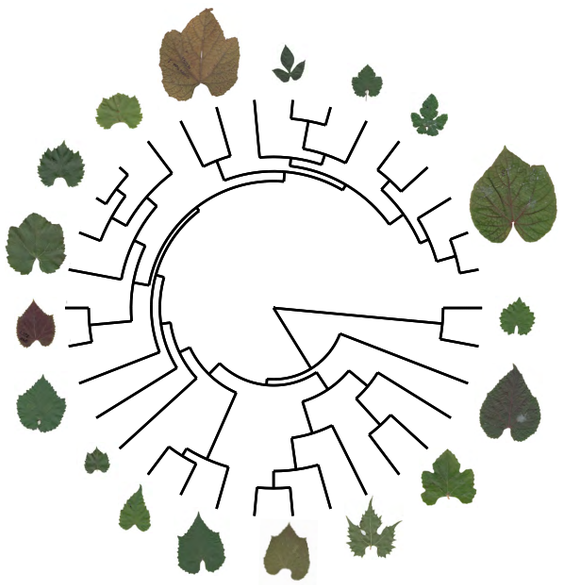

To adapt to climate change, we need to study the diversity present within grapevines.

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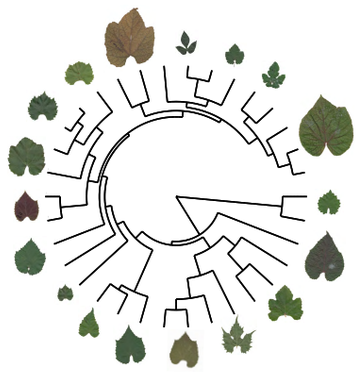

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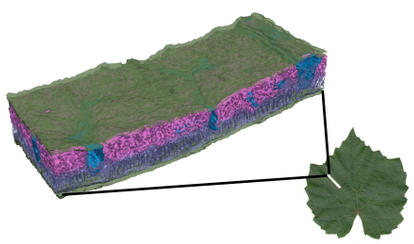


Vitis

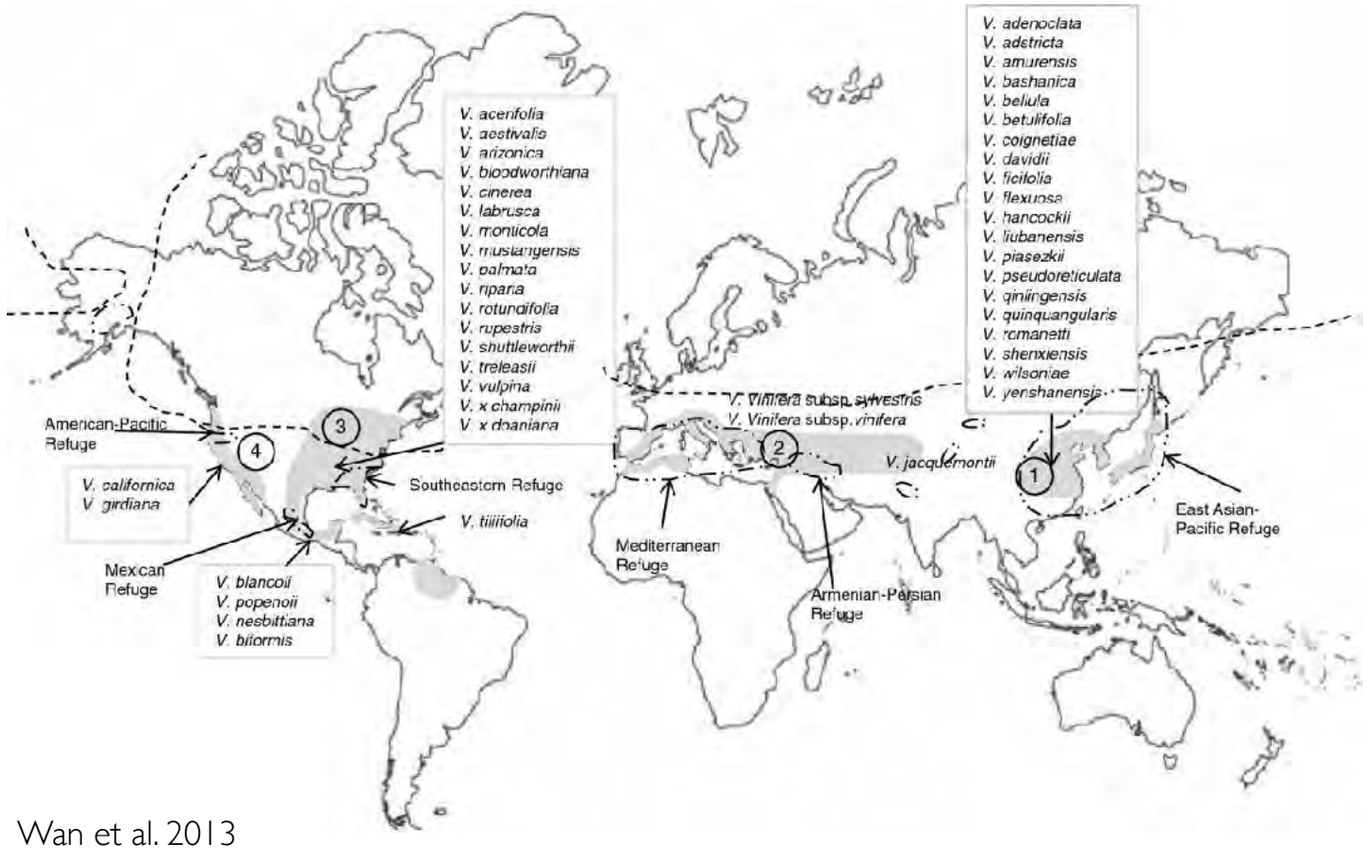
~ 60 species

Primarily Northern hemisphere and temperate climate

Vitis riparia

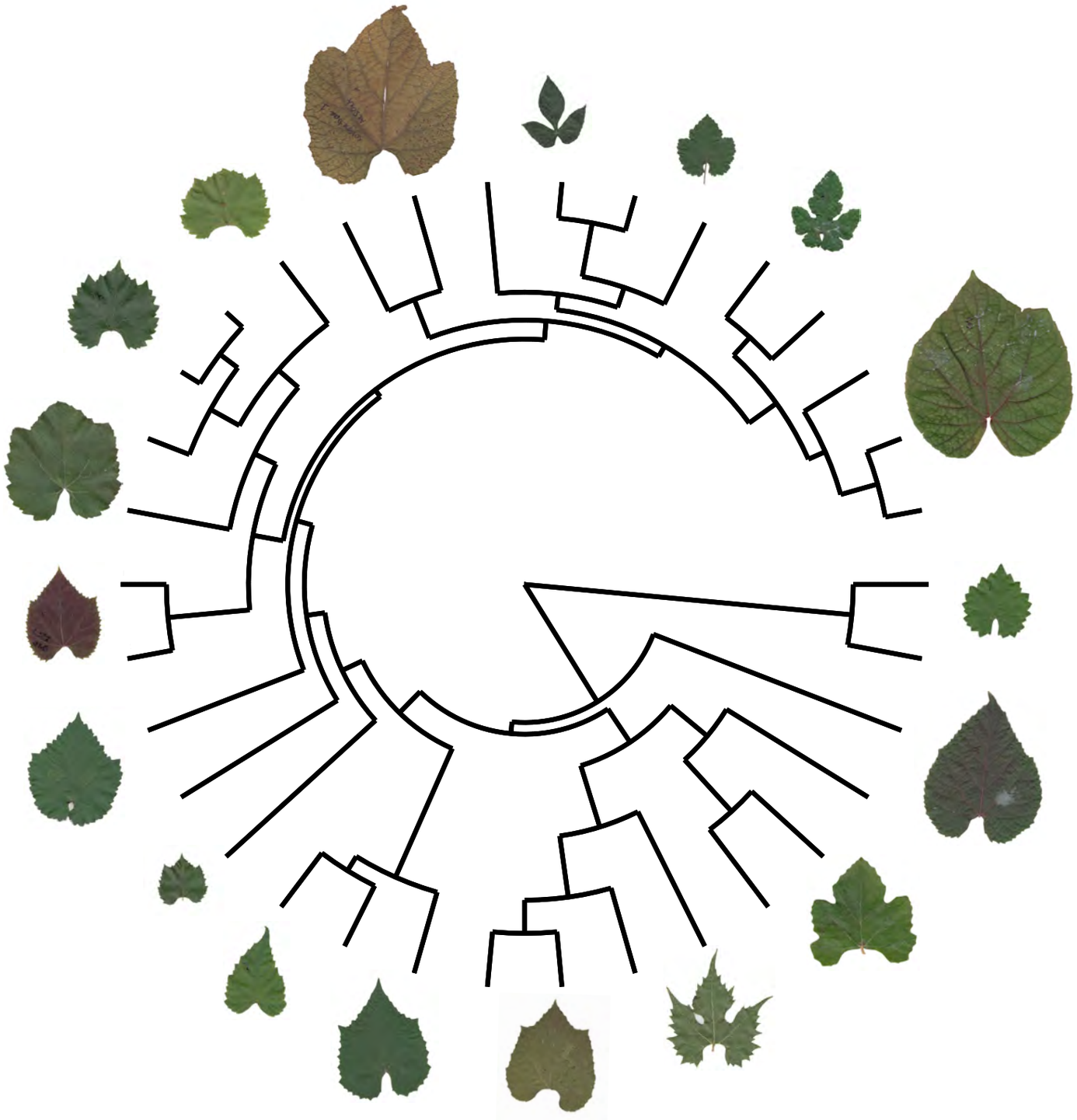
Vitis rupestris

Vitis vinifera subsp *sylvestris*



Wan et al. 2013

Vitis vinifera subsp *vinifera*

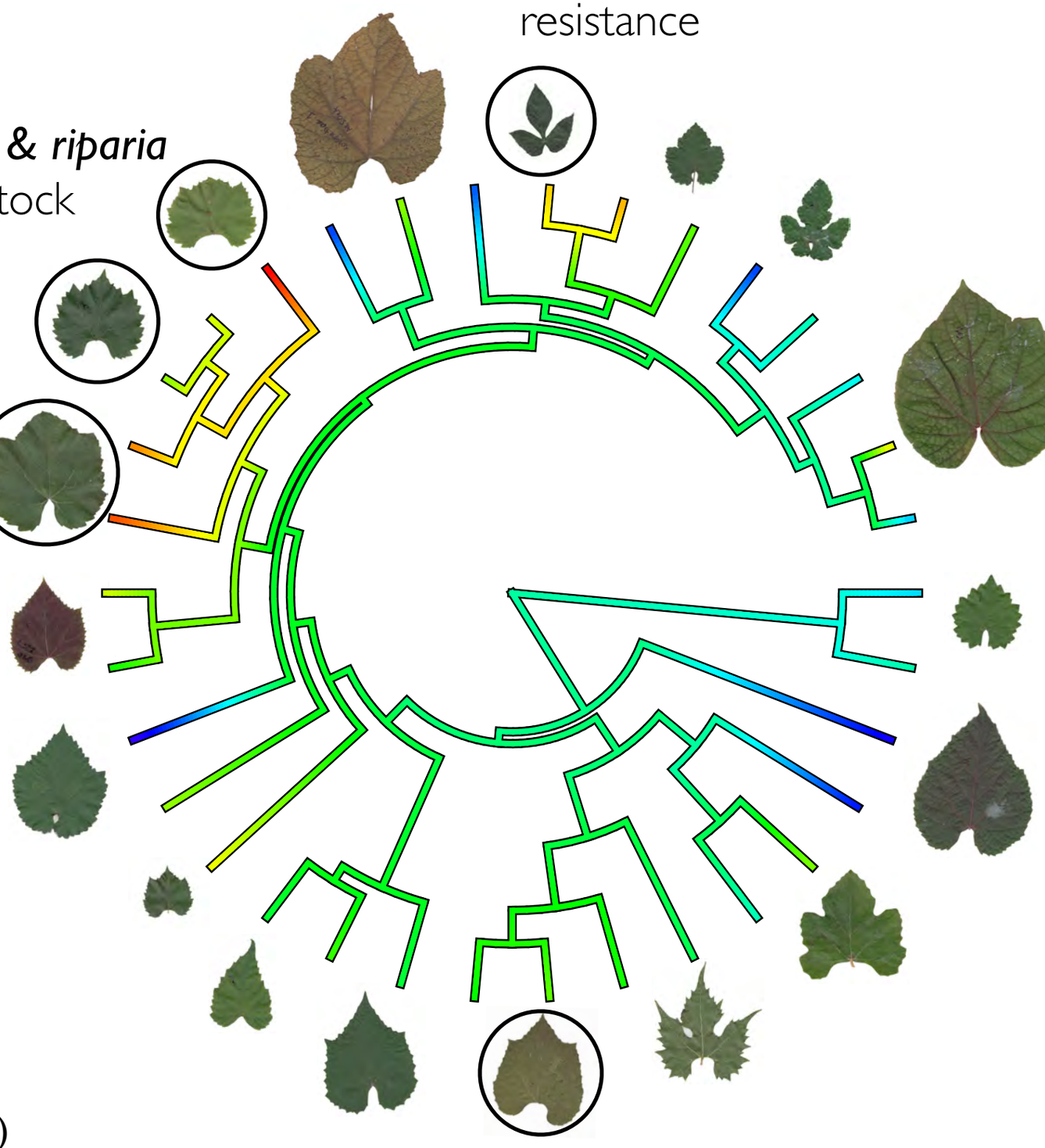



350
1800
Mean Annual Precipitation (mm)

V. piasezkii
powdery mildew
resistance

V. rupestris & riparia
rootstock

V. arizonica
Pierce's disease
resistance



Mean Annual Precipitation (mm)

350 1800

V. berlandieri
rootstock

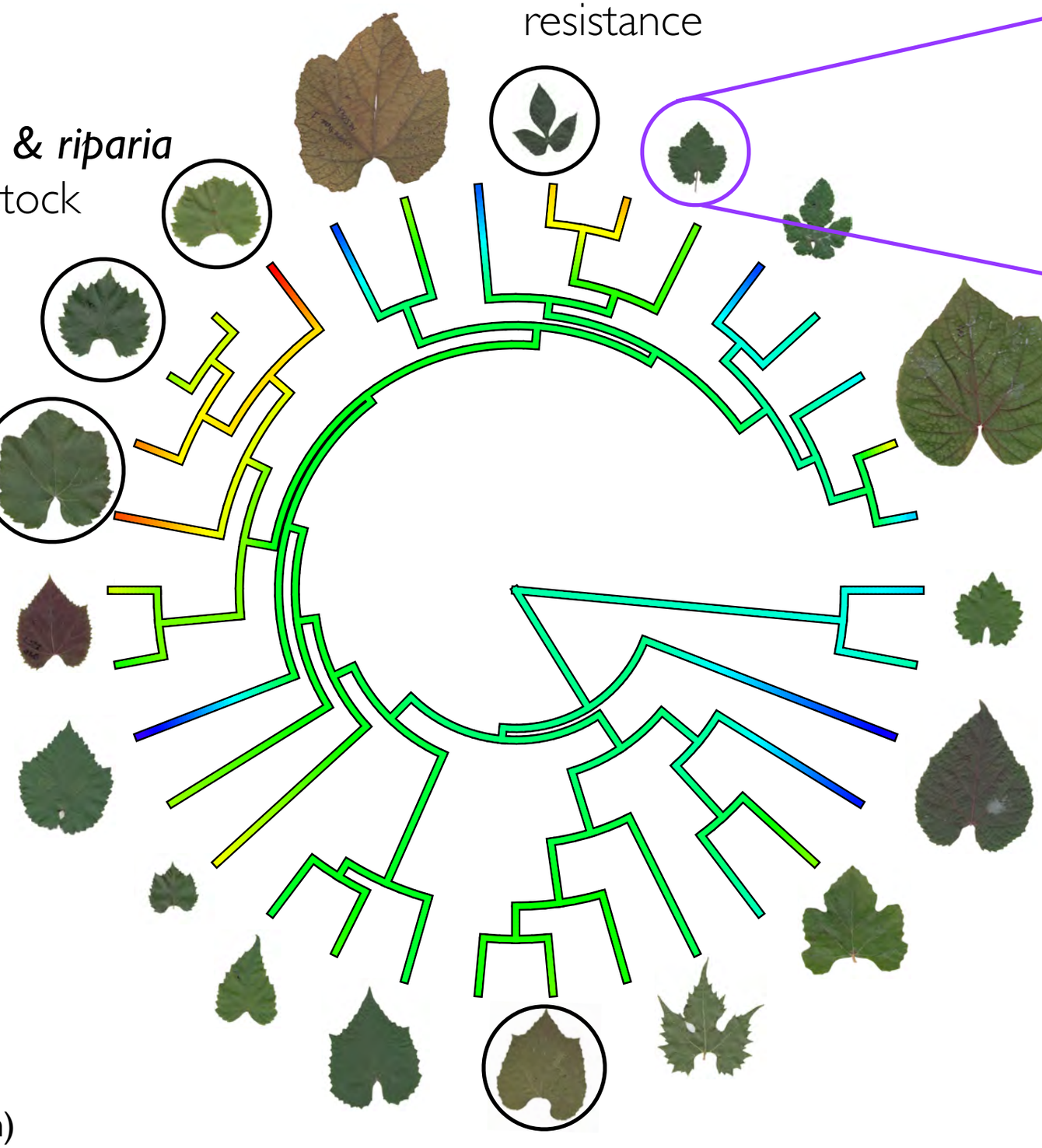
V. piasezkii
powdery mildew
resistance

V. vinifera sups. *vinifera*

5-8,000 cultivars of
table and wine grapes

V. rupestris & *riparia*
rootstock

V. arizonica
Pierce's disease
resistance

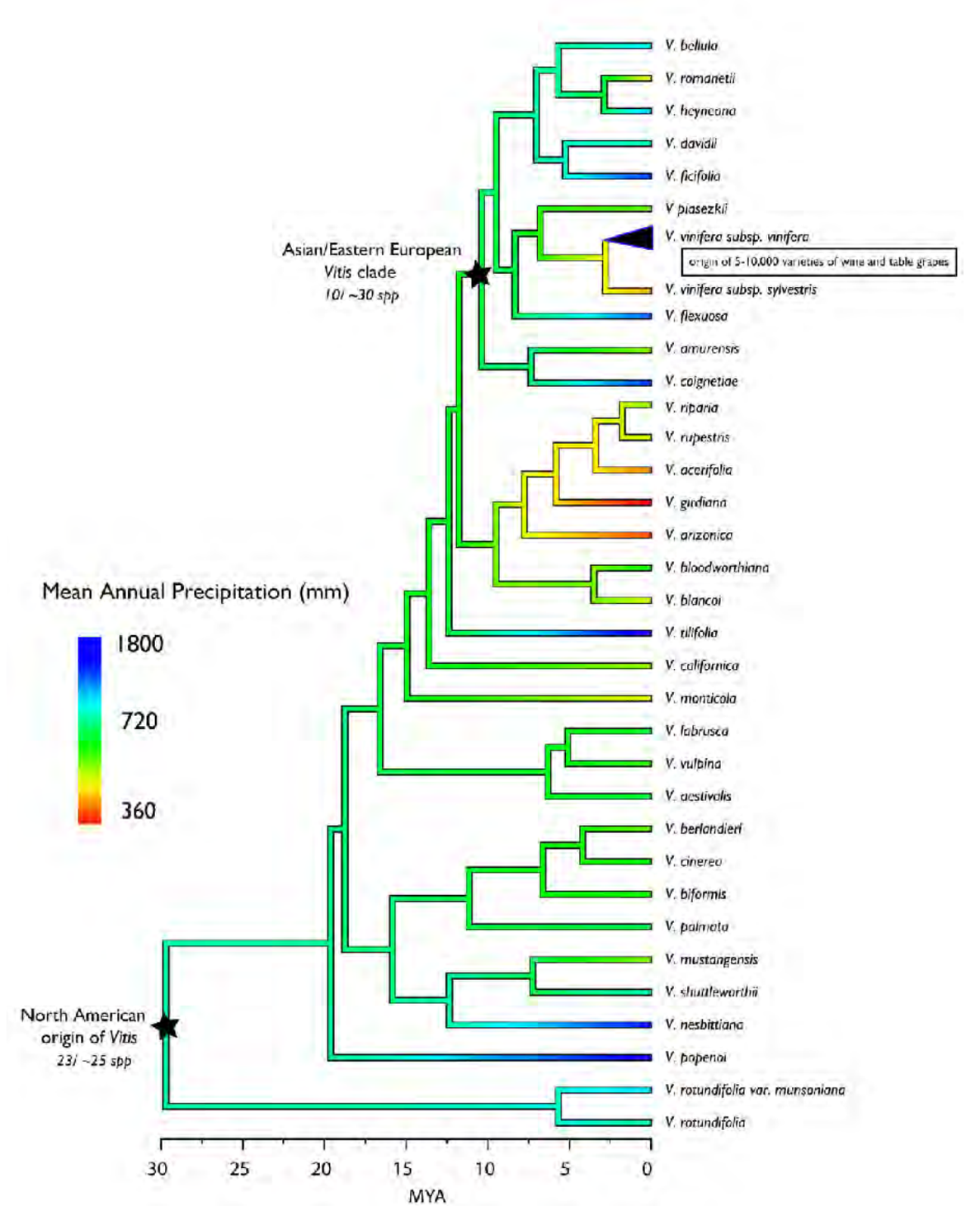


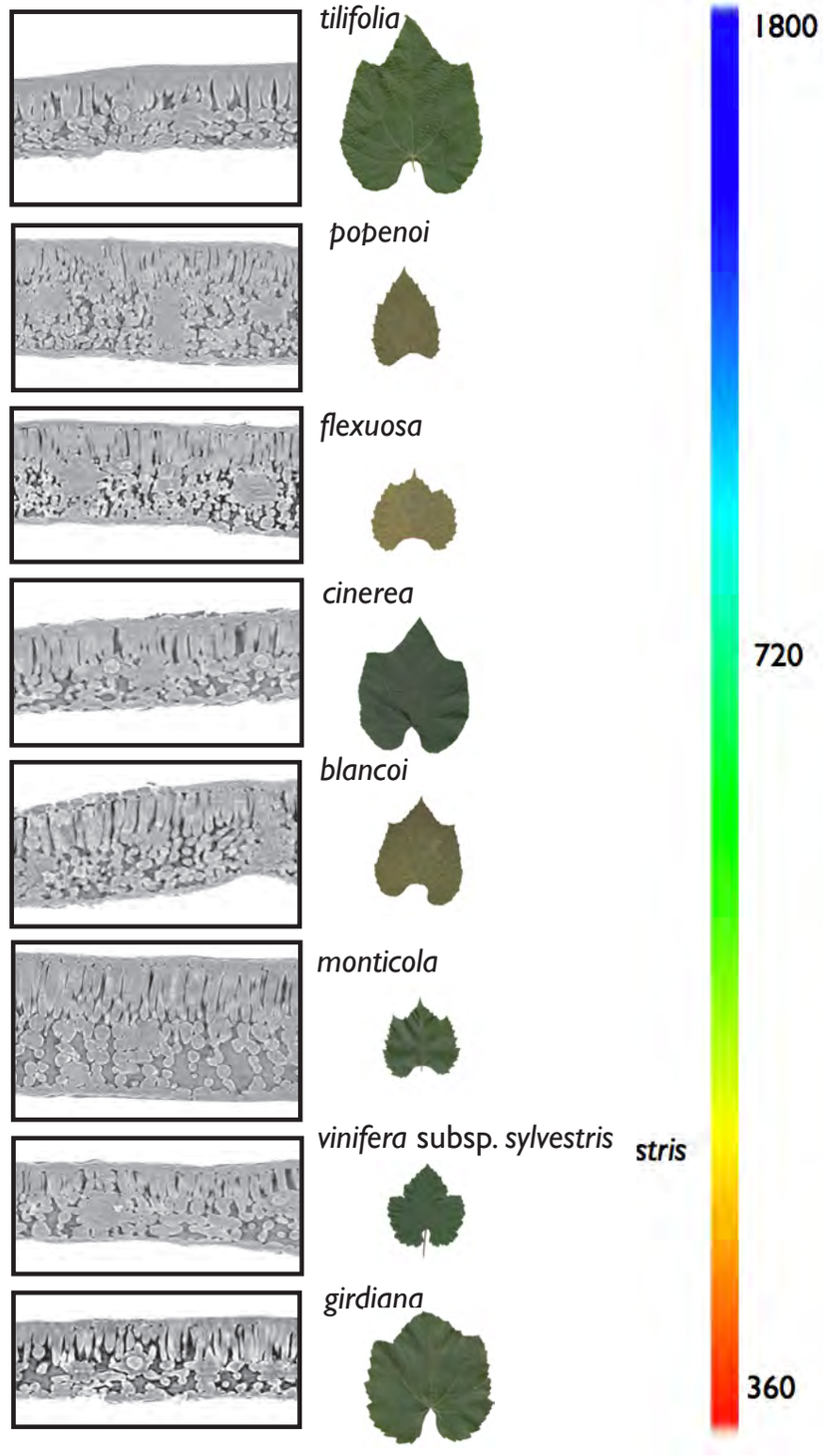
V. berlandieri
rootstock

Mean Annual Precipitation (mm)

350 1800

Climatic drivers of leaf trait evolution in grapevine





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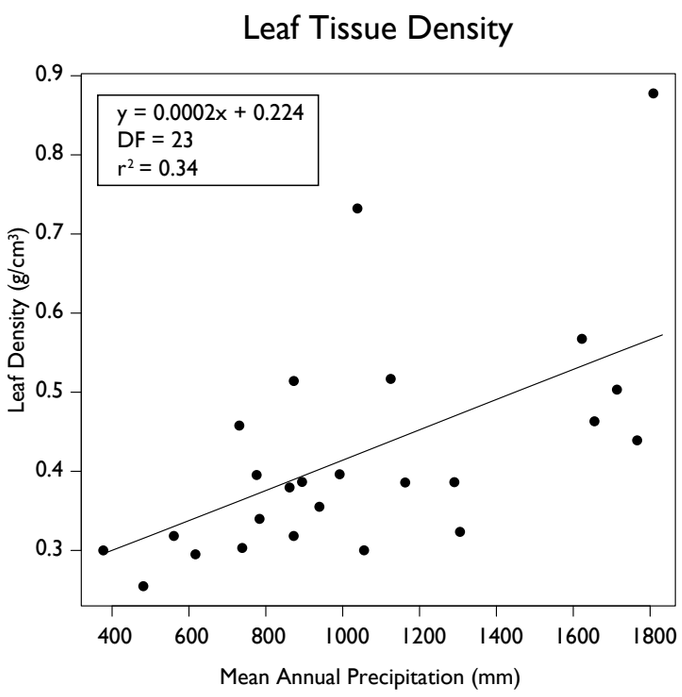
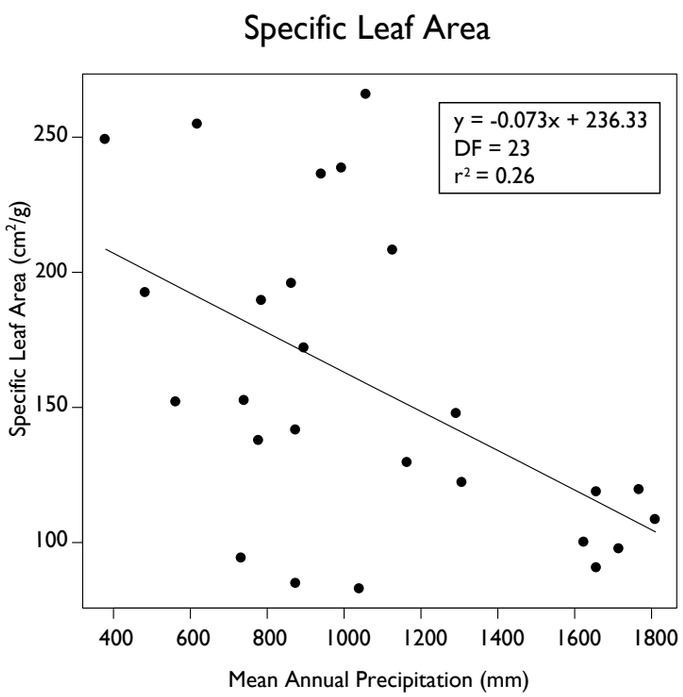
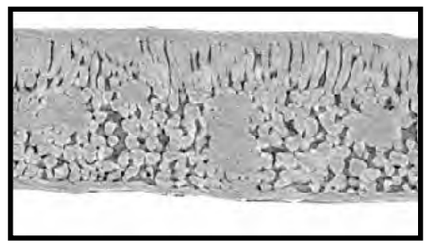
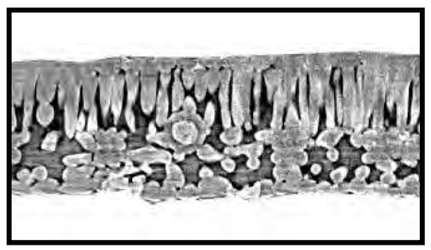


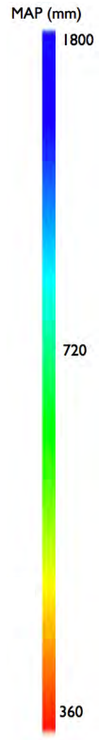


V. popenoi



V. girdiana

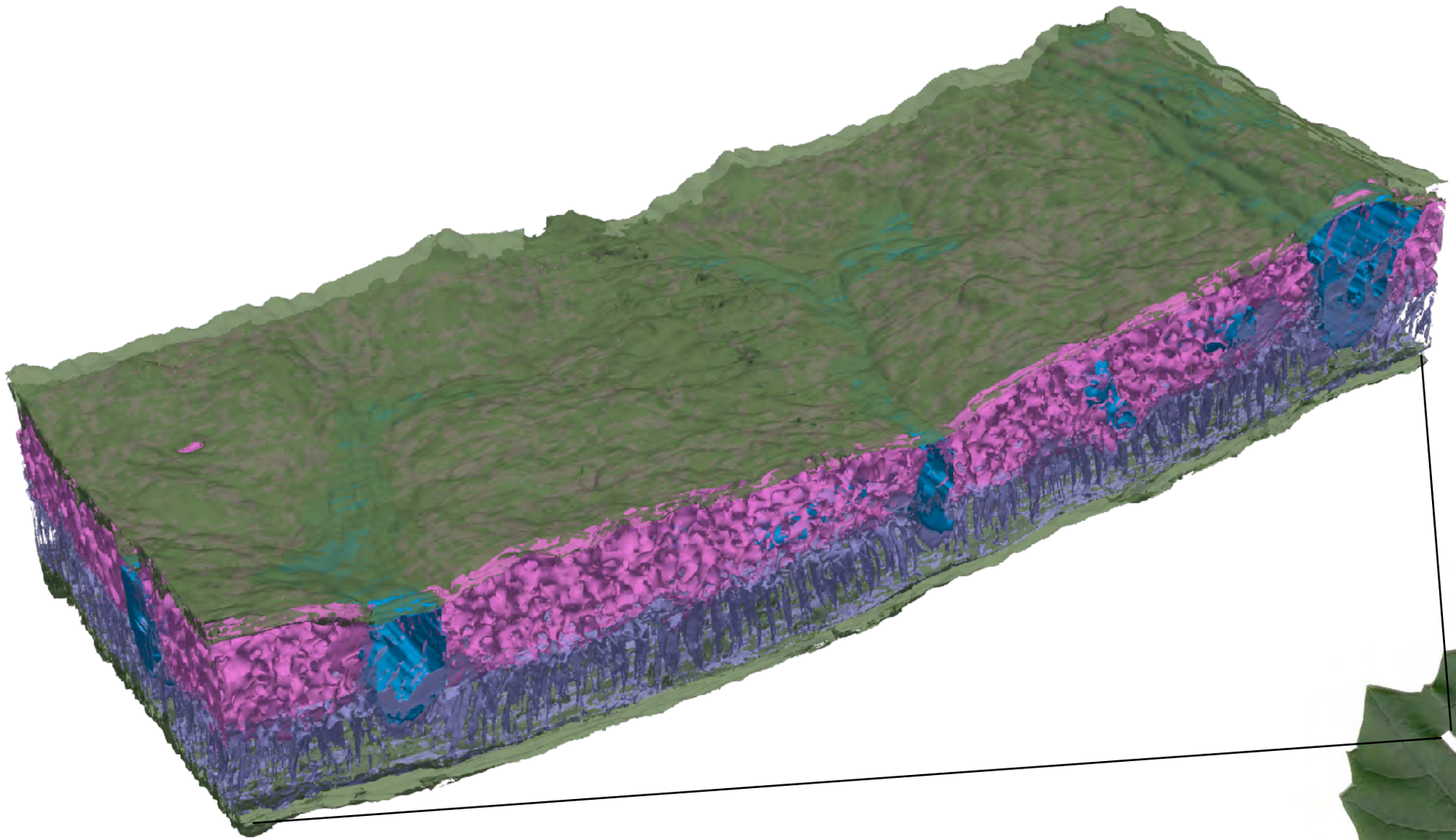




ALS
ADVANCED LIGHT SOURCE

Utilizing X-ray microtomography to generate 2 & 3-dimensional data on leaf anatomy and morphology

Generating public databases of 3D leaf traits



Vitis champinii

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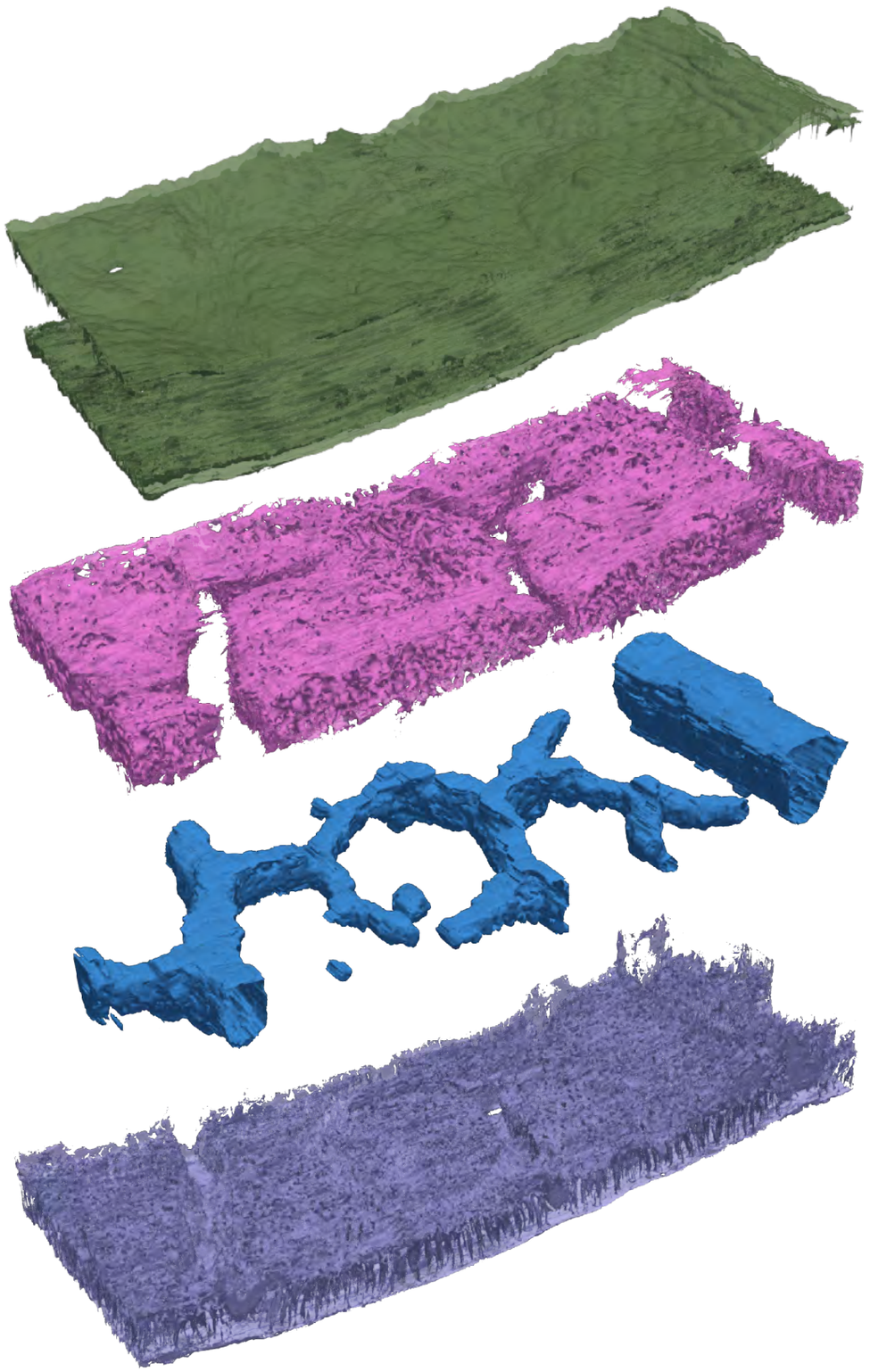


Epidermis
(Abaxial surface with stomata)

Spongy mesophyll

Veins

Palisade Mesophyll

Link structural and anatomical changes to plant physiological function and environmental responses

- Mesophyll surface area
- Air space and tissue volume
- Minor vein lengths
- Distance from stomata to nearest mesophyll surface
- Porosity of different tissues

Vitis champinii

Greenhouse & Field Studies: physiological & molecular basis of drought tolerance

Greenhouse & Field Studies Experimental Setup

Field Experimental Setup

- 38 species & varieties
- 12 replicates, randomized block design with irrigation
- Planting May of 2018
- Drought treatments planned for 2019

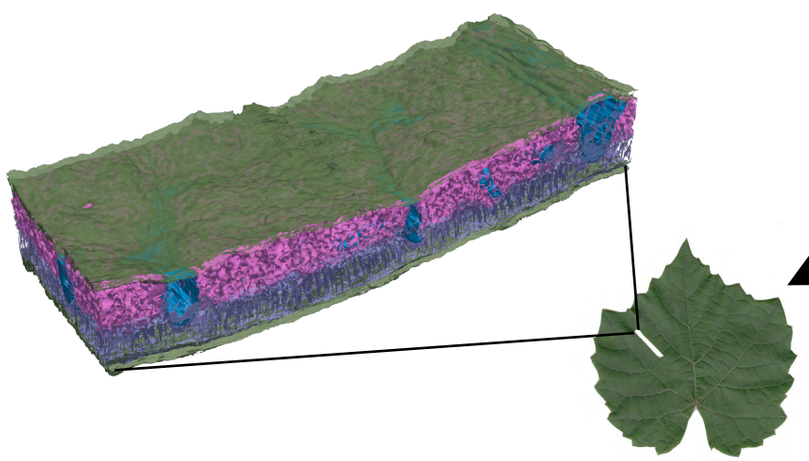
Greenhouse Experimental Setup

- 150 genotypes, including 45 species & varieties
- Dry-down experiment on subset of genotypes(n=4-5 per accession used)
- Root, shoot & leaf tissue collected for gene expression analysis

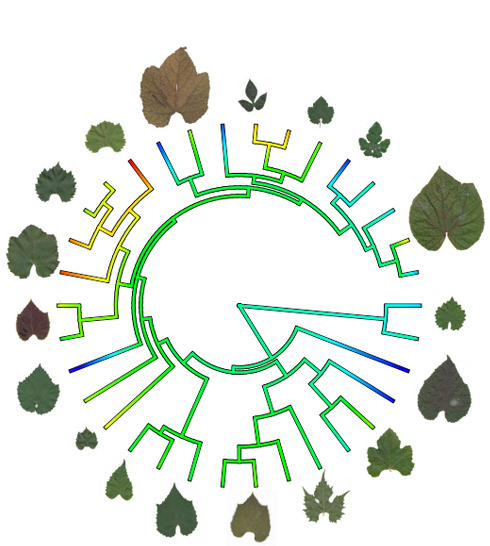
Are there consistent physiological strategies or tradeoffs across *Vitis* in response to drought & extreme heat?

Integrating germplasm collections with trait databases

Germplasm Collections



Public Trait Databases



Ecological & Evolutionary Studies

Acknowledgments

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Thank you for your attention!

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