# Controlling Carpophilus Beetle

**Paul Cunningham,**
Kevin Farnier, Mofakhar Hossain, Blair Grossman,
Lea Rako, Cathy Taylor, David Madge

AGRICULTURE VICTORIA

SUPPORTED BY:
Horticulture Innovation Australia Ltd

HOSTED BY:
The Almond Board of Australia

18th Australian Almond Conference

Pullman Hotel Melbourne, Albert Park, Victoria

October 30th - November 1st, 2018

AUSTRALIAN ALMOND CONFERENCE 2018

# The *Carpophilus* problem

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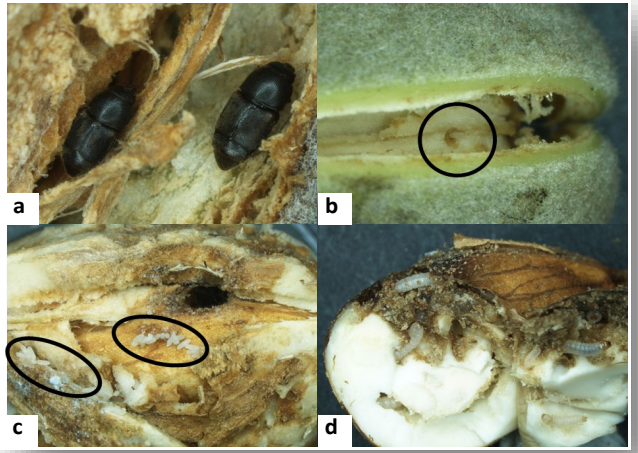
Since 2014, the almond industry has been suffering from unacceptably high levels of kernel damage as a result of *Carpophilus* beetle attack.




Project: 2015-2018

Project Leader: Mofakhar Hossain

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SARDI
SOUTH AUSTRALIAN RESEARCH AND DEVELOPMENT INSTITUTE

Hort Innovation

# The *Carpophilus* problem



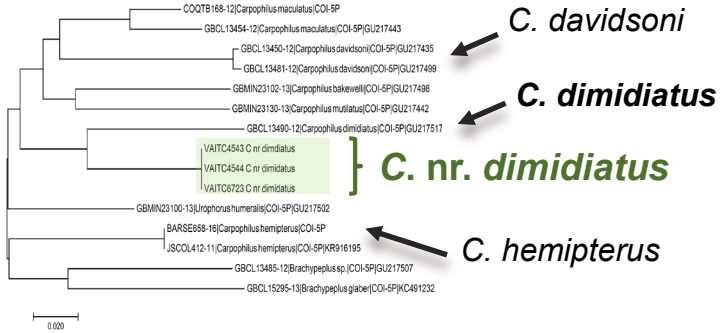
1. **The *Carpophilus* species attacking almonds is <u>not</u> the same species that attacks stone fruit**

Temporarily named *C.* near *dimidiatus*

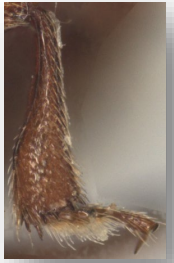
*C.* near *dimidiatus*

*C. dimidiatus*

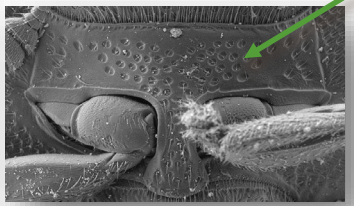
## Genetic differences:




## Morphological differences:



Hind tibia



Pitting on prosternum

[Blacket & Semeraro]

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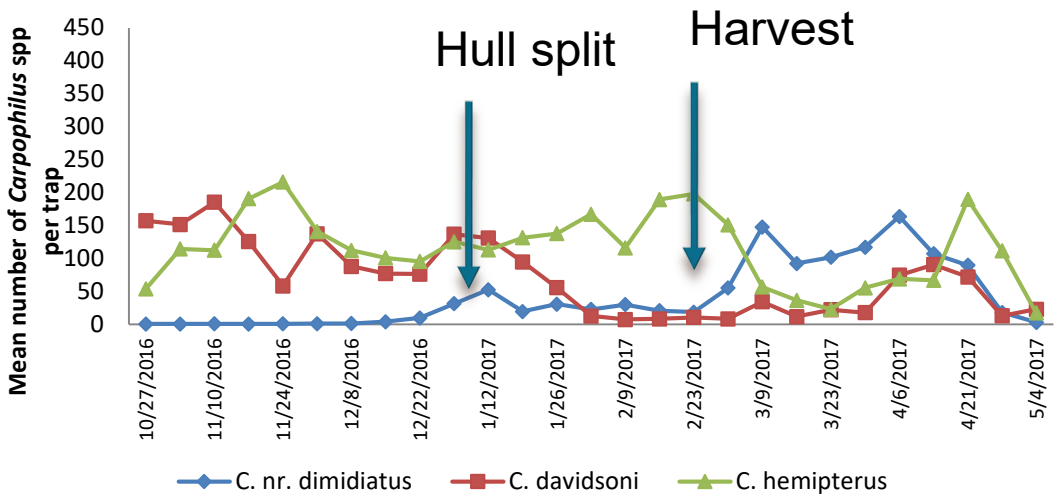
# The *Carpophilus* problem



2. **The current Attract & Kill trap is not sufficiently effective against *C.* nr *dimidiatus***

3. **The ecology of this species is very different from the stone fruit attacking species**




Mean numbers of *Carpophilus* species in A & K traps, Riverland 2016/17

[Hossain 2018]

# Almond IPM Project 2018-2022

18th Australian Almond Conference
October 30th - November1st, 2018

## IPM Project Aim:

*To develop a toolkit of complementary tools and practices that form the backbone of an IPM strategy for almond pest management.*

*Carpophilus*

Carob moth

1. Improved orchard hygiene
2. New technologies in insect Attract & Kill
3. Improved mating disruption
4. IPM compatible pesticides
5. Biocontrol options
6. Post harvest disinfestation
7. Engagement & extension

# Almond IPM Project: Controlling *Carpophilus*

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October 30th - November1st, 2018

## A multipronged attack: all life stages, all angles

Reduce feeding & breeding sites (mummy management)

Work closely with growers and industry

Effectively trap adult beetles as they disperse (A&K)

Assist industry with new pesticide options

Reduce infestation of stored product

Explore ways to utilize natural predators and diseases

- [x] 1. Improved orchard hygiene
- [x] 2. New technologies in insect Attract & Kill
- [x] 3. Improved mating disruption
- [ ] 4. IPM compatible pesticides
- [x] 5. Biocontrol options
- [ ] 6. Post harvest disinfestation
- [x] 7. Engagement & extension

# Almond IPM Project 2018-2022



1. Improved orchard hygiene

# Spatial distribution of insects

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## Infestation of ground vs tree mummies

20 ha block, 133 trees sampled

1. Improved orchard hygiene

### Ground

| Tree \ Row | 518 | 512 | 506 | 500 | 494 | 488 | 482 | 476 | 470 | 464 | 458 | 452 | 446 | 440 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 0% | 10% | 5% | 5% | 5% | 15% | 0% | 0% | 0% | 0% | 0% | 5% | 0% | 0% |
| 2 | 5% | 15% | 15% | 10% | 5% | 5% | 10% | 0% | 5% | 5% | 10% | 5% | 20% | 0% |
| 3 | 5% | 10% | 0% | 5% | 10% | 10% | 15% | 45% | 40% | 5% | 10% | 0% | 0% | 5% |
| 4 | 5% | 5% | 15% | 30% | 25% | 25% | 40% | 60% | 40% | 0% | 10% | 5% | 5% | 0% |
| 5 | 25% | 25% | 15% | 5% | 25% | 20% | 10% | 55% | 45% | 20% | 0% | 10% | 5% | 5% |
| 6 | 25% | 60% | 5% | 0% | 0% | 30% | 15% | 15% | 20% | 15% | 0% | 5% | 15% | 5% |
| 7 | 15% | 20% | 20% | 10% | 10% | 0% | 5% | 0% | 0% | 10% | 5% | 0% | 0% | 5% |
| 8 | 25% | 30% | 5% | 30% | 5% | 10% | 15% | 0% | 0% | 0% | 0% | 0% | 15% | 5% |
| 9 | 40% | 25% | 0% | 20% | 0% | 0% | 0% | 5% | 0% | 0% | 5% | 5% | 0% | 5% |
| 10 | 0% | | 0% | | 10% | | 0% | | 0% | | 0% | | 0% | |

### Tree (low in canopy)

| Tree \ Row | 518 | 512 | 506 | 500 | 494 | 488 | 482 | 476 | 470 | 464 | 458 | 452 | 446 | 440 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 0% | 10% | 0% | 0% | 0% | 0% | 0% | 0% | 0% | 0% | 0% | 0% | 0% | 0% |
| 2 | 0% | 0% | 0% | 0% | 0% | 0% | 0% | 0% | 0% | 10% | 0% | 0% | 0% | 0% |
| 3 | 0% | 0% | 0% | 0% | 0% | 0% | 0% | 0% | 10% | 0% | 0% | 0% | 0% | 0% |
| 4 | 0% | 0% | 0% | 0% | 10% | 0% | 10% | 10% | 0% | 0% | 0% | 0% | 0% | 0% |
| 5 | 0% | 10% | 0% | 10% | 10% | 0% | 0% | 0% | 20% | 0% | 0% | 0% | 0% | 0% |
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| 9 | 10% | 10% | 0% | 0% | 0% | 0% | 0% | 0% | 0% | 0% | 0% | 0% | 0% | 0% |
| 10 | 10% | 0% | 0% | 0% | 0% | 0% | 0% | 0% | 0% | 0% | 0% | 0% | 0% | 0% |

## Findings:

- CB is mainly infesting fallen mummies
- Infestation is lower down in the tree canopy
- Destroying fallen mummies is key to control

[Madge, Grossman, Taylor]

# Mummy nut destruction: Prelim work

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1. Improved orchard hygiene

## Flail mulching

Reduced intact mummies by 70-90%
BUT… left 16,000 intact mummies / ha

## Beetles in kernels one month after mulching

| | Adults | Larvae | n |
|---|---|---|---|
| Intact | 9.3% | 3.7% | 57 |
| Fragments | 1.1% | 3.3% | 91 |

- Producers need to monitor the efficiency of nut destruction
- Mummies probably need to be pulverised to eliminate infestations / reinfestation

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[Madge, Grossman, Taylor]

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# 2. New technologies in insect Attract & Kill

# Developing an effective Attract & Kill trap

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1. Improved orchard hygiene
2. New technologies in insect Attract & Kill

Stone fruit attractant

Co-attractant (host odours) + Beetle aggregation pheromone

Fermenting fruits

*C. davidsoni*
*C. hemipterus*
*C. mutilatis*

"Tri-species lure"

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# Developing an effective Attract & Kill trap

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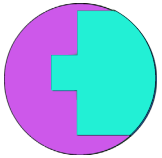
Almond attractant

1. Improved orchard hygiene
2. New technologies in insect Attract & Kill

Co-attractant (host odours)



Beetle aggregation pheromone

Almond odours

*C.* nr *dimidiatus* pheromone?

- ✓ Redesign the co-attractant
- ✓ Analyse / redesign the pheromone

# A new co-attractant: 2018 Plans & Progress



1. Improved orchard hygiene
2. New technologies in insect Attract & Kill

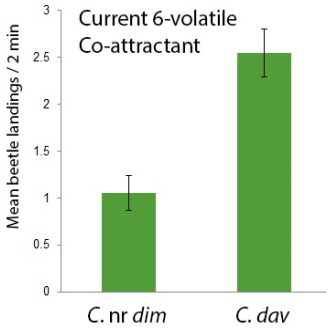
1. Reformulating the current co-attractant
2. Selecting and screening new volatiles
3. Improving the dispenser (odour release)

# A new co-attractant: 2018 Plans & Progress



1. Improved orchard hygiene
2. New technologies in insect Attract & Kill

## 1. Reformulating the current co-attractant



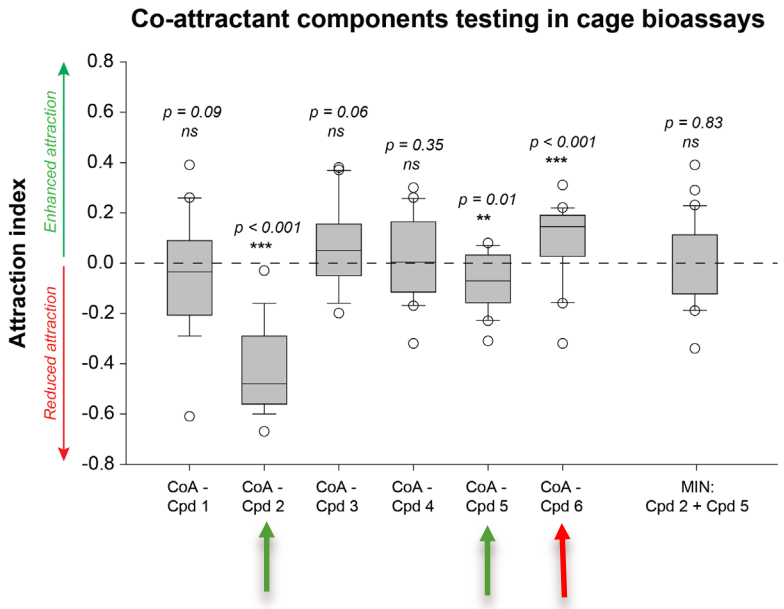

- *C.* nr *dimidiatus* does not respond well to the current co-attractant

Beetle responses to co-attractant in wind tunnel [Hossain 2017]

# 1. Reformulating the current co-attractant



## Bioassays on current 6-volatile co-attractant




1. Improved orchard hygiene
2. New technologies in insect Attract & Kill

RESULTS:

Volatiles 2 & 5 are main attractants (removal decrease attraction)

Volatile 6 is a deterrent (also maybe 3) (removal increases attraction)

- Some but not all of the volatiles attract *C.* nr *dimidiatus*

[Farnier]

# A new co-attractant: 2018 Plans & Progress



1. Improved orchard hygiene
2. New technologies in insect Attract & Kill

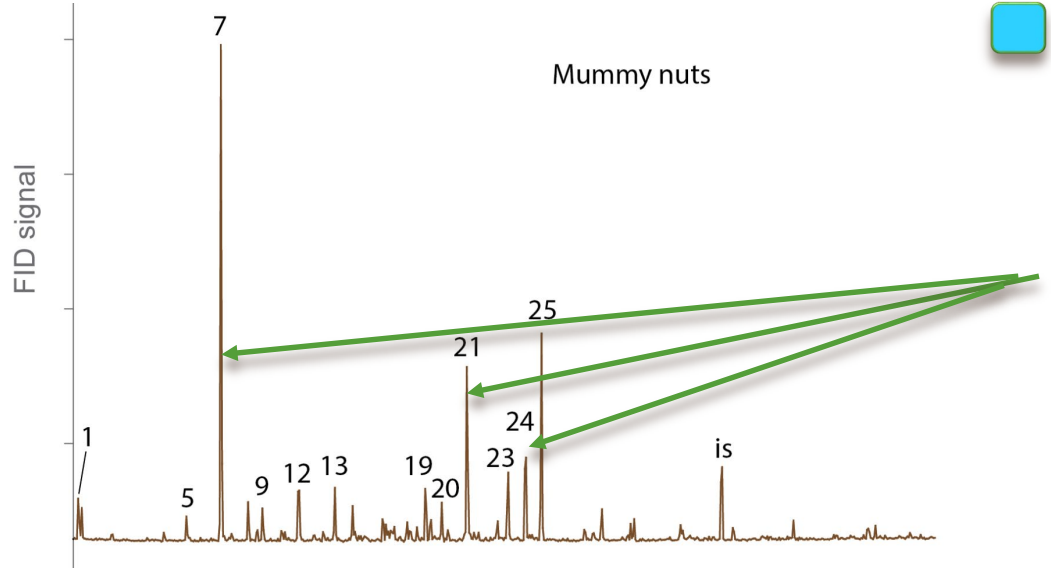
2. Selecting and screening new volatiles

# 2. Selecting and screening new volatiles



## Odours are complex blends of volatile compounds

Gas chromatogram (GC-MS)




- Each peak represents a volatile
- The area beneath the peak (height) = relative proportion in the blend

1. Improved orchard hygiene
2. New technologies in insect Attract & Kill

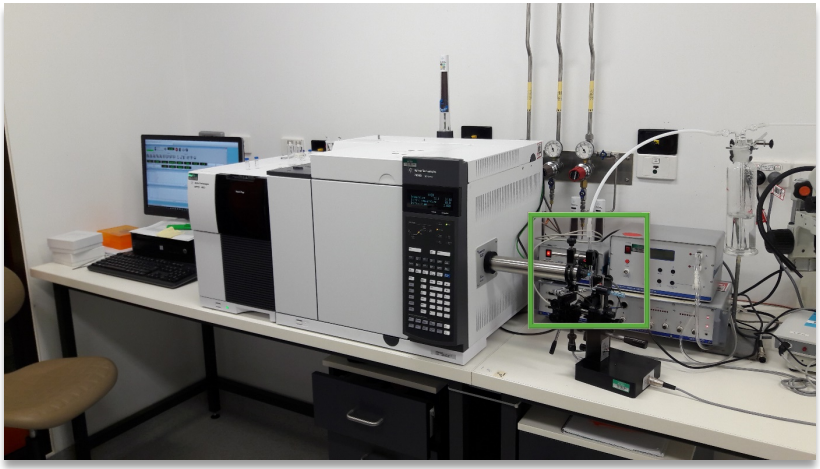
Only some of these will be detected by the insect

**How do we decide which ones to select?**

# 2. Selecting and screening new volatiles

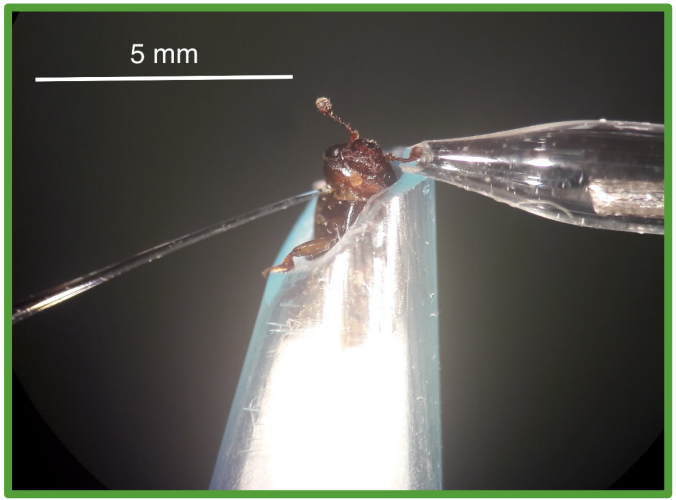


Using electro-antennography to select attractants



First time for *Carpophilus*!

1. Improved orchard hygiene
2. New technologies in insect Attract & Kill



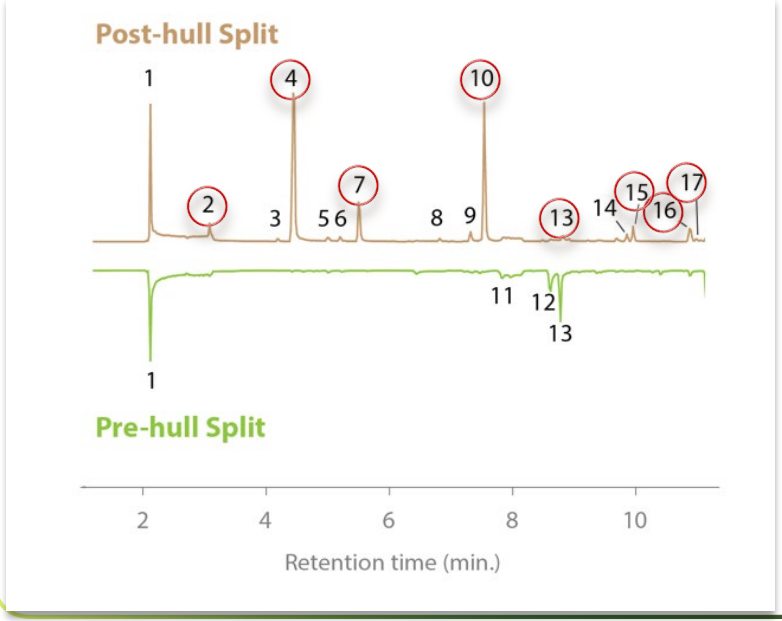

[Farnier & Baig]

# Screening hull split volatiles

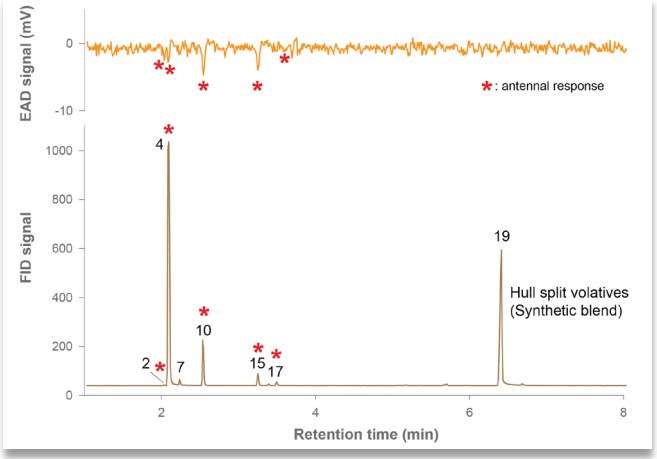


Volatiles sampling

1. Improved orchard hygiene
2. New technologies in insect Attract & Kill




○* = detection by antennae




[Farnier]

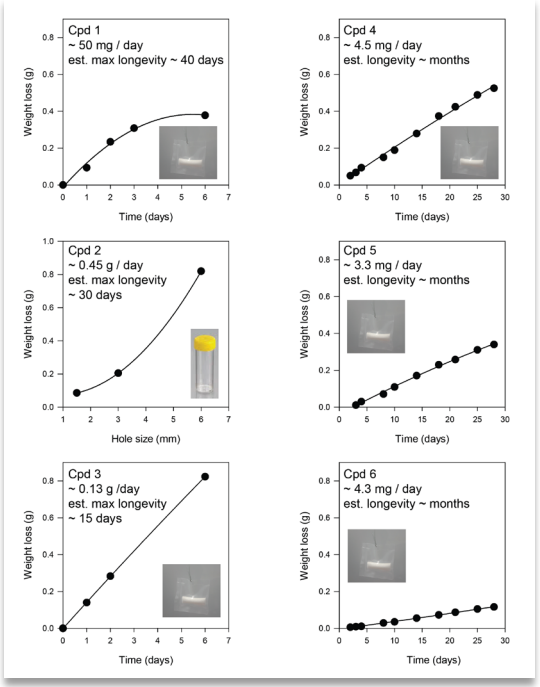
# A new co-attractant: 2018 Plans & Progress

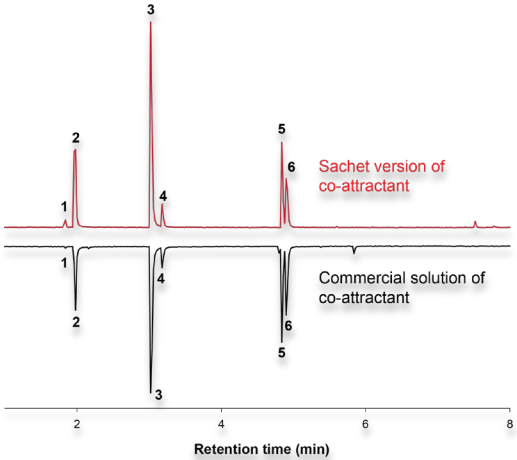


1. Improved orchard hygiene
2. New technologies in insect Attract & Kill
3. Improving the dispenser (odour release)

# 3. Improving the dispenser






1. Improved orchard hygiene
2. New technologies in insect Attract & Kill

- RESULTS: Sachets emit the same proportions of components, but last FAR longer (weeks to months)

[Farnier]

# Field testing – December 2018 to March 2019



1. Improved orchard hygiene
2. New technologies in insect Attract & Kill

1. Dispenser efficacy and longevity
2. Efficacy of current tri-species lure (pheromone)
3. Modified versions of the co-attractant (in solution and sachet form)
4. First prototype hull split synthetic blends
5. Yeast volatiles blends

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# 5. Biocontrol Options

# Exploring biocontrol options

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October 30th - November1st, 2018

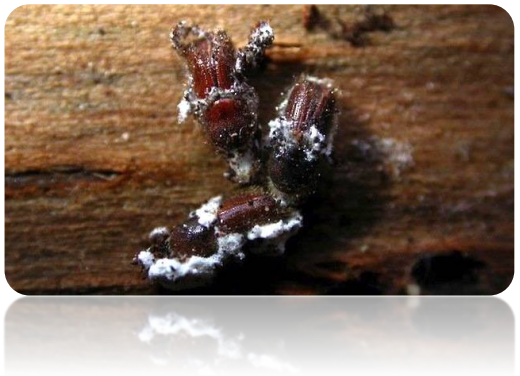
## 1. Field Surveys

- Molecular barcoding
- Morphology

## 2. Desktop review

- Biopesticides (*Beauveria)*
- Auto-dissemination?

Wasps emerging from mummies

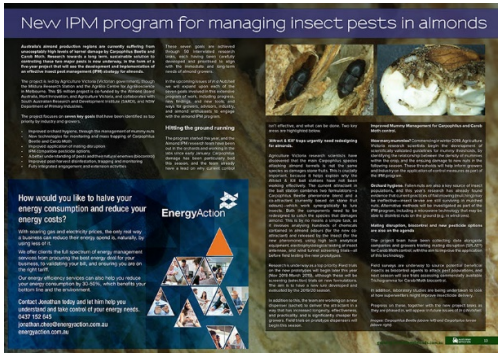
1. Improved orchard hygiene
2. New technologies in insect Attract & Kill
3. Improved mating disruption
4. IPM compatible pesticides
5. Biocontrol options

[1. Rako, Semeraro, Blacket]

[2. Lubanga]

# Almond IPM project

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6. Post harvest disinfestation
7. Engagement & extension

# Acknowledgements

18th Australian Almond Conference
October 30th - November1st, 2018

## Project Team

David Madge (lead Mildura / field)
Kevin Farnier (lead lure development)
Mofakhar Hossain (lead field trapping)

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Cathy Taylor (Mildura)
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Mark Blacket (diagnostics)
Lea Rako (diagnostics)

Joanne Hollaway (NSW DPI)
Greg Baker (SARDI)

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