Pheromone lures: their role in vineyard insect pest management

Malkie Spodek, PhD
CCOVI Lecture Series
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Cool Climate Oenology & Viticulture Institute
Brock University

Outline of talk

- Introduction to pheromones
- Types of insect pheromone lures in viticulture with examples
- Current research: Developing a Grape Mealybug pheromone lure for Canada; Updates and future plans

Credit: M. Spodek

Credit: M. Spodek

Credit: Bell, VA, et al 2022, Monitoring mealybugs in Central Otago vineyards, NZ

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Introduction to pheromones

- Based on the Greek φέρω phérō ('I carry') and ὁρμων hórmōn ('stimulating')

- Definition:
  Substances released externally by one individual that elicit specific responses in another individual of the same species“ (Peter Karlson & Martin Lüscher, 1959).

- They are neurotransmitters that serve the chemical communication between individuals of a species.

- Intraspecific communication via these substances takes place in a variety of ways and serves:

    - for mating
    - to mark territories
    - to find nest sites
    - to find food sources

https://en.wikipedia.org/wiki/Pheromone

Ex: dogs communicate using pheromones and olfactory signals in urine

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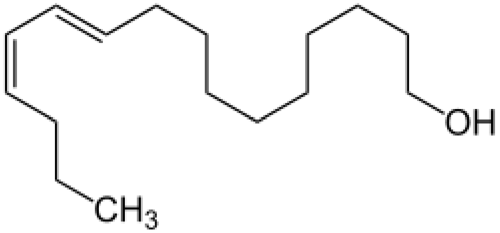
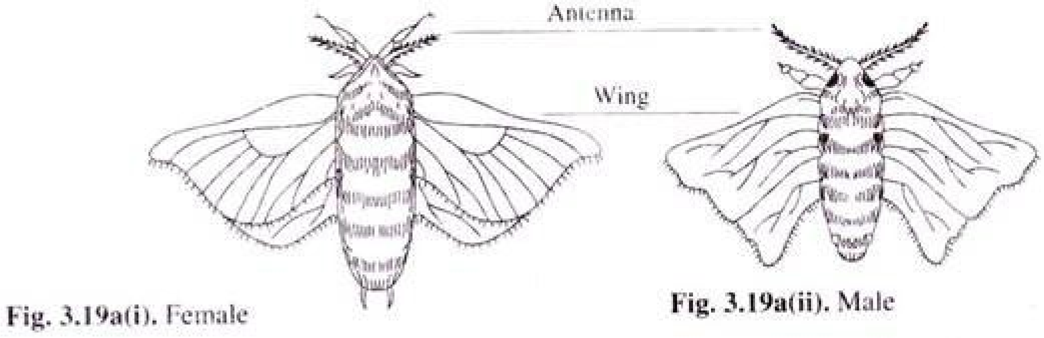
Introduction to insect pheromones

- Major breakthrough in 1961, German biochemist, Adolf Butenandt characterized the first chemical, **bombykol**, a pheromone released by the female silkworm to attract mates

male silkworm





notesonzoology.com/sericulture/differences/differences-between-female-and-male-moths-mulberry-silk-moths/269

- Most male insects detect pheromones with sensilla, hairs on their antenna
- Several thousand sex pheromones have been identified in insects
- Sex pheromones used as synthetic baits to trap pests or as behavioral modifiers in agriculture, forestry, horticulture etc.

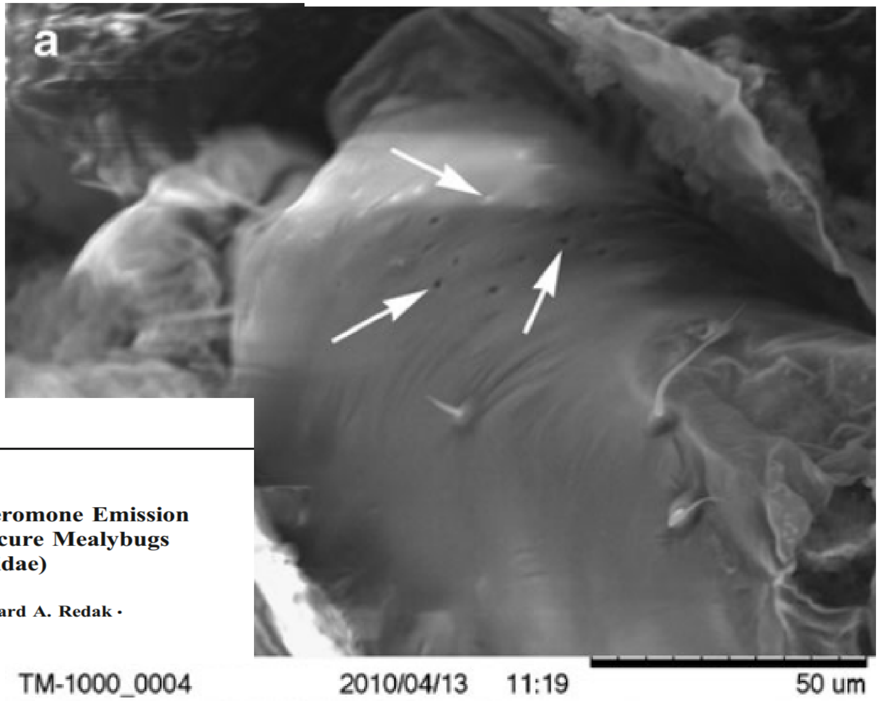
Mealybug morphology for pheromone emission and sensing

♀

female vine mealybug

♂

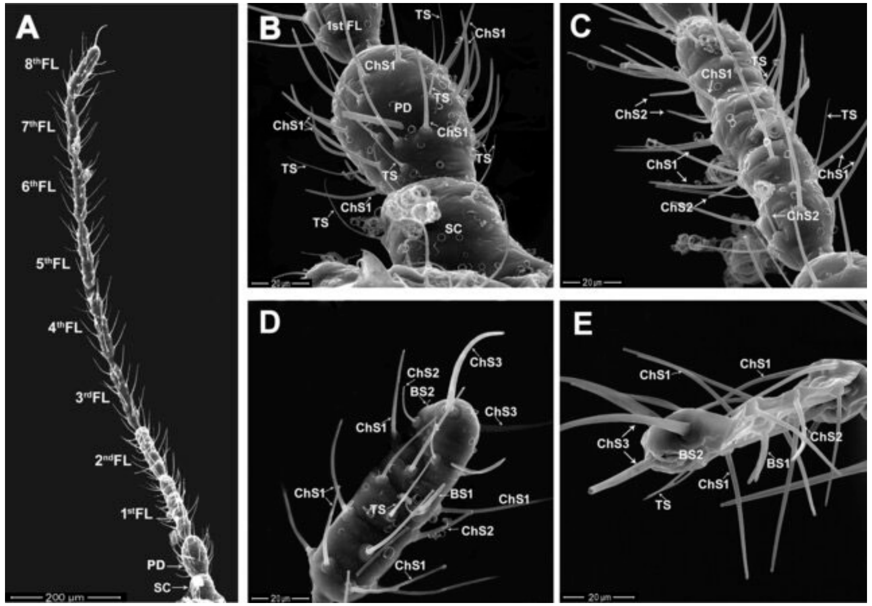
male vine mealybug



J Insect Behav (2012) 25:287–296
DOI 10.1007/s10905-011-9297-1

Probable Site of Sex Pheromone Emission in Female Vine and Obscure Mealybugs (Hemiptera: Pseudococcidae)

Rebeccah A. Waterworth · Richard A. Redak · Jocelyn G. Millar



Scanning electron microscopy (SEM) of the male antenna of *P. solenopsis* (Abd El-Ghany et al, 2022)

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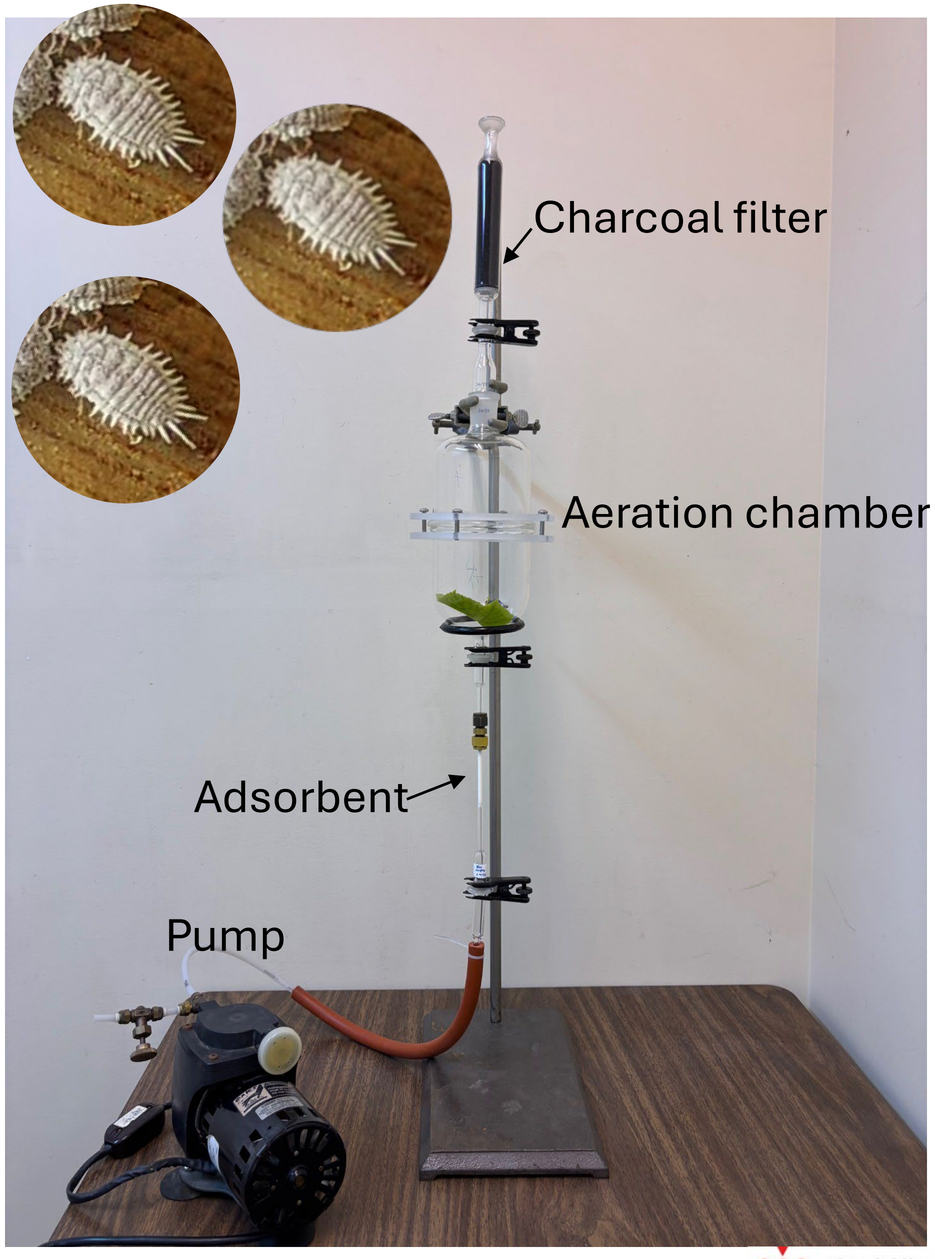
Development of a pheromone lure

(1) Volatile extraction method

- Virgin female insects are placed on any host substrate
  (e.g. potato, unripe grapes, leaf) in aeration chamber
- Charcoal filtered air is drawn with a small pump over the content in the aeration chamber
- The adsorbent capture the volatiles emitted by the leaf and the insects
- After 24-72 (any time period can be chosen) hours of aeration, the adsorbent is desorbed with solvent
- Aeration extract analyzed by Gas Chromatography-ElectroAntennal Detection (GC-EAD)



Credit: R. Gries

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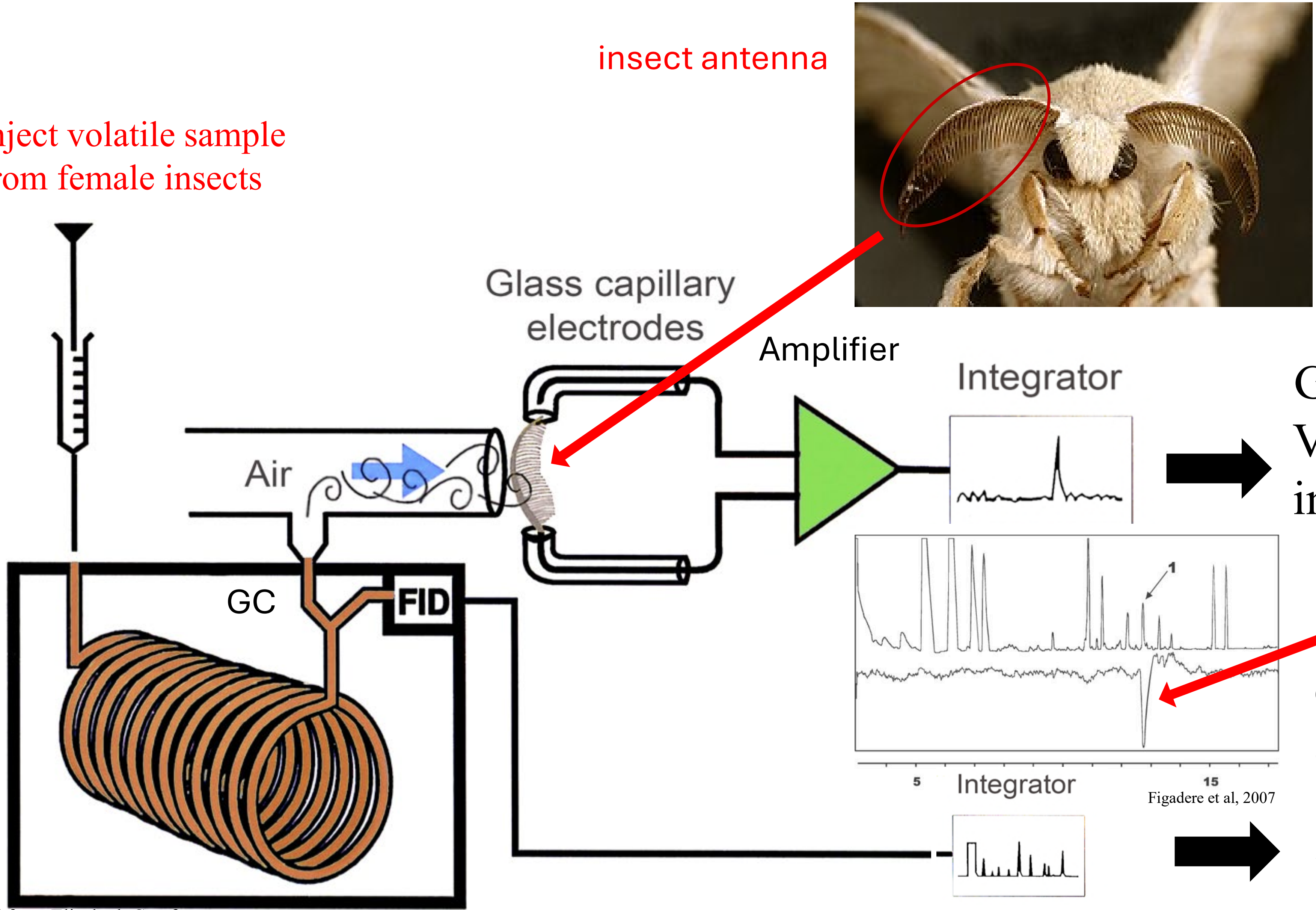
Development of a pheromone lure

(2) Gas Chromatography-ElectroAntennal Detection(GC-EAD)



Modified from Elizabeth Carefoot

GC-EAD:
Voltage changes in the insect's antenna

GC-FID
(flame ionization detector):
detects compounds in the sample

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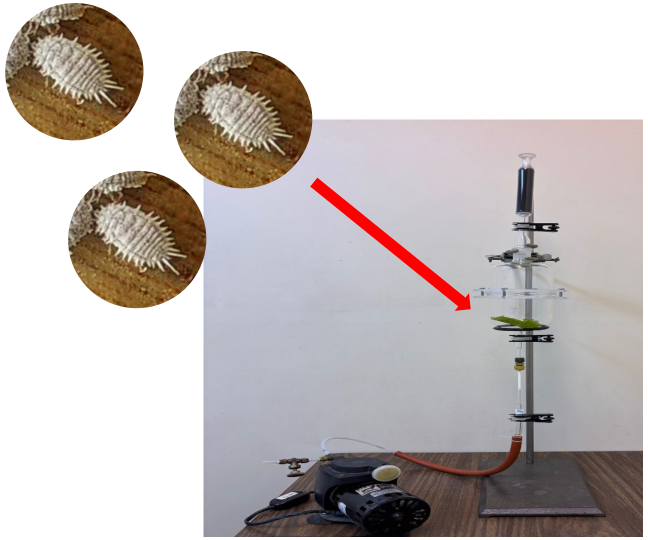
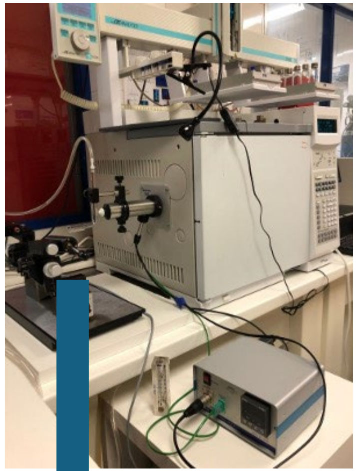
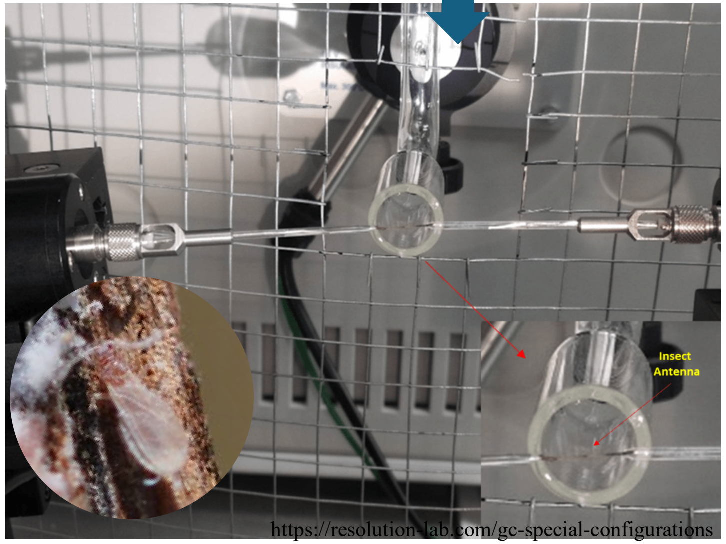
Steps of pheromone lure development

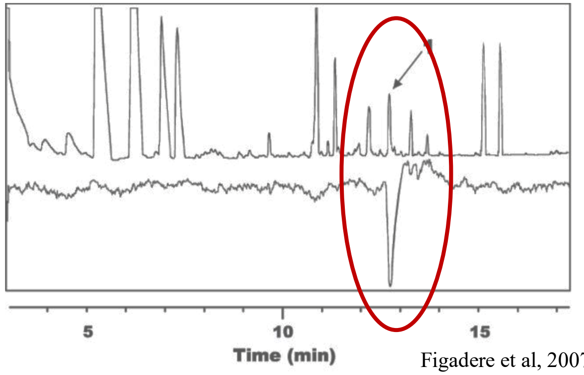


(1) aeration extraction from live virgin adult female insects





(2) gas chromatography-electroantennal detection (GC-EAD) with antenna of live adult male insect



Figadere et al, 2007

(3) identification of antennal response to aeration extraction

(4) rubber septum (lure) with synthetic version of the pheromone identified

Credit: M. Spodek

(5) lab and field trials with lure on sticky traps to test the attractiveness of the pheromone and develop optimal dosage and trap interval rates

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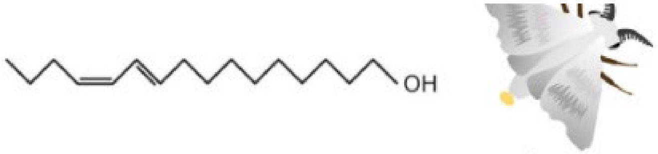
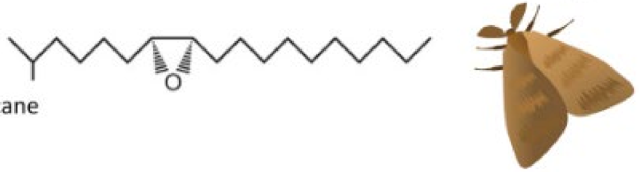
Introduction to insect pheromones

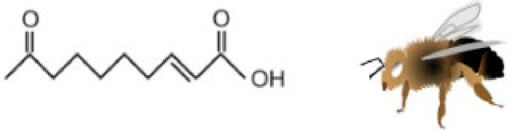
Silkmoth (*Bombyx mori*)
(E,Z)-10-12-hexadecadien-1-ol



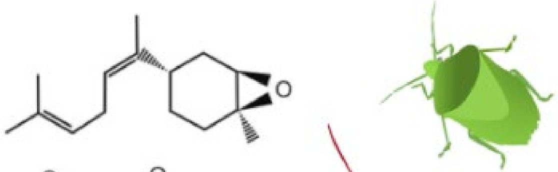
Gypsy moth (*Lymantria dispar*)
Disparlure (+)
(7R,8S)-cis-7,8-Epoxy-2-methyloctadecane



Honeybee (*Apis mellifera*)
(E)-9-oxo-2-decenoic acid



Green stink bug (*Nezara viridula*)
(1S,4S,6R)-1-methyl-4-((Z)-6-methylhepta-2,5-dien-2-yl)-7-oxabicyclo[4.1.0]heptane



Cockroach (*Periplaneta americana*)
Periplanone B
(1Z,5E)-1,10(14)-diepoxy-4(15),5-germacradien-9-one

Fruit fly (*Drosophila melanogaster*)
7 tricosene, non volatile

J.B. Harborne (1993), Introduction to Ecological Biochemistry (Fourth Edition)

https://www.pestcontrolindia.com/pheromone-lures/

- Species specific lures
- Commercially available

https://semios.com/our-hardware/pheromone-aerosol-dispensers/

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Pheromone lure applications

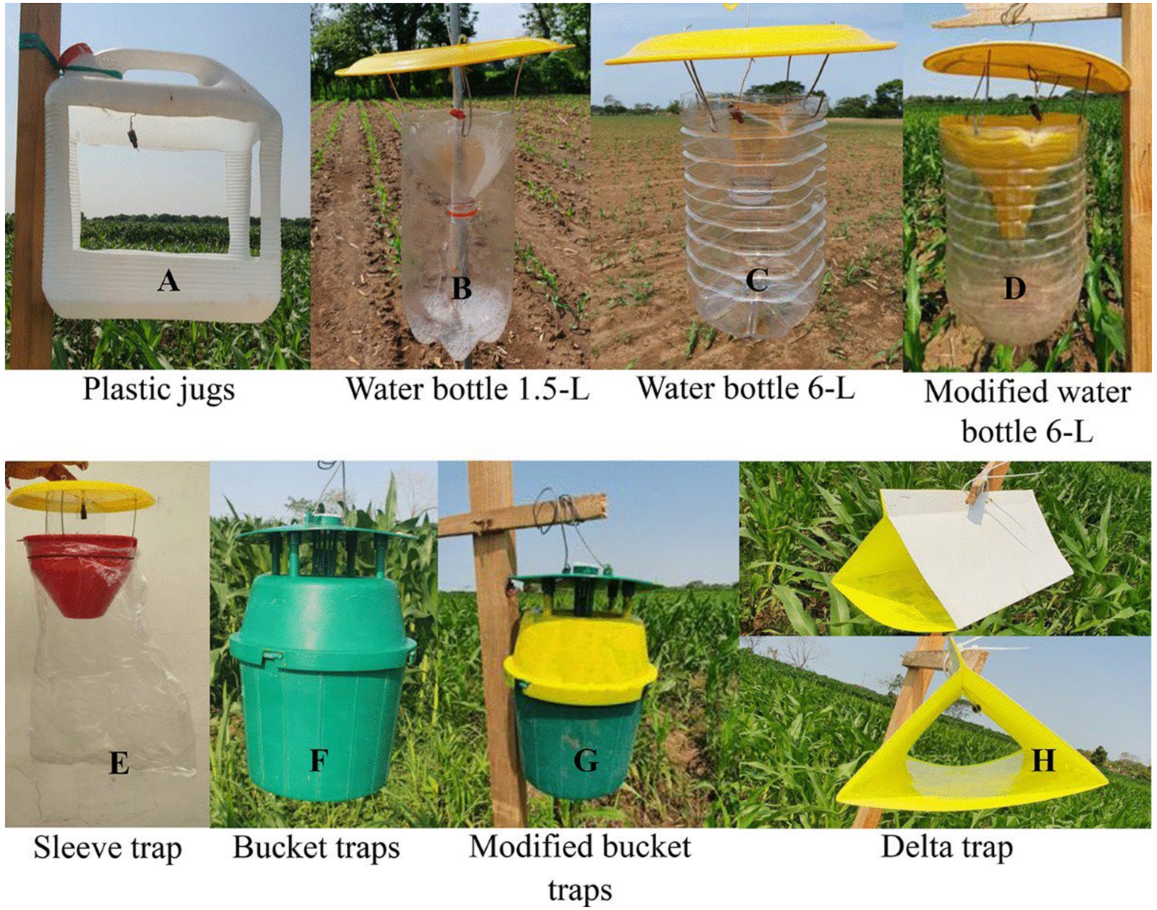
Table 1 Use of sex pheromone lures for detection (D) and population monitoring (M), and for mass annihilation tactics, by mass trapping (MT) and attract-and-kill (AK)

Species	Purpose	Region	Lures/year
Horticulture			
Coleoptera			
Red palm weevil *Rynchophorus ferrugineus*	MT	Asia	1.175.000
American palm weevil *Rhynchophorus palmarum*	MT	Central and South America	25.000
Palm fruit stalk borer *Oryctes elegans*	MT	Asia	125.000
Banana weevil *Cosmopolites sordidus*	MT	Worldwide	120.000
Coffee white stem borer *Xylotrechus quadripes*	MT	India	40.000
Diptera			
Olive fruit fly *Bactrocera oleae*	MT, AK	EU	–[a]
Lepidoptera			
Grapevine moth *Lobesia botrana*	M	EU, Mediterranean countries, Chile, USA	–
Codling moth *Cydia pomonella*	M, AK	Worldwide	–
Oriental fruit moth *Grapholita molesta*	M, AK	Worldwide	–
Tomato leafminer *Tuta absoluta*	M, MT	South America, EU, North Africa	2.000.000
Brinjal fruit and shoot borer *Leucinodes orbonalis*	MT	India, Bangladesh	400.000
Fall armyworm *Spodoptera frugiperda*	MT	Central America	50.000
Agriculture			
Coleoptera			
Cotton boll weevil *Anthonomus grandis*	MT (AK)	North and South America	2.600.000
Click beetles *Agriotes spec.*	M	Europe	–
Lepidoptera			
Pink bollworm *Pectinophora gossypiella*	M, AK	North and South America, South Asia	–
Old World bollworm *Helicoverpa armigera*[b]	M, MT		830.000
Cotton leafworm *Spodoptera litura*[b]	M, MT		480.000
African armyworm *Spodoptera exempta*	D	East Africa	–
Spotted bollworm *Earias vittella*[b]	M, MT		280.000
Yellow rice stem borer *Scirpophaga incertulas*	M, MT	India	100.000
Southwestern Corn Borer *Diatraea grandiosella*	D	USA	–
Potato tuber moth *Phthorimaea operculella*	AK	South Africa	–
Forestry			
Coleoptera			
Spruce bark beetle *Ips typographus*	MT	Europe, China	800.000
Mountain pine beetle *Dendroctonus ponderosae*	MT	North America	–
Douglas-fir beetle *D. pseudotsugae*	MT	North America	–
Lepidoptera			
Gypsy moth *Lymantria dispar*	D	USA, EU	250.000
Spruce budworm, *Choristoneura fumiferana*	D	Canada, USA	–
Pine processionary moth, *Thaumetopoea pityocampa*	D, M	EU	–
Stored products			
Cigarette beetle *Lasioderma serricorne*	M, MT	Worldwide	2.500.000
Indian meal moth, *Plodia interpunctella*	M, MT	Worldwide	2.000.000
Households and gardens			
Japanese beetle *Popillia japonica*	MT	North America	–
Oriental beetle *Anomala orientalis*	MT	North America	–
House fly *Musca domestica*	MT	Worldwide	2.000.000
German cockroach, *Blattella germanica*, American cockroach, *Periplaneta americana*	MT	Worldwide	1.000.000

Witzgall, Kirsch and Cork, 2010; Sex pheromones and their impact on pest management

Purpose of lures:

- Mass trapping
- Attract and Kill
- Detection and population monitoring
- Mating Disruption (MD)



(Cruz-Esteban, S. et al. 2022)

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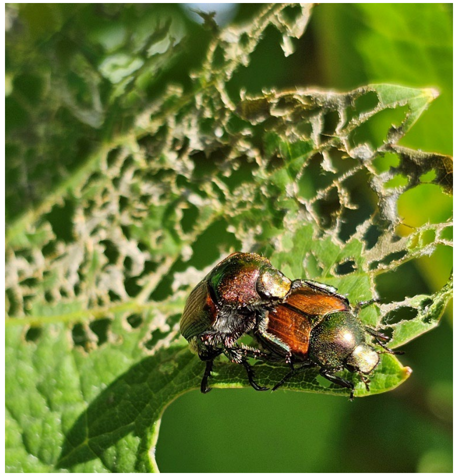
Mass trapping with pheromones

- Large numbers of traps with pheromone lures can be used to physically remove large numbers of male pests from the population, directly reducing the number of mating pairs.

Example:

Japanese beetle (*Popillia japonica*)

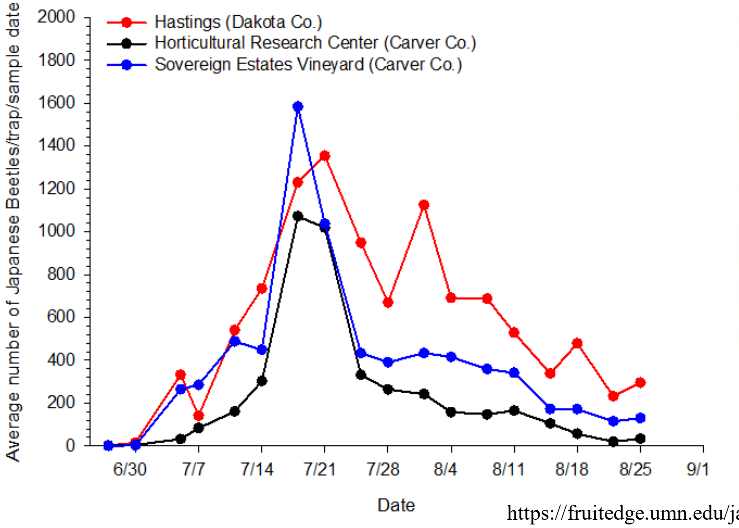
- Pest of grapes, feeds mainly on foliage and rarely on berries
- Baited with floral lure for females and sex pheromone for males
- Very efficient at trapping beetles
- Attract beetles to the vineyard!
- Use them as a lure-and-kill strategy at a distance or for scouting to minimize overall population pressure



Credit: M. Spodek

Credit: S. J. Wold-Burkness, UMN

Japanese beetle pheromone traps in a vineyard in the USA



Missouri farmers have expressed the need for an organic management tool for Japanese beetles.
Left: Mass trapping design developed for research purposes. **Right:** High-capacity mass trapping system intended to be used by farmers to trap Japanese beetles on farms, developed by Piñero and Dudenhoeffer (2018).

Credit: J. Pinero, University of Massachusetts

https://fruitedge.umn.edu/japanese-beetle/japanese-beetle-trapping University of Minnesota

Attract and kill

- Combines a pheromone lure to attract pests with a toxic agent or a mechanism to kill them, such as a sticky trap or a pesticide-treated container, creating a targeted method for eliminating pests.

Credit: Christopher Bergh

Example:

- The Grape Root Borer (*Vitacea polistiformis*)
- Moth native to Eastern USA, not a pest in Canadian vineyards
- Larvae feed on roots, reducing vine vigor and cold tolerance
- Pheromone traps are very efficient and sensitive for monitoring the onset, peak, and duration of its flight activity in vineyards

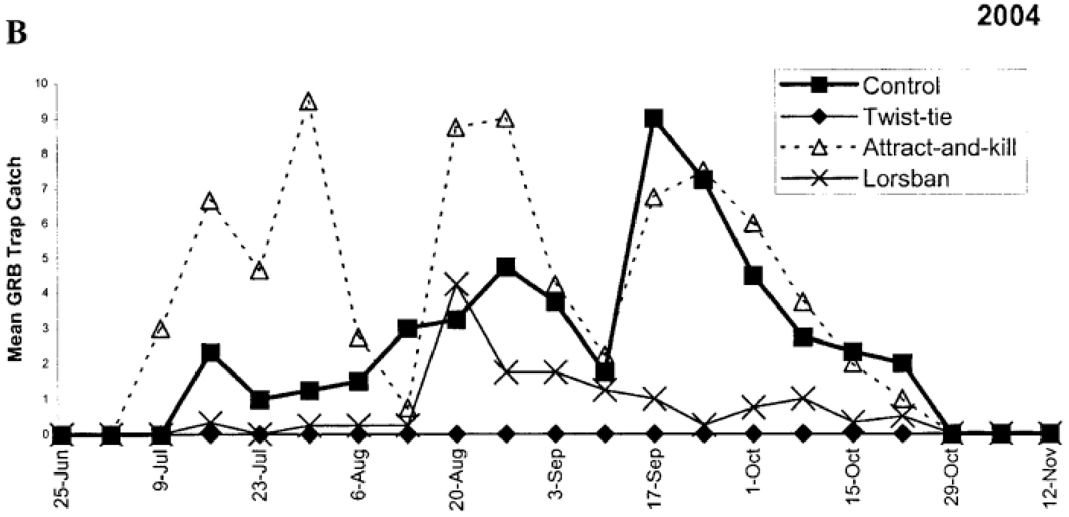


Fig. 1 A&B. Mean number of grape root borer males caught in monitoring traps per week for four treatments: untreated control, pheromone twist-ties, attract-and-kill gels, and Lorsban 4E for 2003 and 2004.

Fig. 4: Pheromone trap. Dead moths and insecticidal strip inside of trap (right).

https://uthort.tennessee.edu/wp-content/uploads/sites/228/2024/01/W171-The-Grape-Root-Borer-in-Tennessee.pdf

Detection/Monitoring

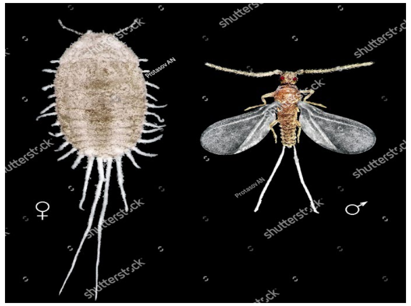
Pheromone-filled lures are placed in sticky traps to attract and capture specific male insects

- **Early Detection:** Finds new infestations and hot spots early
- **Timely Treatments:** Helps decide *when* and *where* to apply insecticides, reducing broad-spectrum chemical use
- **Population Mapping:** Shows the pest's spread and density within the vineyard

Example:

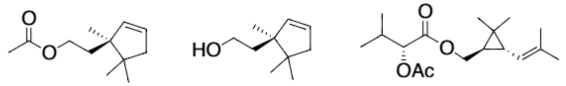
mealybugs; longtailed mealybug (*Pseudococcus longispinus)* and Citrophilus mealybug (*Pseudococcus calceolariae*) are major pests, vectors of vine virus in New Zealand vineyards

- Combining lures of both species provides viticultural industry with an efficient monitoring tool



Credit: A. Protasov/Shutterstock

Credit: R.J. Gill

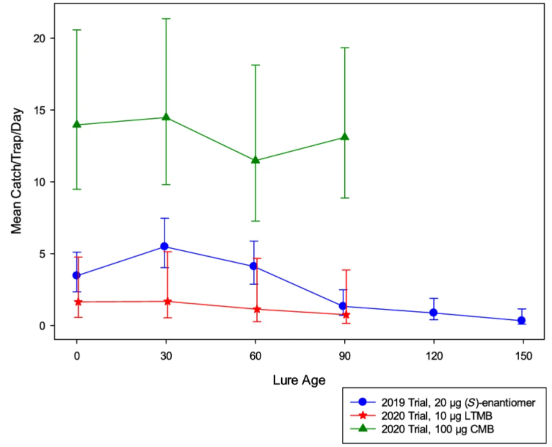


1 2 3

Fig. 1 The mealybug pheromones and pheromone analogue structures. (**1**) *Pseudococcus longispinus* pheromone: (*S*)-2-(1,5,5-trimethylcyclopent-2-en-1-yl)ethyl acetate; (**2**) *P. longispinus* pheromone corresponding alcohol (*S*)-2-(1,5,5-trimethylcyclopent-2-en-1-yl)ethan-1-ol; (**3**) The active (*R,R,R*) isomer of *P. calceolariae* pheromone (chrysanthemyl 2-acetoxy-3-methylbutanoate)

Marilyn Duxson with mealybug monitoring pheromone traps.

https://www.ruralnewsgroup.co.nz/hort-news/hort-management/mealybug-warnings



Lure longevity trials. Effects of lure age on mean total catch per trap per day of male *Pseudococcus longispinus*. Lures were aged for 0, 30, 60, 90 120 or 150 days before deployment in Marlborough 2019 and Gisborne 2020. Error bars are 95% confidence limits

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Detection/Monitoring

Adult moth

Example:

Grape Berry Moth (GBM) (*Paralobesia viteana*)

- Major insect pest causing serious economic losses to commercial vineyards in Eastern NA
- Developed resistance to more frequently used insecticides
- Decoy Grape Berry Moth Pheromone is first sex pheromone product registered under Pest Control Products Act for control of an insect pest in Canada (1992)
- Helps to determine spray application timings in vineyards and effectiveness of Mating Disruption (MD) lures

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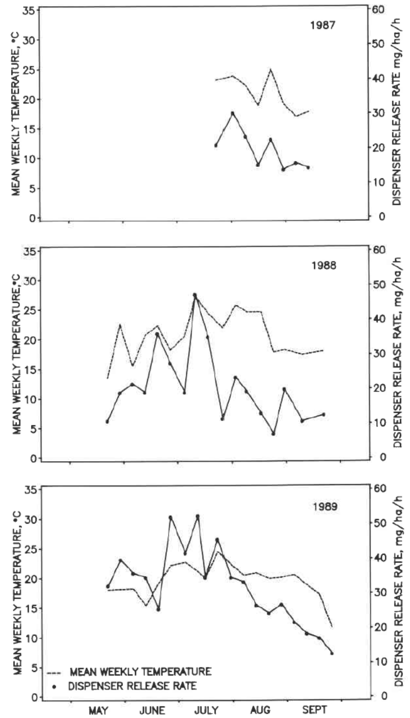

G. 1. Estimated grape berry moth pheromone dispenser release rates (milligrams per hectare per hour) for the Biocontrol tape-type (1987 and 1988) and wire-type (1989) dispensers, and mean weekly temperature, °C.

Credit: Trimble et al, 1991

Credit: K. Ker

Credit: W. McFadden-Smith

https://extension.okstate.edu/programs/digital-diagnostics/insects-and-arthropods/grape-berry-moth-endopiza-viteana/
https://pesticideguy.org/2014/12/18/new-insecticides-greatly-improve-grape-insect-management/

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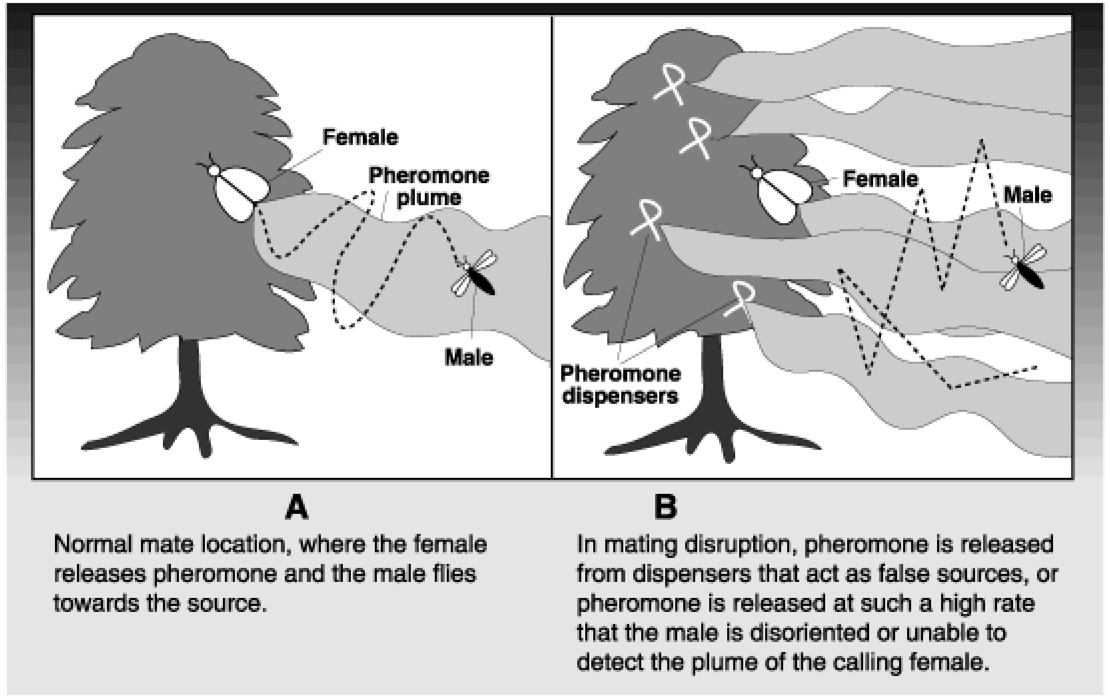
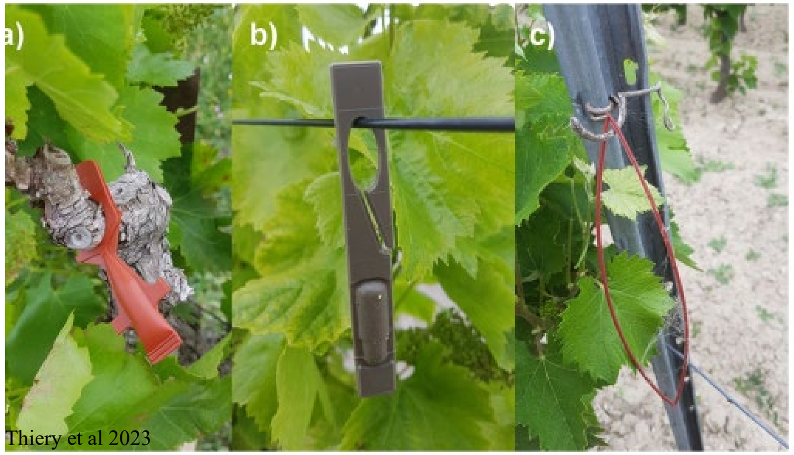
Mating Disruption (MD)



https://treefruit.wsu.edu/crop-protection/opm/mating-disruption/



Passive dispensers developed for MD in viticulture: Ampoules and tubes filled with pheromones

Artificial pheromone released in large amounts:

- Interferes with mate location; disorients the male
- Controls pest by preventing mating
- Unmated females lay non-fertilized eggs

https://lodigrowers.com/disruption-of-vine-mealybug-mating/

Active aerosol dispenser developed for MD in viticulture

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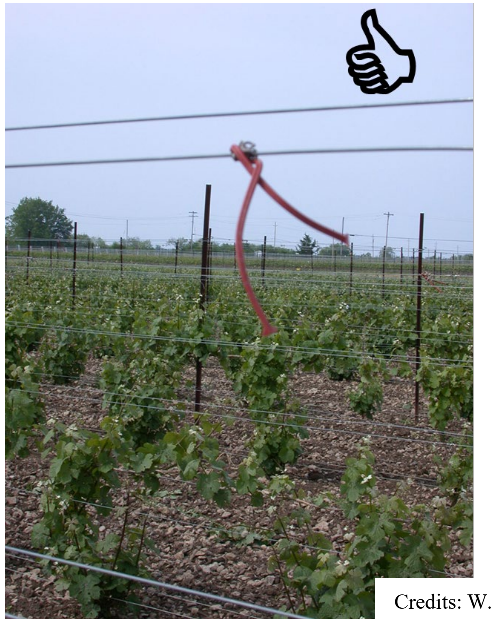
Mating Disruption (MD)

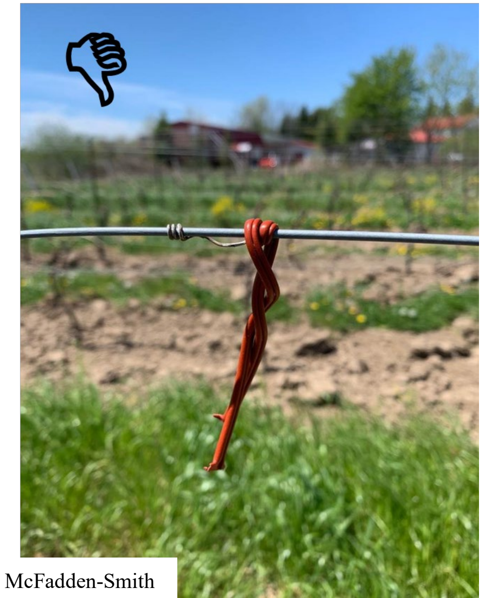
- An advanced technique where dispensers release a continuous, high concentration of synthetic pheromones throughout the vineyard.
- This creates a "fog" that confuses male insects, making it impossible for them to locate females
- Disrupts the mating cycle and significantly lowering the number of offspring

Example:

Grape Berry Moth (GBM) (*Paralobesia viteana*)

- Introduced and trialed in Niagara vineyards in 2007 and used mainly by organic growers
- For low to moderate GBM pressure
- 500 dispensers/ha and correct application is critical
- Use sentinel traps for monitoring effectiveness





Credits: W. McFadden-Smith

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Consumer Product Safety

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Label Search Results

Product Information

Registration Number :	27525
Product Name :	ISOMATE-GBM PLUS GRAPE BERRY MOTH PHEROMONE
Registrant Name :	PACIFIC BIOCONTROL CORPORATION*
Registration Status :	REGISTERED
Date of First Registration :	2004-01-29
Last Sale by Registrant :	
Last Sale by Retail :	
Expiry Date of Registration :	2029-12-31
Marketing Type :	COMMERCIAL
Active Ingredient(s):	(Z)-9-DODECENYL ACETATE Z-9-Dodecen-1-yl acetate **CASN** = 16974-11-1 (**GUAR** = 91.07 % NOMINAL)

Date Modified: 2026-01-09

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Important Notices

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MD for Grape Berry Moth

ADVANTAGES

- Application not restricted by weather conditions
- Does not rinse off
- Single application per generation
- No drift
- Unlimited re-entry

CHALLENGES

- Labor intensive and expensive
- Dispenser can accumulate on wires over time
- Preventative NOT corrective measure

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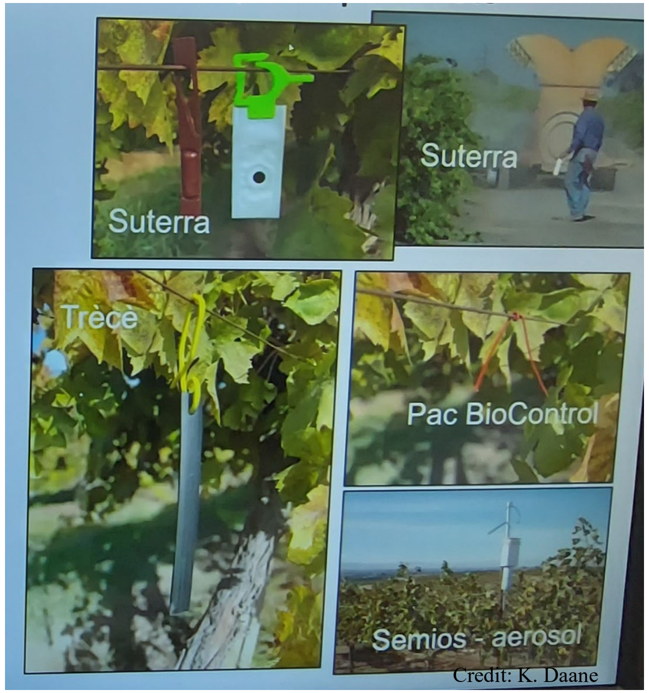
Mating disruption (MD) with pheromones

Example:

Vine mealybug (*Planococcus ficus*)

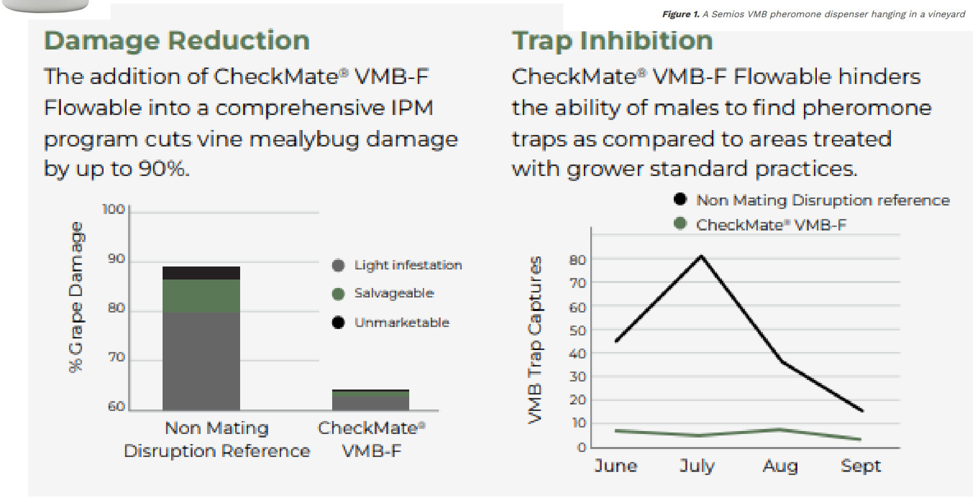
- 2001-sex pheromone identified and developed by Dr. J.G. Millar and team
- 2002-commercial use of monitoring traps in Californian vineyards
- 2004-2006 MD programs developed and trialed by Dr. K. Daane and team
- MD is well-established and growing practice in California vineyards, with adoption varying by region and grower, often seen in large-scale efforts in prominent areas like Napa and Lodi, supported by research trials.

Credit: K. Daane, 2006



Types of MD dispensers

Figure 1. A Semios VMB pheromone dispenser hanging in a vineyard



https://www.suterra.com/products/vmb

https://www.trece.com/products/vine-mealybug-mating-disruption/

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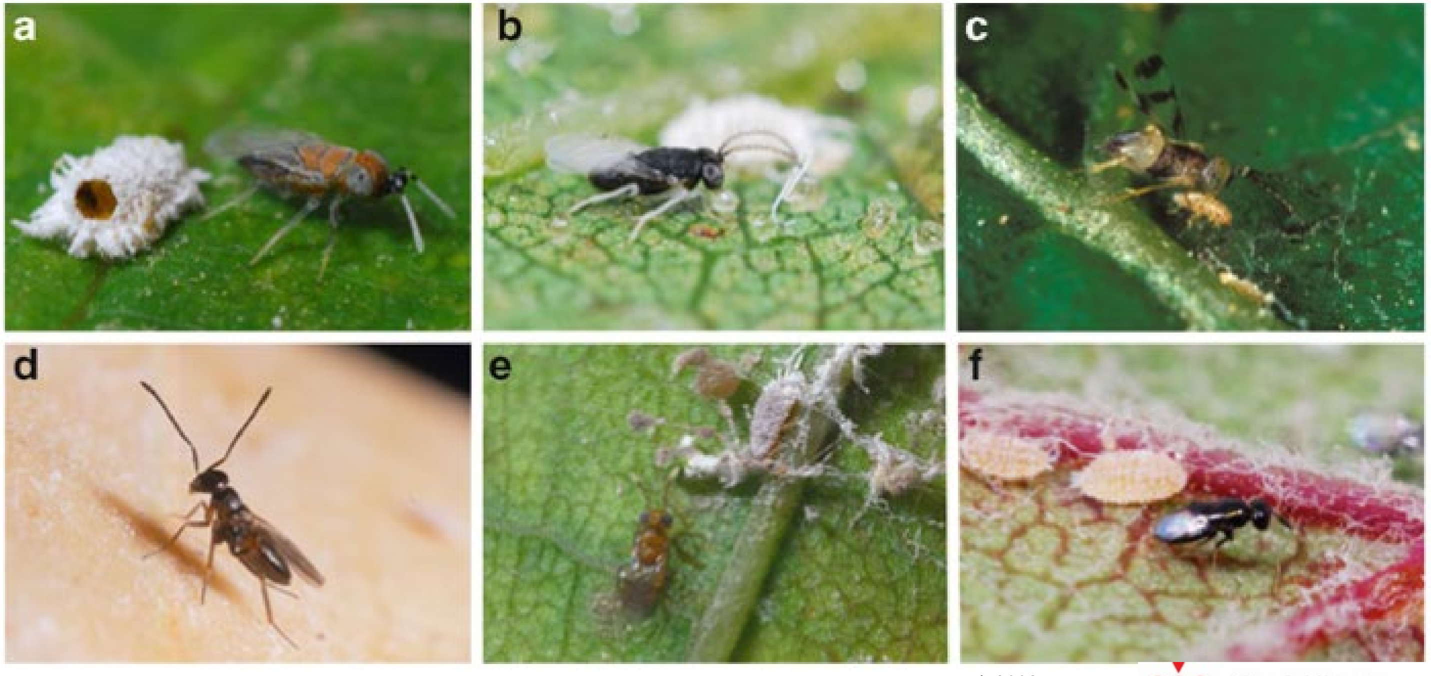
Bonus to mealybug pheromone lures: attracting parasitoid wasps, natural enemies

- Parasitoid wasps are significant natural enemies of mealybugs, and their effectiveness can be enhanced by the strategic use of mealybug sex pheromones.
- Mealybug sex pheromones play a dual role in vineyard management

•**Attraction (Kairomonal Response):** female parasitoid wasps are naturally attracted to sex pheromone released by female mealybugs to locate their hosts.

•**Integrated Strategy:** pheromone dispensers are used to concentrate parasitoid activity in specific areas of the vineyard, increasing the rate of mealybug parasitism.

Male and female vine mealybug. Photo: University of California



Heppner et al. 2008

various parasitoid wasps of mealybugs

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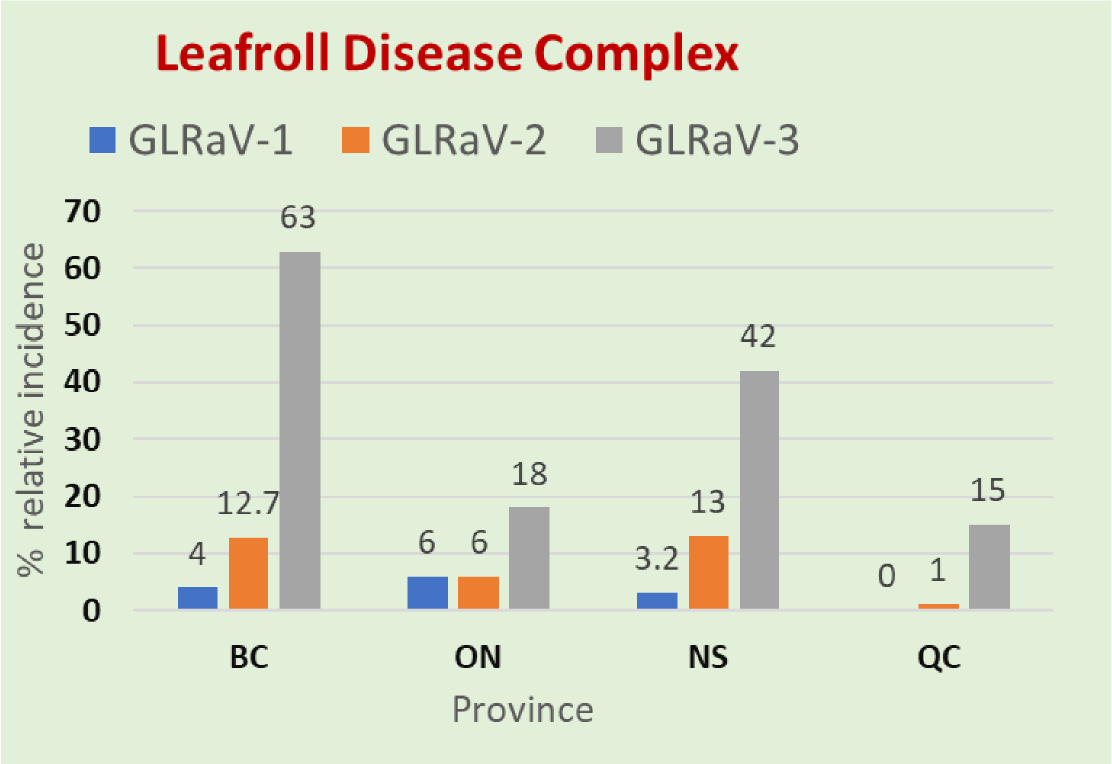
In Canada: Grapevine cultivation in four provinces

- Ontario (ON): 7168 ha, 58% of total, 500 growers
- British Columbia (BC): 4848 ha, 36% of total, 900 growers
- Québec (QC): 848 ha, 6% of total, 107 growers
- Nova Scotia (NS): 391 ha, 3% of total, 100 growers

Statistics Canada. 2023



Vemulapati et al, 2025

Credit: M. Spodek

Cool Climate Oenology & Viticulture Institute Brock University

Grapevine leafroll on cv. Merlot

Grapevine leafroll on cv. Chardonnay

Grapevine Leafroll Virus 3 (GLRaV-3) symptoms:

- Red or purple coloration on mature leaves with green veins in red-fruited cultivars
- Yellowing on the mature leaves in white-fruited cultivars
- Backward rolling of mature leaf margins commonly found in both white and red fruited cultivars
- Uneven ripening of berries and thin clusters
- Reduced yield and poor quality of grapes would result in significant economic losses

Long-term productivity losses of up to CAD $298,784 per hectare (ha)

Credits: Poojari, 2020

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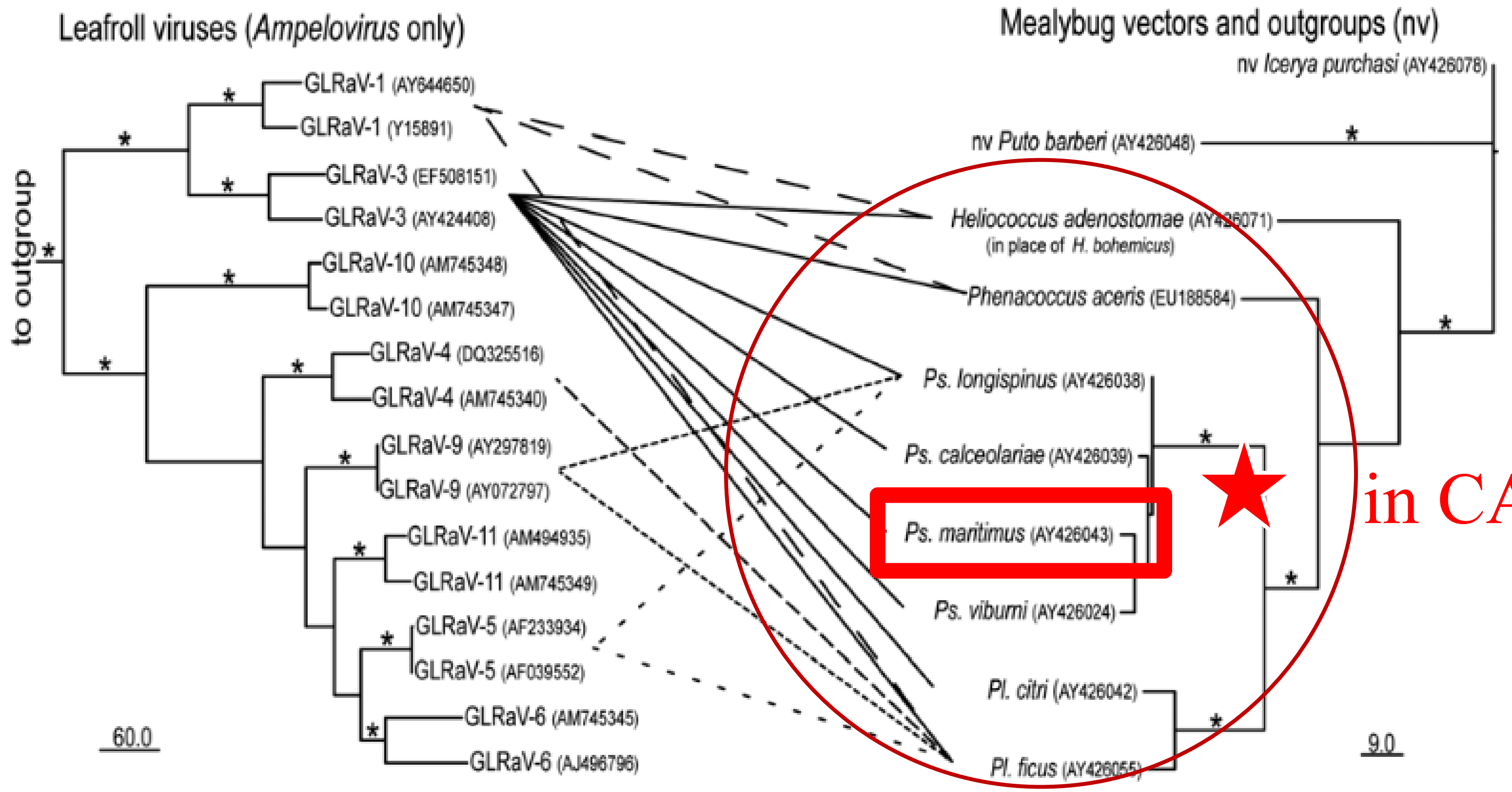
Brock University

Mealybugs that vector
Grapevine Leafroll Virus 3 (GLRaV-3)



in CANADA

Credit: Protasov AN / Shutterstock

Fig. 1. Maximum parsimony trees of grapevine ampeloviruses (left) and all mealybug species shown to transmit grapevine leafroll-associated viruses; asterisks indicate >70% branch support. Lines indicate which virus species were transmitted by each mealybug vector; nv = nonvector species. Supplementary material provides more detail.

Tsai et al 2010

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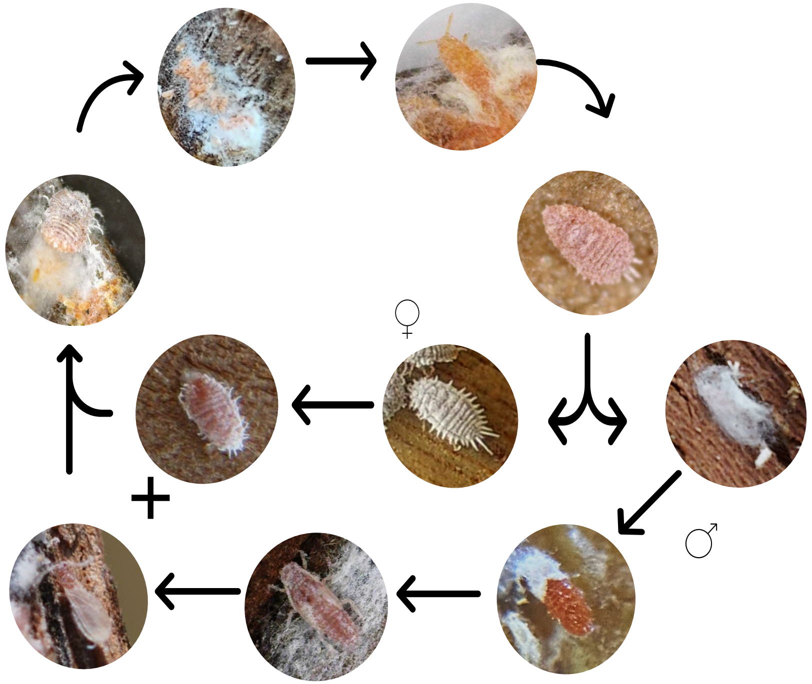
Background on Grape Mealybug

- Soft bodied insects
- Sexual dimorphism: different appearance of males and females
- Females are neotenic and almost immotile with no wings and retrogressed legs
- Adult males are winged, don't have mouthparts and live a few days
- Feed on vine sap (phloem) not on grapes
- Live most of life under the bark of vines

Credits: M. Spodek



3 month lifecycle

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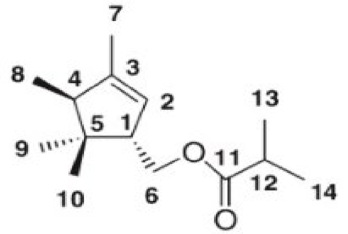
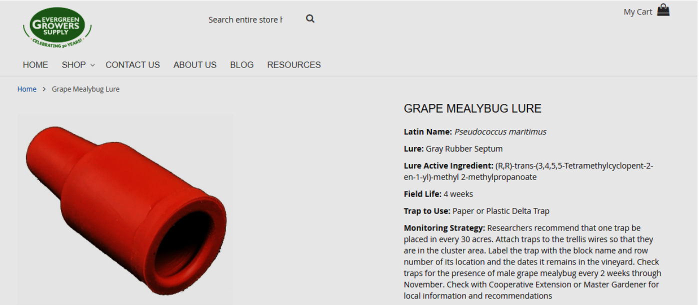
Pheromone traps for Grape mealybug (*Pseudococcus maritimus*)

- In 2007-2010, sex pheromone identified and synthesized from virgin female grape mealybug by team at University of California (Figadere et al. 2007; Zou and Daane 2010)
- Used to determine seasonal phenology in 3 wine grape growing regions of Oregon (Walton et al, 2013)
- Pheromone-based Monitoring in Washington State (Bahder et al, 2013)
- Mating Disruption for Grape Mealybugs in Washington Vineyards (Onayemi and Walsh, 2022)
- Optimizing insecticide timings based on pheromone trap capture data (Onayemi et al, 2025)



Structure of trans-a-necrodyl isobutyrate 1

Figadere et al. 2007; Zou et al. 2010



Photos: R. Isaacs, MSU & S. Onayemi WSU

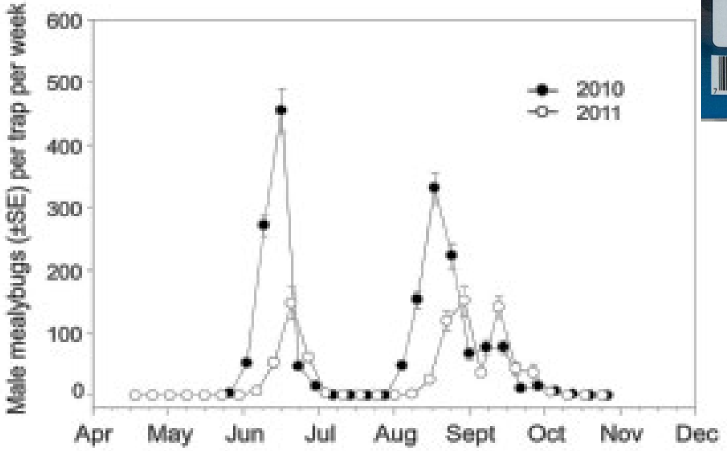
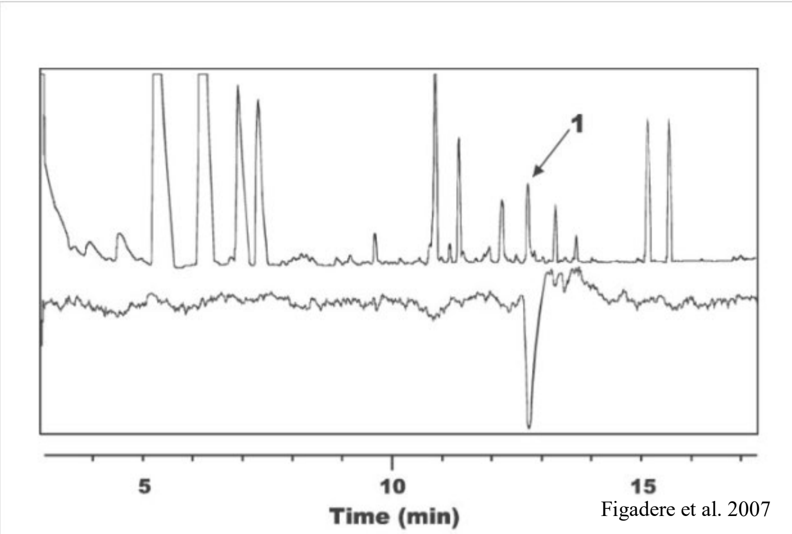


Fig. 2. Mean numbers (±SE) of adult male *Pseudococcus maritimus* recorded per trap per week in 2010 and 2011 show two distinct flight periods in each year.

Walton et al, 2013

Fig. 5 – Sentinel trap with pheromone lure for monitoring grape mealybug males

Onayemi and Walsh, 2022



Figadere et al. 2007

Couple gas chromatography electroantennogram analysis of virgin grape mealybugs

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Grape mealybug in Canadian vineyards

- Identified as vector of grapevine leafroll associated virus-3 (Bahdar et al. 2013)
- Currently controlled by Movento (spirotetramat), systemic insecticide
- Scouting by removing bark from vine trunks in early spring, visual inspections
- Pheromone lures from USA trialed 2017-2023, not successful at trapping males


male mealybug on sticky trap


https://www.instagram.com/p/DJ2T3DwTJp-/

WHY ARE TRAPS NOT WORKING??

Credits: M. Spodek

Credits: W. McFadden-Smith

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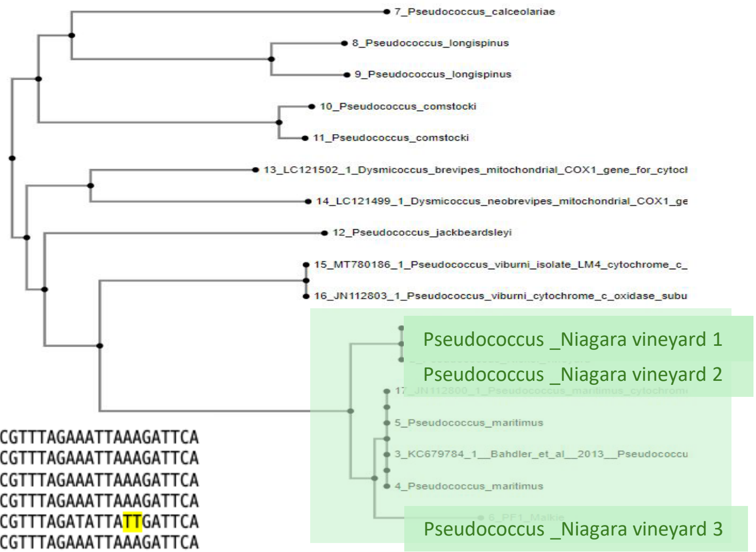
Why Grape mealybug pheromone traps not working in Canada?

- Perhaps not the same species as US Grape mealybug or maybe a subspecies??

Grape mealybug   Obscure mealybug

- Need more robust genomic tools to clarify the identity of Canada's Grape mealybug



Tree credit: Dr. V. Cezar Pacheco da Silva, Universidad de la República, Uruguay

Molecular analysis with CO1 (barcode gene) segment of ON+BC+US grape mealybug specimens

CLUSTAL O(1.2.4) multiple sequence alignment

```
BC_PM                    TTTCATTAAATGTATGATTTAAATTTGGATTATTATTTAATCATTCAGGATTAAAAAATTTTATTTTAAATAAAATTAAACGTTTAGAAATTAAAGATTCA
US_PV                    TTTCATTAAATGTATGATTTAAATTTGGATTATTATTTAATCATTCAGGATTAAAAAATTTTATTTTAAATAAAATTAAACGTTTAGAAATTAAAGATTCA
ON_PF                    TTTCATTAAATGTATGATTTAAATTTGGATTATTATTTAATCATTCAGGATTAAAAAATTTTATTTTAAATAAAATTAAACGTTTAGAAATTAAAGATTCA
JN112800.1_Pmaritimus    TTTCATTAAATGTATGATTTAAATTTGGATTATTATTTAATCATTCAGGATTAAAAAATTTTATTTTAAATAAAATTAAACGTTTAGAAATTAAAGATTCA
MT762939_Pviburni        TTTCATTAAATGTATGATTAATATTTGGATTATTATTTAATCATTCAGGATTAAAAAATTTTATTTTAAATAAAATTAATCGTTTAGATATTATTGATTCA
AB512118.1_Plongispinus  TTTCATTAAATGTATGATTTAAATTTGGTGAATTATTTAATCATTCTCTATTGAAAAATTTTATTTTAAATATAATTAATCGTTTAGAAATTAAAGATTCA
LC121496.1_Pcomstocki    TTTCATTAAATGTATGATTTAAATTAGGCGAATTATTTATTCATTCTATATTAAAAAATTTAATTTTAAAAATAATTAATCGTTTAAAAATTAAAGATTCA
                         ****************** * *** **   ******** ******   *** ******** ******** * ****** ****** * ****  ******

BC_PM                    ATAATAATAAAAATGAATATAATAGTAAATAAAATAGTTATAAAAGATCCAATAGAAGAAATATTGTTTCATAAAATAAAATAATCTGAATATATAATAT
US_PV                    ATAATAATAAAAATGAATATAATAGTAAATAAAATAGTTATAAAAGATCCAATAGAAGAAATATTATTTCACAAAATAAAATAATCTGAATATATAATAT
ON_PF                    ATAATAATAAAAATGAATATAATAGTAAATAAAATAGTTATAAAAGATCCAATAGAAGAAATATTATTTCATAAAATAAAATAATCTGAATATATAATAT
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MT762939_Pviburni        ATAATAATAAAAATAAAAATTAAGTAAATAAAATAGTTATGAATGAACCAATAGAAGAAATATTATTTCATAAAATAAAATAATCAGAATATATAATAT
AB512118.1_Plongispinus  ATAATAATAAAAATAAATATTATGGTGAAAATAATAGTTATTGAAGAACCAATTGAAGAAATATTATTTCATAAAATAAAATAATCTGAATATATAATGT
LC121496.1_Pcomstocki    ATAATAATAAAAATAAAAATTATTGTAAAAATAATAGTTATTGATGATCCAATAGATGAAATATTATTTCATAAAATAAAATAATCTGAATATATAATAT
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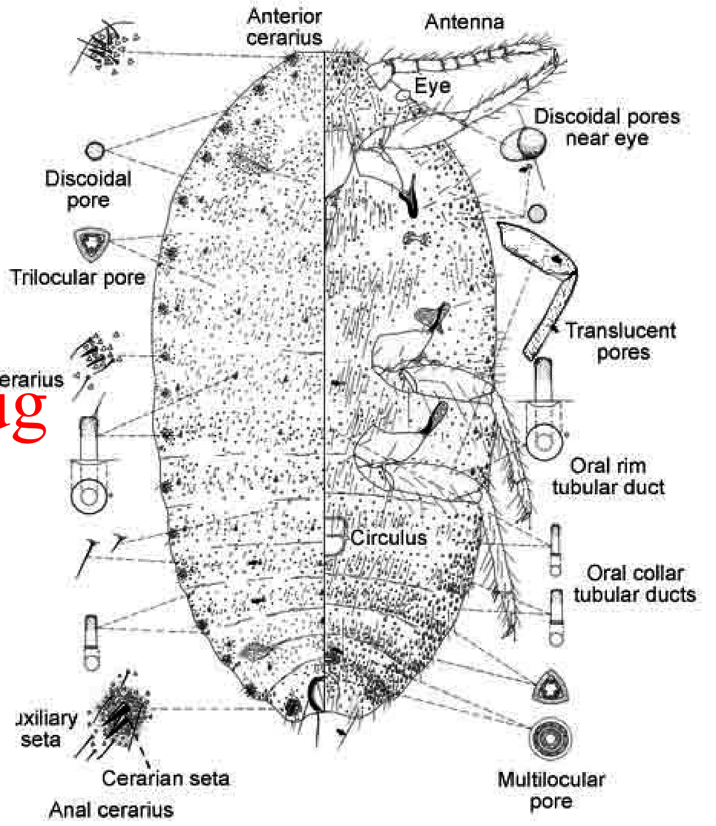
P. Liang unpublished data



Grape Mealybug; Adult female

Miller, D., et al, 2014 <https://idtools.org/scales/>

unpublished data

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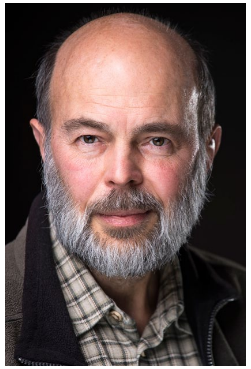
Mealybug pheromone development

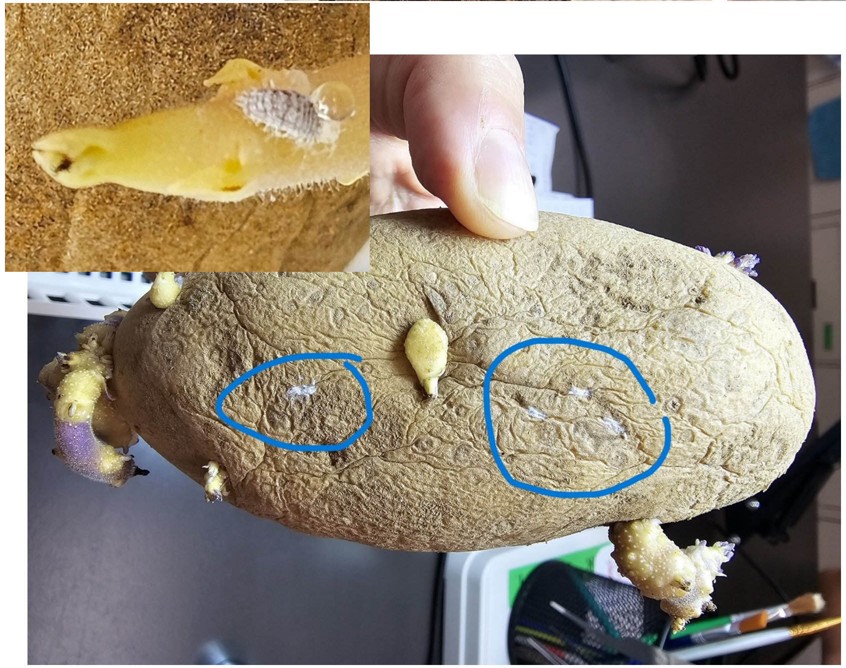



Professor G. Gries & R. Gries
semiochemical ecologists, Simon Fraser University, BC

Credits: M. Spodek

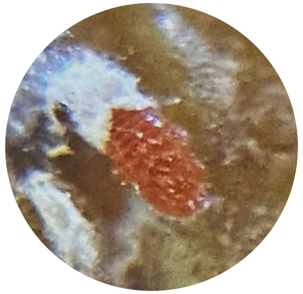
Credit: A. Brauner

Establishing a mealybug rearing for pheromone identification



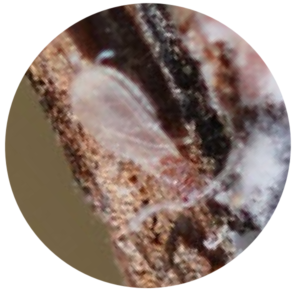
male mealybug development, complete metamorphosis

cocoon



prepupa

pupa



adult male

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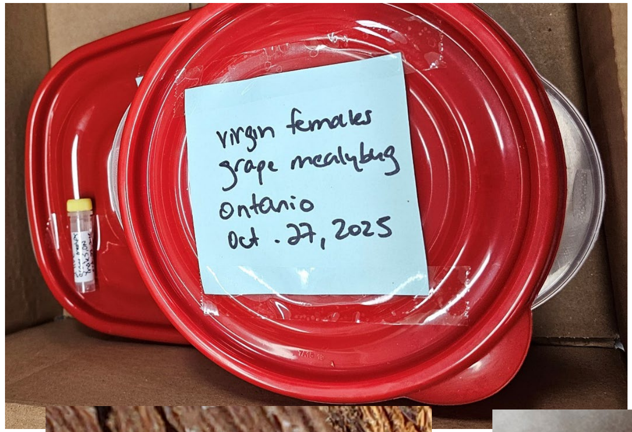
Credits: M. Spodek

Shipping Grape mealybugs for pheromone extraction

unmated Grape mealybug females



Grape mealybug egg sacs

Grape mealybug cocoon

adult male Grape mealybug

- unmated females, egg masses, male cocoons and 1 live adult male shipped overnight to Gries lab, Burnaby, BC several times last summer and early fall for establishing a rearing and pheromone extractions

Credits: M. Spodek

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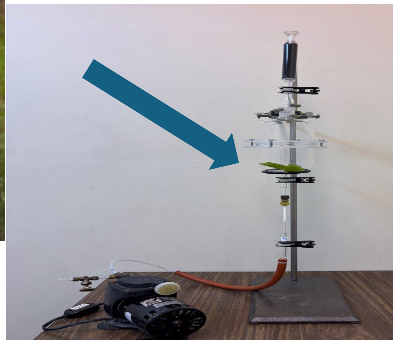
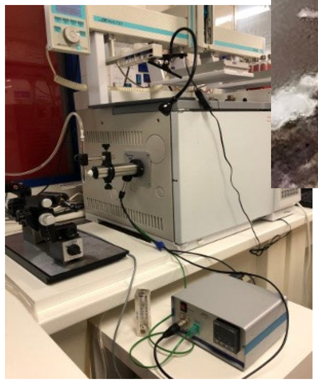
Results of 1st aeration extraction trial with Canadian Grape mealybugs

BC female grape mealybugs



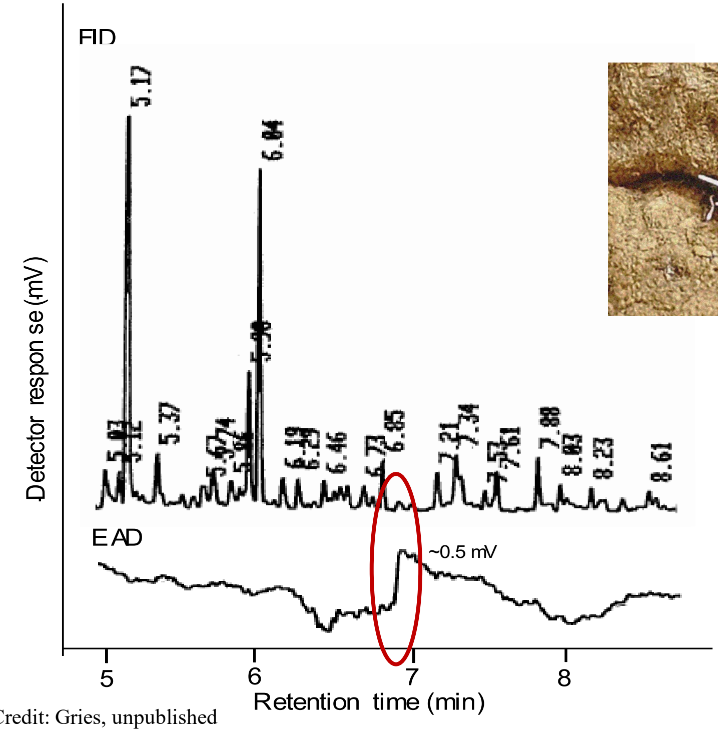
aeration extraction



GC-EAD

ON male grape mealybug

Response of Ontario male Grape mealybug antenna to aeration extract of 12 Grape mealybug females from BC



Credit: Gries, unpublished

- There is only a blip in the FID (Flame Ionization Detector) trace
- All other peaks are volatiles most likely emitted from the substrate the mealybugs were feeding on and have nothing to do with the pheromone

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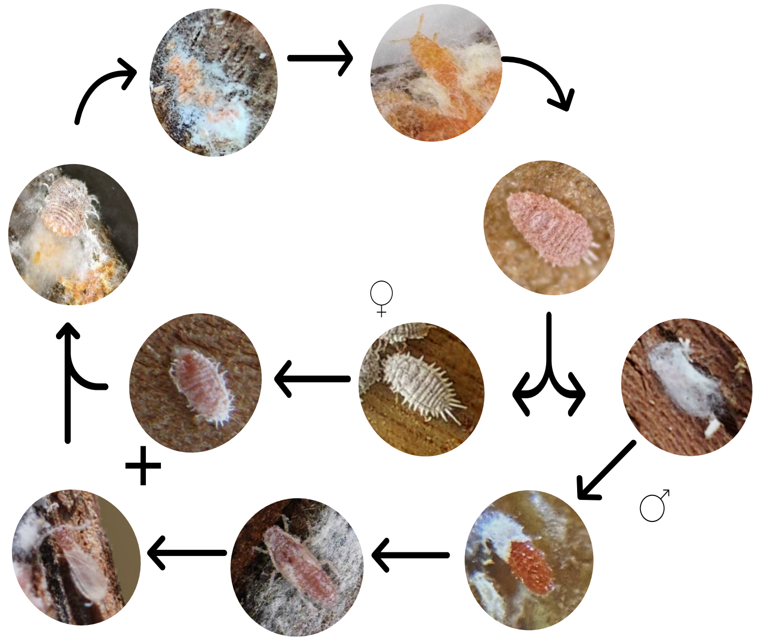
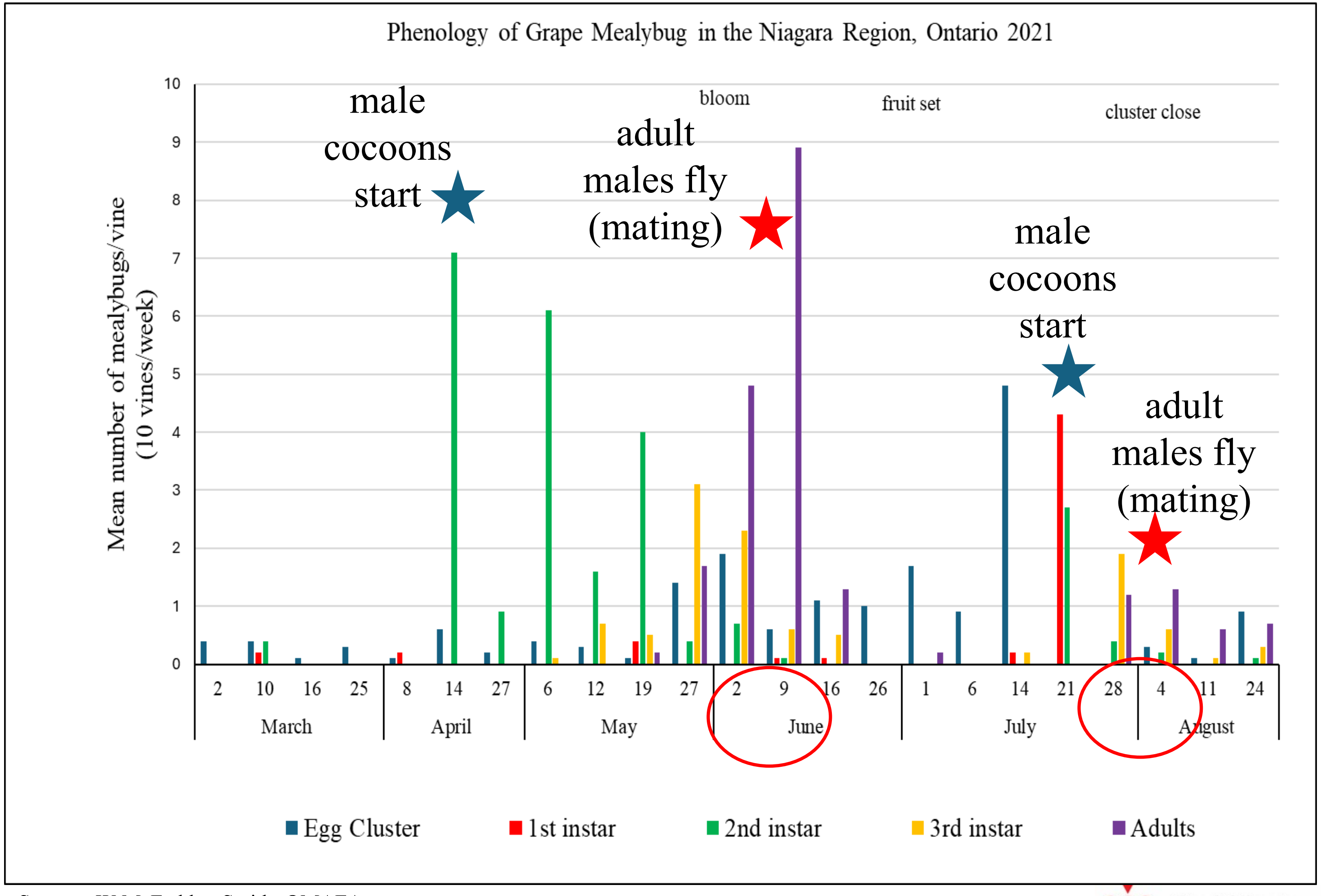
Field testing new lures in ON+BC



Lifecycle of grape mealybug

- Trapping field tests with synthetic lures
- Compare the number of males trapped to control lures
- Determine lure dosage and trap interval in vineyard



Source: W McFadden-Smith, OMAFA unpublished data

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Future research plans

- Genomics of both ON and BC mealybugs
- Collect more adult female and male mealybugs from ON and BC vineyards
- Repeat aeration extraction with more live virgin females from ON+BC
- Compare aeration extraction to existing grape mealybug pheromone compound
- Test lures in lab and ON +BC vineyards trials with different pheromone dosages and trap intervals

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Benefits of using pheromone lures in vineyards

- **Species-specific:** they target only the pest species and don't harm non-target organisms like beneficial insects or pollinators.
- **Environmentally safe:** they are naturally occurring or easily degradable synthetic substances that leave no harmful residues on the fruit, soil, or water.
- **Effective for management:** prevent or reduce pest populations to a manageable level, which is crucial for vineyard sustainability and productivity.
- **Supports integrated pest management (IPM):** provide data for monitoring and can reduce the need for broadcast chemical applications.
- **Resistance Management:** the development of pest resistance is highly unlikely, because they disrupt behavior rather than biochemistry.
- **Long-lasting effectiveness:** a single lure can remain effective for weeks or even months, depending on the product, making them a cost-effective solution.
- **Supports Worker Safety:** because pheromones are naturally occurring and species-specific, they are non-toxic and safe for workers.

Challenges of using pheromone lures in vineyards

Higher Cost: The initial cost of pheromone products and dispensers can be higher than conventional insecticides, which has been a barrier to wider adoption in the past.

Labour Intensive: To deploy dispensers in vineyards and dispensers can accumulate on wires over time (would need to be removed). Newer technologies like aerosols, flowable sprays, and drone applications are addressing this.

Pest Density: Mating disruption is less effective when pest populations are already very high, requiring a combination with other methods as part of an IPM strategy.

Credit: M. Spodek

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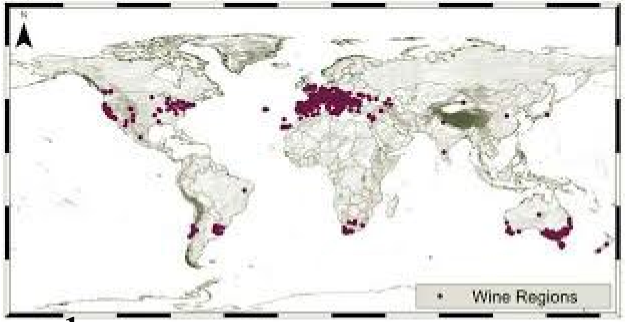
Global use of pheromone practices in vineyards



Compes, 2019

- **Europe:** Pheromone mating disruption is a standard practice in many European vineyards
  - France: used to protect over 100,000 hectares of vines (12% of the total, 2019)
  - Switzerland and Germany: used on approximately 60-65% of vineyards
  - Italy: largely replacing insecticides in some regions mainly for moths and mealybugs
- **North America:** USA: California, Washington State and Oregon, vine mealybug and codling moth

  Canada: Grape Berry Moth pheromone for monitoring and MD
- **South America:** Argentina (Mendoza) + Chile: successful programs have been implemented controlling the European grapevine moth

  Argentina+Chile+Peru: various mealybug species
- **Australia+New Zealand:** monitoring and MD under R&D for mealybugs; longtailed mealybug, vine mealybugs, Citrophilus mealybugs

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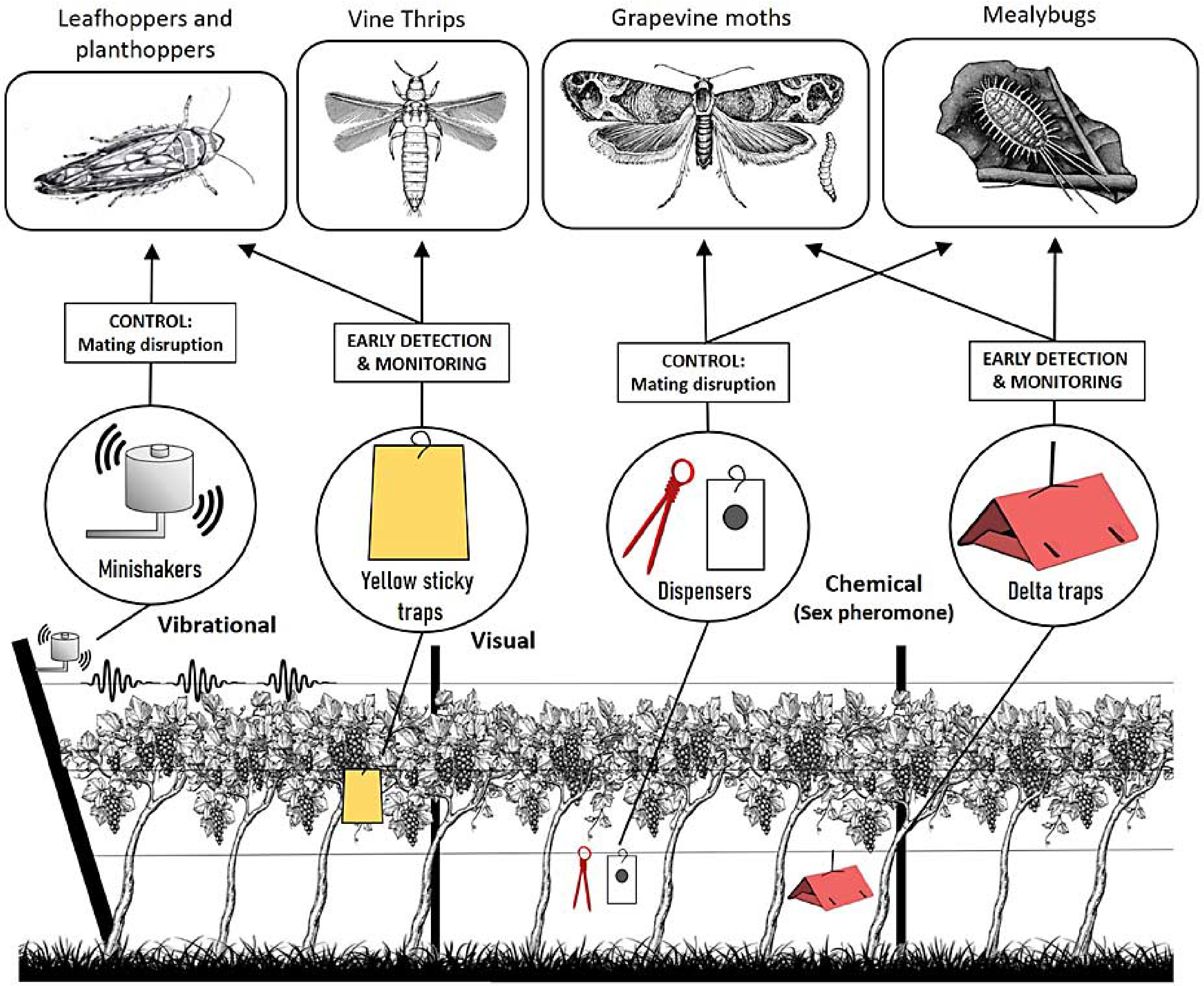
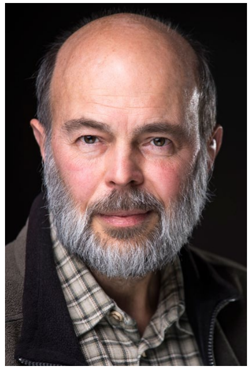
IoT-integrated "smart traps" with real-time monitoring sensors +

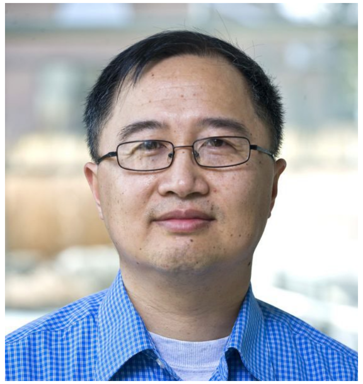
Integrated Pest Management (IPM) using different tools to reduce chemical inputs for sustainable grape growing in vineyards



Courtesy Rachele Nieri/University of Trento, Italy

Research Partners:





Dr. W. McFadden-Smith
grape IPM specialist, OMAFA

Professor G. Gries & R. Gries
semiochemical ecologists,
SFU, BC

Dr. A. Renyard
entomologist,
AAFC-Summerland, BC

Dr. S. Poojari
plant virologist,
CCOVI/Brock University, ON

Dr. P. Liang
genomicist
Brock University, ON

Industry Partners:

- Stouck Vineyard and North of King Viticultural Services
- Cave Spring Vineyard
- Synergy Semiochemicals Corporation

CAVE SPRING
VINEYARD

Synergy Semiochemicals Corporation

Research Assistants:

Mansi Pandya
Harman Singh
Andrew Legros

Funder:

Ontario Research Fund (ORF-RE)-VINO Solutions

Ontario
Research Fund

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