Cornell University

Biology of Redleaf Viruses

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Redleaf?

Potassium

Magnesium

Phosphorous

Nutritional deficiencies

M. Sudarshana, USDA-ARS

Girdling

Girdling

Leafhopper

Mite

Physical & pest damage

Esca

M. Sudarshana, USDA-ARS

Agrobacterium vitis

Pierce's disease

Bacteria & fungi

Syrah decline

Bois noir

Phytoplasmas & unknown condition

Leafroll

Roditis

Red Blotch

Viruses

Leafroll

Red Blotch

Viruses

Biology of Leafroll Viruses

- Etiology
- Ecology
- Impact
- Distribution
- Management


Leafroll disease

V. vinifera cv. Cabernet franc

Leafroll Disease

Leafroll agents are members of the family *Closteroviridae*

Genus	Species	Vector
Closterovirus	GLRaV-2	Unknown
Ampelovirus	GLRaV-1	6 pseudococcid mealybugs, 3 soft scale insects
	GLRaV-3	10 mealybugs, 8 scale insects
	GLRaV-4	3 mealybugs
Velarivirus	GLRaV-7	Unknown

Maliogka et al. (2014); Martelli (2014)

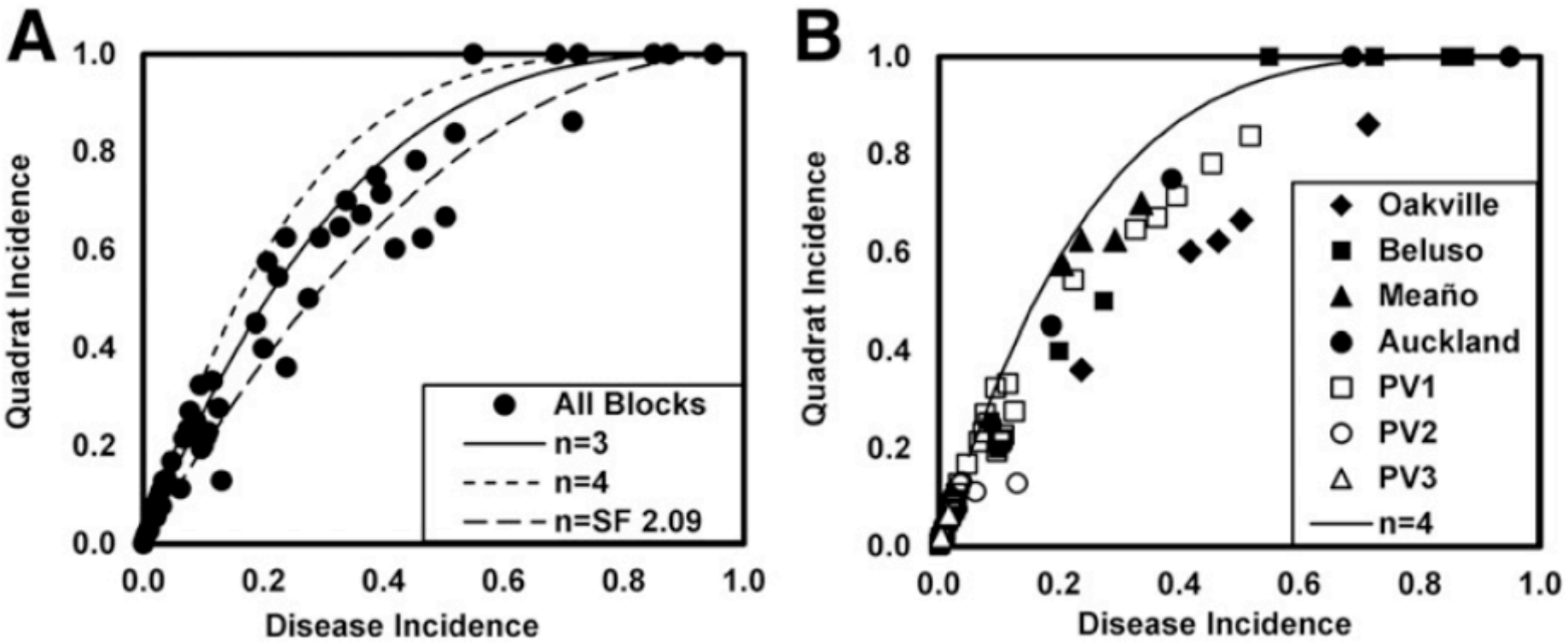
Soft scale (Coccidae)

- *Pulvinaria*
- *Neopulvinaria*
- *Parthenolecanium*
- *Coccus*
- *Saissetia*
- *Parasaissetia*
- and genus *Ceroplastes*

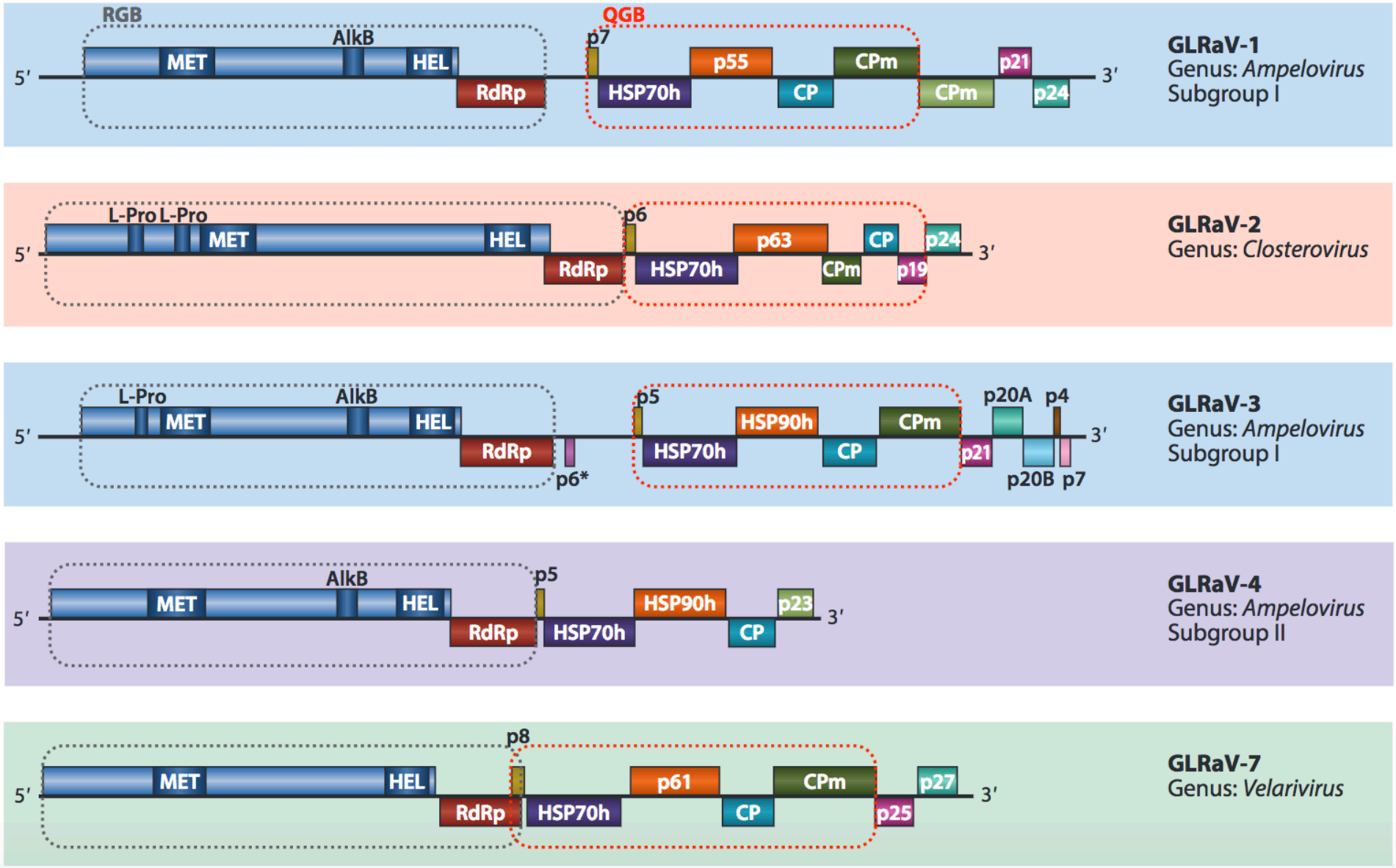
Mealybug (Pseudooccidae)

- *Heliococcus*
- *Phenacoccus*
- *Planococcus*
- *Pseudococcus*

Maliogka et al. (2014)

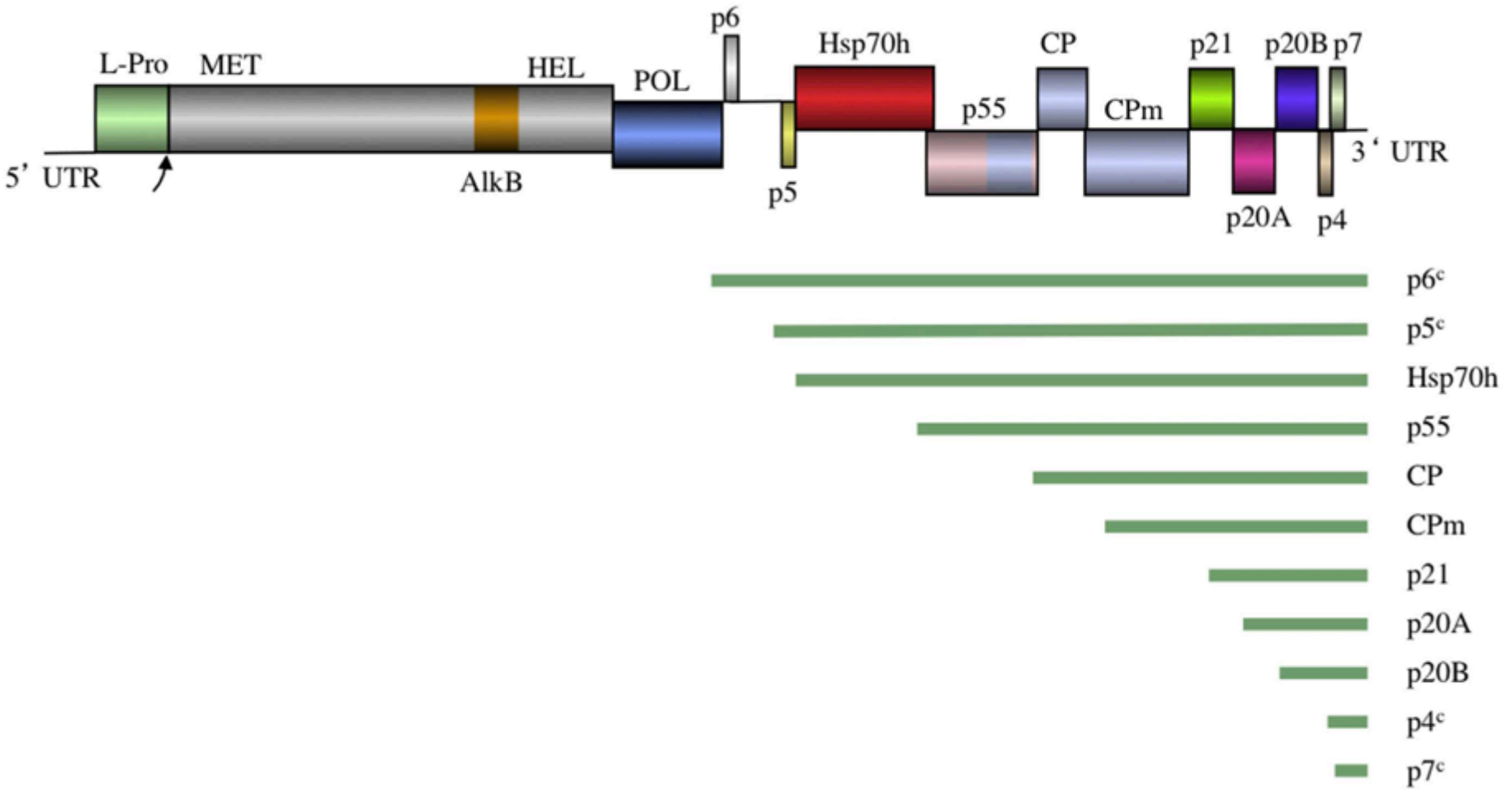


Arnold et al. (2017)

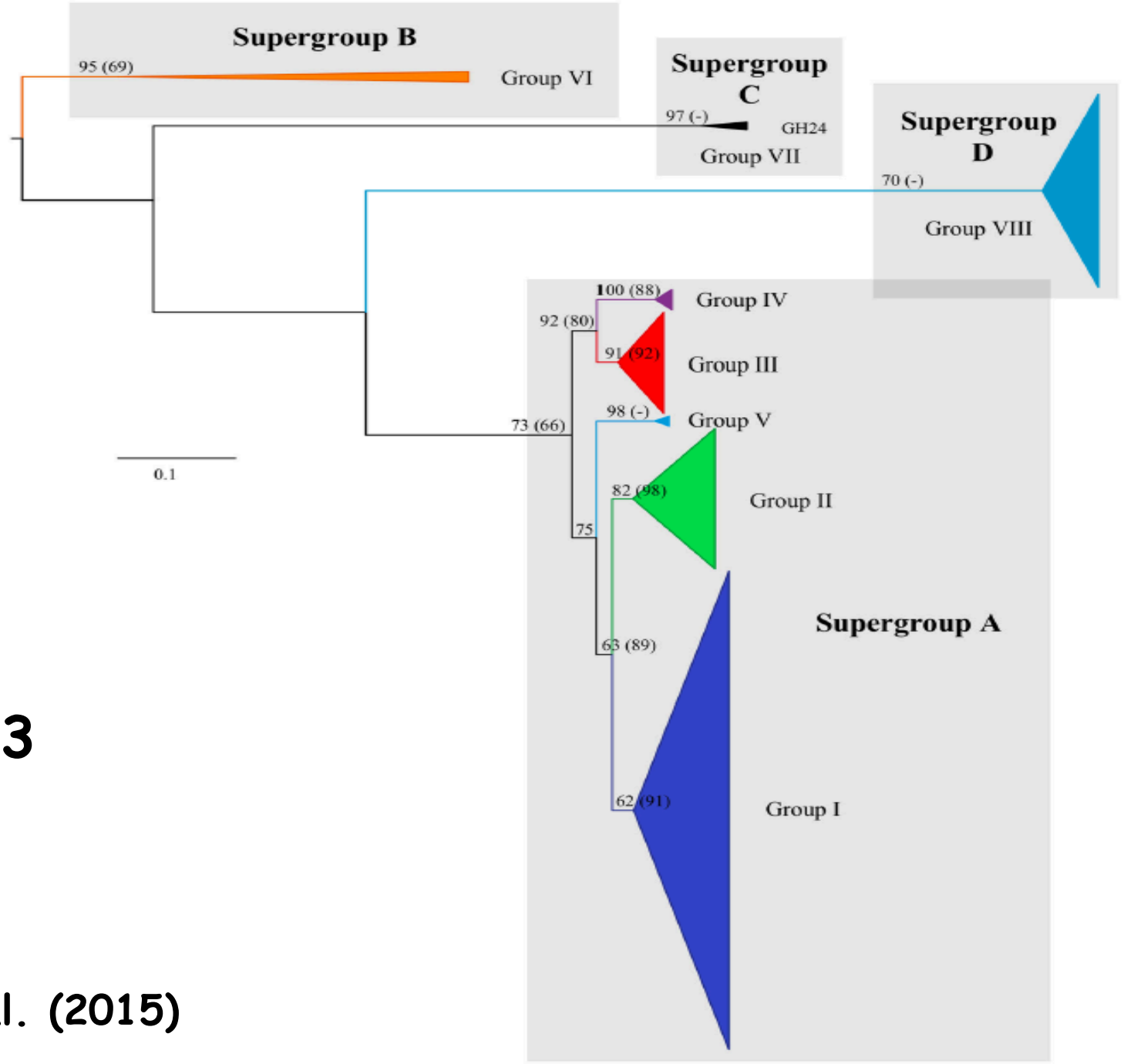


Naidu et al. (2015)

GLRaV-3 genome expression



Naidu et al. (2015)



GLRaV-3

Maliogka et al. (2015)

Leafroll impact

- Lower vigor
- Lower yield
- Lower total soluble solids
- Lower berry skin anthocyanins
- Lower putrescine
- Lower total polyamines
- Lower valine, methionone and glutamic acid
- Lower malic acid
- Lower total organic acids
- Increased pulp weight
- Increased skin weight

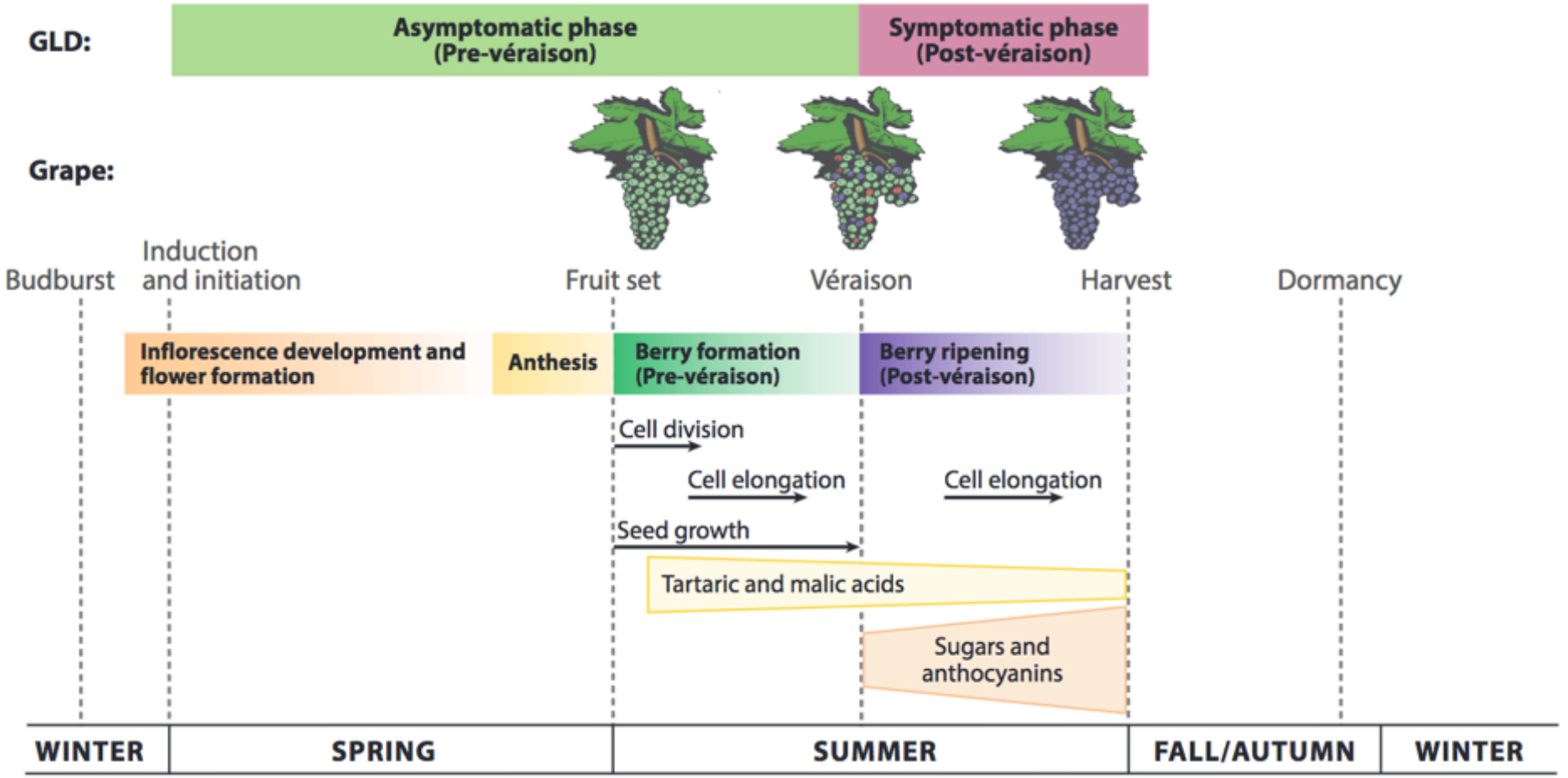
Berries

- Lower alcohol
- Lower anthocyanins
- Lower polymeric pigments in wines

Wines

Alabi et al. (2016); Lee & Martin (2009, 2010); Lee et al. (2009)

Leafroll impact



Maree et al. (2015)

Pinot noir

Healthy

GLRaV-3

Dr. P. Gugerli, RAC, Changins, Switzerland

Leafroll detection

- Visual inspection
- Biological indexing
- ELISA
- RT-PCR
- High throughput sequencing
- Remote hyperspectral imaging

Distribution of Leafroll Viruses

- Worldwide

- Wine grapes
  - Red
  - White
- Table grapes
- Raisin grapes
- Interspecific hybrids
- Rootstocks

Leafroll Management

- Vines derived from virus-tested stocks
- Roguing
- Removal of vineyards
- Insecticides

Leafroll

Red blotch

Biology of Red Blotch Viruses

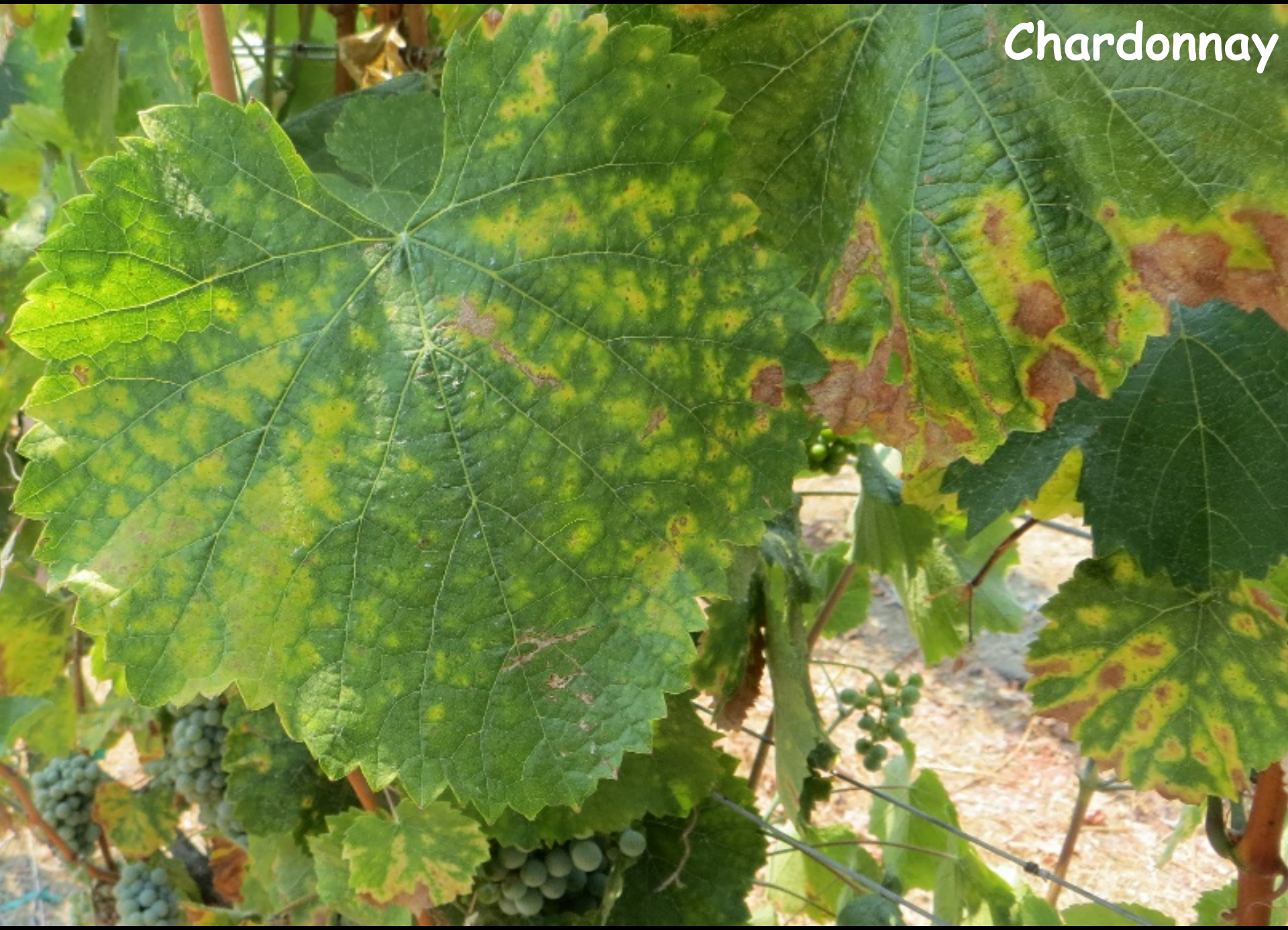
- Etiology
- Ecology
- Impact
- Distribution
- Management


Cabernet franc

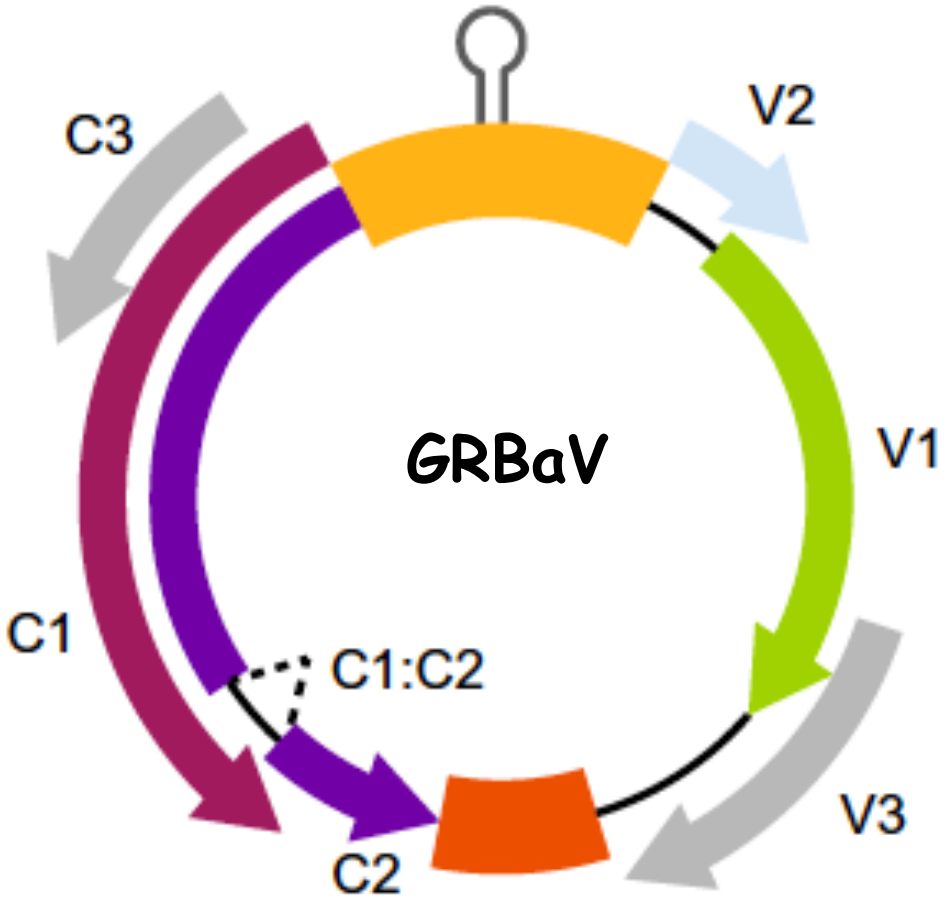
Red blotch- Pinot noir

Symptomatic

Asymptomatic

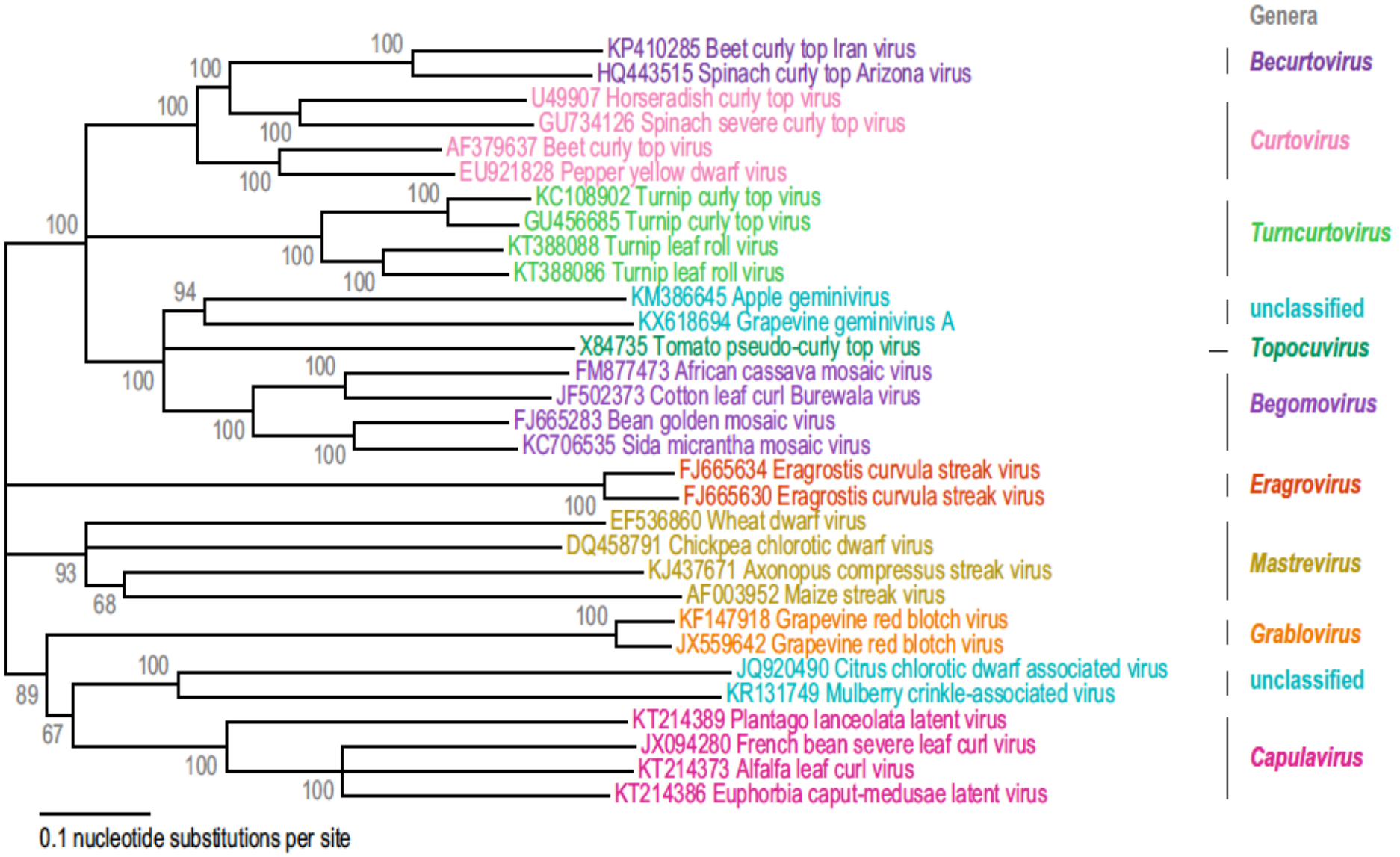

Chardonnay

Red Blotch Disease

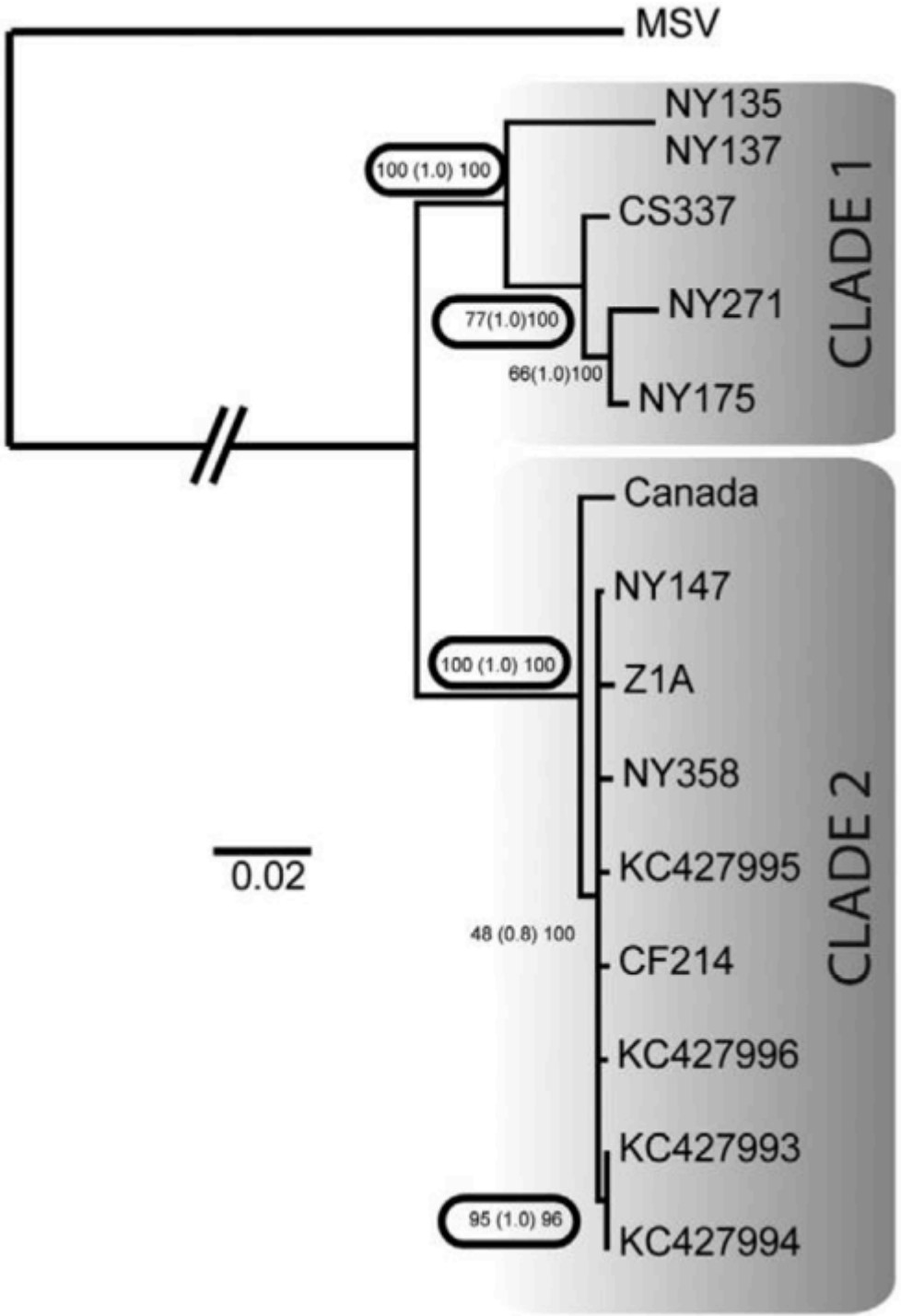


Grapevine red blotch-associated virus (GRBaV)

Family *Geminiviridae*



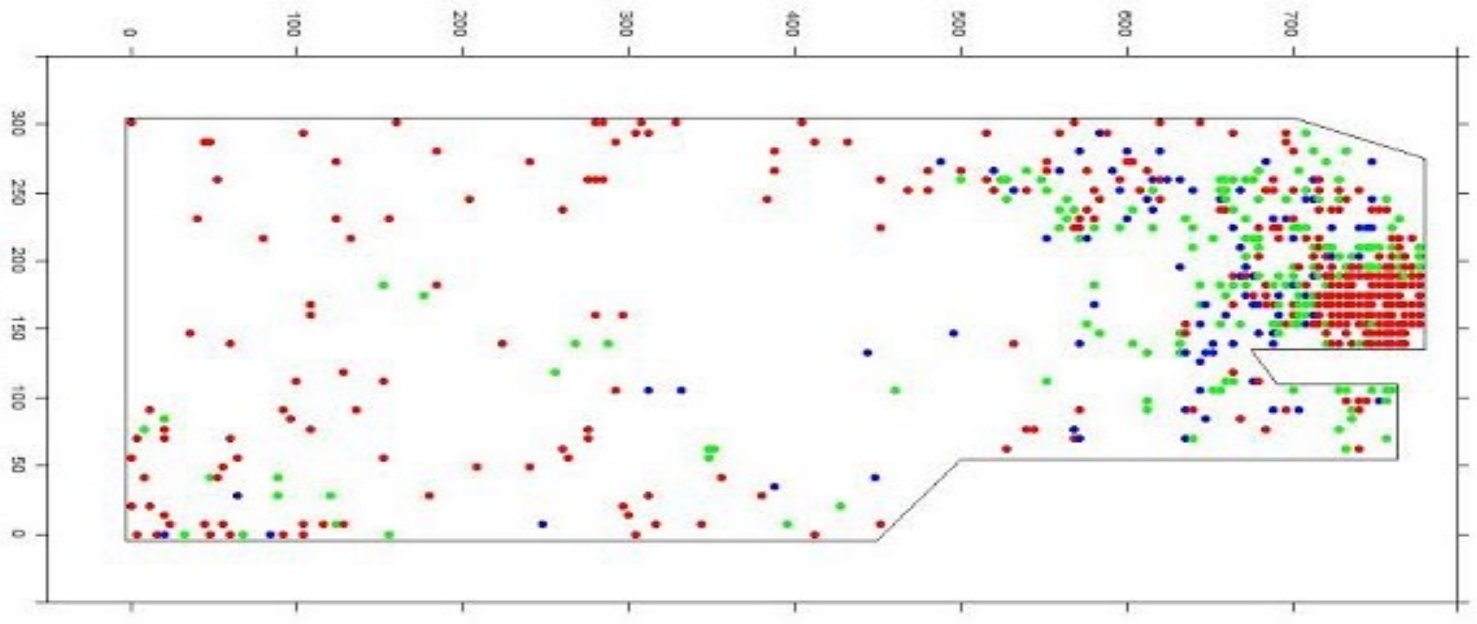
Varsani et al. (2017)

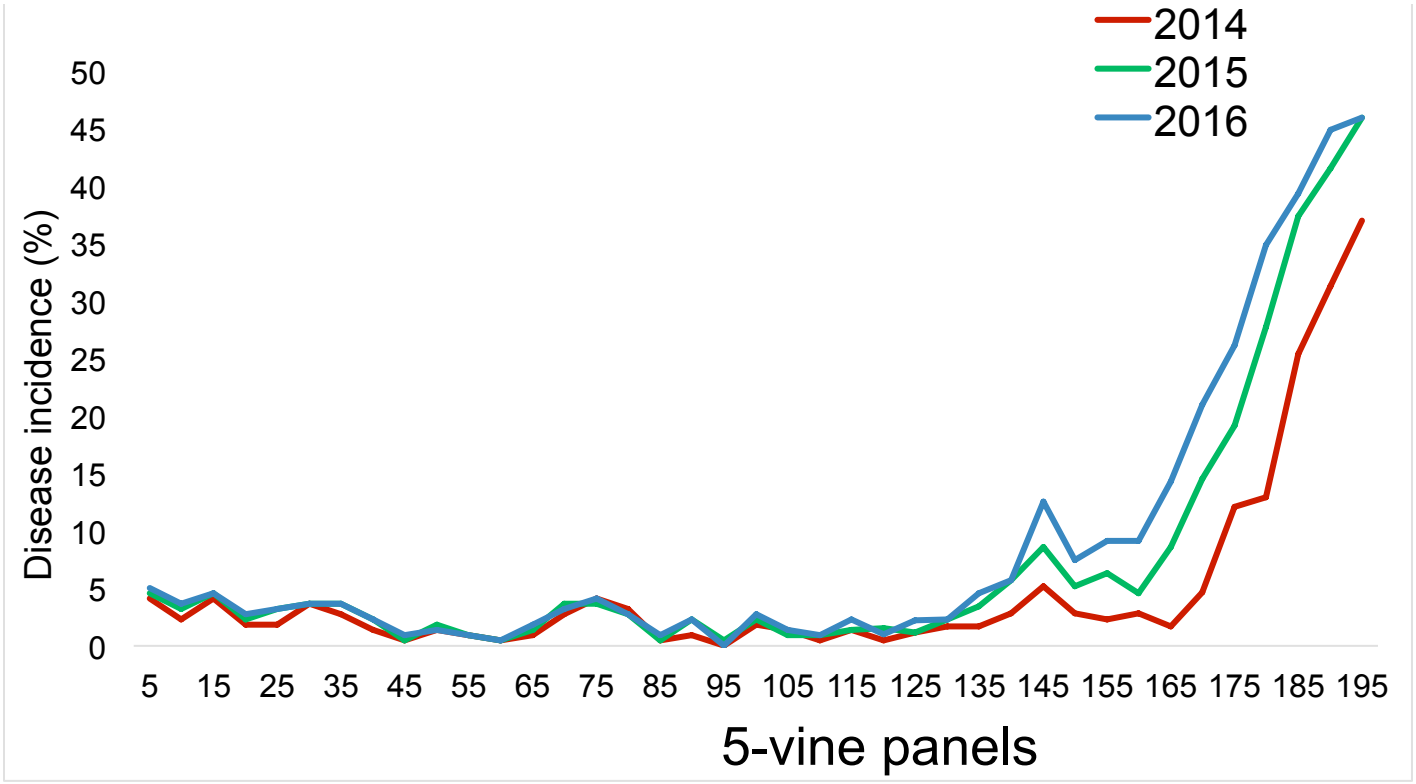


Krenz et al. (2014)

Three-cornered alfalfa treehopper
(*Spissistilus festinus*)

Cieniewicz et al. (2017)





Red Blotch Impact

- Lower vigor
- Lower yield
- Lower soluble solids
- Increased fructose
- Increased glucose
- Increased favonoids
- Increased amino acids

Leaves

- Induction of primary early ripening metabolic pathways
- Inhibition of ripening-associated pathways

Berries

Blanco-Ulate et al. (2017); Wallis and Sudarshana (2016)

Red Blotch Detection

- Visual inspection
- Biological indexing
- PCR
- High throughput sequencing
- Remote hyperspectral imaging

Distribution of Red Blotch

- North America, Switzerland, South Korea, India

- Wine grapes
  - Red
  - White
- Table grapes
- Raisin grapes
- Interspecific hybrids
- Rootstocks

Distribution of GRBaV-infected vines

Management of Red Blotch

- Vines derived from virus-tested stocks
- Roguing
- Removal of vineyards

Biology of Leafroll/Red Blotch Viruses

Similarities:

- *Vitis* sp. is the only known host
- Negative impact on vigor, yield and quality
- Graft-transmissible
- Disseminated through vegetative propagation
- Vector-transmissible
- Free-living *Vitis* sp. are reservoirs
- No resistance source in *Vitis* sp.
- Infectious clones

Biology of Leafroll/Red Blotch Viruses

Differences:

- Distribution
- Genome composition
- Genome organization
- Number of open reading frames
- Transmission mode
- Vector species
- Rate of spread

Thank you