Breeding for Drought Tolerance

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- CDFA NT, FT, GV Improvement Advisory Board
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- CDFA PD/GWSS Board
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Rootstock Origin

- First developed to address grape phylloxera in the late 1800s
- The French came to the US to collect species resistant to phylloxera
- Took back cuttings of most of the US species, but only *V. riparia* and *V. rupestris* rooted well from dormant cuttings

V. riparia

Missouri River

V. rupestris

Wichita Refuge, OK

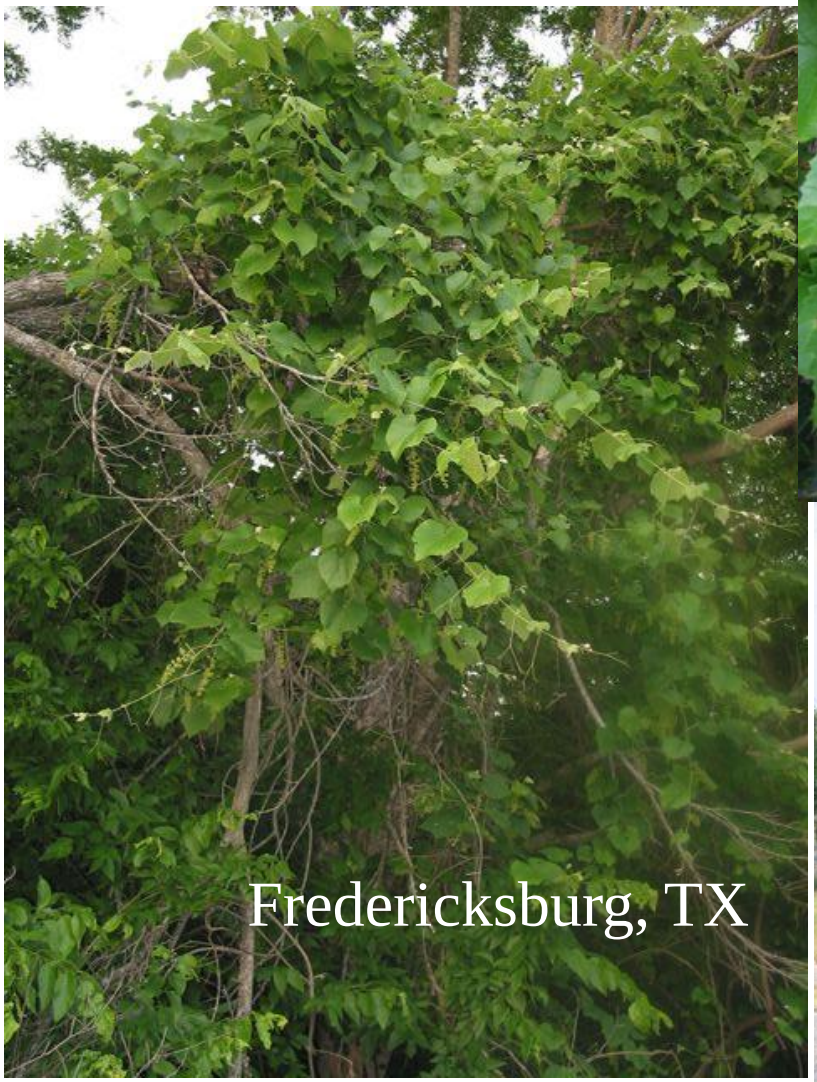
Rootstock Origin

- Vineyards grafted on these species grew well initially, but on limestone-based soils they began to decline
- Un-grafted plants of these species thrive on lime-based soils, but scions grafted on them do not take up enough iron (Fe)

Rootstock Origin

- So the French came back to the US and with the assistance of T.V. Munson they collected *Vitis* species from the limestone plateau of central Texas
- *V. berlandieri* was the best of these and it was hybridized with *V. riparia* and *V. rupestris* in Europe to produce easy to propagate and lime tolerant hybrids

V. berlandieri



Rootstock Origin

- A few other species were used for breeding rootstocks with adaptation to coarse textured soils and limited rainfall… *V. longii* (*V. acerifolia*), *V. candicans*, *V. champinii* and *V. monticola*
- But none propagate as easily as the *V. riparia* and *V. rupestris* based rootstocks

History of rootstock use in California

- *vinifera* moved up from Mexico in the 1700s
- In the Gold Rush era *vinifera* came from Europe and eastern US, and American hybrids from eastern US
- Phylloxera came from the eastern US and Europe

History of rootstock use in California

- Rootstock trials by 1890s with European rootstocks
- Tested for adaptation to a large array of sites and ability to produce vigorous vines with good crops

History of rootstock use in California

- Most vineyards were dry-farmed or had limited irrigation
- *vinifera* x *rupestris* rootstocks thrived on most sites – AXR#1, 1202C, 93-5C
- St. George did well too
- *berlandieri* x *rupestris* (110R, 99R, 140Ru) were often strong, but may have been compromised by virus

Rootstocks in 2010

- About 20 available, but 101-14Mgt and 1103P predominate
- Close spacing trend continues – 420A, 3309C, Riparia Gloire, 1616C
- Interest in drought adaptation – 110R, 1103P, 420A (?) might be increasing

Current Rootstock Breeding Efforts

- Broader nematode resistance
- Fanleaf tolerance
- Adaptation to drought and salinity
- Easier to propagate *berlandieri* forms/420A – devigoration ?
- And phylloxera, root angles and architecture, vigor control

New Rootstock Summary

	Citrus Nematode	Ring Nematode	Phylloxera Nodosities	Rooting Depth
GRN-1	R	R	HR	D
GRN-2	MS	S	HR	S
GRN-3	R	S	R	M
GRN-4	R	MS	R	M
GRN-5	R	MR	MS	D

All resistant to aggressive strains of root-knot, *X. index*, the combination of those nematodes, and maintain their resistance at 30°C

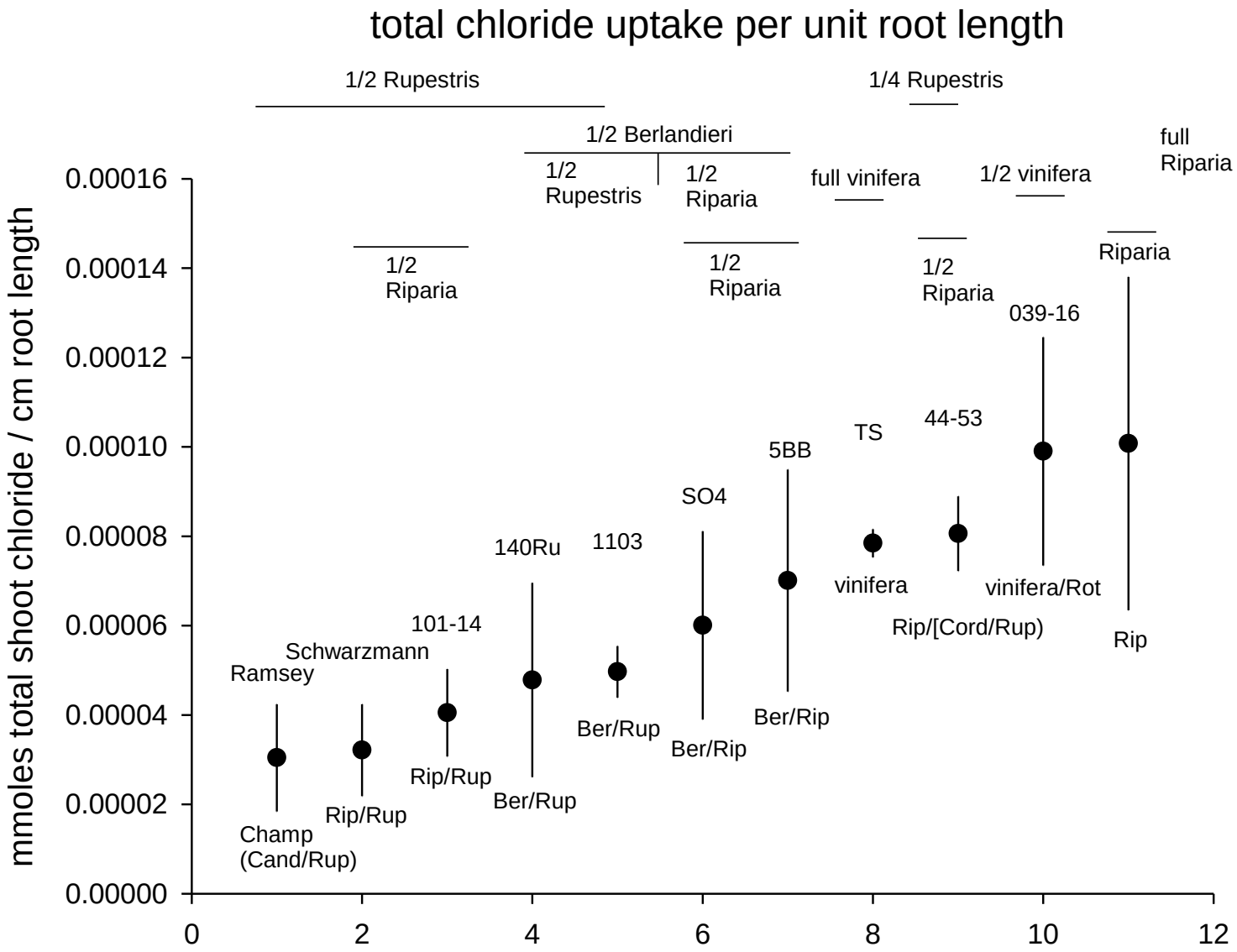
Salt/Drought Tolerance Studies

- Kevin Fort – develop an effective screening system; determine how rootstocks tolerate salt; genetically map salt tolerance
- Determine if salt tolerance and drought tolerance can be uncoupled from root architecture -- do grape roots exclude salts?

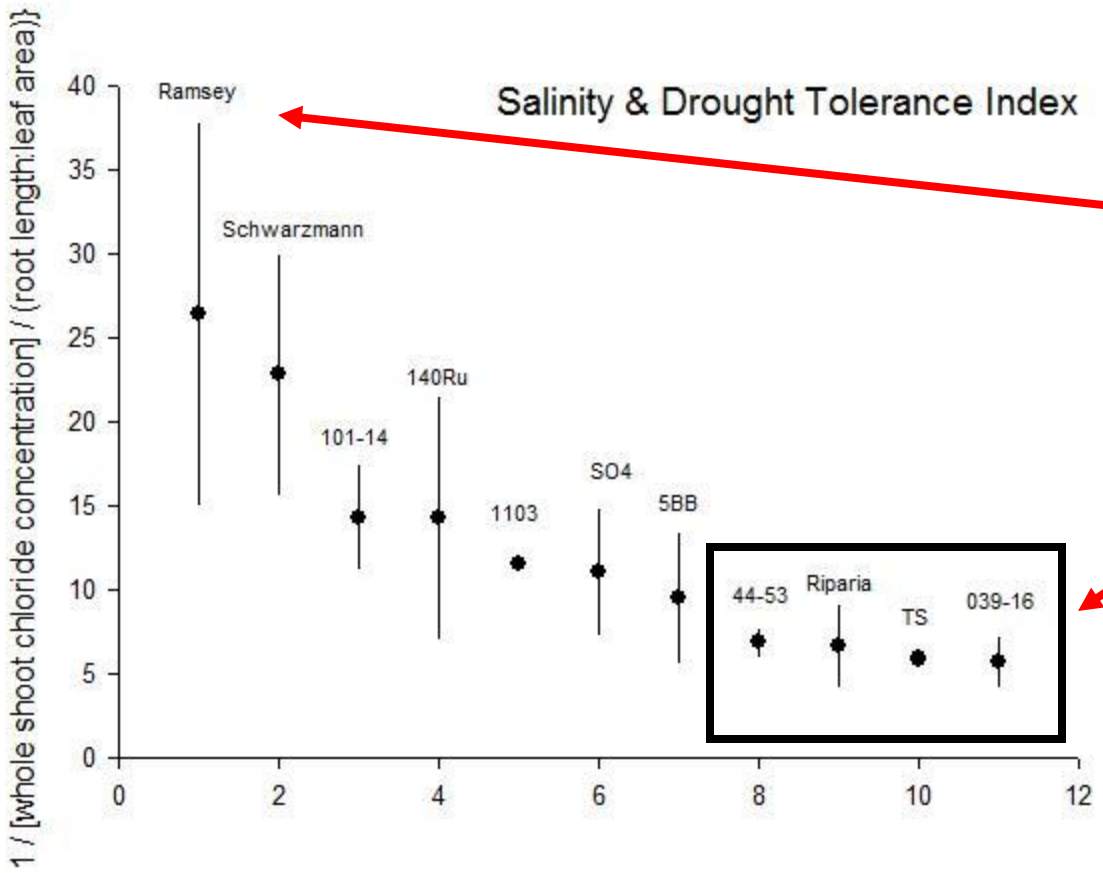
Evaluating Salt Tolerance

- Fritted clay media
- 11 genotypes
- Root biomass, root length

- ***rupestris* and *berlandieri* segregate**
- ***riparia* lacks a comparable exclusion phenotype**



A potential means of measuring and integrating both salt exclusion and drought tolerance



Ramsey rises to the top

Poor performers all sink to the bottom

Why does this assay work better than others?

- Consistent root and shoot development from herbaceous cuttings
- Uneven budbreak and root initiation with dormant cuttings, CHO storage also likely uneven
- Start test with small plants so no need for pruning (which affects root to shoot ratios)
- Short time period for assay – 14 days of salinization – no time for root restrictions
- Very porous media
  – excellent and rapid root growth
  – easy to quantify roots as media cleans off easily

Root architecture

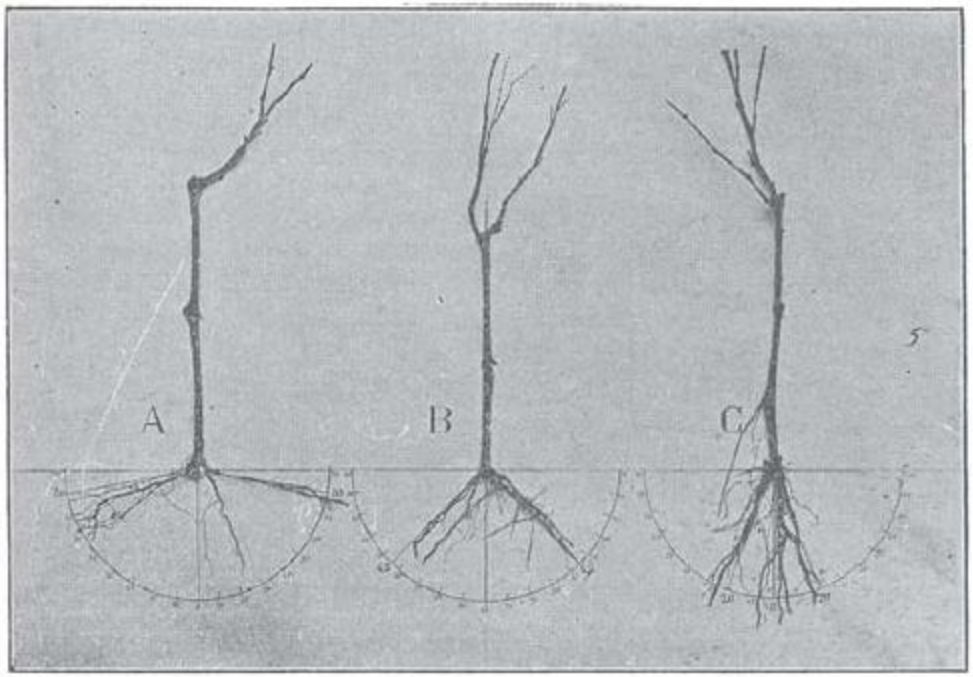
- The root architecture and density of the deep and surface roots relates directly to nutrient and water uptake
- Water is hydraulically lifted from deep in the soil profile to keep the surface roots active
- These characters vary and allow rootstocks to be more or less drought tolerant and impacts their ability to take up nutrients

Root architecture differences

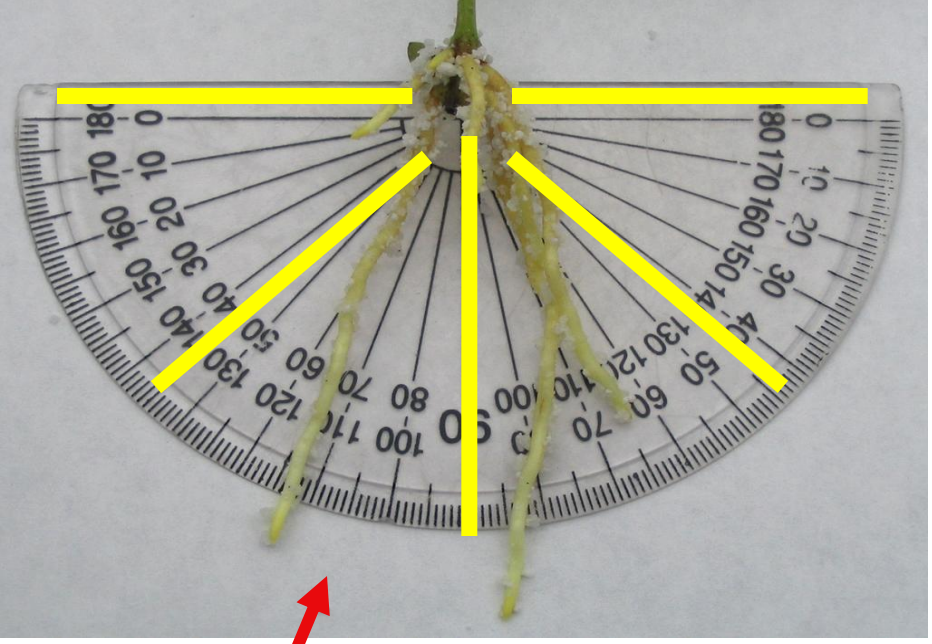
- Mostly deep roots: Ramsey, 140Ru, 1103P, 110R
- Broadly distributed roots: 1103P, Freedom, Harmony, St. George, O39-16, 5BB, 420A Mgt
- Primarily shallow roots: 101-14 Mgt, Schwarzmann, 5C, 16161C

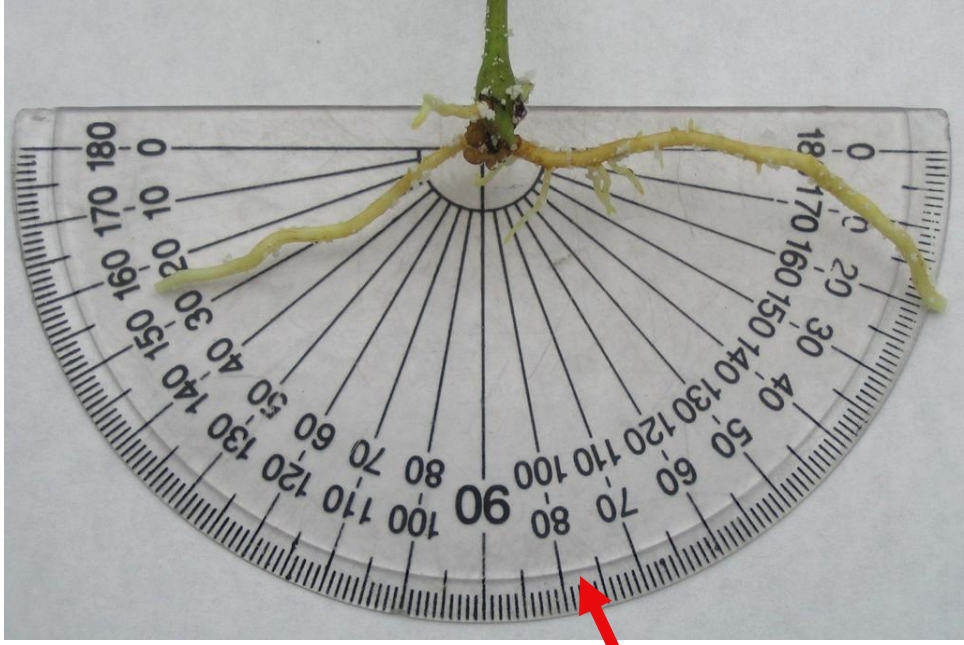
Root angle / Root architecture Assay: Background

V. riparia ***V. riparia x V. rupestris*** ***V. rupestris***



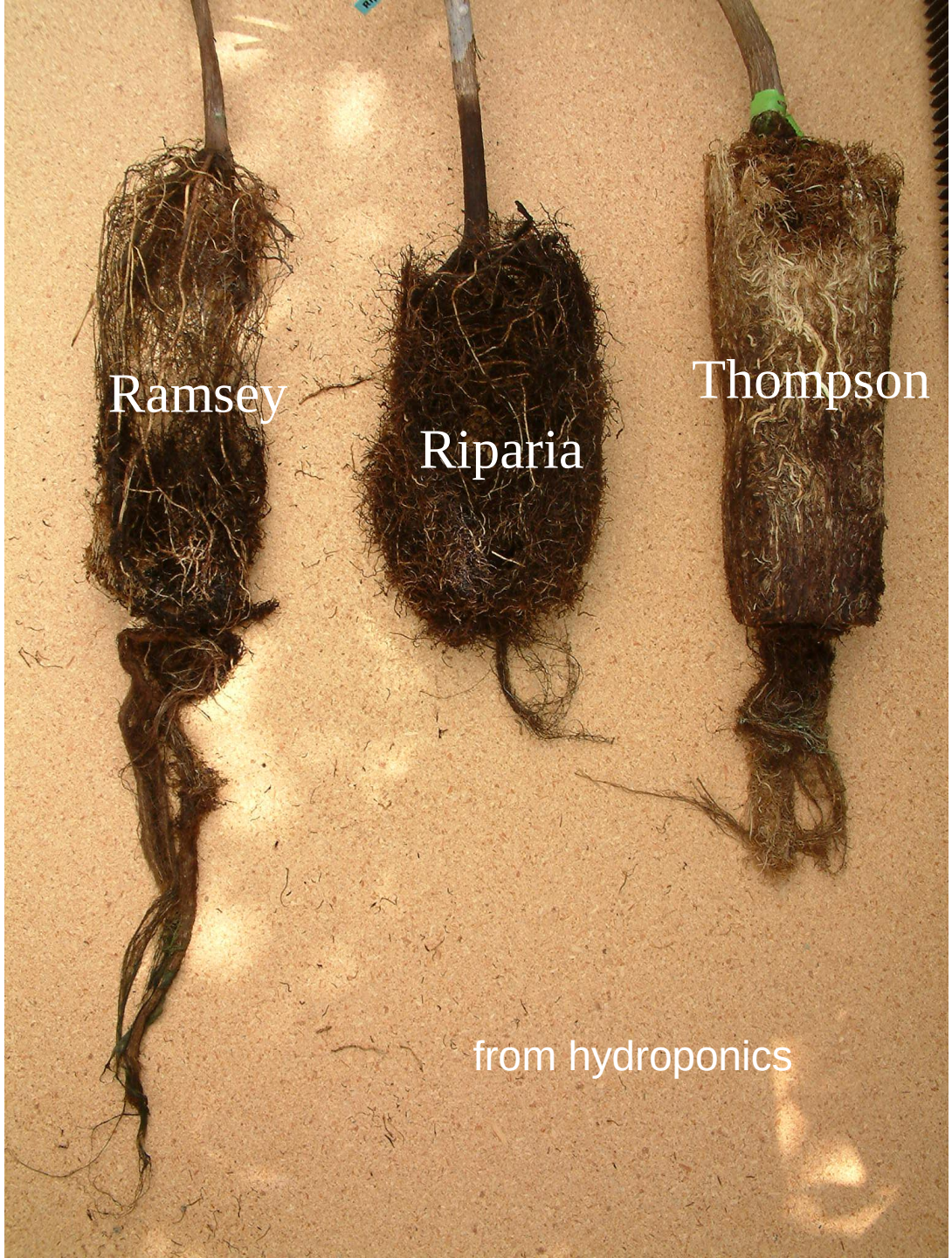
Guillon 1905



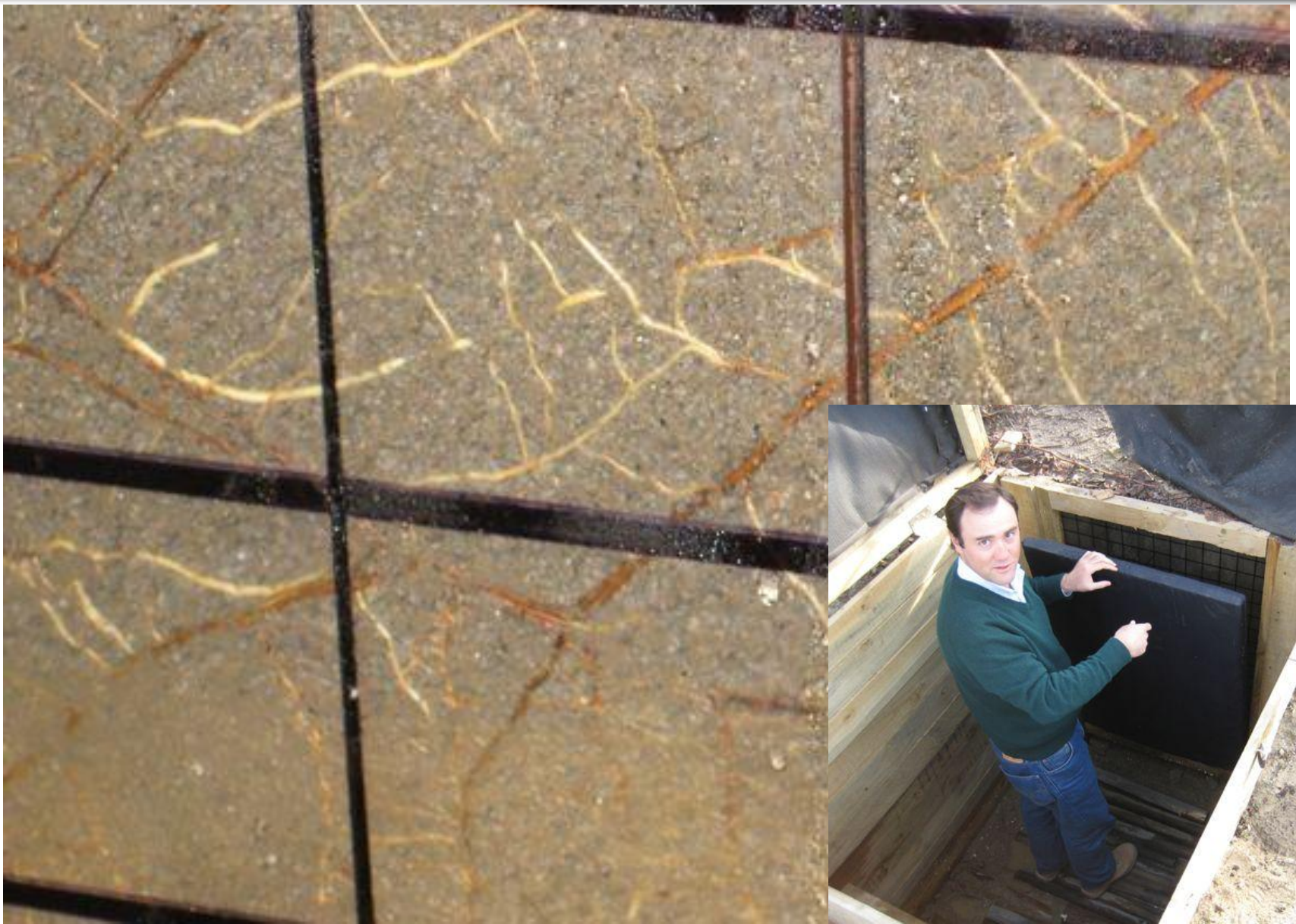


Ramsey

Riparia
Gloire


Ramsey
Riparia
Thompson
from hydroponics

Rhizotron in Winter



V. californica and *V. arizonica*

Salt flat NW of
Las Vegas, NV

Lake Mead, NV

Sustainable Viticulture

- Dry-farming as the true expression of terroir
  - Yield and quality issues
- Reducing water use / needs
- Drought adaptation vs tolerance

V. monticola


Thanks!