Controlling Pierce's Disease with Molecular and Classical Breeding

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BREEDING FOR PD RESISTANCE

- Lenoir (Jacquez, Black Spanish) an accidental cross of *V. aestivalis* x *V. vinifera*; Blanc du Bois wine grape with Cardinal as last vinifera parent
- Many resistant cultivars/selections exit, but often moderate resistance and multigenic control
- We discovered single dominant gene for resistance in *V. arizonica* (b43-17), which has served as the foundation of our PD breeding program

WALKER GRAPE BREEDING PROGRAM

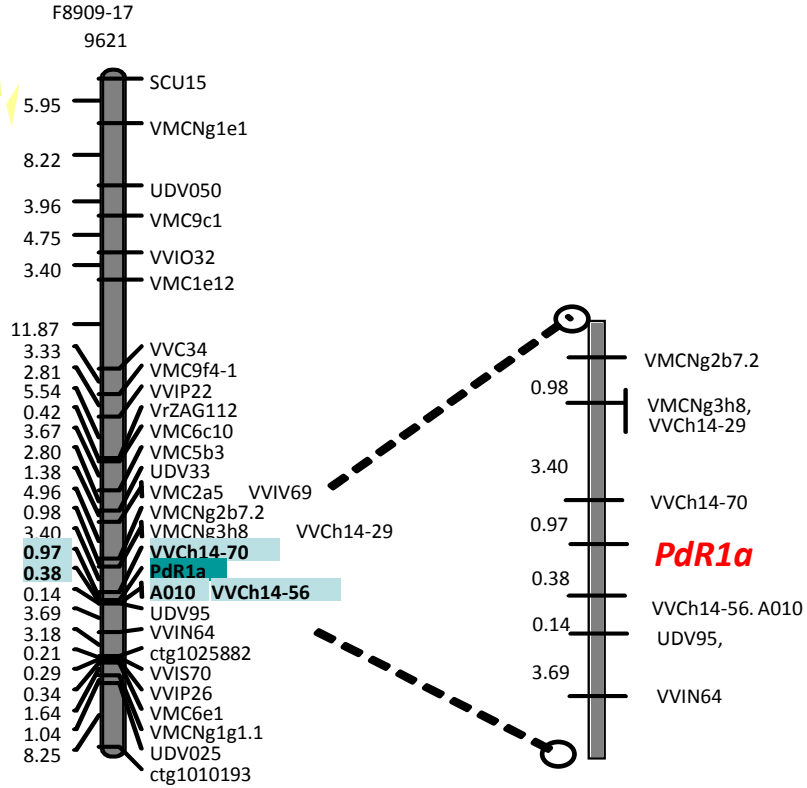
- Olmo gave me seeds from 12 populations of *V. rupestris* x *M. rotundifolia*
- Tested for resistance to phylloxera, dagger nematode, root-knot nematode, PD, but odd segregation ratios
- Plants had small amounts of tomentum on internodes and petioles, and set viable seeds
- Strong resistance, but …

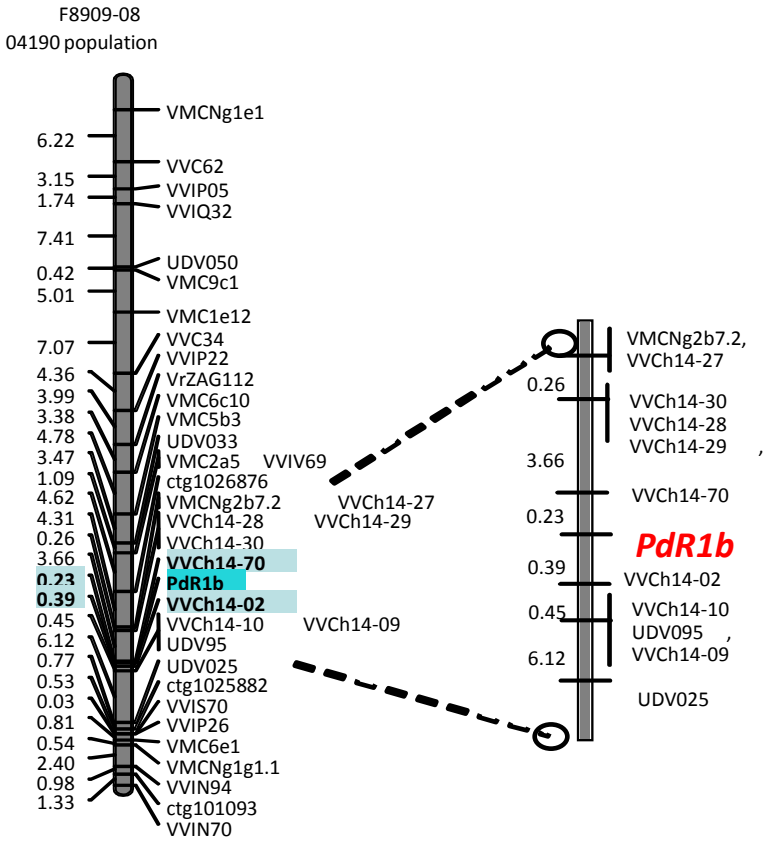
RUPESTRIS X ROTUNDIFOLIA

- 2002 - began mapping these resistances in sibling matings – first with RAPD and AFLP markers and then in 2006 with SSR markers…
- First discovery – they were not *rupestris* x *rotundifolia*!
- Used DNA markers to fingerprint all possible pollen sources – *rupestris* x Mexican *Vitis spp.*
- AJEV (2007) 58:494-498

Mapping and Characterizing PD Resistance – Summaira Riaz

- *V. arizonica*/*candicans* b43-17 has single dominant gene for resistance to PD and it's homozygous
- All progeny from crosses to b43-17 are resistant to PD
- Genetically mapped PD resistance (*PdR1*), to chromosome 14. Linked markers have been used for marker-assisted selection (MAS)





Krivanek et al. 2005. Theor Appl Genet 111:110-119

Riaz et al. 2006. Theor Appl Genet 113:1317-1329

Studying *PdR1* function – Cecilia Agüero

New gene constructs were prepared with grape promoters, and under testing.

MARKER-ASSISTED SELECTION FOR *PDR1*

- DNA extracted from seedlings
- Aggressive growing techniques to get flowers and fruit in year 2
- Two-year cycle with marker-assisted selection (MAS)
- Select for lack of symptoms and very low bacterial levels
- F1 = 50% *vinifera*; BC1 = 75%; BC2 = 88%; BC3 = 94%; BC4 = 97%
- Optimizes classical breeding – not GMOs

BREEDING OBJECTIVES

- Develop large seedling populations at the 97% *vinifera* level in diverse, high quality *vinifera* winegrape backgrounds
- Intercross advanced high quality selections with *Xf* resistance from other resistance sources
- Use and map multigenic resistances *V. arizonica/girdiana* b42-26 and others
- Characterize additional unique resistances to create broadly and durably resistant varieties

PROVEN POTENTIAL OF CLASSICAL BREEDING

F8909-08 to 97% *vinifera* in about 12 yrs

From peppery, herbaceous wines with blue-purple pigments to high quality *vinifera* characters

FIELD TESTING PD RESISTANT SELECTIONS

- Vines inoculated and wines made … 75%, 88%, 94% and 97% *vinifera* along the Napa River have been inoculated multiple times
- Small scale wines have been made since 2010 with Davis and Napa fruit, compared with wine from classic *vinifera* cultivars made at the same small scale
- 88% and 94% in Fredericksburg TX, Auburn AL (88%), and Gainesville, FL (94%).
- 2014 to 2016 – new plots in Temecula, Santa Barbara, Napa (4X)

NAPA *PDR1B* (94% *VINIFERA*) VS PURE *VINIFERA*

09331-047 ALONG THE NAPA RIVER

09338-016

- 62.5% Cab Sauv, 12.5% Carig, 12.5% Chard
- Not yet in large scale field trials
- Late bloom, mid-season ripening
- Small berries, small clusters
- Medium productivity

09314-102

- 62.5% Cab Sauv, 12.5% Carig, 12.5% Chard
- Temecula, Sonoma 75, Silverado
- Early bloom, early ripening
- Small - medium berries, medium large clusters
- High productivity

09331-047

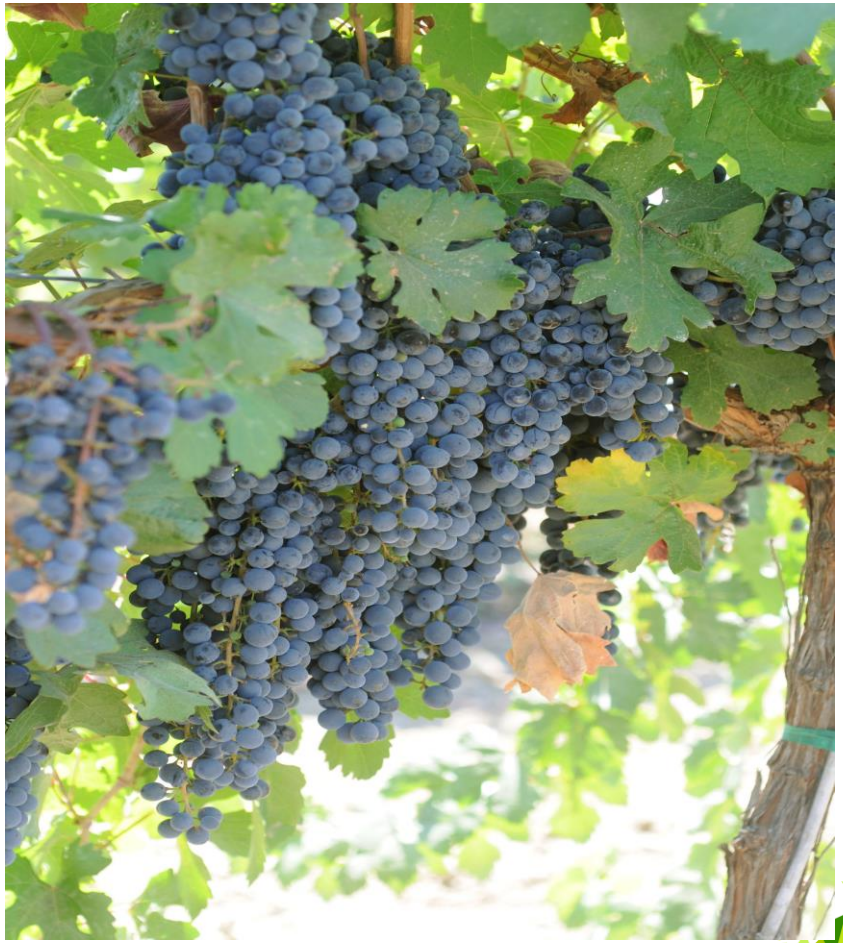
- 50% Zin, 25% Petite Sirah, 12.5% Cab Sauv
- Caymus 1125, Temecula, Silverado
- Late bloom, mid-season ripening
- Relatively large berries, large clusters
- Moderate-low productivity

07355-075

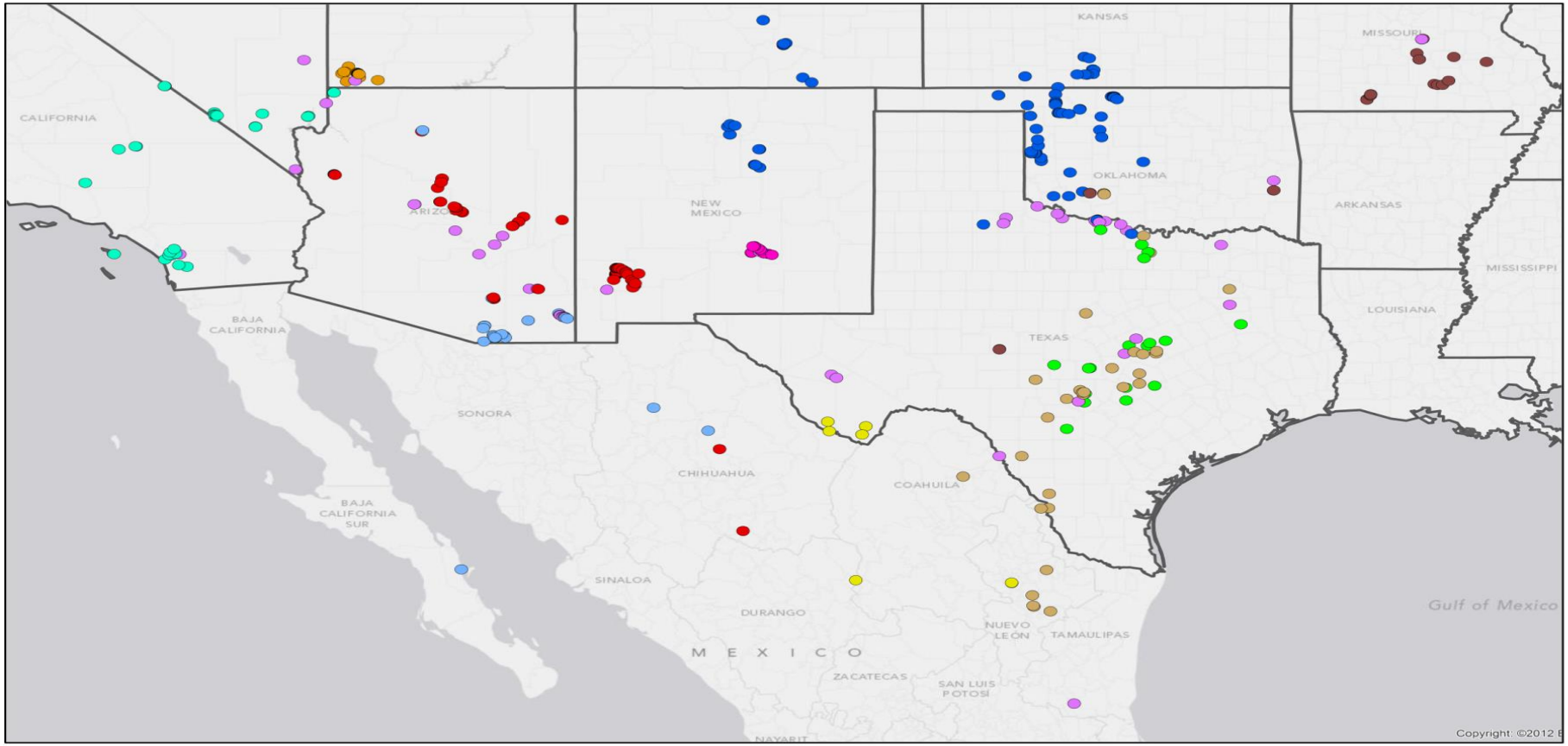
- 50% Petite Sirah, 25% Cab Sauv
- Caymus 375, Sonoma,
- Early bloom, early ripening
- Relatively large berries, medium large clusters
- Medium productivity

09356-235

- 50% Sylvaner, 12.5% Cabernet Sauvignon, Carignane, Chardonnay
- Not yet in large scale field trials
- Mid-season bloom and ripening
- Large berries, loose medium cluster
- High productivity

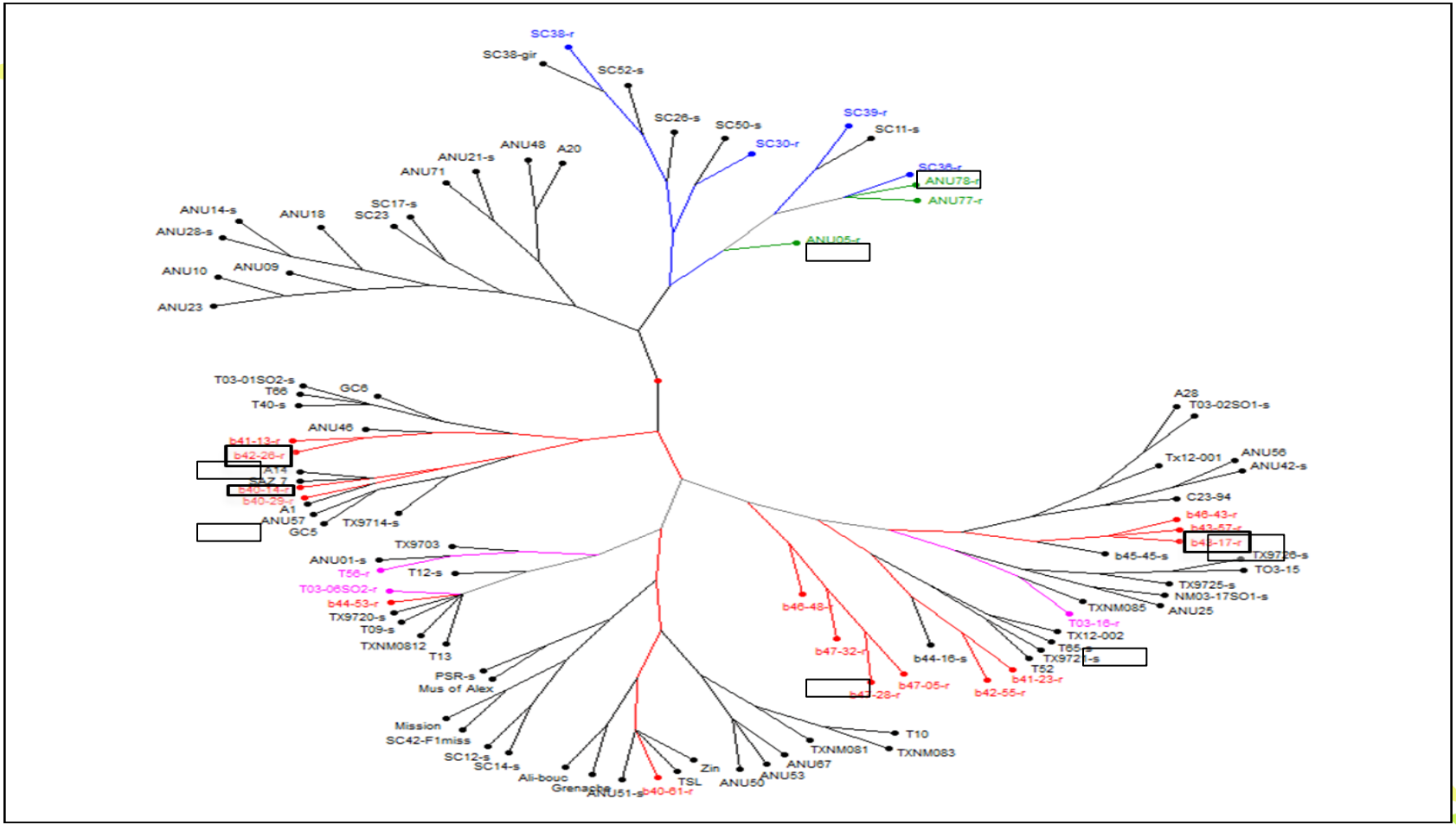


SOUTHWEST *VITIS* GERMPLASM



V. girdiana
V. arizonica
V. berlandieri, V. cinerea
V. mustangensis
V. riparia, V. acerifolia
V. rupestris
Hybrid

Claire Heinitz


SC38-r
SC38-gir
SC52-s
SC26-s
SC50-s
SC30-r
SC39-r
SC11-s
SC36-r
ANU78-r
ANU77-r
ANU05-r
ANU48
A20
ANU21-s
ANU71
SC17-s
SC23
ANU14-s
ANU18
ANU28-s
ANU10
ANU09
ANU23
T03-01SO2-s
T66
T40-s
GC6
ANU46
b41-13-r
b42-26-r
A14
SAZ 7
b40-29-r
A1
ANU57
GC5
TX9714-s
TX9703
ANU01-s
T56-r
T12-s
T03-06SO2-r
b44-53-r
TX9720-s
T09-s
TXNM0812
T13
PSR-s
Mus of Alex
Mission
SC42-F1miss
SC12-s
SC14-s
Ali-bouc
Grenache
ANU51-s
b40-61-r
TSL
Zin
ANU55
ANU53
ANU67
TXNM081
TXNM083
T10
A28
T03-02SO1-s
Tx12-001
ANU56
ANU42-s
C23-94
b46-43-r
b43-57-r
b41-17-r
b45-45-s
TX9726-s
TO3-15
TX9725-s
NM03-17SO1-s
ANU25
TXNM085
T03-16-r
TX12-002
T65
TX9721-s
T52
b41-23-r
b42-55-r
b47-05-r
b47-28-r
b44-16-s
b47-32-r
b46-48-r

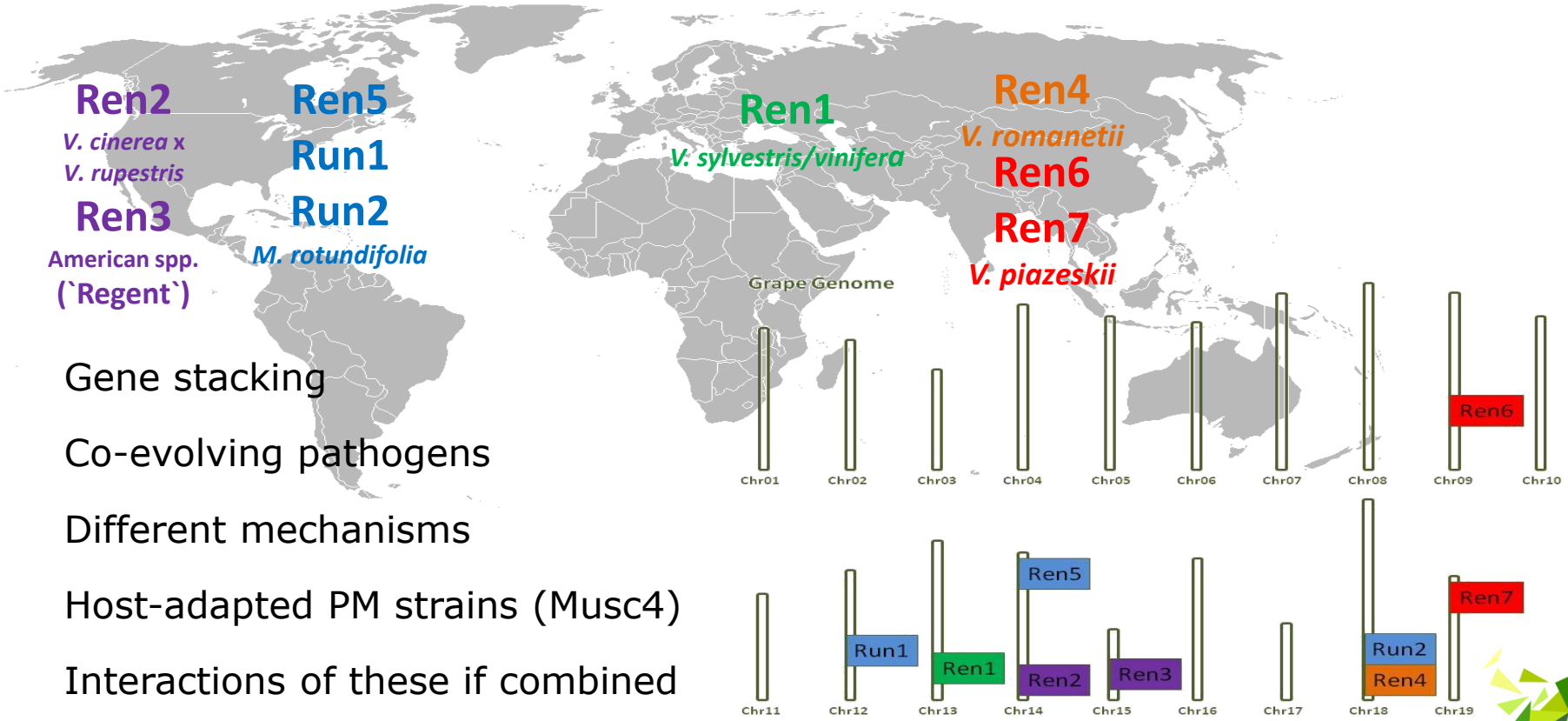
STACKING PD RESISTANCE LINES

- 2006 & 2008 crossed *PdR1a* x *PdR1b* – no decrease in mean Xf levels.
- 2011 crossed 97% *vinifera PdR1b* x 75% *vinifera* b42-26 lines to create 86% *vinifera*
- 2014 crossed 97% *vinifera PdR1b* x 88% *vinifera* b42-26 line to create ~ 92% *vinifera*
- Added *PdR2* b40-14 from Chihuahua *V. arizonica* and many other sources

2017 AND BEYOND

- Broaden the use of *V. vinifera* cultivars – acidity, color, tannins, aromatics, ripening profiles
- Add Powdery Mildew from multiple sources and advanced backcross generations

NEW POWDERY MILDEW RESISTANCE LOCI



- Gene stacking
- Co-evolving pathogens
- Different mechanisms
- Host-adapted PM strains (Musc4)
- Interactions of these if combined


4-36
READY MADE WALL FRAME
THANK YOU!
AIChE