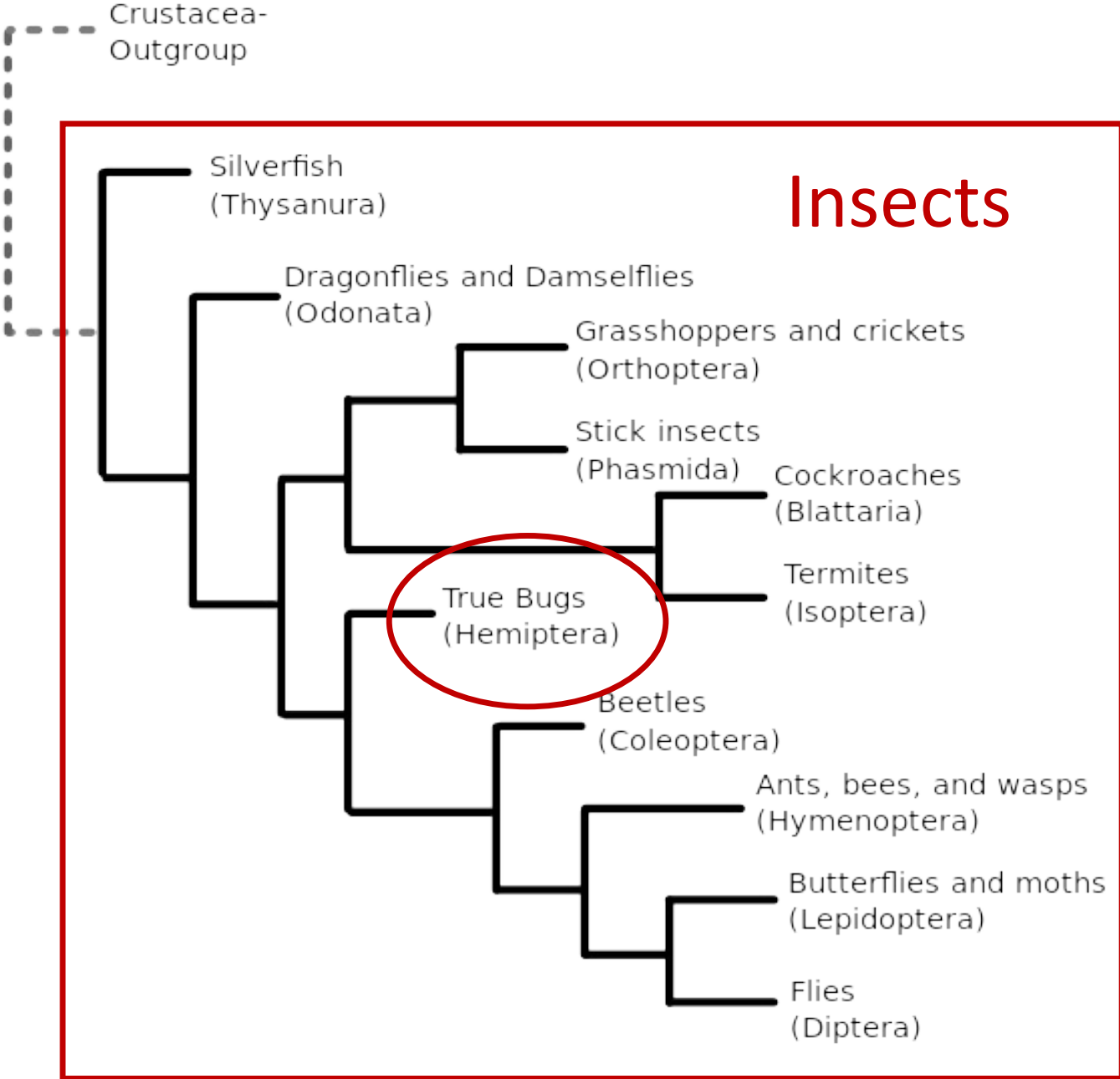
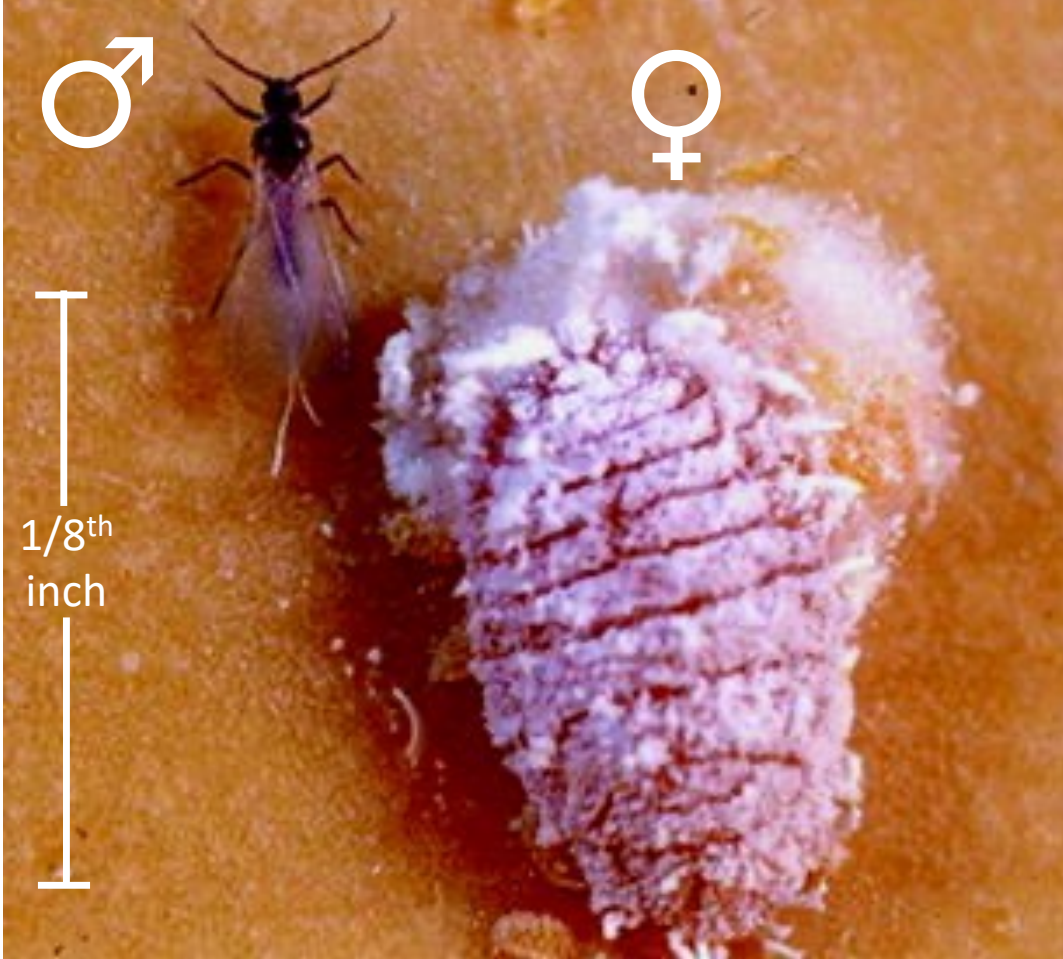


The role of grape mealybugs in spreading grape leafroll disease in mid-Missouri vineyards



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What are mealybugs?



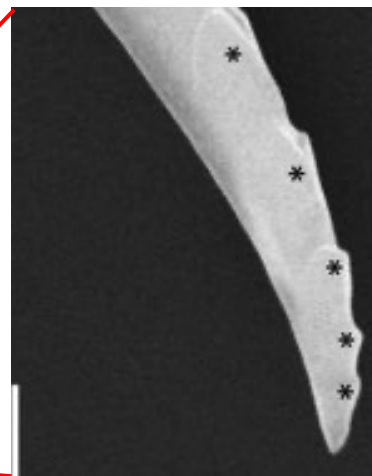
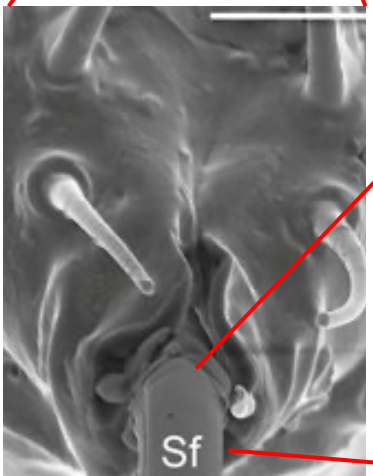
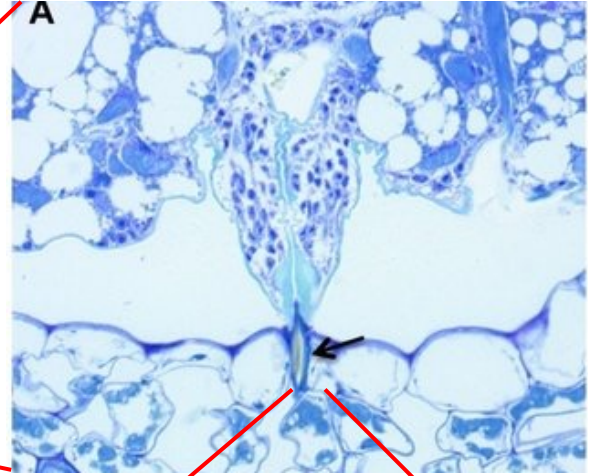
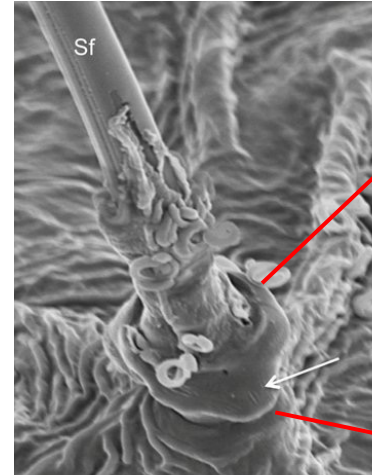
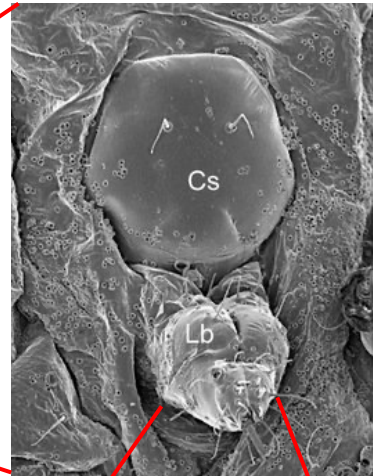
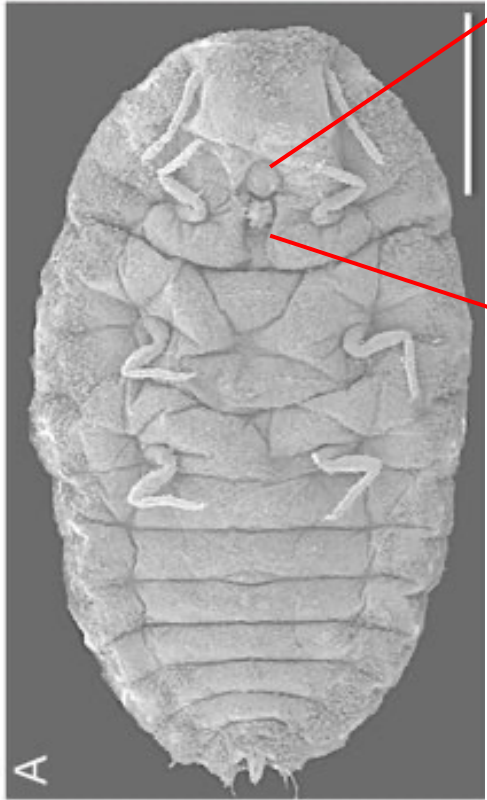
Hemipteran Insects

All have piercing-sucking mouthparts



Hemipteran Insects

All have piercing-sucking mouthparts



Economically-relevant mealybug species



Vine



Gill's



Pink Hibiscus



Pineapple



Citrus



Long-tailed



Citrophilus



Grape



Obscure

How do mealybugs affect the grape industry?

Physical damage



Virus transmission



Mealybugs spread viruses in vineyards

California mealybugs can spread grapevine leafroll disease

Authors

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[PDF](#) | [Citation](#) | [Permissions](#)

Transmission of *Grapevine leafroll-associated virus 3* by the Vine Mealybug (*Planococcus ficus*)

C.-W. Tsai, J. Chau, L. Fernandez, D. Bosco, K. M. Daane, and R. P. P. Almeida

PLANT-INSECT INTERACTIONS

Pseudococcus maritimus (Hemiptera: Pseudococcidae) and *Parthenolecanium corni* (Hemiptera: Coccidae) Are Capable of Transmitting Grapevine Leafroll-Associated Virus 3 Between *Vitis x labruscana* and *Vitis vinifera*

B. W. BAHDER,^{1,2} S. POOJARI,³ O. J. ALABI,³ R. A. NAIDU,³ AND D. B. WALSH¹

Survey for Viruses of Grapevine in Oregon and Washington

R. R. Martin, Horticultural Crops Research Lab, USDA-ARS, Corvallis, WA 97330; **K. C. Eastwell**, Department of Plant Pathology, Washington State University, Prosser 99350; **A. Wagner**, Washington State Department of Agriculture, Olympia 98501; **S. Lamprecht**, Horticultural Crops Research Lab, USDA-ARS, Corvallis 97330; and **I. E. Tzanetakis**, Department of Botany and Plant Pathology, Oregon State University, Corvallis 97331

Chapter 24

Vector Transmission of Grapevine Leafroll-Associated Viruses

E. Herrbach, A. Alliaume, C.A. Prator, K.M. Daane, M.L. Cooper, and R.P.P. Almeida

Mealybug Transmission of Grapevine Leafroll Viruses: An Analysis of Virus–Vector Specificity

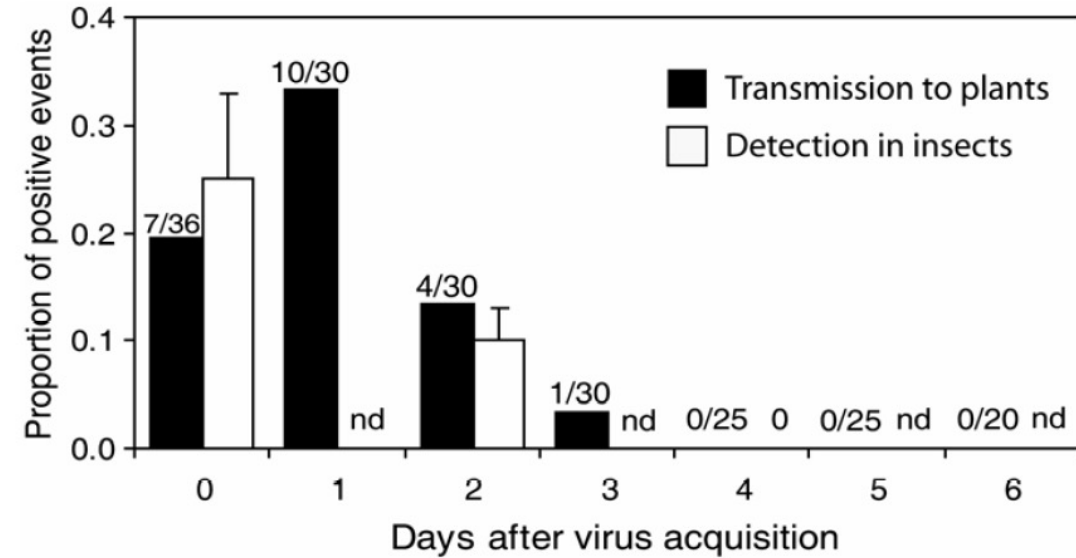
Chi-Wei Tsai, Adib Rowhani, Deborah A. Golino, Kent M. Daane, and Rodrigo P. P. Almeida

Mealybugs spread viruses in vineyards



Infected

Clean  Infected



Viruses† detected in acquisition-access parent plant by ELISA and/or PCR	Virus detected in inoculated test plant
GLRaV-3, GRSPaV	GLRaV-3
GLRaV-1, GLRaV-2, GLRaV-5, GVB, GRSPaV	GLRaV-5
GLRaV-4, GRSPaV	None
GLRaV-2, GLRaV-3, GFkV, GRSPaV, GVC	GLRaV-3
GLRaV-1, GLRaV-2, GVB, GRSPaV	None
GLRaV-2, GVB	None
GLRaV-3, GVA, GVB, GVD	GLRaV-3
None	None

Viruses found in mid-Missouri vineyards

Table 2. Virus incidence in each cultivar

Virus	Survey Average	Vidal blanc	Vignoles	Chardone	Norton	Chambourcin	Valvin Muscat	Crimson Cabernet	Vivant	Vincent	Concord	Lenior	Albania	Hidalgo	Muench	Wetumka	Cloeta	Traminette	Catawba	Cayuga	Rayon	Saperavi	Cabernet franc	Noiret	Viognier	Foch
GRSPaV ³	58.7 ¹	100	100	46.7	0	100	100	0	15.0	80.0	0	0	0	0	0	0	0	36.4	0	0	100	100	100	0	100	100
GLRaV-3	52.7	91.1	88.5	33.3	85.0	3.3	10.0	0	10.0	0	100	40.0	100	40.0	100	100	0	0	100	50.0	50.0	0	0	0	0	100
GRBV	35.0	24.4	4.3	75.5	77.5	26.7	40.0	90.0	0	0	20.0	100	20.0	80.0	0	100	100	0	0	0	0	0	0	60.0	20.0	100
GVE	31.0	26.7	85.7	8.9	30.0	0	0	0	0	0	100	0	100	40.0	100	100	0	0	80.0	0	0	0	0	0	0	0
GLRaV-2	19.0	91.1	54.2	6.7	0	26.7	0	0	0	0	0	100	0	0	0	0	0	0	0	0	20.0	0	0	0	0	0
GVB	17.2	0	65.7	0	22.5	0	0	0	0	0	10.0	60.0	40.0	0	20.0	100	0	0	80.0	0	10.0	0	0	0	0	0
GVkV	13.5	28.9	38.5	0	15.0	3.3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	40.0	0	0	0	0	40.0
GLRaV-2RG	9.2	0	1.4	0	72.5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	60.0	0	0	0	0	0
GVCV	8.2	33.3	1.4	24.4	0	0	20.0	0	0	0	0	0	0	0	0	0	0	0	0	10.0	0	0	0	10.0	10.0	0
GVA	0.5	0	0	0	2.5	3.3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
GLRaV-5	0.2	0	0	2.2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Sample # ²	400	45	70	45	40	30	20	10	20	10	10	5	5	5	5	5	5	11	5	10	10	4	5	10	10	5

2017: A Survey of Viruses Found in Grapevine Cultivars Grown in Missouri

James Schoelz, Dean Volenberg and Maher Al Rawhanh

- Grape LeafRoll-associated Viruses (GLRaVs) are quite prevalent
- GLRaV-3, the main causal agent of Grape Leafroll disease, found in 52.7% of vineyards surveyed

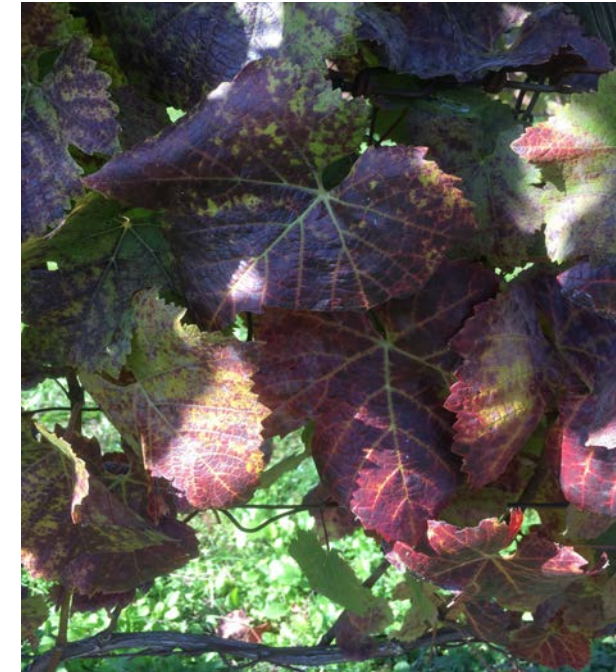
¹This value is the percentage of the composite samples positive for the selected virus.

²The number of composite samples collected for each cultivar.

³Virus acronyms: GRSPaV, Grapevine stem pitting associated virus; GLRaV-3, grapevine leafroll associated virus 3; GRBV, grapevine red blotch virus; GVE, Grapevine virus E; GLRaV-2, Grapevine leafroll associated virus 2; GVB, Grapevine virus B, GVkV, Grapevine fleck virus, GLRaV-2RG, Grapevine leafroll associated virus 2RG; GVCV, Grapevine vein clearing virus; GVA, Grapevine virus A, GLRaV-5, Grapevine leafroll associated virus 5.

Grape Leafroll Disease (GLD)

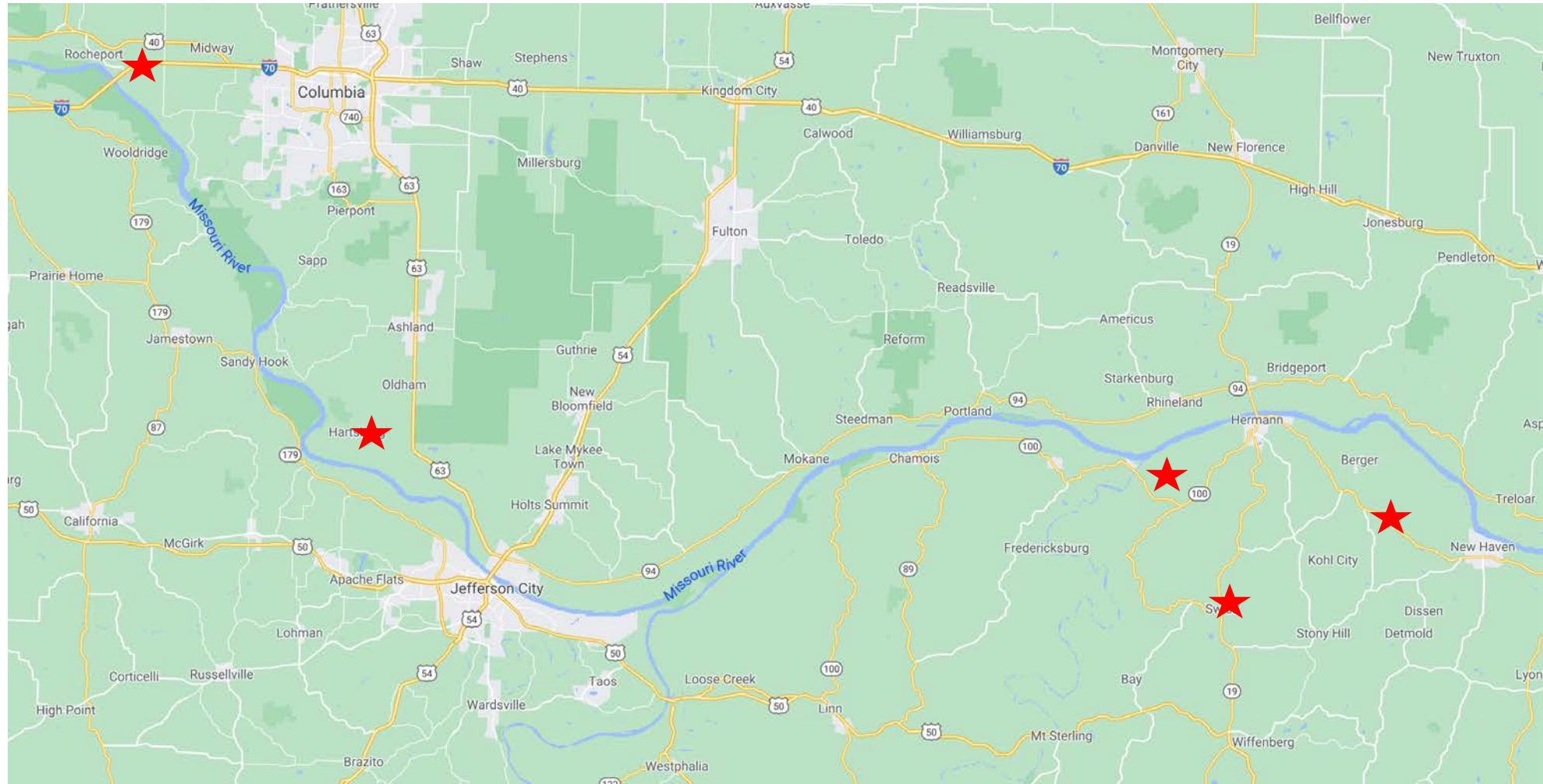
- Caused by grape leafroll-associated viruses (GLRaV-3)
- Spread by mealybugs and scale insects; graft transmissible
- Visual symptoms (*V. vinifera*)
 - red cultivars: curled leaf margins, leaf reddening/green veins
 - white cultivars: curled leaf margins, mild leaf blotching
- Physiological symptoms (*V. vinifera*)
 - delayed budbreak, flowering, maturation
 - change in berry color, sugar content & acidity
- Susceptibility
 - **genetic background**, age, viral load, etc.
- No cure or treatment
 - virus-free rootstock
 - control mealybug populations



Are mealybugs present in mid-Missouri Vineyards?

Summer 2020:

Field surveys: yes

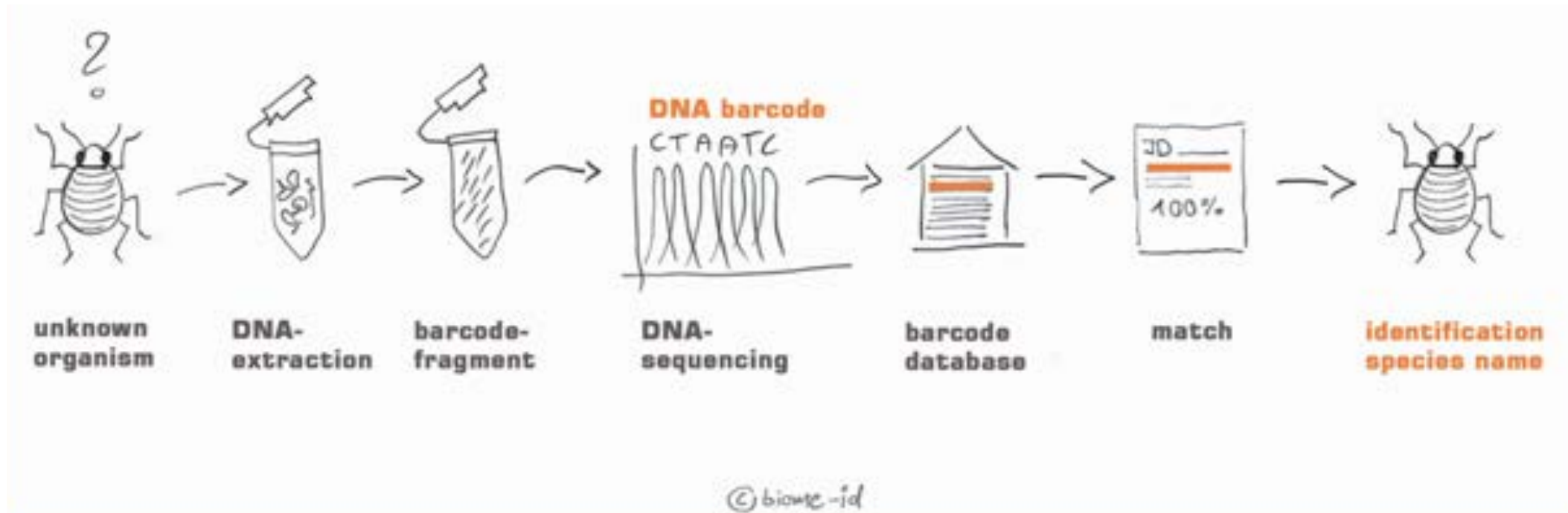


Are mealybugs present in mid-Missouri Vineyards?

Summer 2020:

Field surveys: yes

Species ID: grape mealybug (*Pseudococcus maritimus*)

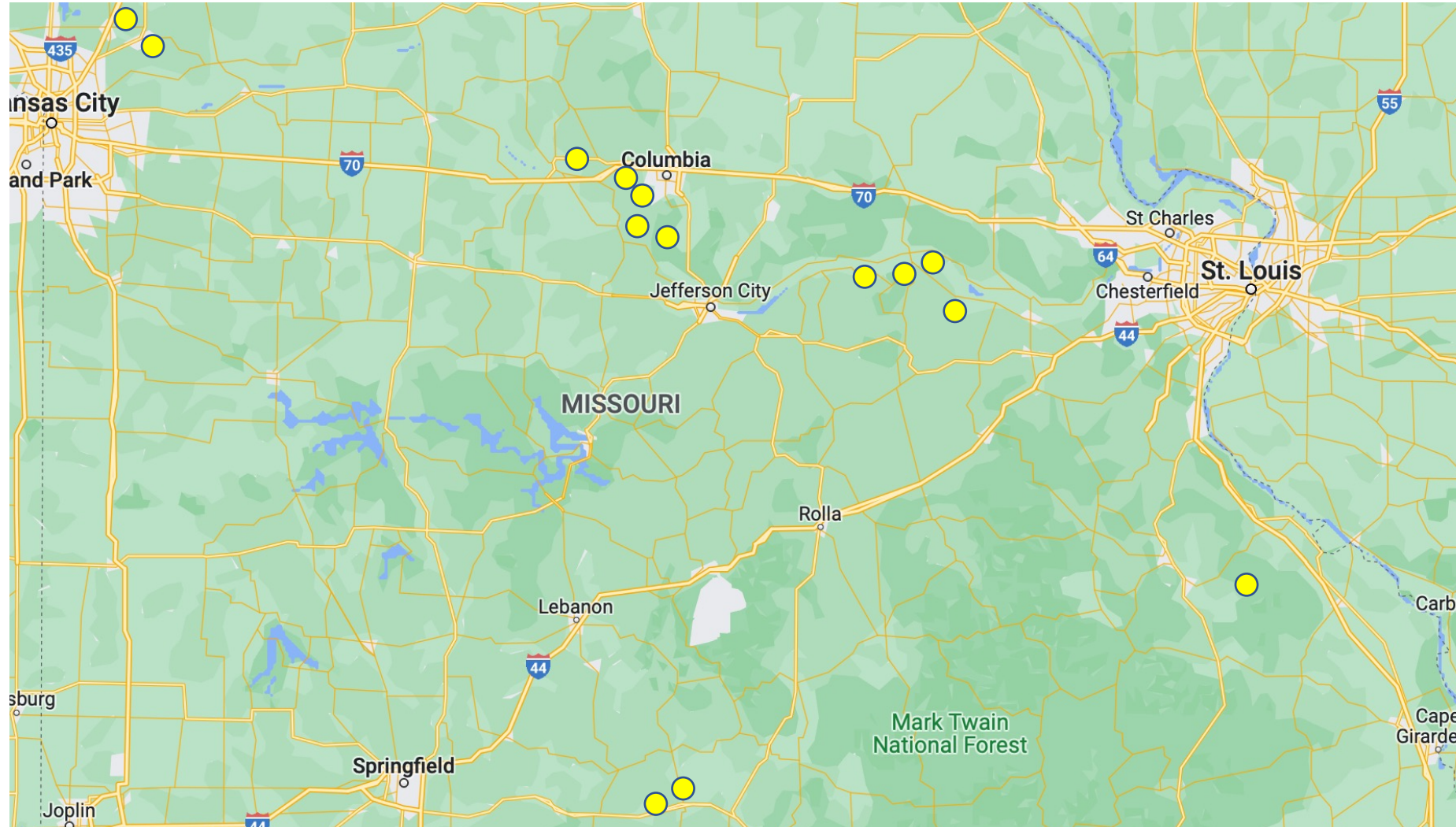


Spatial and temporal distribution of grape mealybugs in mid-Missouri vineyards



2021 field season

- Formal surveying for mealybugs in mid-Missouri vineyards
- 30 grape mealybug pheromone traps deployed at 14 vineyards
- Traps monitored biweekly from mid-April to mid-September



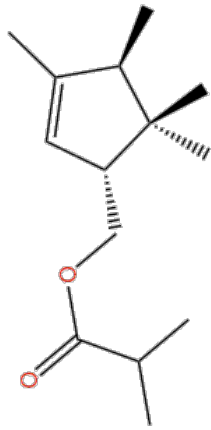
Insect sex pheromone biology, briefly



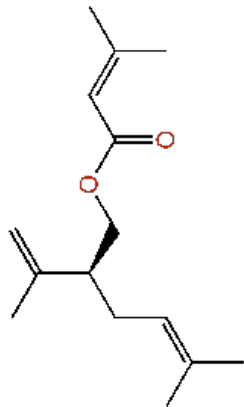
Insects rely upon sex pheromones to find each other in the environment

Insect sex pheromone biology, briefly

Grape mealybug
(*Pseudococcus maritimus*)



Vine mealybug
(*Planococcus ficus*)



Sex pheromone compounds, or blends, are species-specific

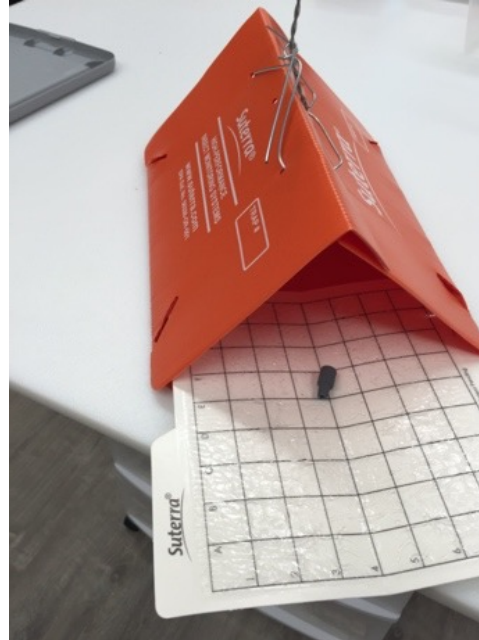
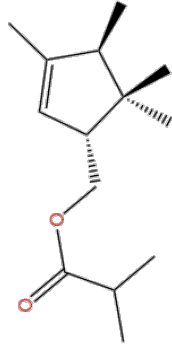
Insect sex pheromone biology, briefly



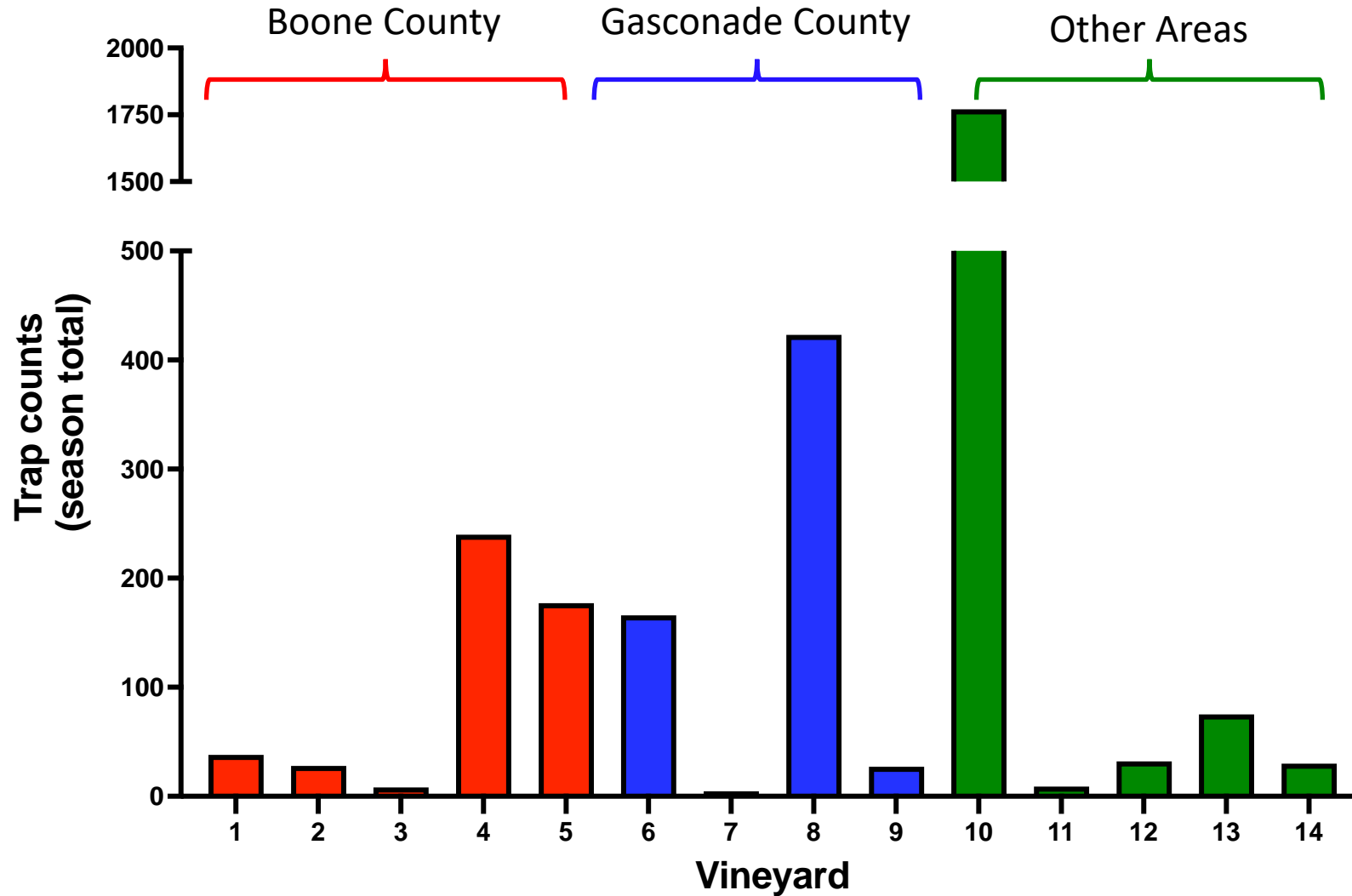
Sex pheromones are typically released by females to attract males

Exploiting grape mealybug sex pheromone communication to monitor field populations

Grape mealybug sex pheromone

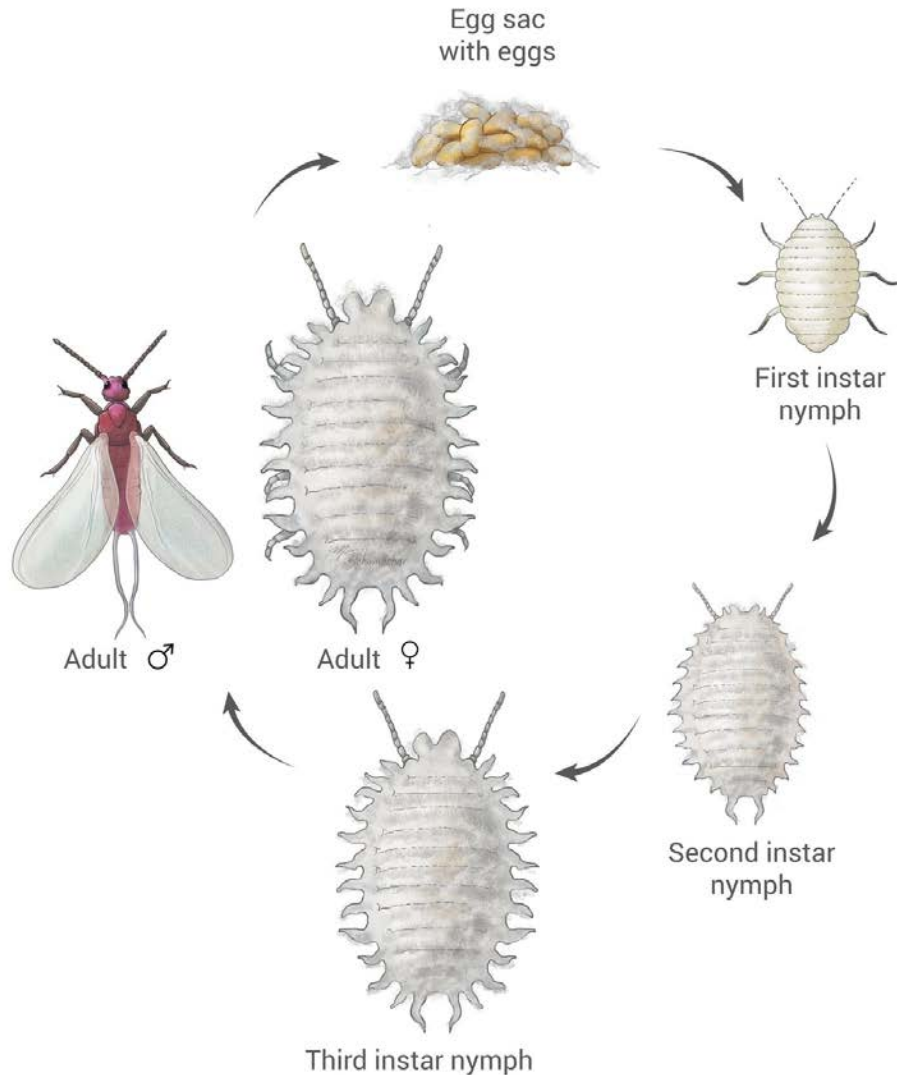


2021 Results: Where are grape mealybugs?



2021 Results: When are grape mealybugs active?

Grape mealybug life cycle

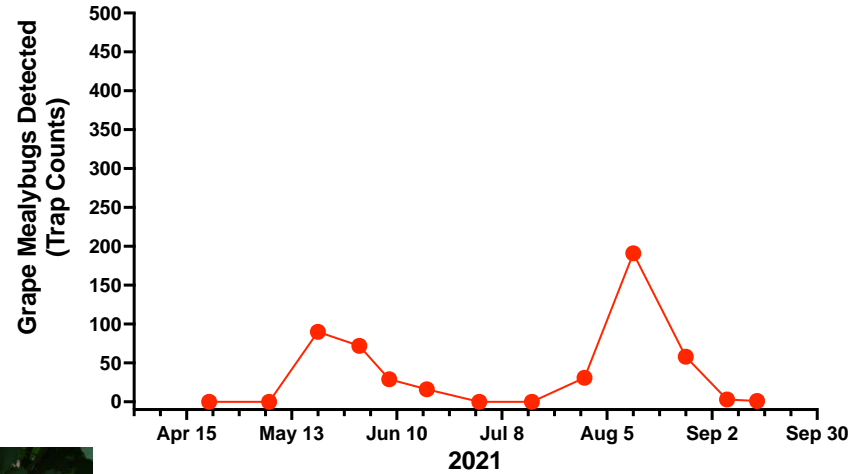


Grape mealybugs typically have two generations per year

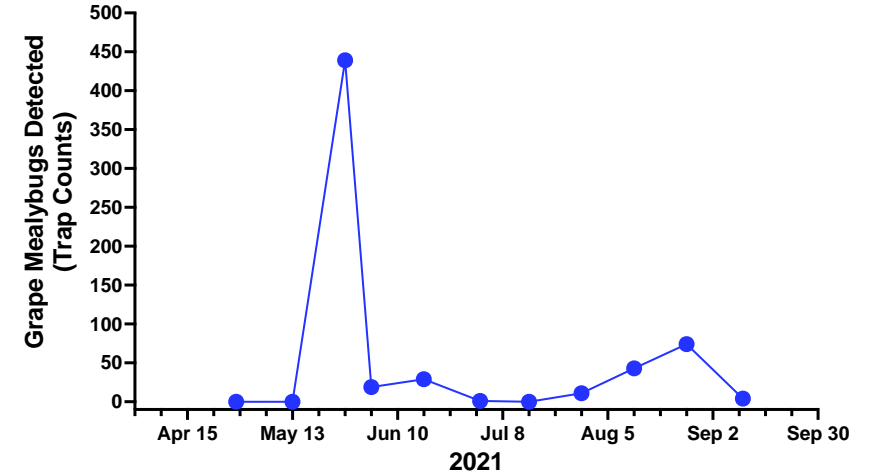
- overwintering generation (active April - June)
- summer generation (June - August)

2021 Results: When are grape mealybugs active?

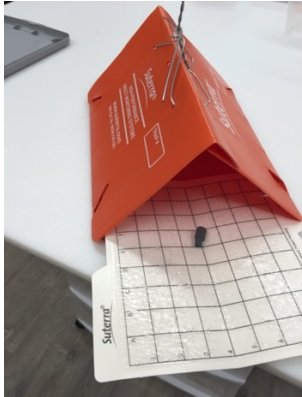
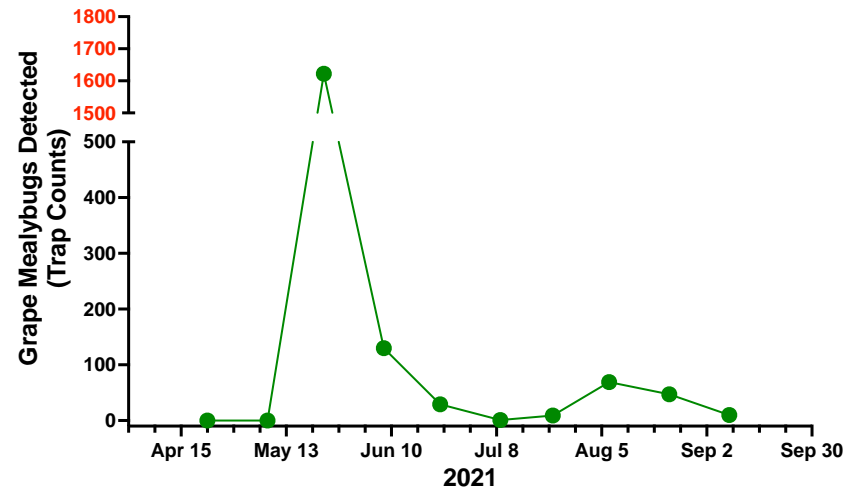
Boone County



Gasconade County



Other Areas



Controlling Mealybug populations

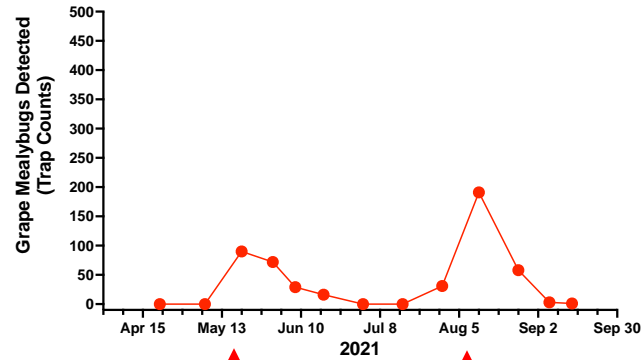


Insecticides

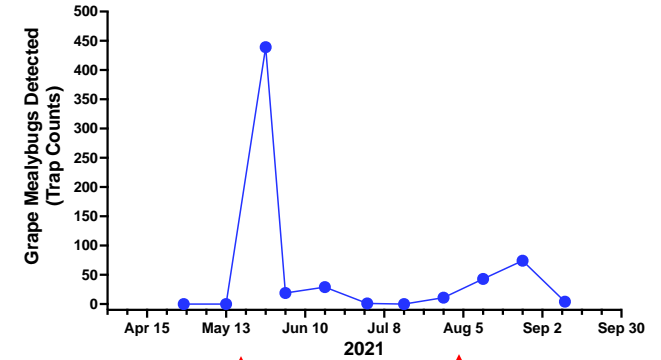
Systemic vs contact
MOA rotation

↑ = optimal time for biological or chemical control applications

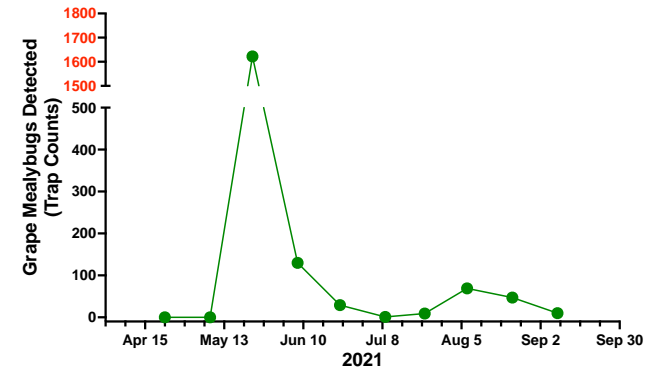
Boone County



Gasconade County



Other Areas



Biocontrol agents
predators, parasites, pathogens

Controlling Mealybug populations



Insecticides

Systemic vs contact
MOA rotation



Biocontrol agents

predators, parasites, pathogens

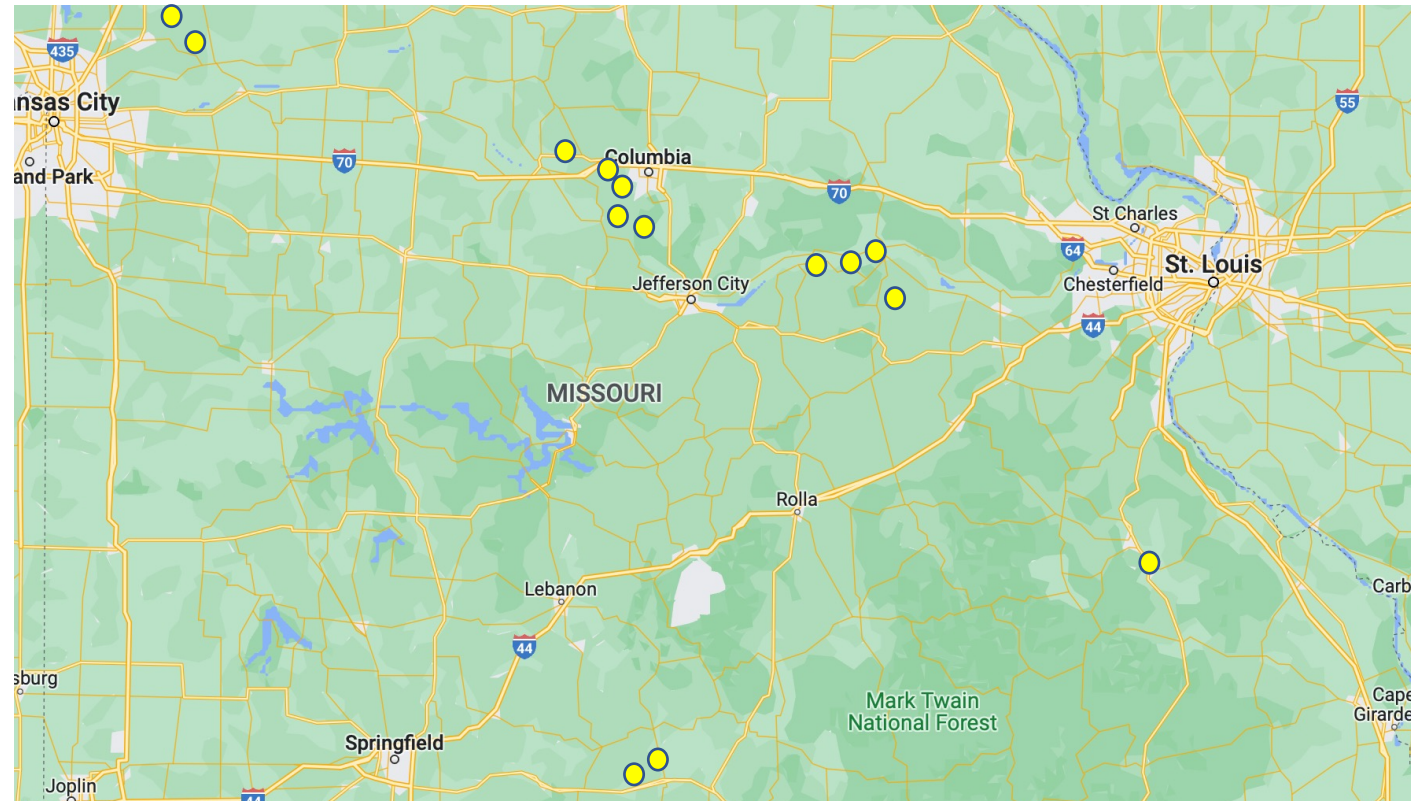
Cultural Practices

Knowledge of infestations, biology
Limiting spreading by humans

Molecular testing of field-collected mealybugs

Genetic material extracted and tested from 56 mealybugs

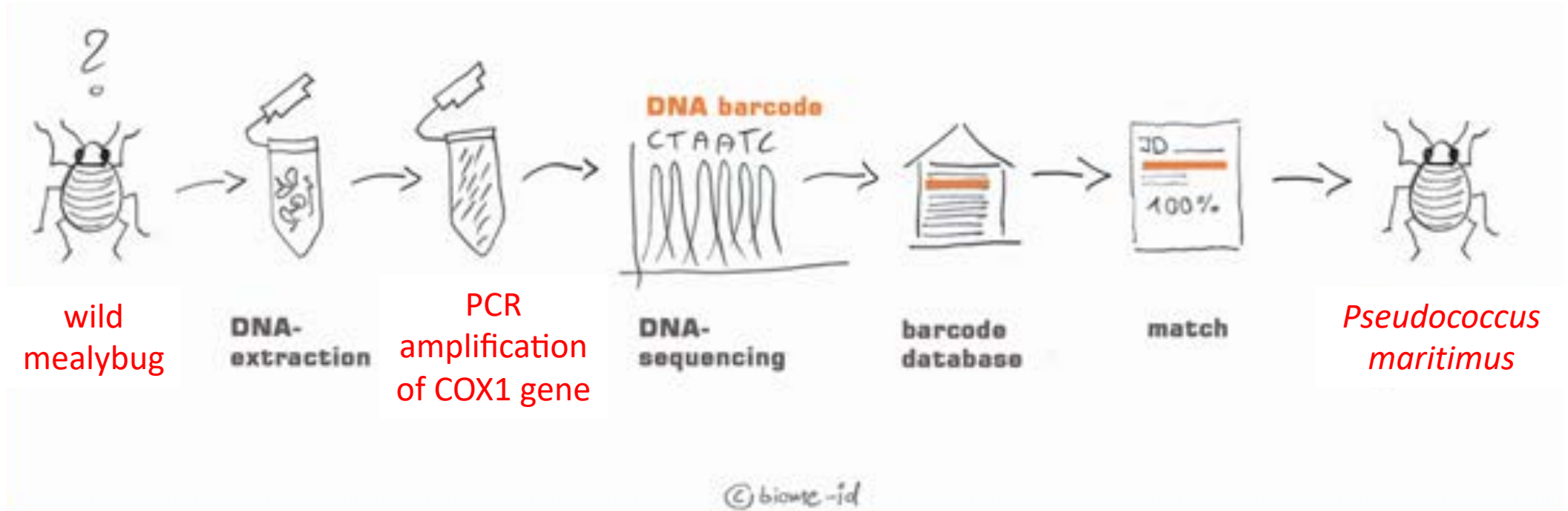
- Collected from 14 vineyards during 2021 growing season



Molecular testing of field-collected mealybugs

Genetic material extracted and tested from 56 mealybugs

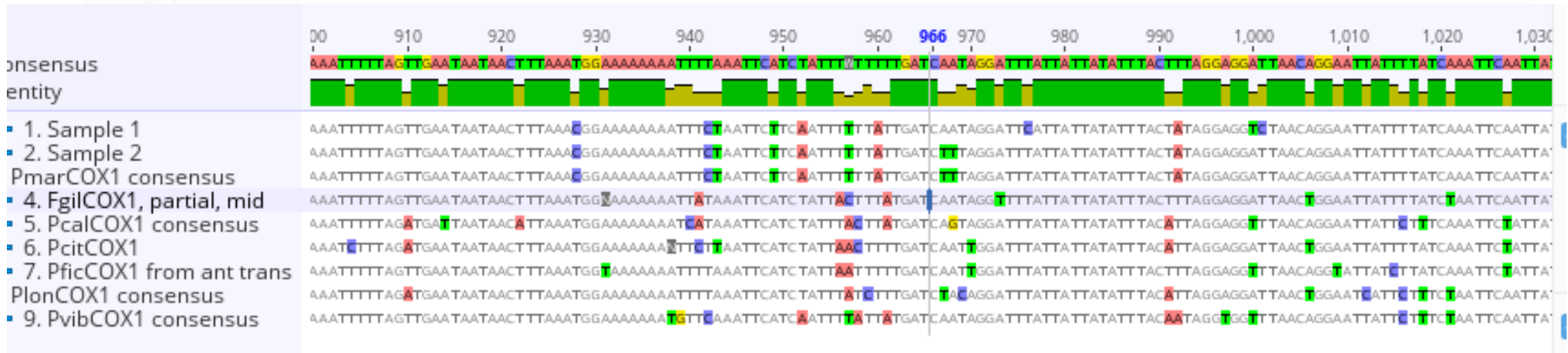
- Species identification:
verified by DNA testing



Molecular testing of field-collected mealybugs

Genetic material extracted and tested from 56 mealybugs

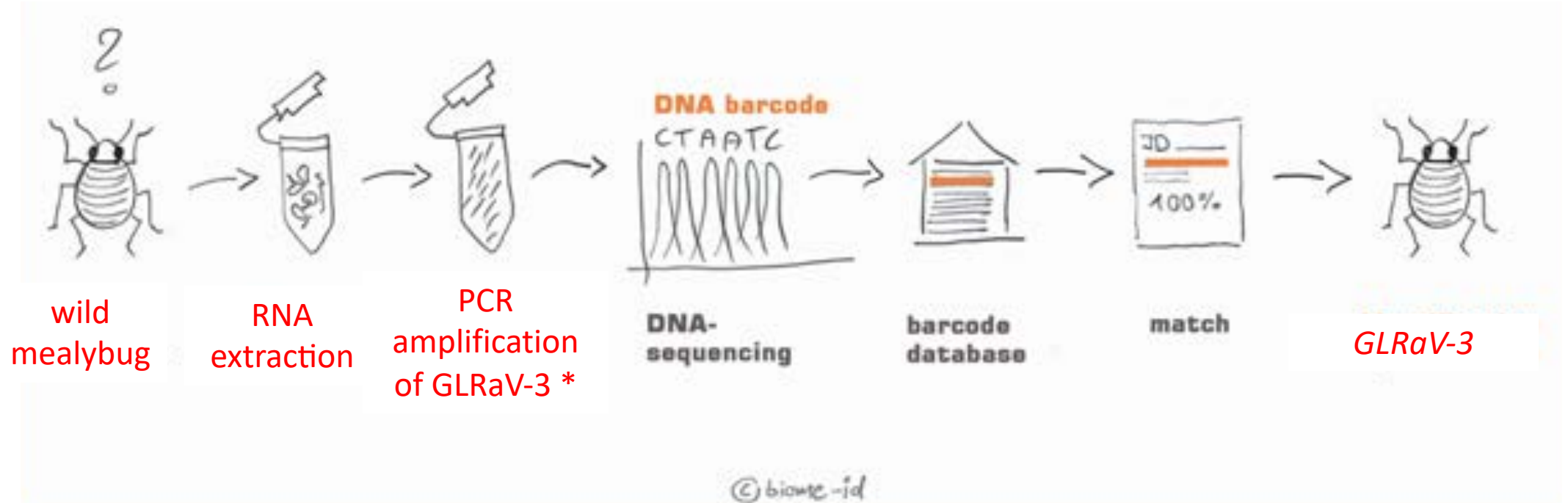
- Species identification:
all verified to be grape mealybug



Molecular testing of field-collected mealybugs

Genetic material extracted and tested from 56 mealybugs

- GLRaV-3 detection by DNA analysis:
10 samples positive for GLRaV-3

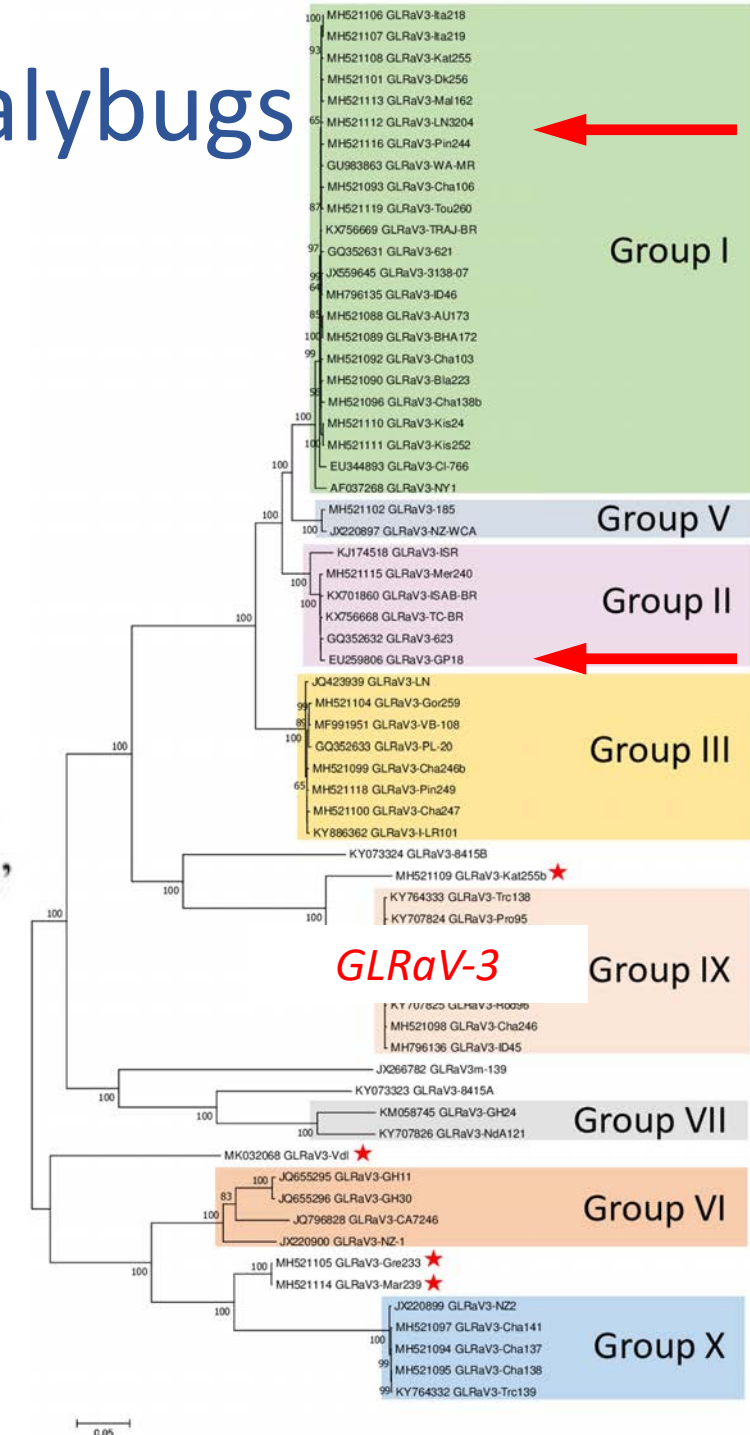
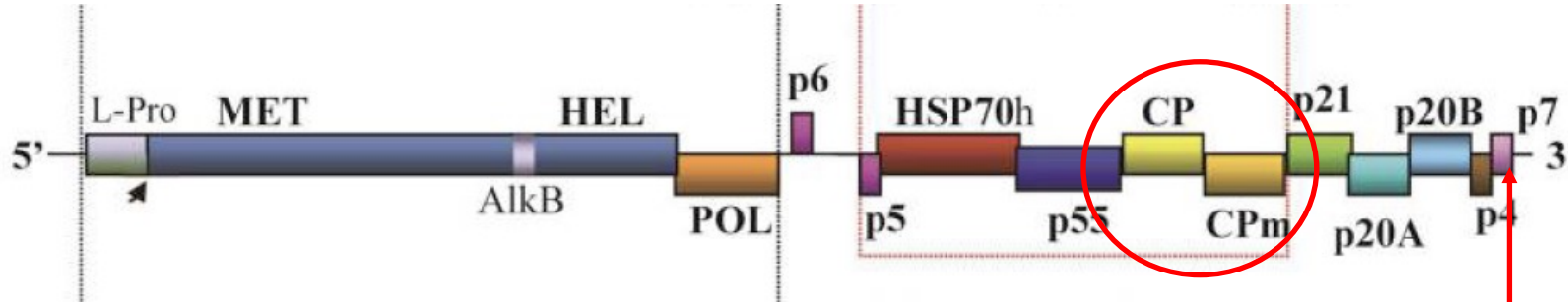


Molecular testing of field-collected mealybugs

Genetic material extracted and tested from 56 mealybugs

- 10 samples positive for GLRaV-3:
- analysis of GLRaV-3 genome verifies virus strain/origin

GLRaV-3 genome



Future plans

To continue through 2022, 2023 field seasons:

GMB pheromone-based monitoring program

- 2021 locations, plus more?

Field collection of vineyard mealybugs

- Other species present?

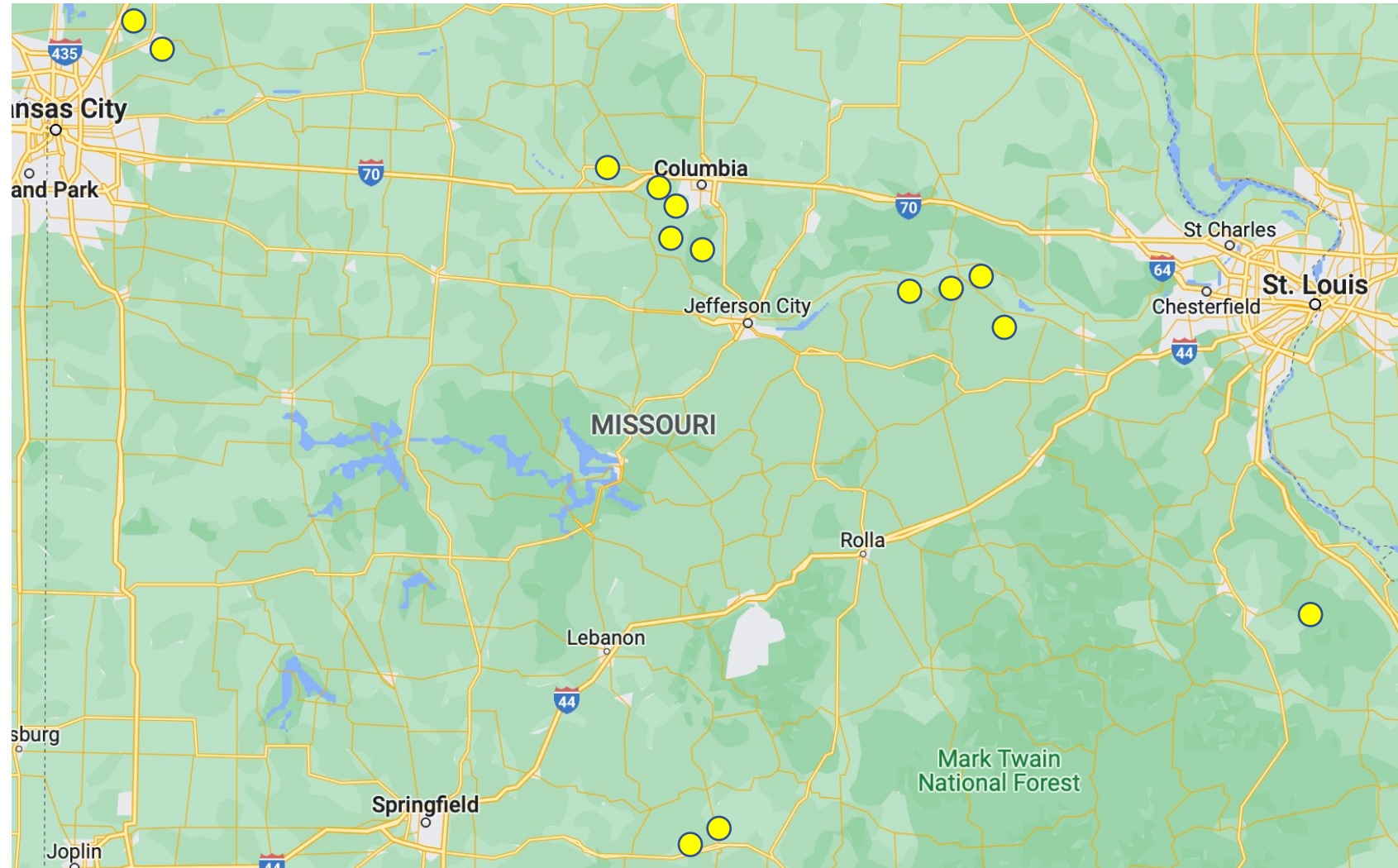
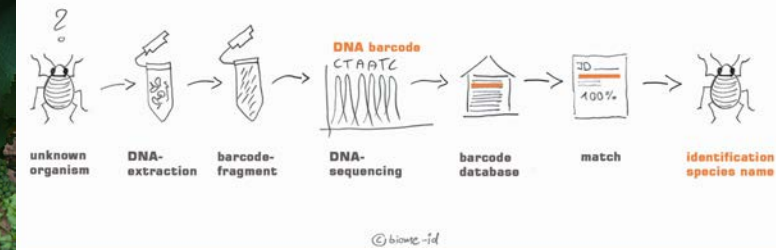
Testing mealybugs for GLRaVs

- Characterize viruses present

New goals:

Pheromone-based monitoring of other vineyard pests

Detection of other grapevine viruses in mealybugs



The role of grape mealybugs in spreading grape leafroll disease in mid-Missouri vineyards

Conclusions, so far...

- Grape mealybugs (GMBs) are in mid-Missouri
- GMBs spread GLRaVs
- GMBs in mid-Missouri test (+) for GLRaV-3
- Effects of GLD in Missouri are unclear
- GMB trapping data can improve control measures



Acknowledgements

Project Facilitation

Dean Volenberg

Nick Pehle

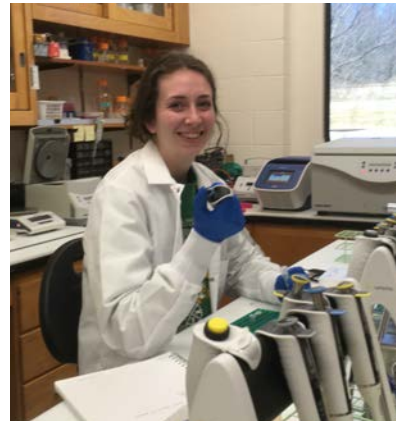
Bill Wiebold

Participating Vineyards

Technical Support

James Smith

Claire Bilyeu



Grape and Wine Institute
University of Missouri