



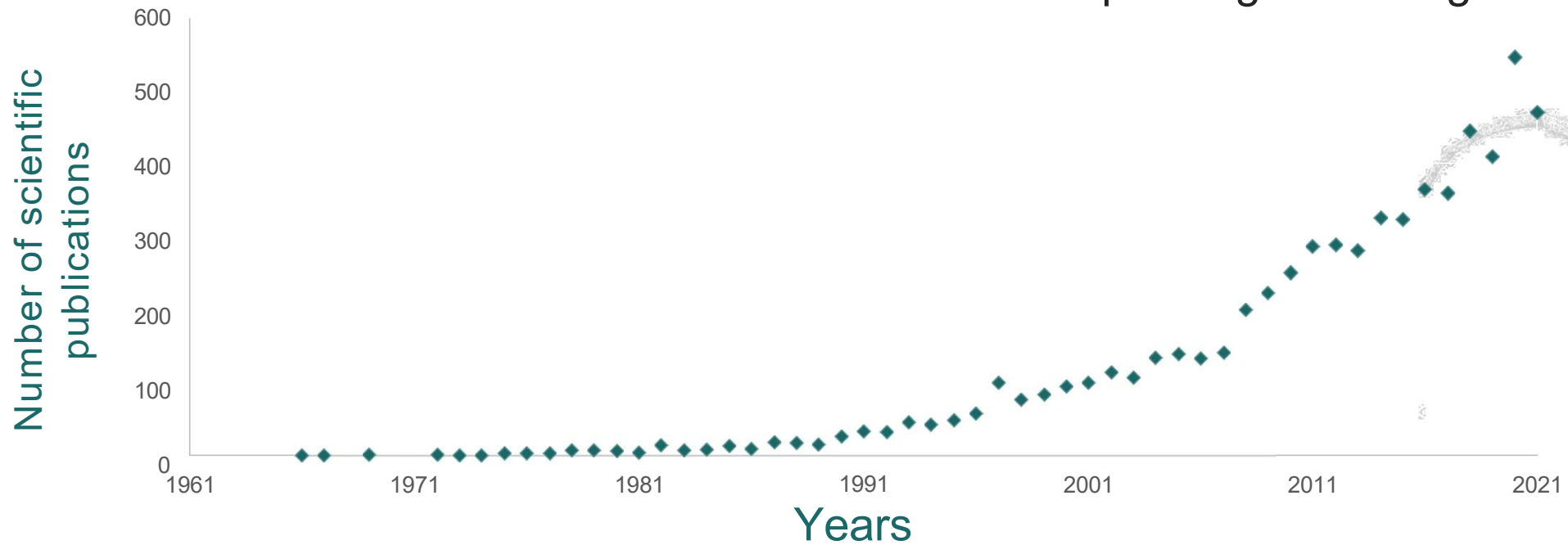
Development of biological alternatives
to insecticides to control *Drosophila
suzukii* with **semiochemicals** and
entomopathogenic fungi

Galland C., Capelle J., Lalaymia I., Declerck S. et Verheggen F.



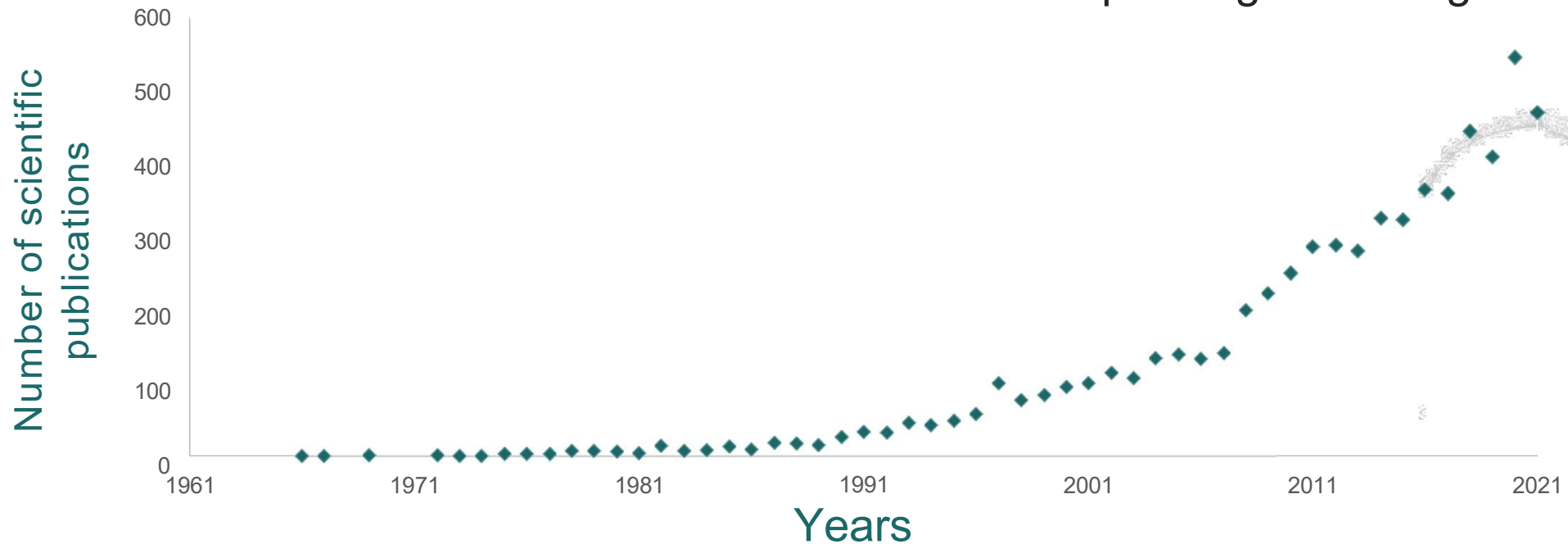
Context

Evolution of research about entomopathogenic fungi



Context

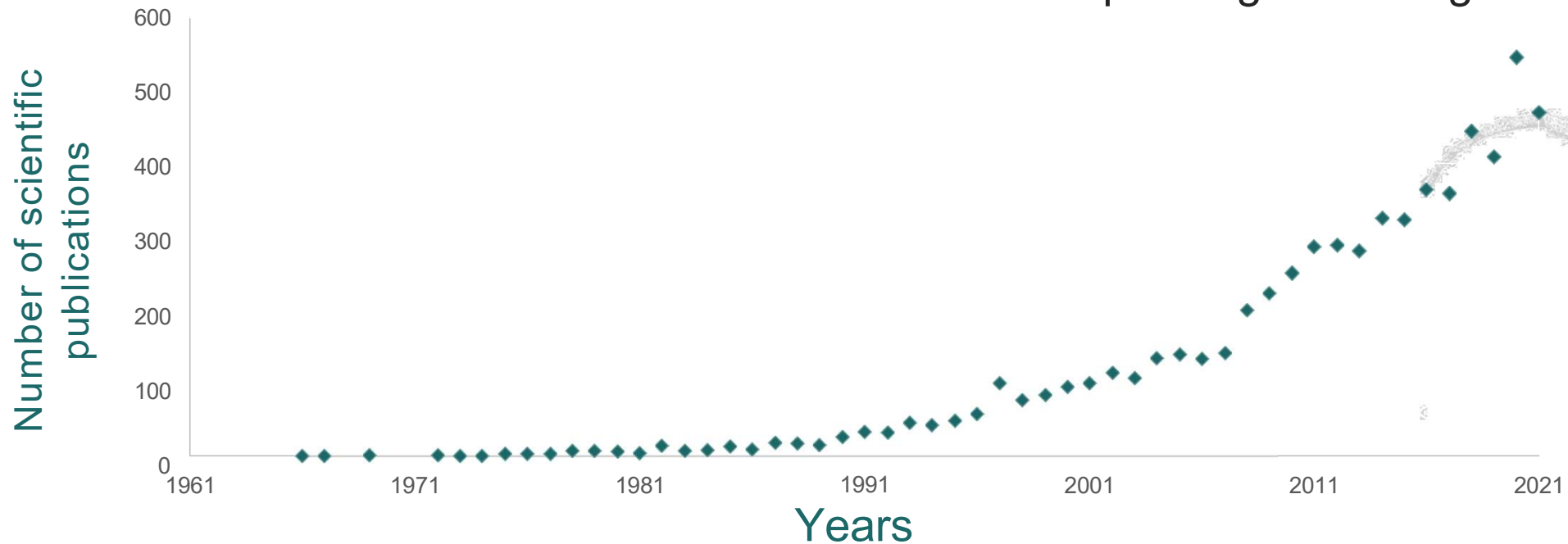
Evolution of research about entomopathogenic fungi



Why are entomopathogenic fungi (EPF) interesting ?

Context

Evolution of research about entomopathogenic fungi



Why are entomopathogenic fungi (EPF) interesting ?

Why is the number of commercial products low ?






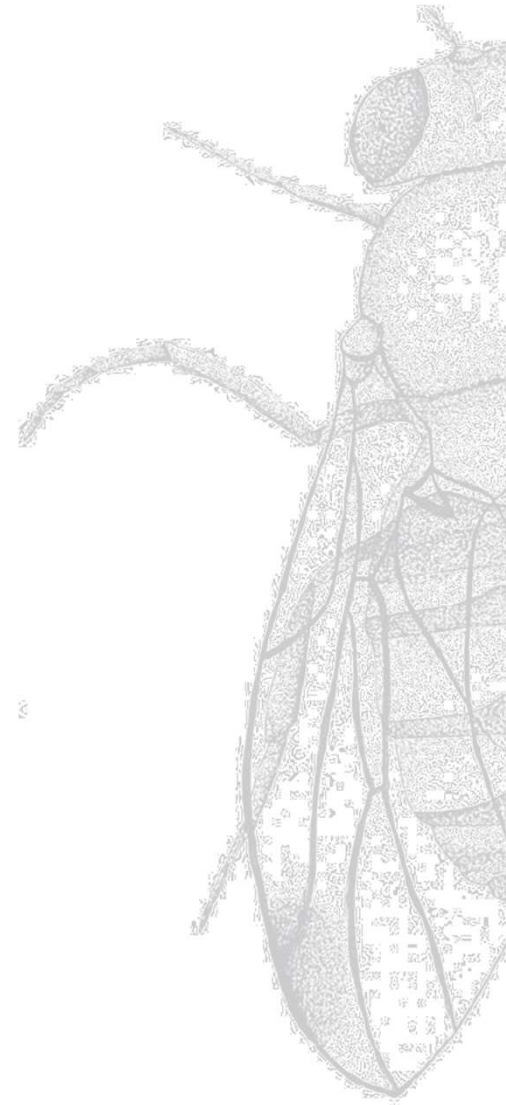
Why are EPF interesting ?



Why are EPF interesting ?




Insecticide limitations

- No human-safety 
- Environmental cost 
- Legislation 






Why are EPF interesting ?

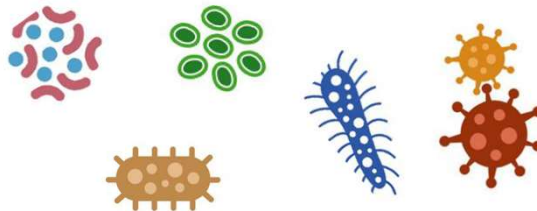
Insecticide limitations

- No human-safety 
- Environmental cost 
- Legislation 






Microbial organisms

- Coevolution 
- Human safety 
- No toxic residue 






Why are EPF interesting ?

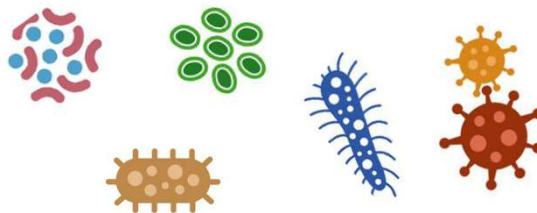
Insecticide limitations

- No human-safety 
- Environmental cost 
- Legislation 






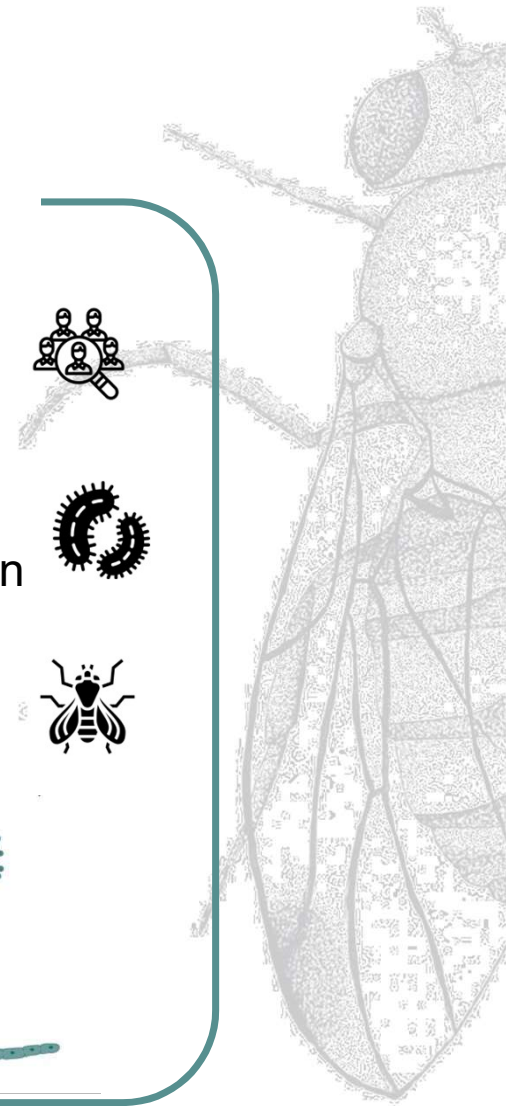
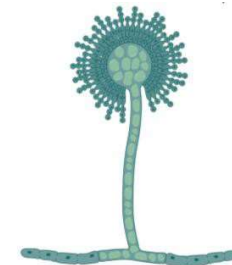
Microbial organisms

- Coevolution 
- Human safety 
- No toxic residue 



EPF

- Selectivity 
- High reproduction 
- Diptera 

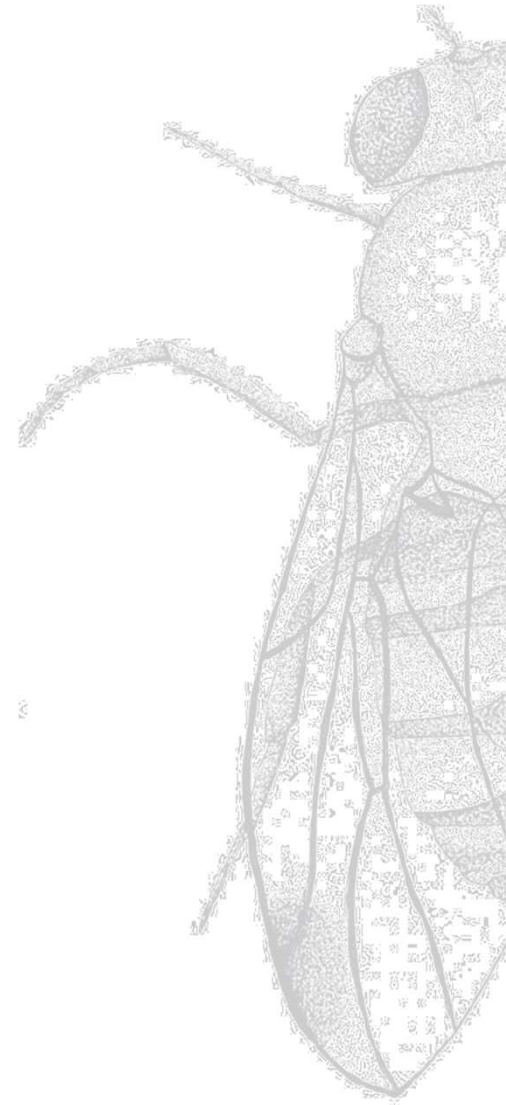
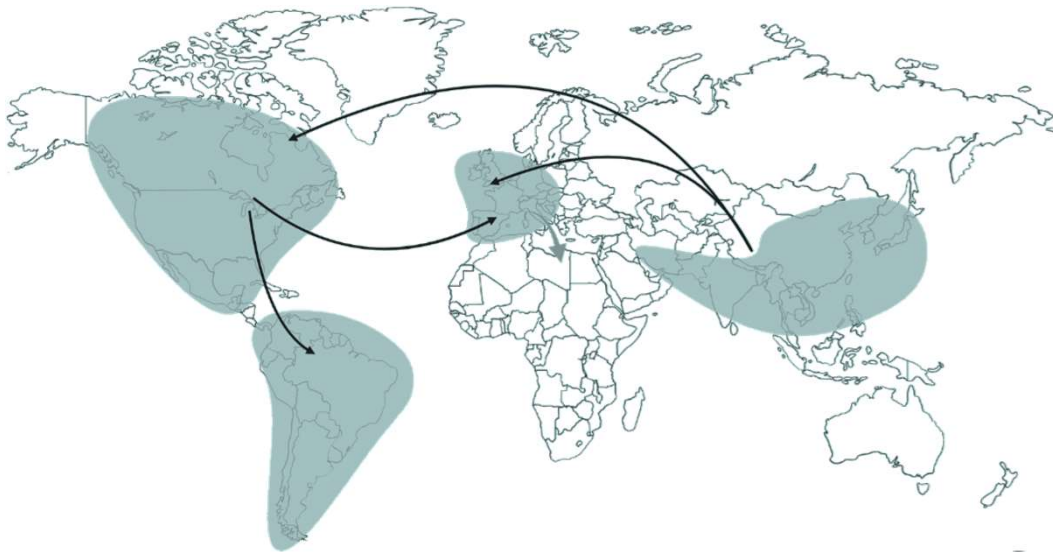


Drosophila suzukii



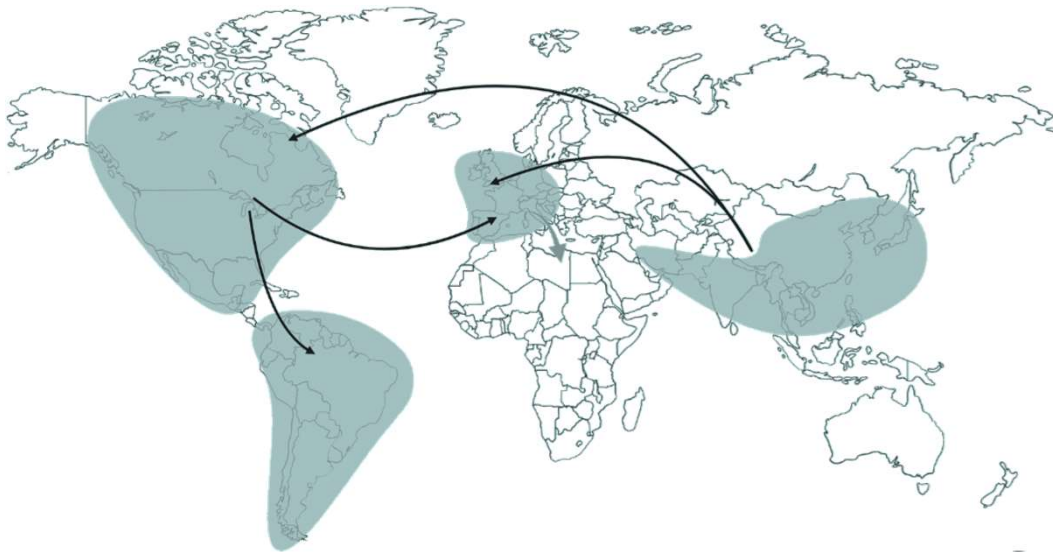
Drosophila suzukii

➤ Invasive specie

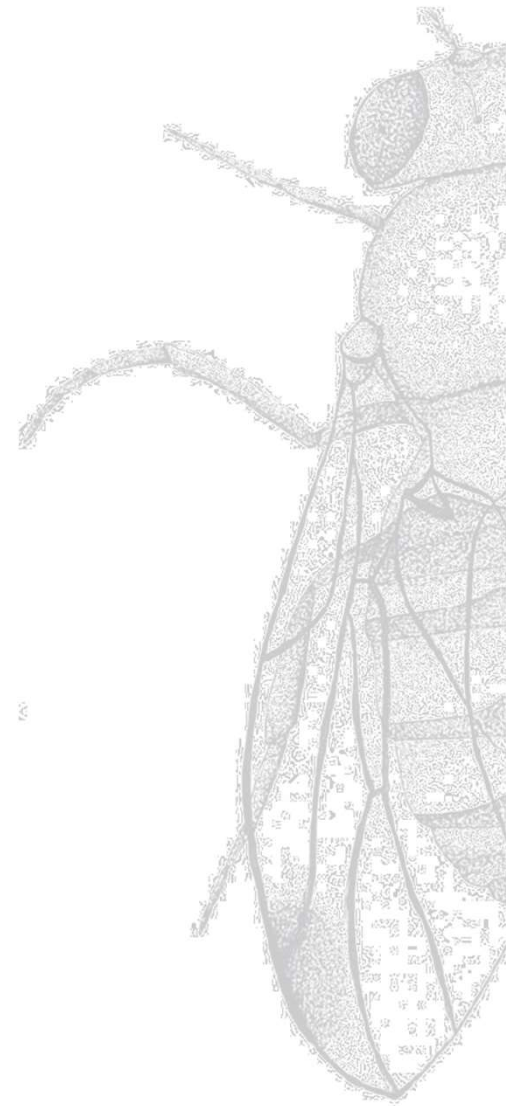
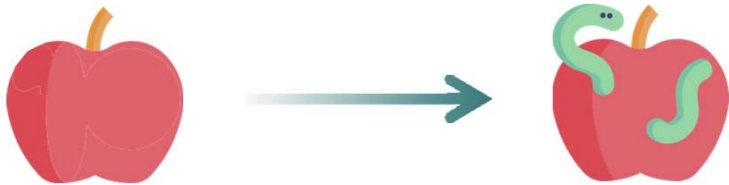


Drosophila suzukii

➤ Invasive specie



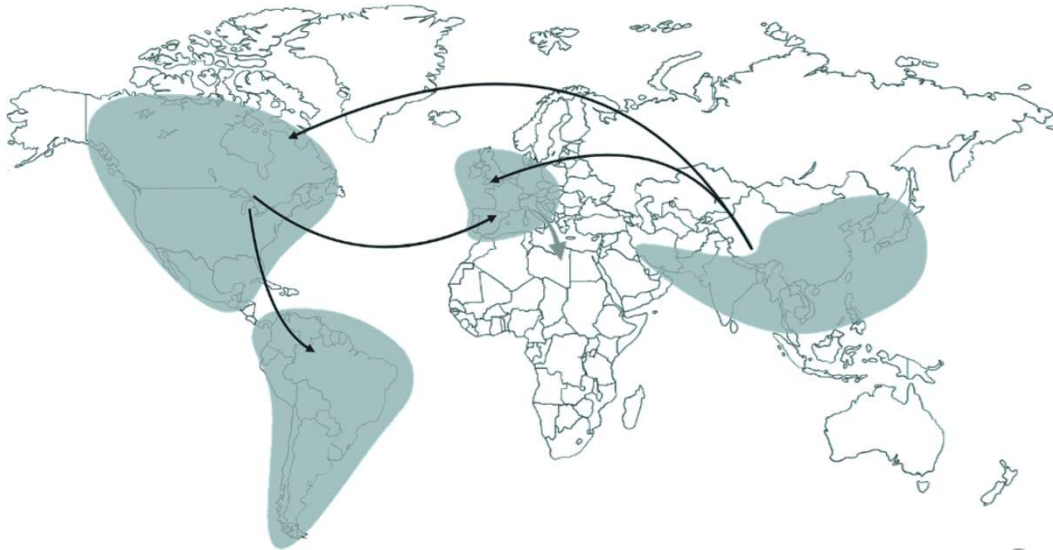
➤ Laying their eggs in ripe fruits



Asplen et al, 2015 ; Calabria et al, 2012

Drosophila suzukii

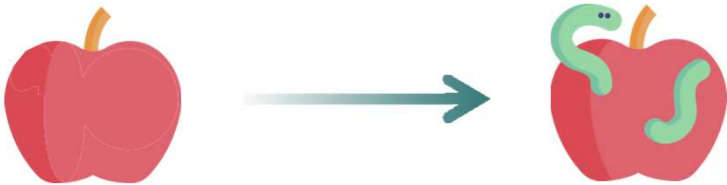
➤ Invasive specie



➤ Short generation time



➤ Laying their eggs in ripe fruits

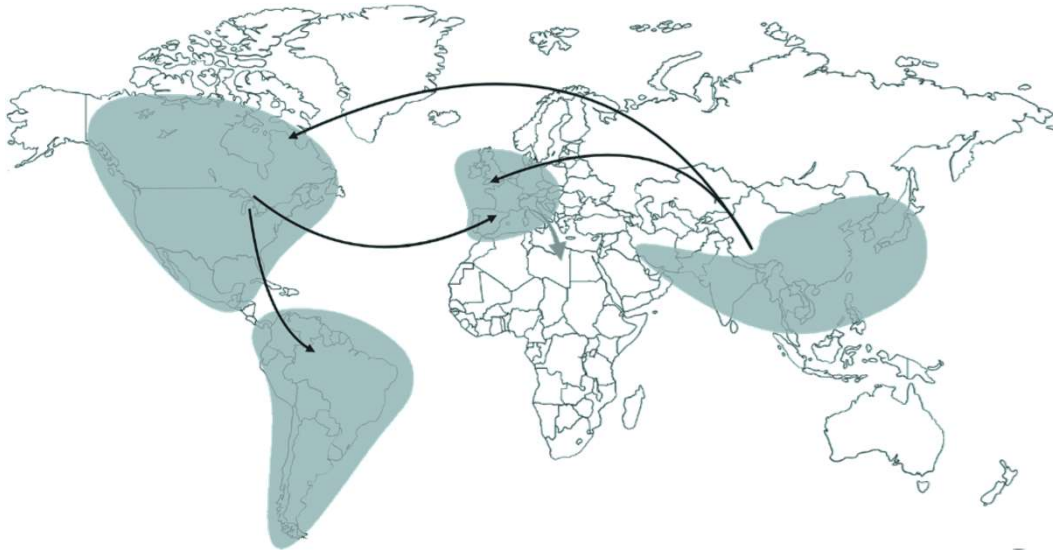


Asplen et al, 2015 ; Calabria et al, 2012



Drosophila suzukii

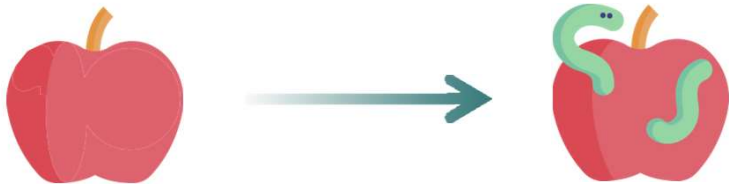
➤ Invasive specie



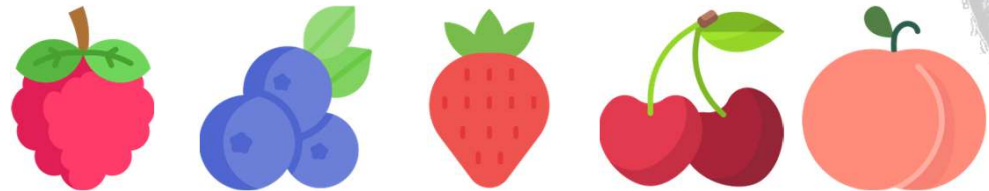
➤ Short generation time



➤ Laying their eggs in ripe fruits

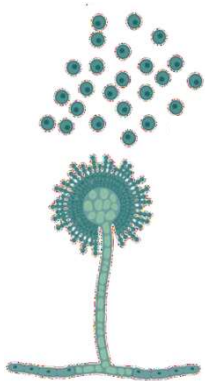


➤ Large number of potential hosts



Asplen et al, 2015 ; Calabria et al, 2012

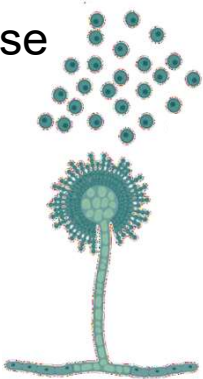
Why is the number of commercial products low ?



Bugti et al, 2020
Sharma et al, 2020

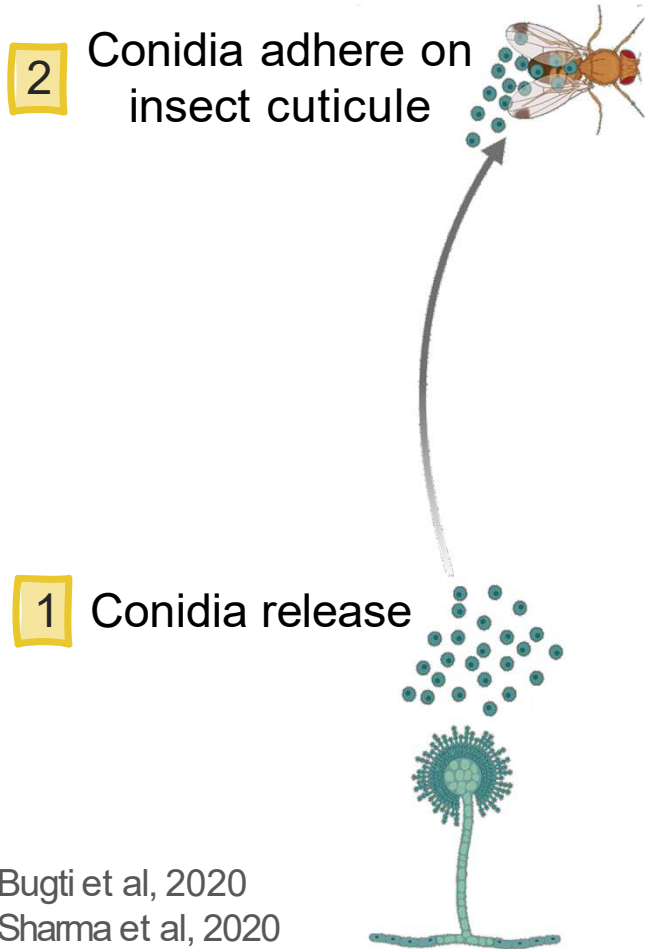
Why is the number of commercial products low ?

1 Conidia release



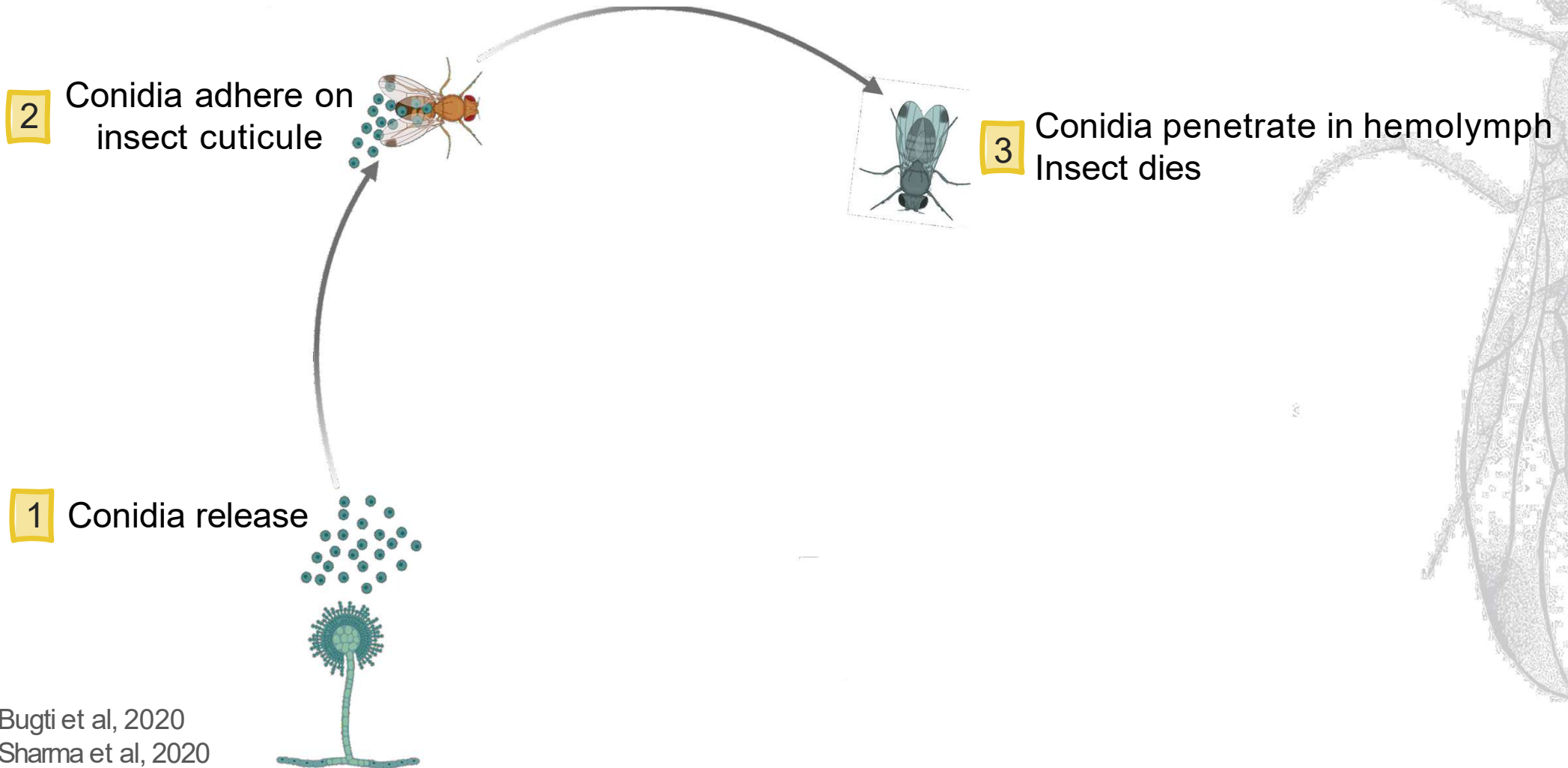
Bugti et al, 2020
Sharma et al, 2020

Why is the number of commercial products low ?

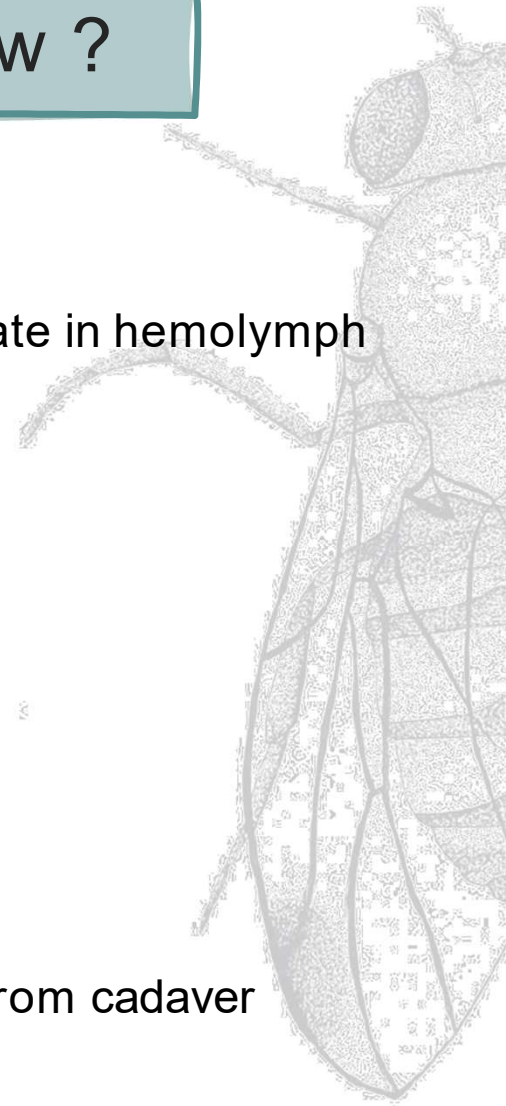
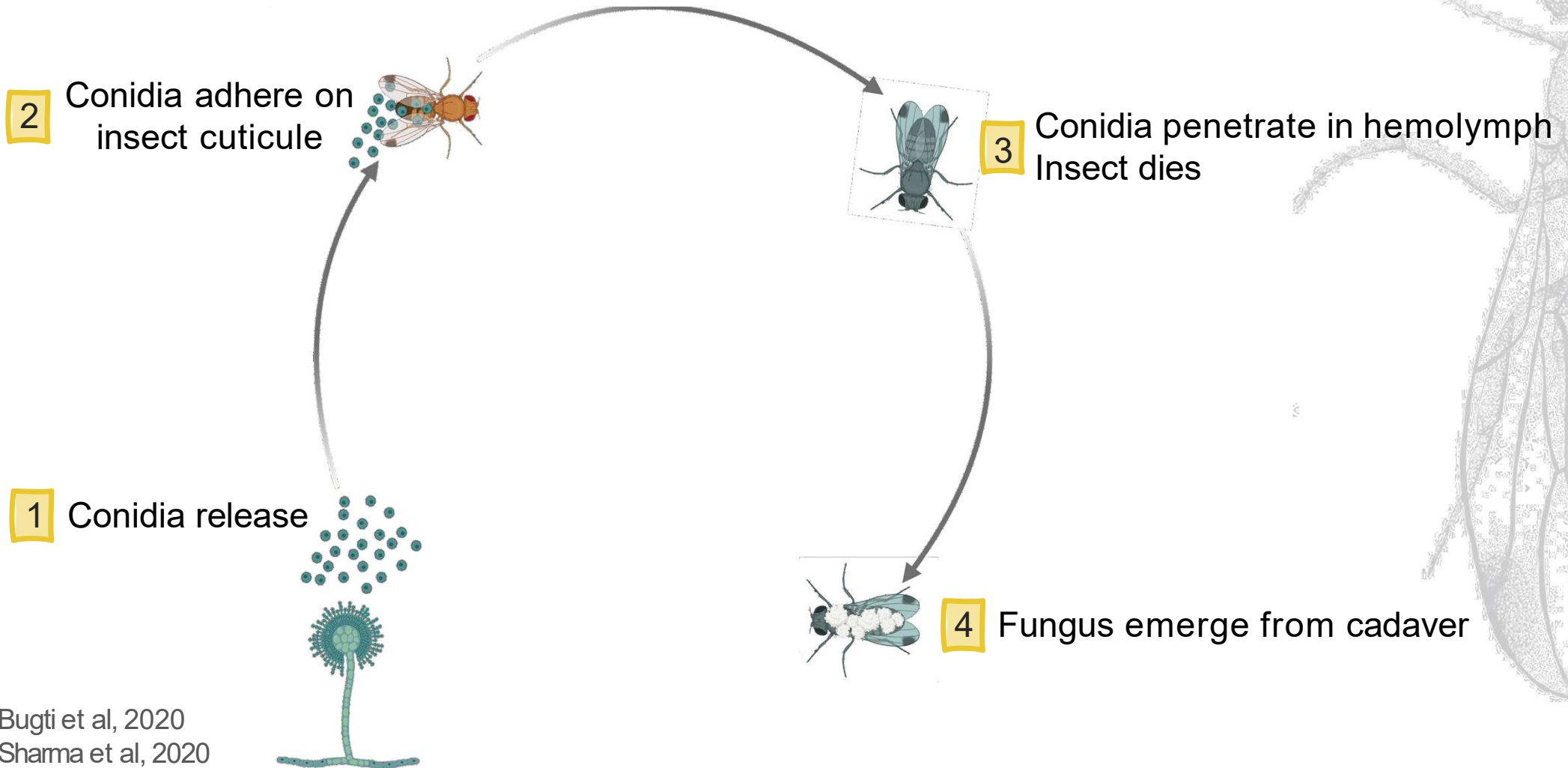


Bugti et al, 2020
Sharma et al, 2020

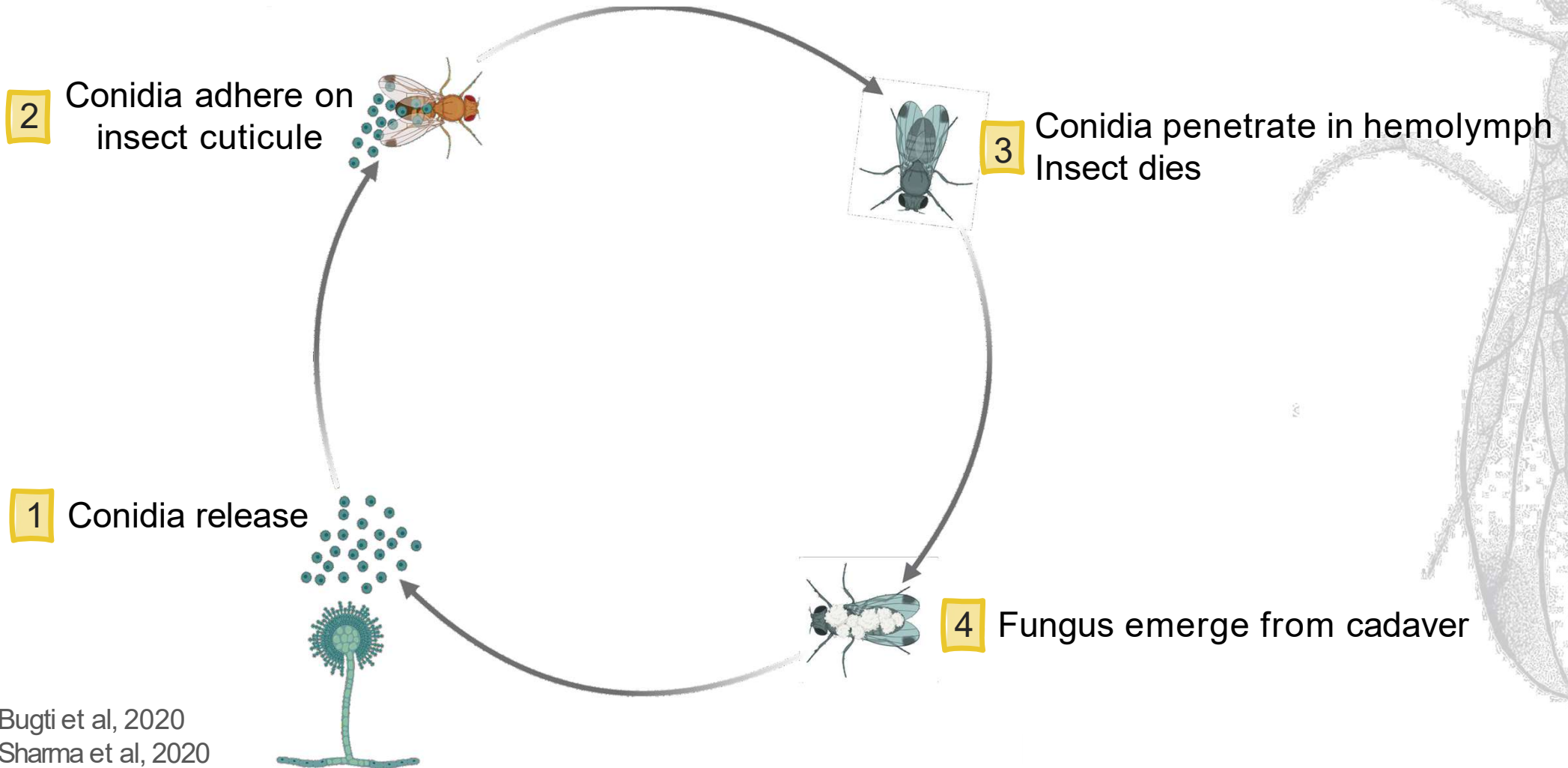
Why is the number of commercial products low ?



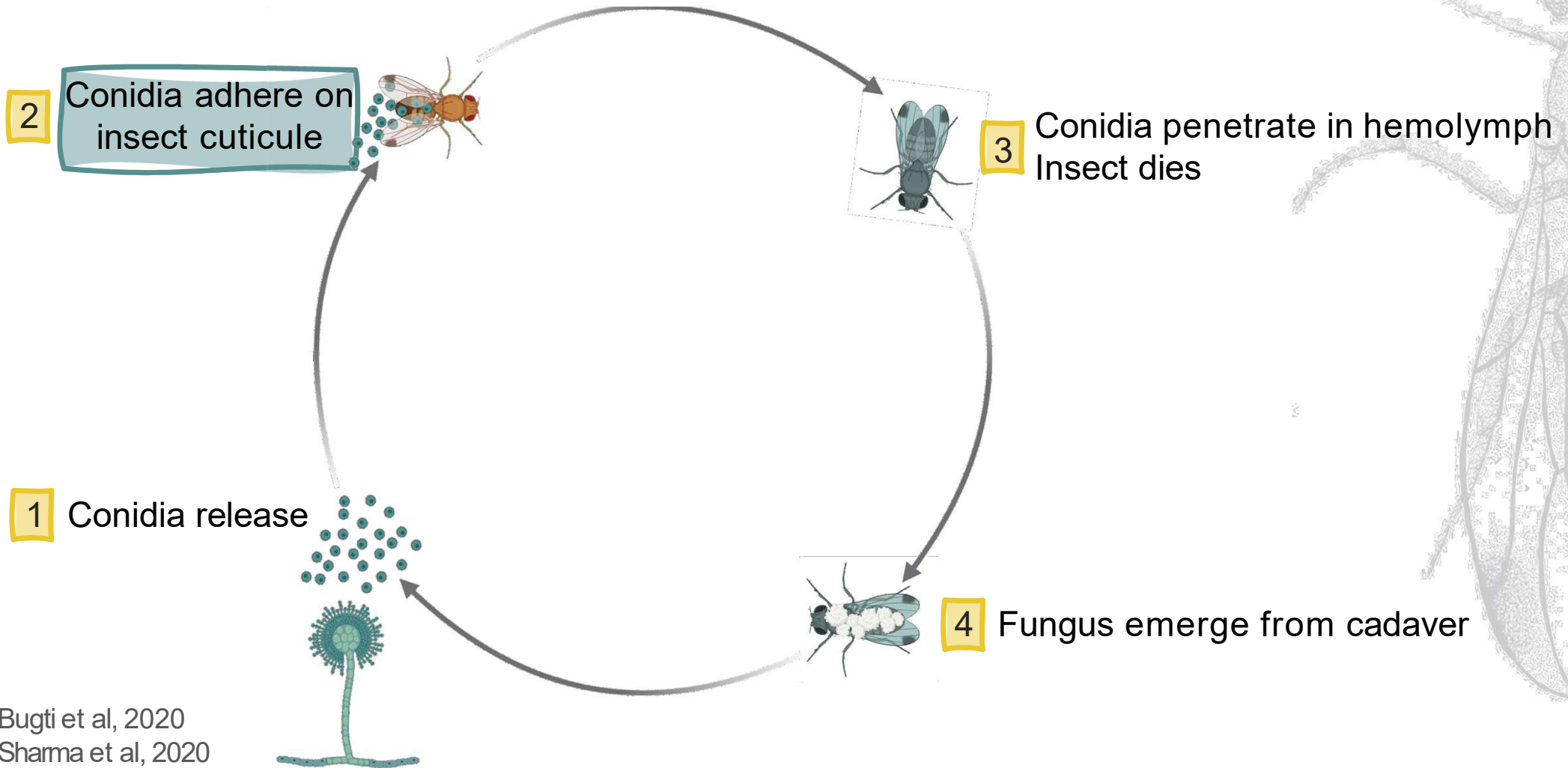
Why is the number of commercial products low ?



Why is the number of commercial products low ?



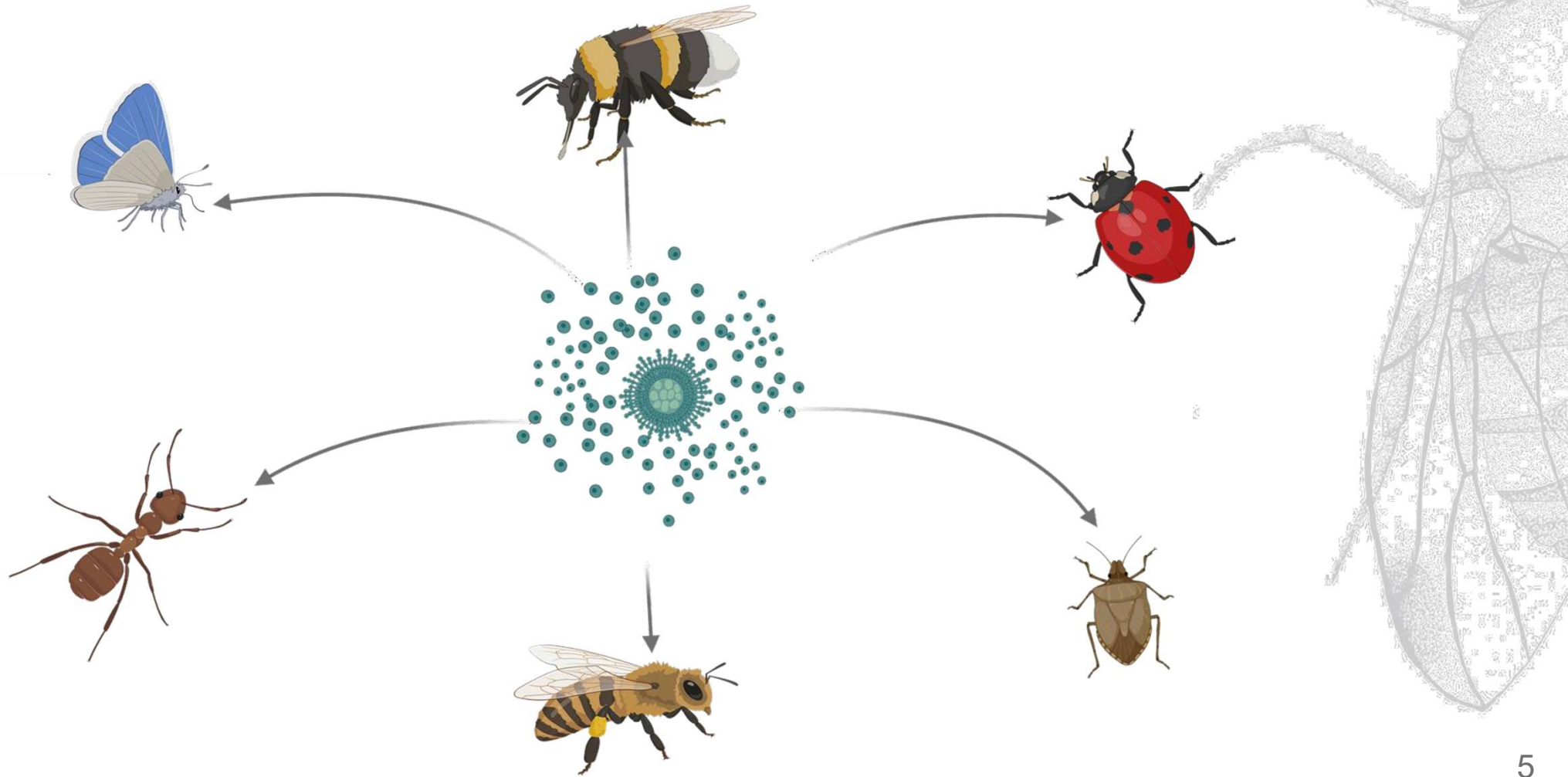
Why is the number of commercial products low ?



Why is the number of commercial products low ?



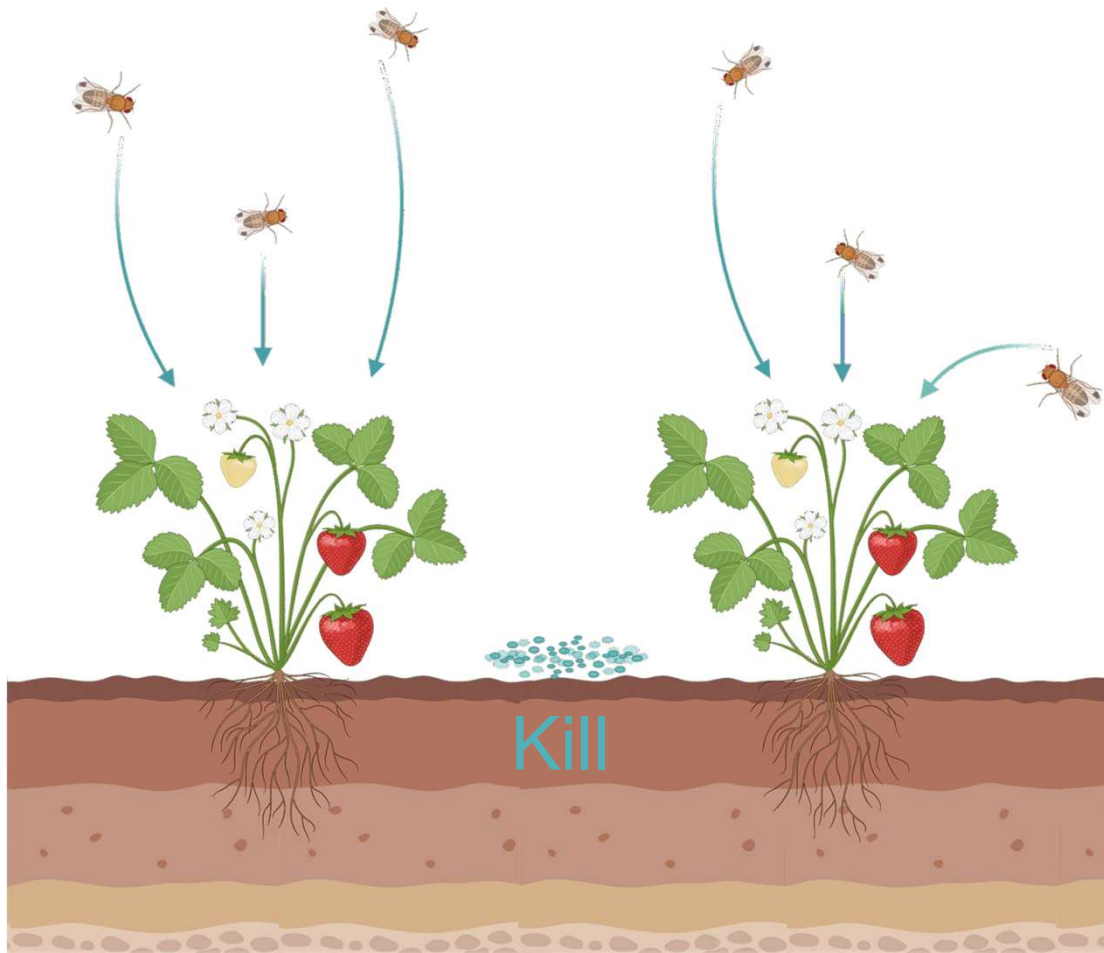
Why is the number of commercial products low ?



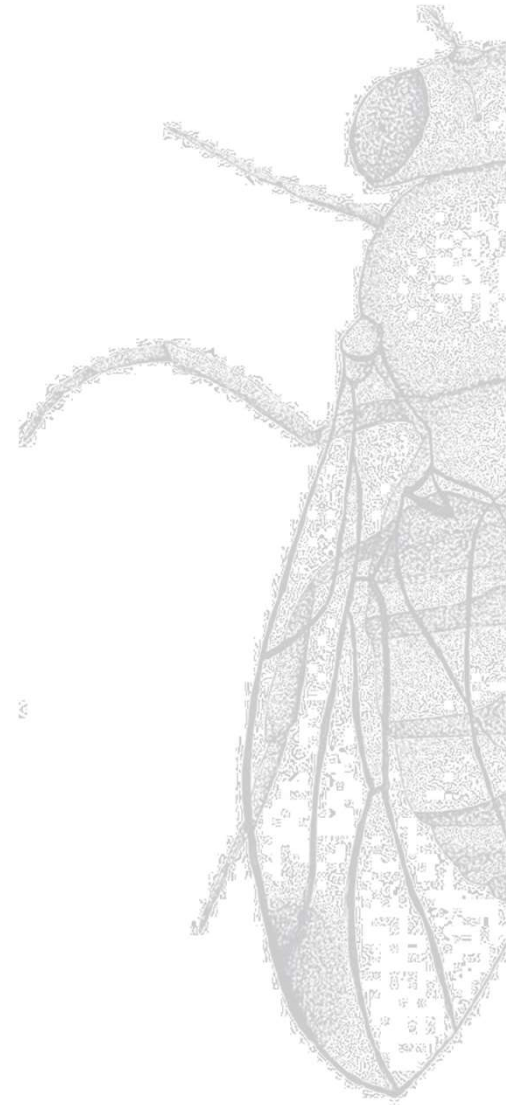
Why is the number of commercial products low ?



Why is the number of commercial products low ?



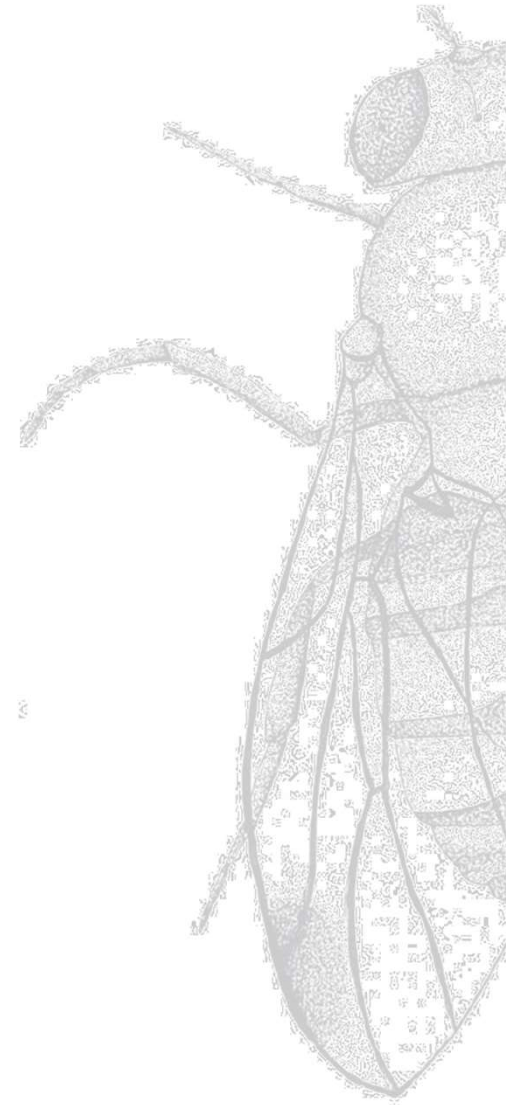
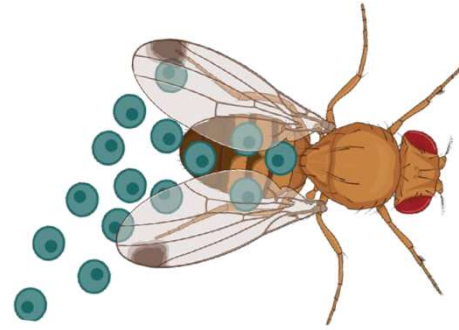
Aims



Aims

1

Select an effective EPF by integrating its ability of adhesion



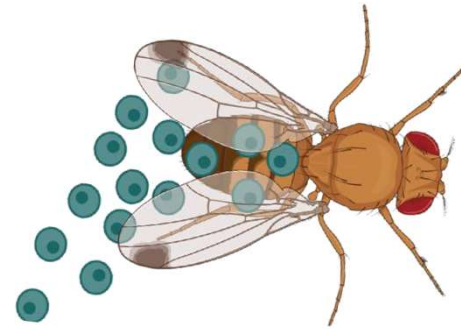
Aims

1

Select an effective EPF by integrating its ability of adhesion

2

Test impact of EPF on non-target insects



Aims

1

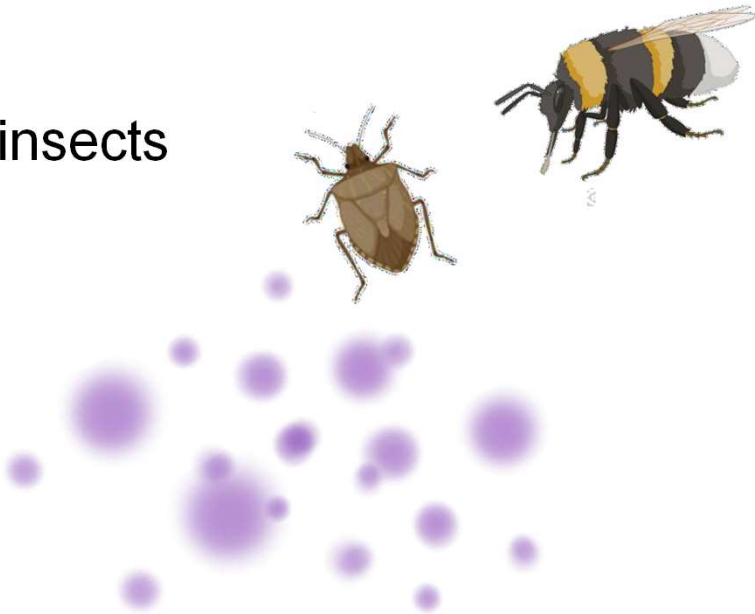
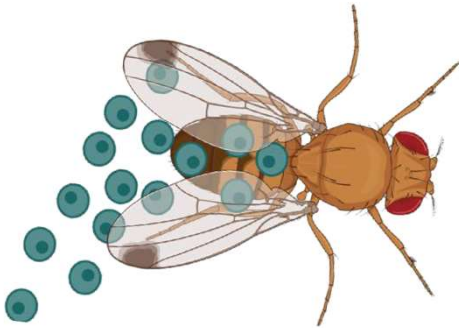
Select an effective EPF by integrating its ability of adhesion

2

Test impact of EPF on non-target insects

3

Select semiochemicals



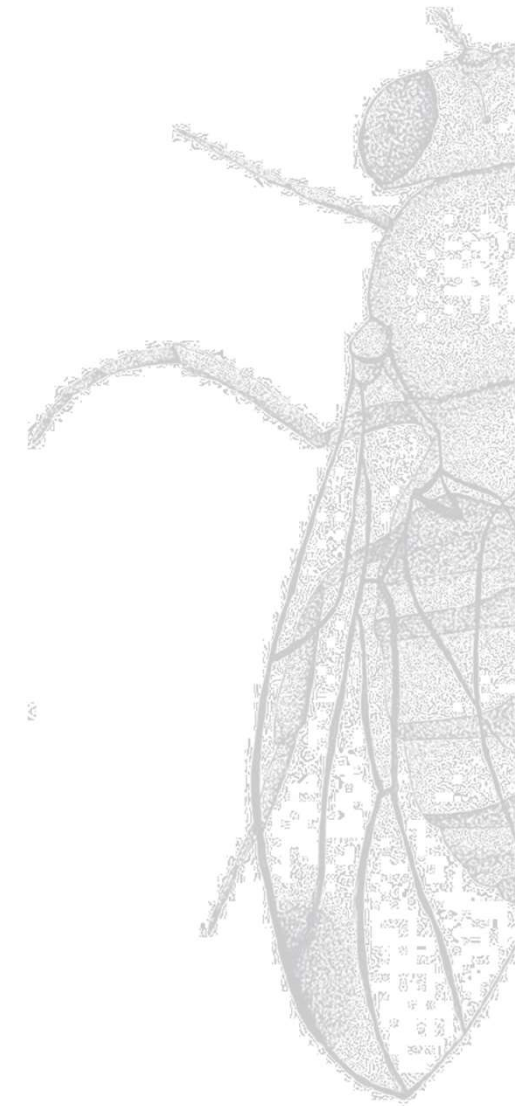
Selecting an effective EPF against *D. suzukii*



Selecting an effective EPF against *D. sukuzii*

EPF tested

Species	Strains
<i>Beauveria bassiana</i>	MUCL 1555
<i>Metarhizium anisopliae</i>	MUCL 6859
<i>Metarhizium brunneum</i>	MUCL 9645
<i>Lecanicillium lecanii</i>	MUCL 8115
<i>Paecilomyces fumosoroseus</i>	MUCL 15122



Selecting an effective EPF against *D. sukuzii*

EPF tested

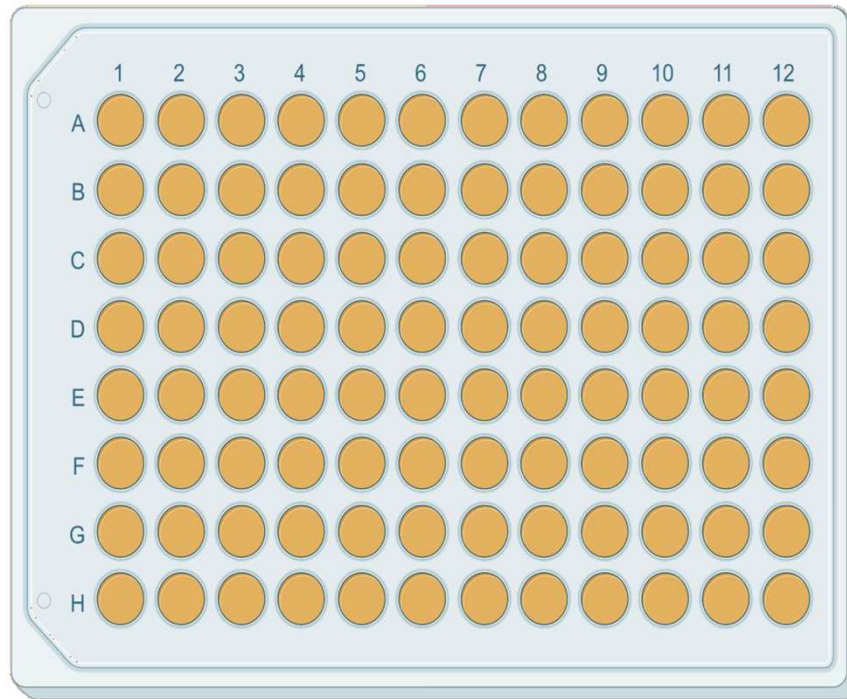
Species	Strains
<i>Beauveria bassiana</i>	MUCL 1555
<i>Metarhizium anisopliae</i>	MUCL 6859
<i>Metarhizium brunneum</i>	MUCL 9645
<i>Lecanicillium lecanii</i>	MUCL 8115
<i>Paecilomyces fumosoroseus</i>	MUCL 15122

+ Positive control (insecticide)

+ Negative control



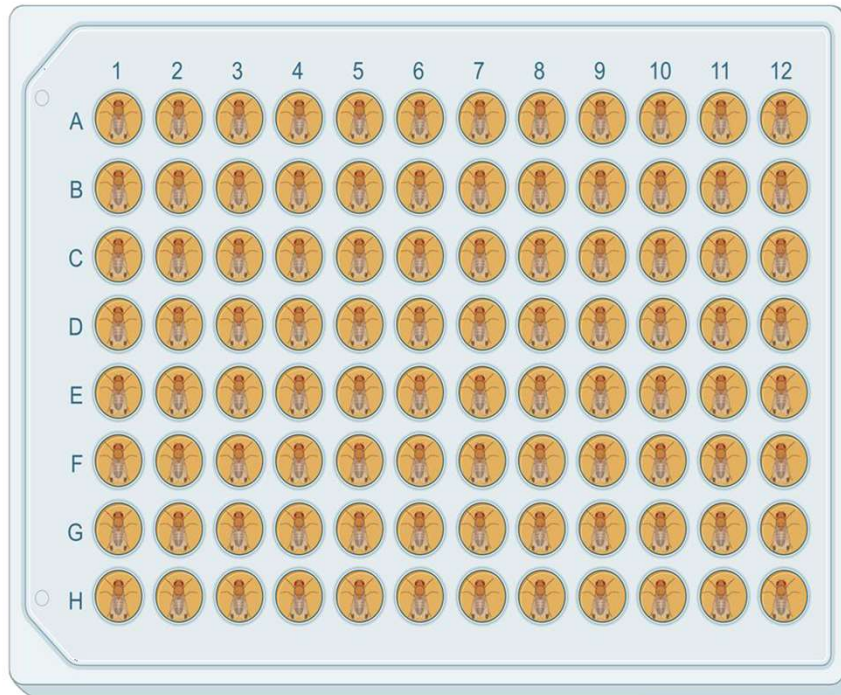
Selecting an effective EPF against *D. suzukii*




Selecting an effective EPF against *D. sukuzii*

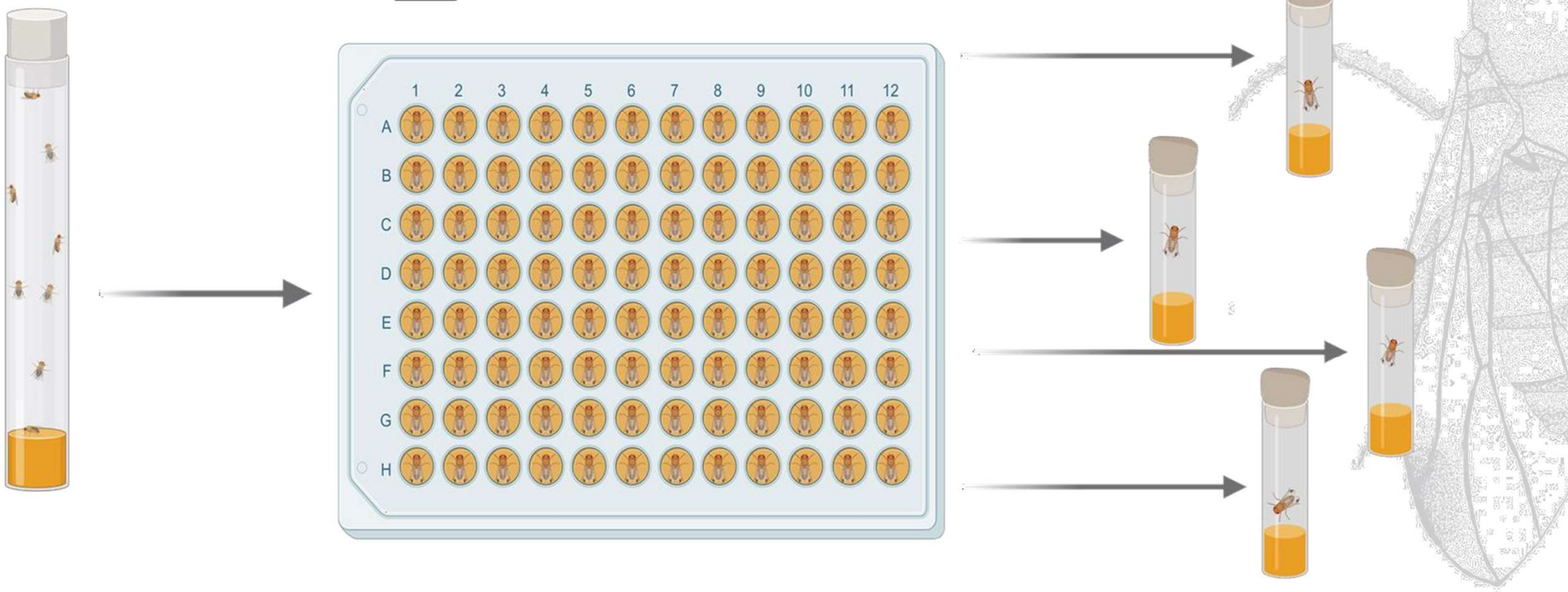


3 hours



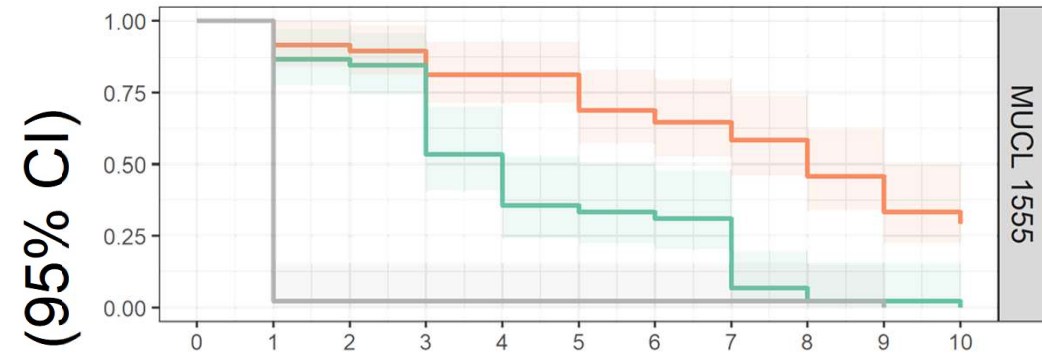
Selecting an effective EPF against *D. suzukii*

 3 hours



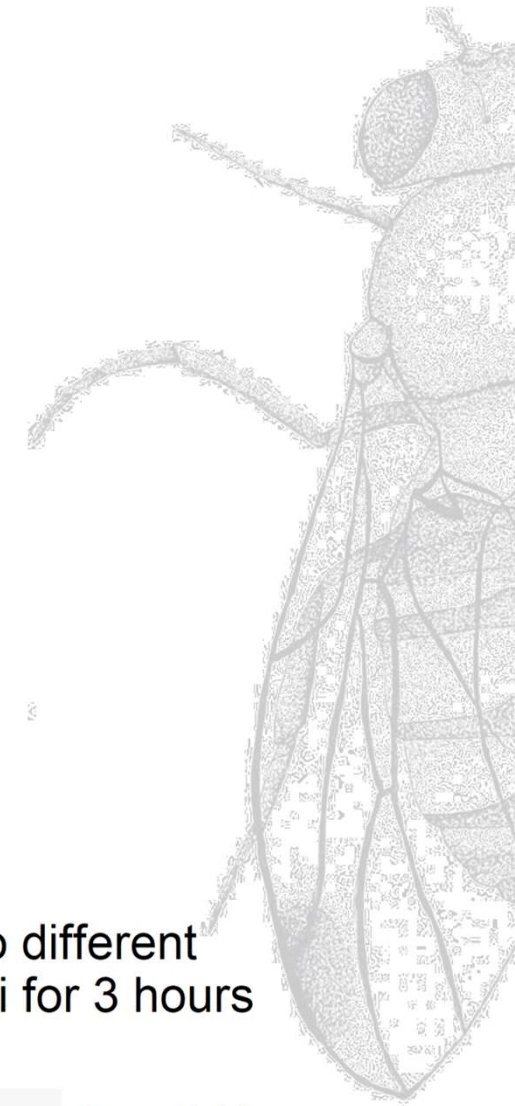
Evaluating mortality for 10 days

Selecting an effective EPF against *D. sukuzii*

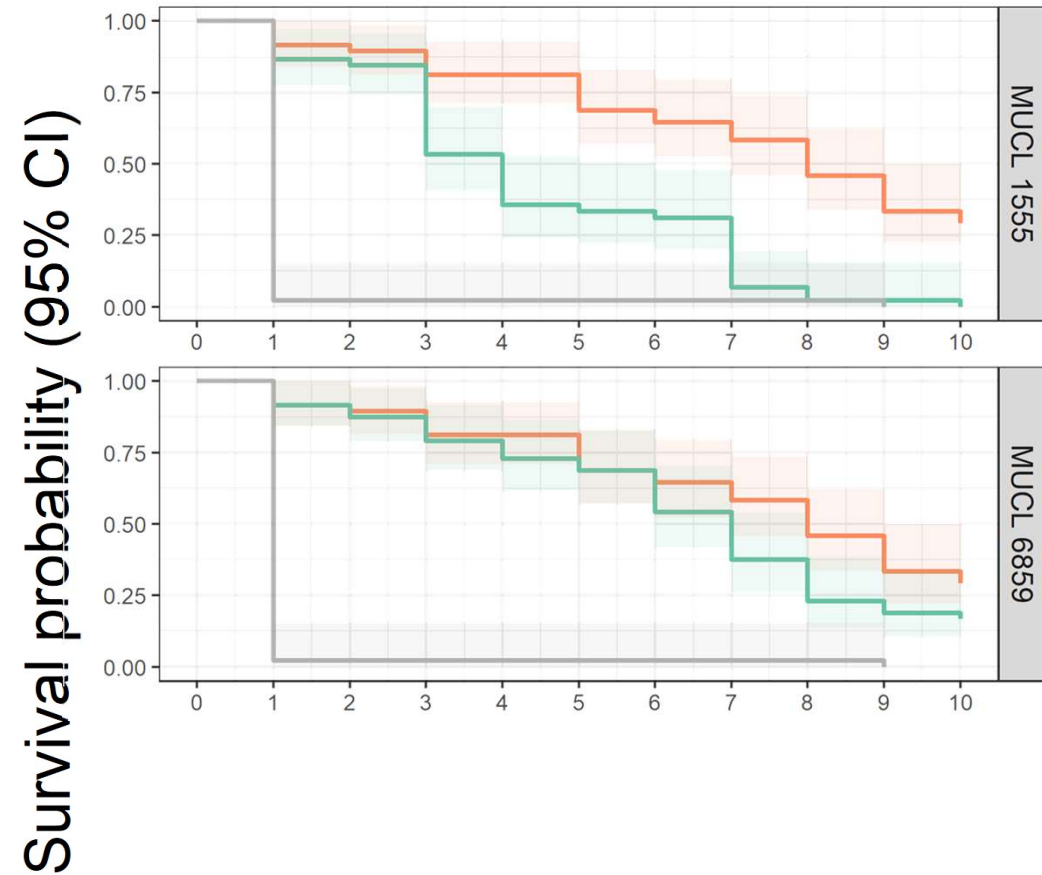


Days after exposure to different entomopathogenic fungi for 3 hours

Control Fungus Insecticide



Selecting an effective EPF against *D. sukuzii*

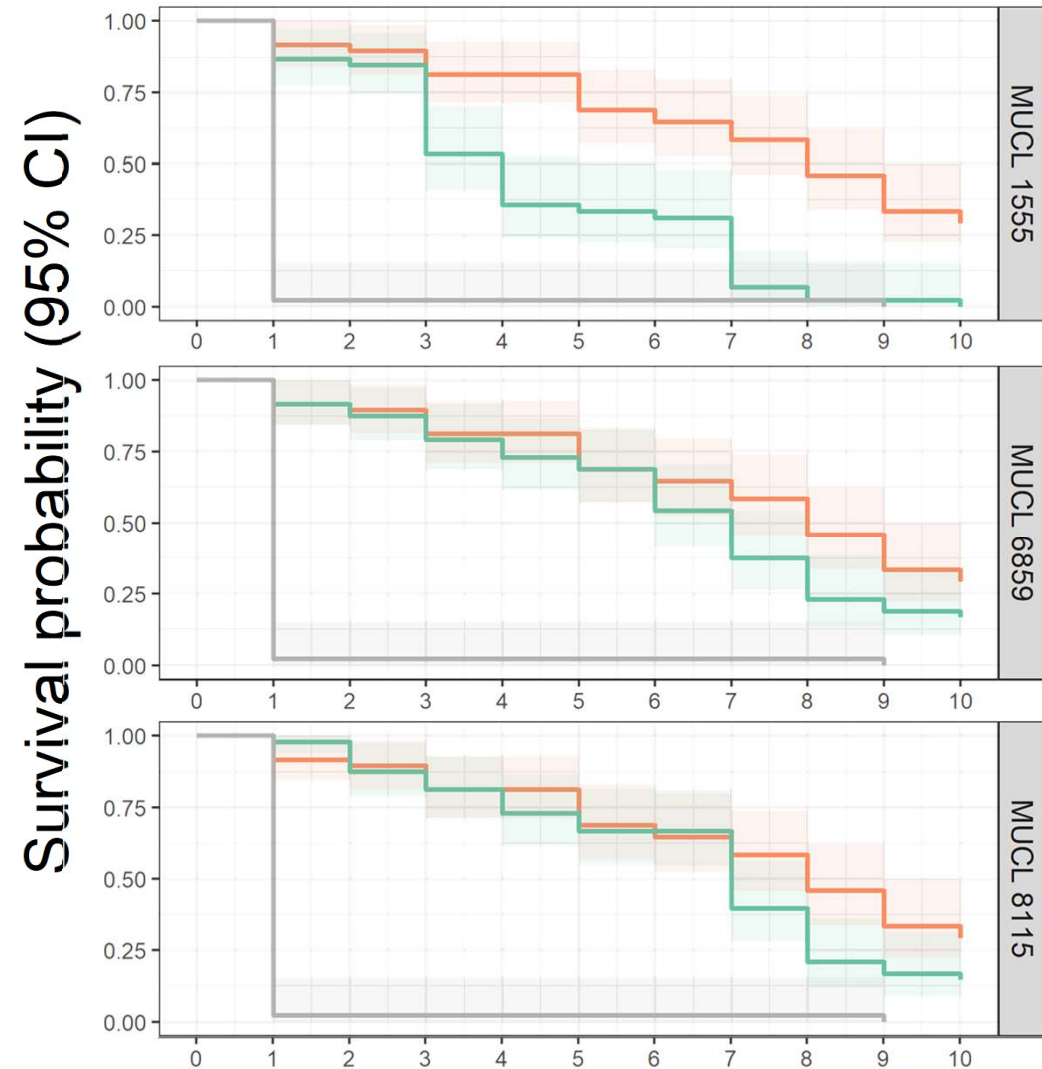


Days after exposure to different entomopathogenic fungi for 3 hours

Control Fungus Insecticide



Selecting an effective EPF against *D. sukuzii*

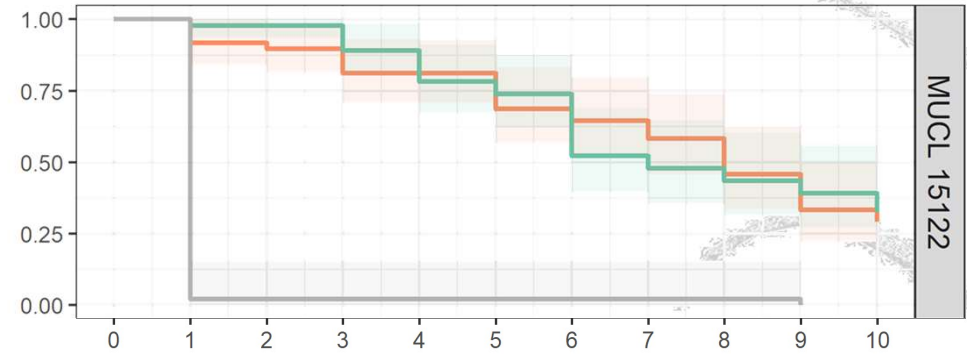
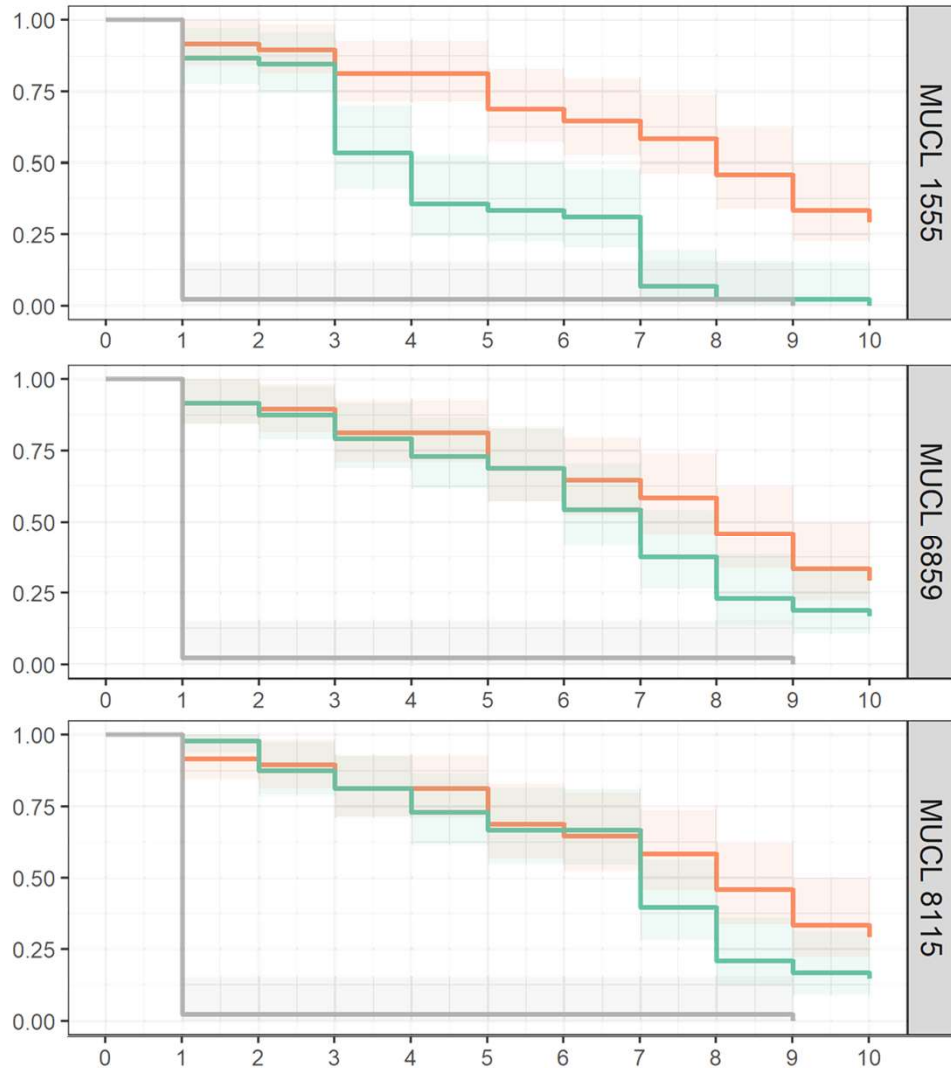


Days after exposure to different entomopathogenic fungi for 3 hours

Control Fungus Insecticide

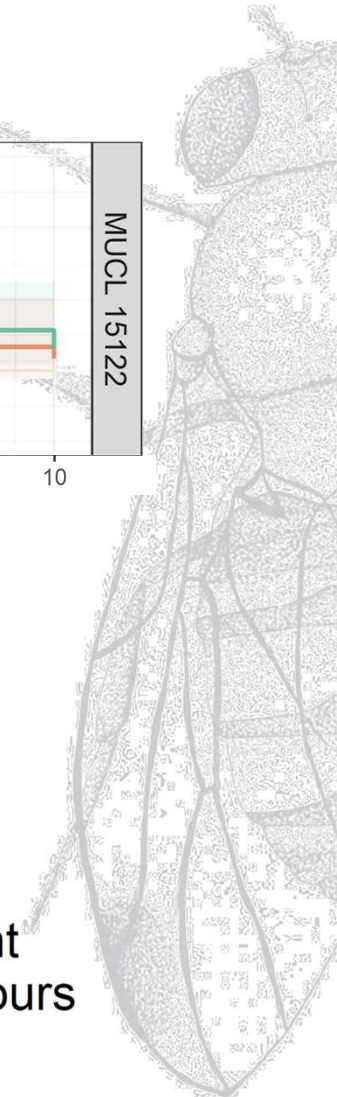
Selecting an effective EPF against *D. sukuzii*

Survival probability (95% CI)



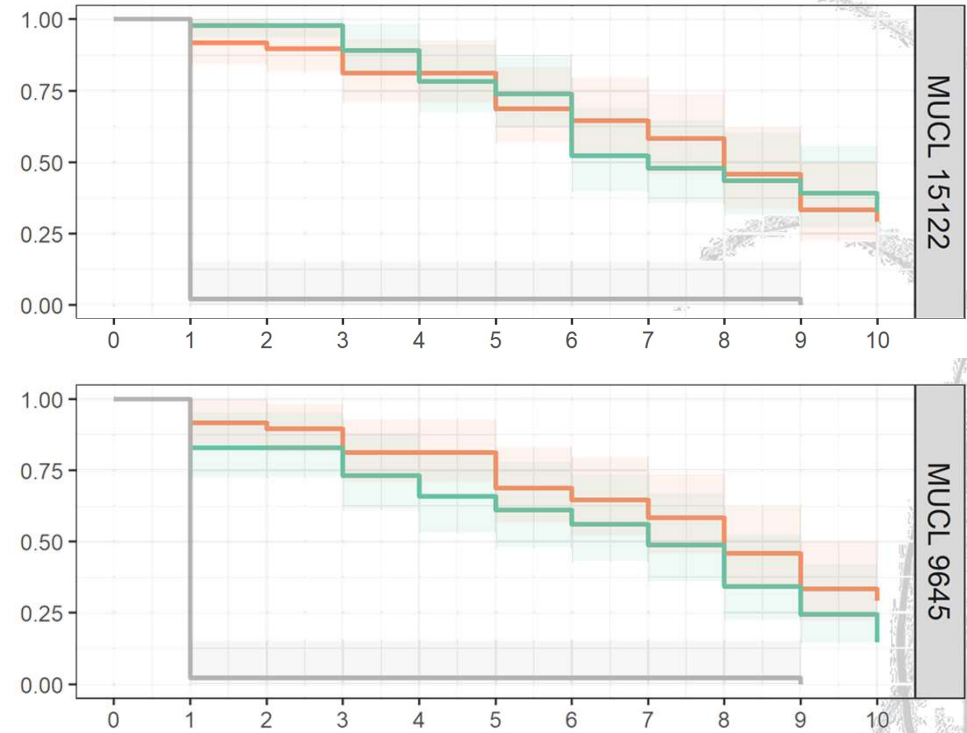
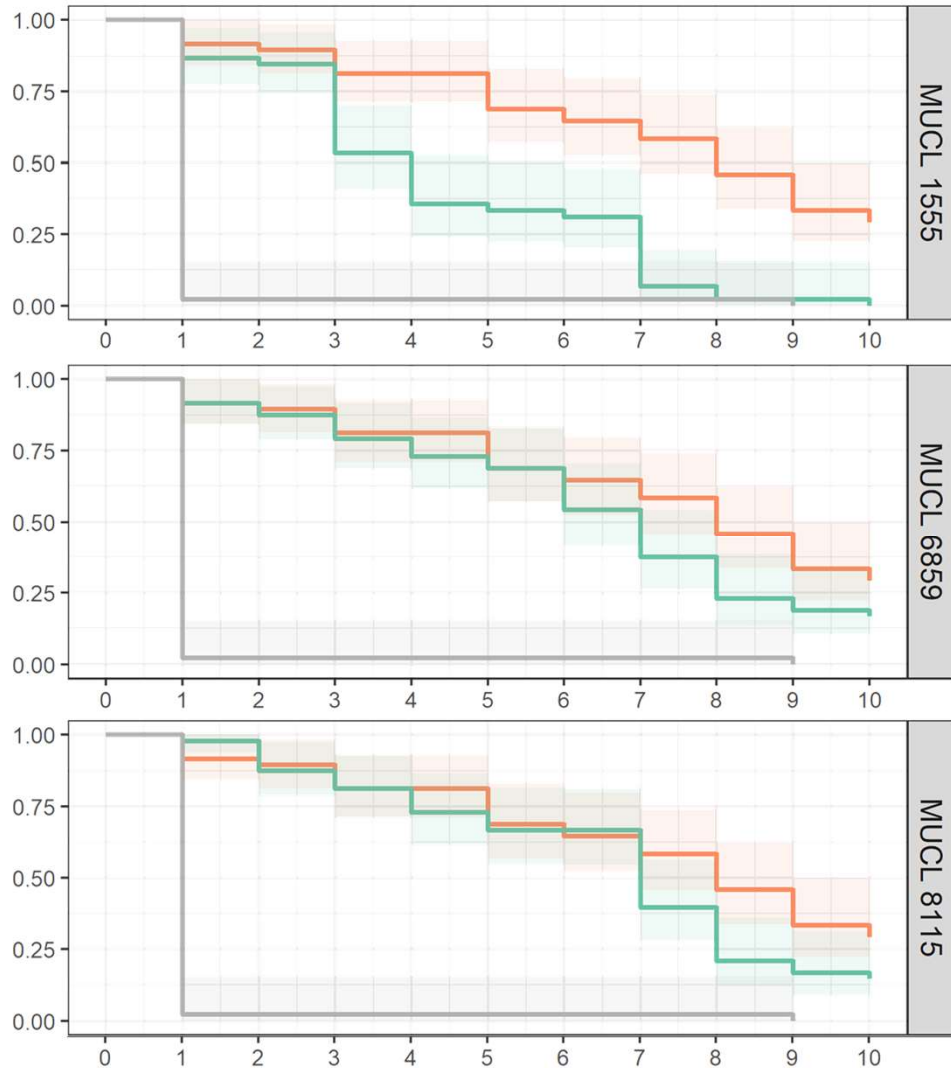
Days after exposure to different entomopathogenic fungi for 3 hours

Control Fungus Insecticide



Selecting an effective EPF against *D. sukuzii*

Survival probability (95% CI)



Days after exposure to different entomopathogenic fungi for 3 hours

Control Fungus Insecticide

TAKE-HOME MESSAGES

1 | MUCL 1555 is lethal for *D. sukuzii* after a 3hr-contact

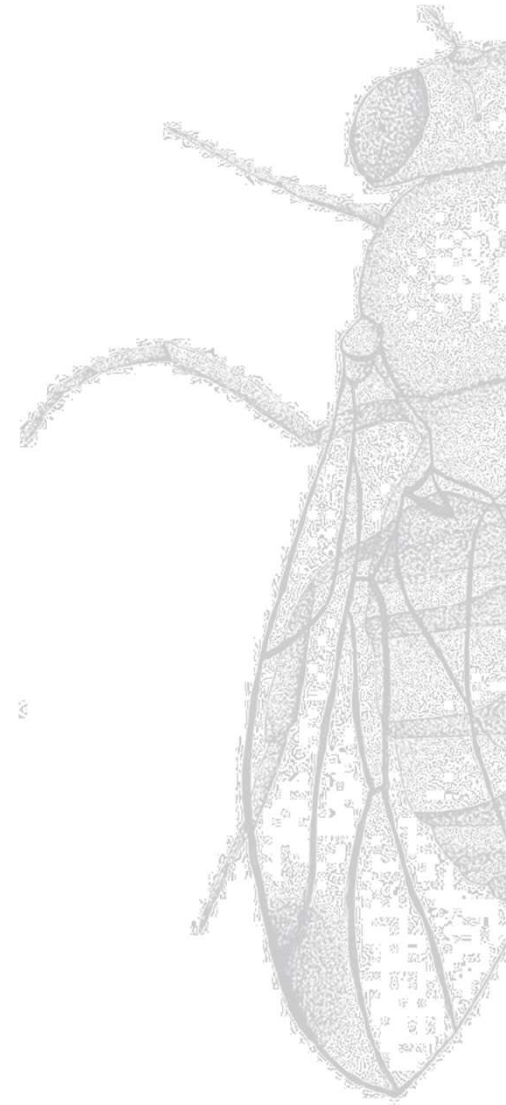
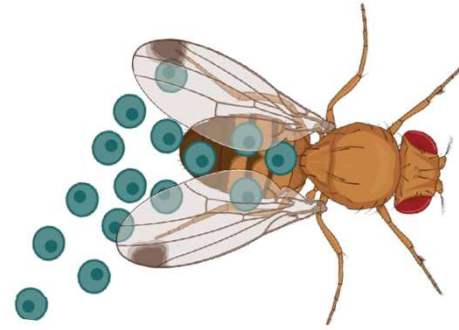


Aims

1

Select an effective EPF by integrating its ability of adhesion

About shorter contact times?

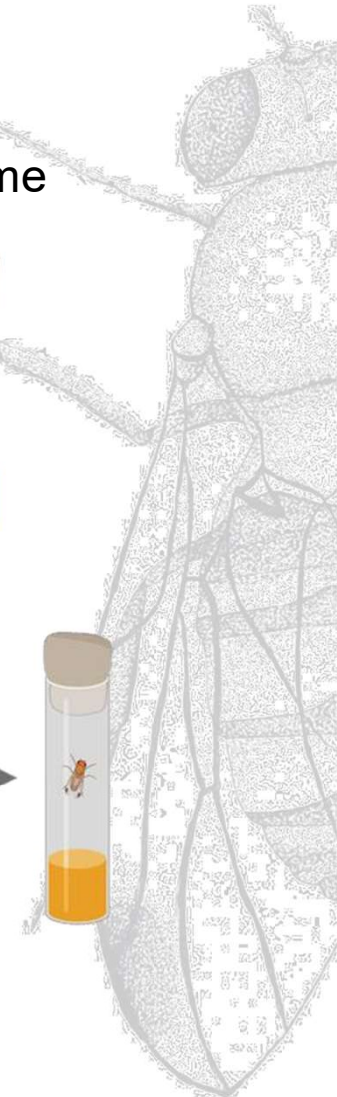
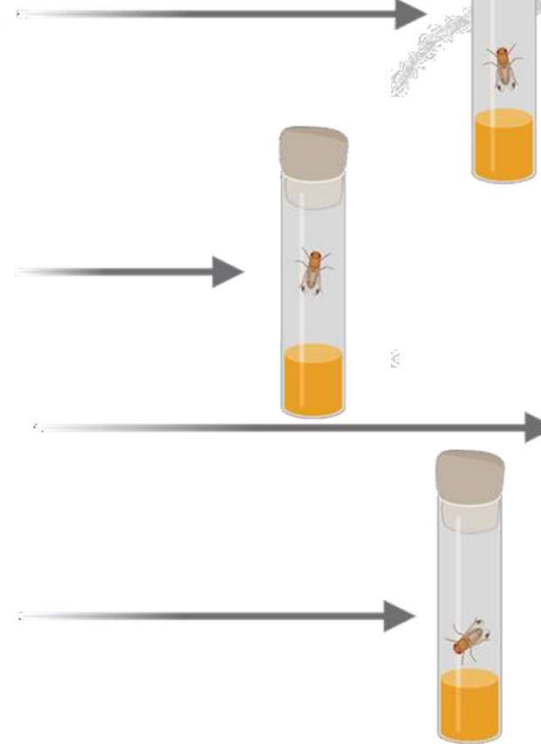
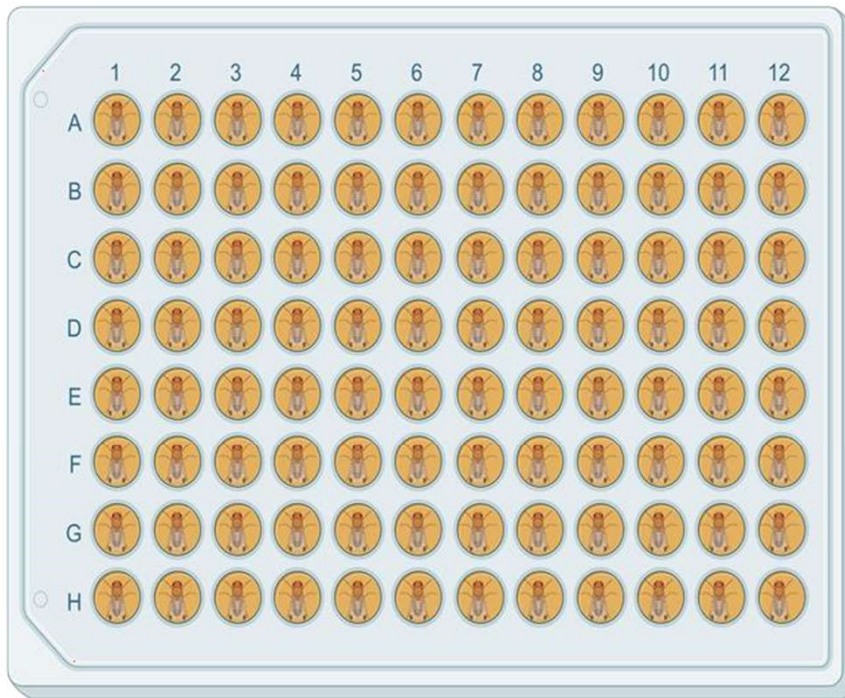


About shorter contact time ?



10 sec, 1min, 10min, 1h

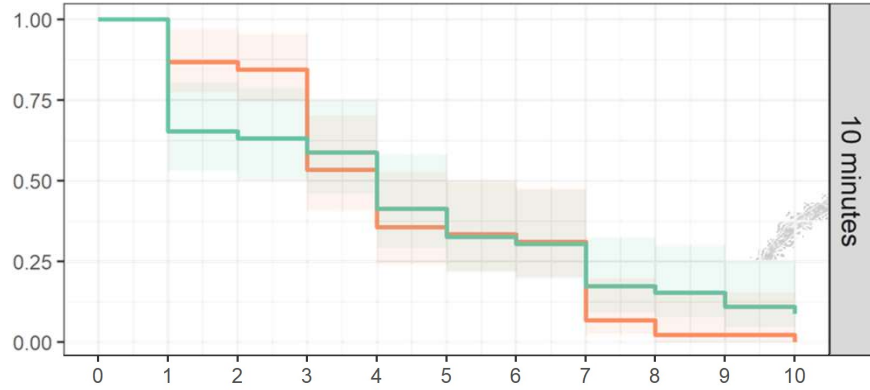
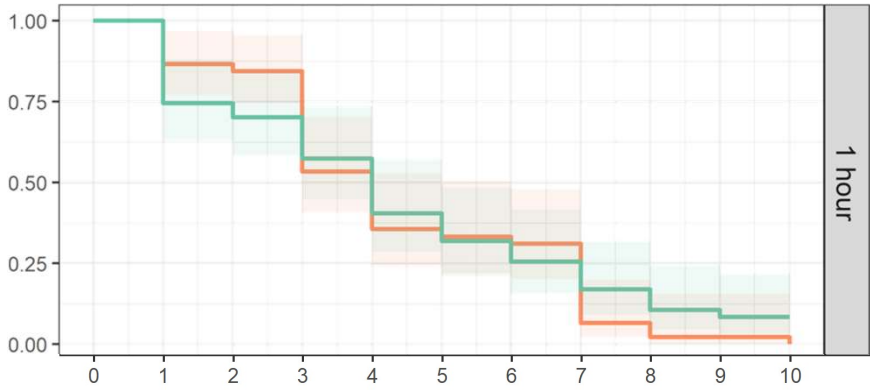
N = 48 / time



Evaluating mortality for 10 days

About shorter contact time ?

Survival probability (95% CI)



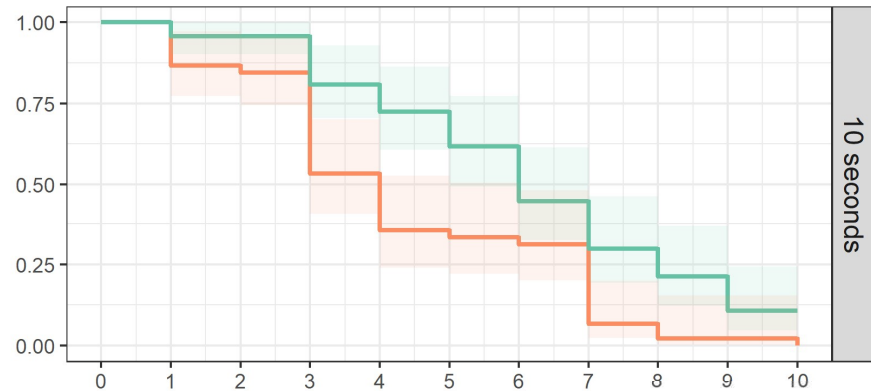
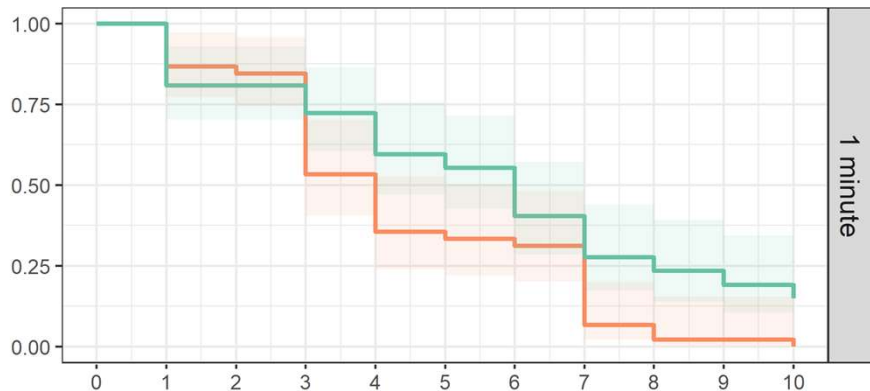
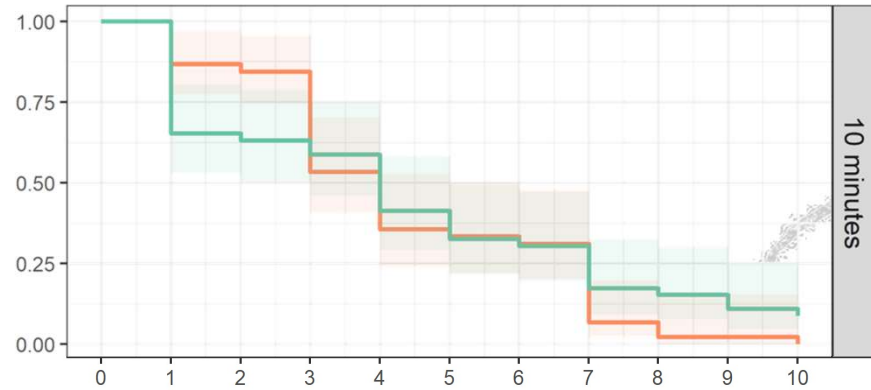
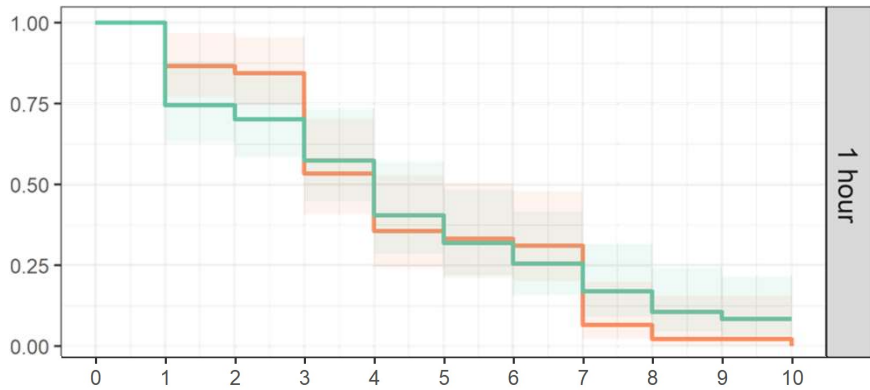
Days after exposure to *B. bassiana* (MUCL 1555) for different times

- 3 hours
- Different times



About shorter contact time ?

Survival probability (95% CI)



Days after exposure to *B. bassiana* (MUCL 1555) for different times

- 3 hours
- Different times



TAKE-HOME MESSAGES

1 | MUCL 1555 is lethal for *D. sukuzii* after a 3hr-contact



TAKE-HOME MESSAGES

1 | MUCL 1555 is lethal for *D. sukuzii* after a 3hr-contact

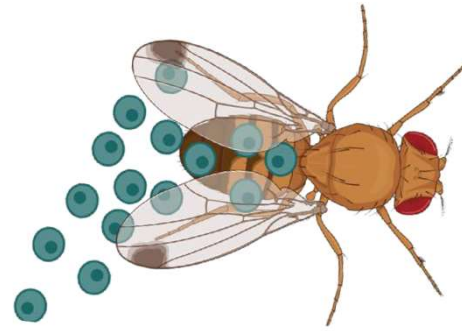
2 | MUCL 1555 has an ability to adhere to insect cuticule quickly and to kill this insect



Aims

1

Select an effective EPF by integrating its ability of adhesion



2

Test impact of EPF on non-target insects



Side effect on non-target insects ?



Side effect on non-target insects ?



Orius laevigatus

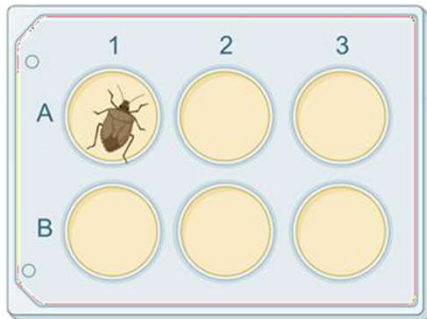


Bombus terrestris

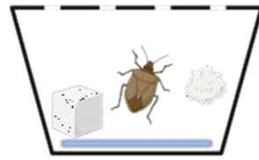


Evaluate mortality for 20 days

Side effect on non-target insects ?

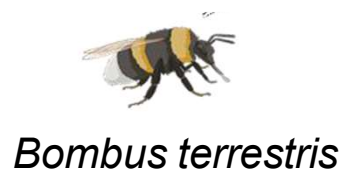


3 hours



Evaluating mortality for 10 days

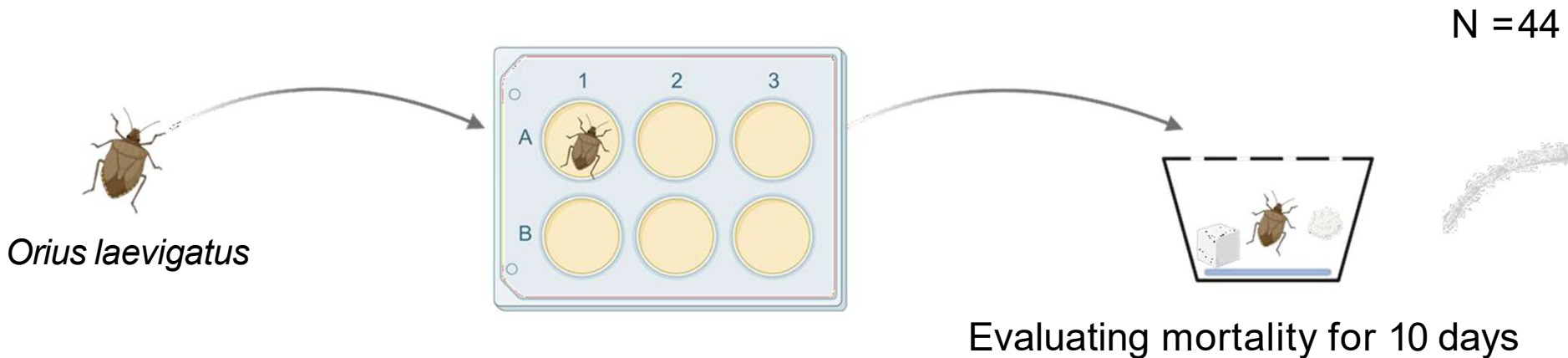
N = 44




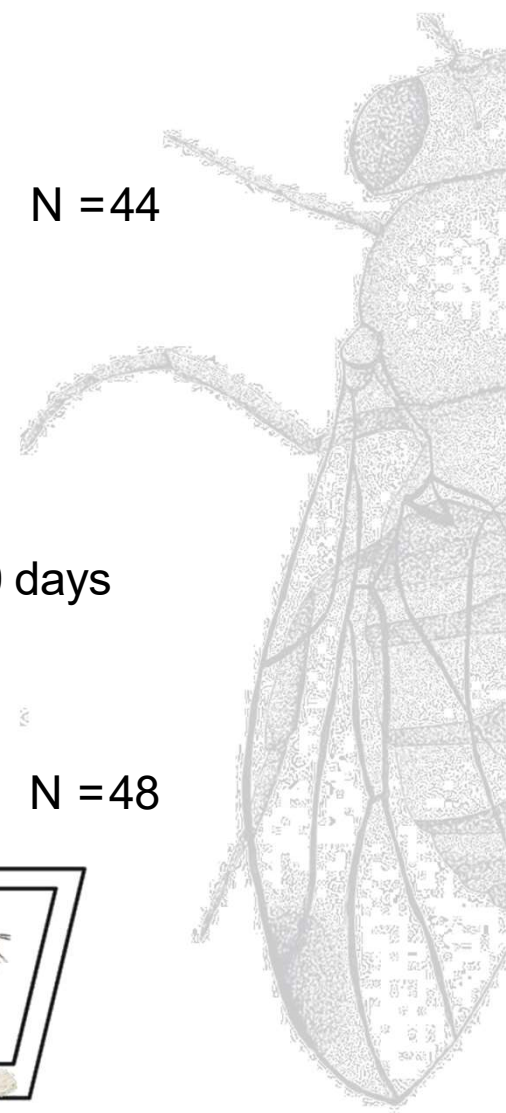
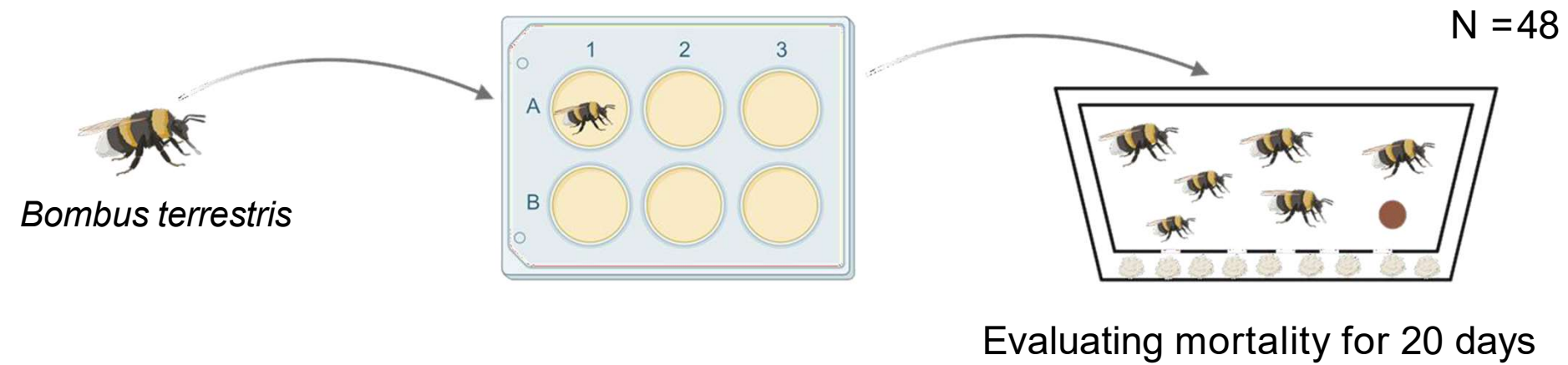
Evaluate mortality for 20 days



Side effect on non-target insects ?

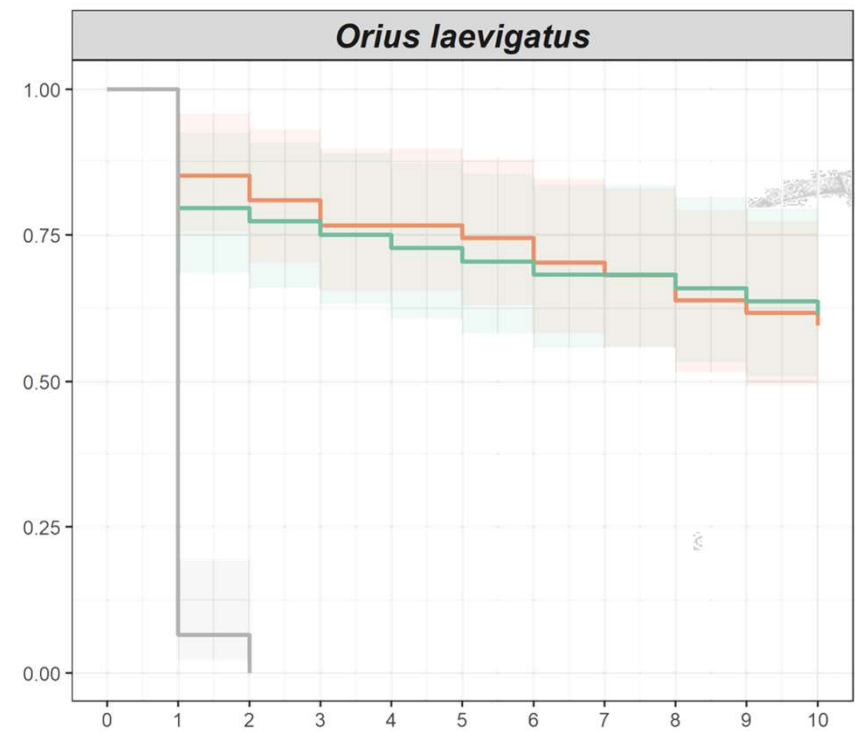
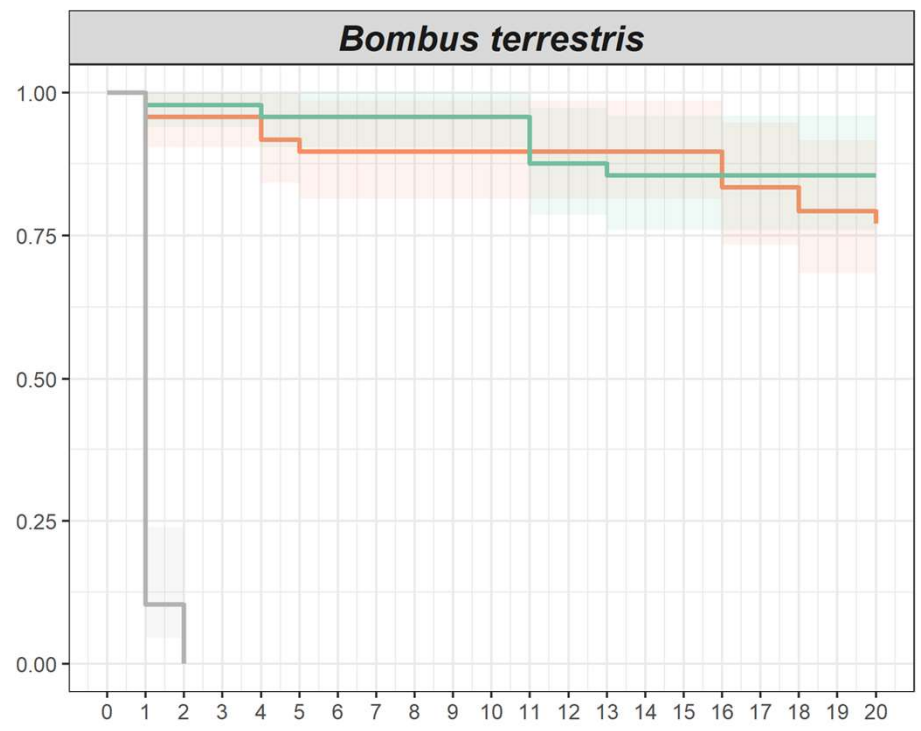


 **3 hours**



Side effect on non-target insects ?

Survival probability (95% CI)



Days after exposure to *B. bassiana* for 3 hours

Control Fungus Insecticide



TAKE-HOME MESSAGES

1 | MUCL 1555 is lethal for *D. sukuzii* after a 3hr-contact

2 | MUCL 1555 has an ability to adhere to insect cuticule quickly and to kill this insect

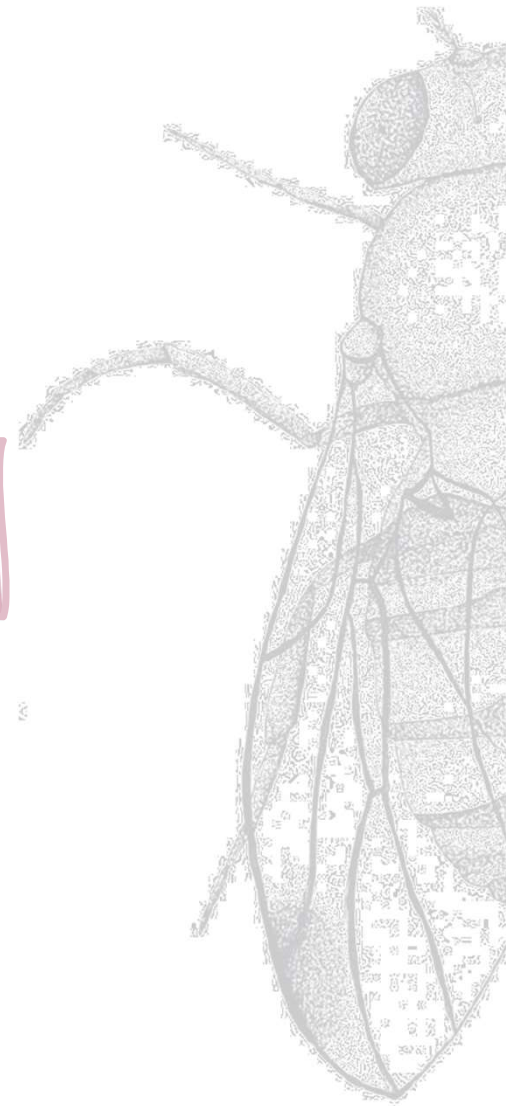


TAKE-HOME MESSAGES

1 | MUCL 1555 is lethal for *D. suzukii* after a 3hr-contact

2 | MUCL 1555 has an ability to adhere to insect cuticule quickly and to kill this insect

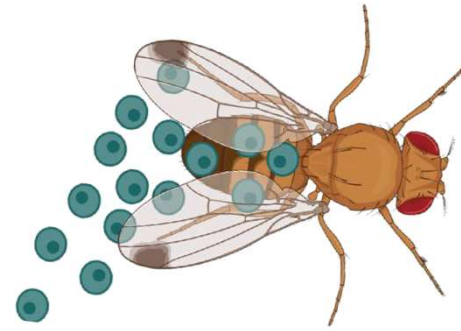
3 | MUCL 1555 is specific



Aims

1

Select an effective EPF by integrating its ability of adhesion



2

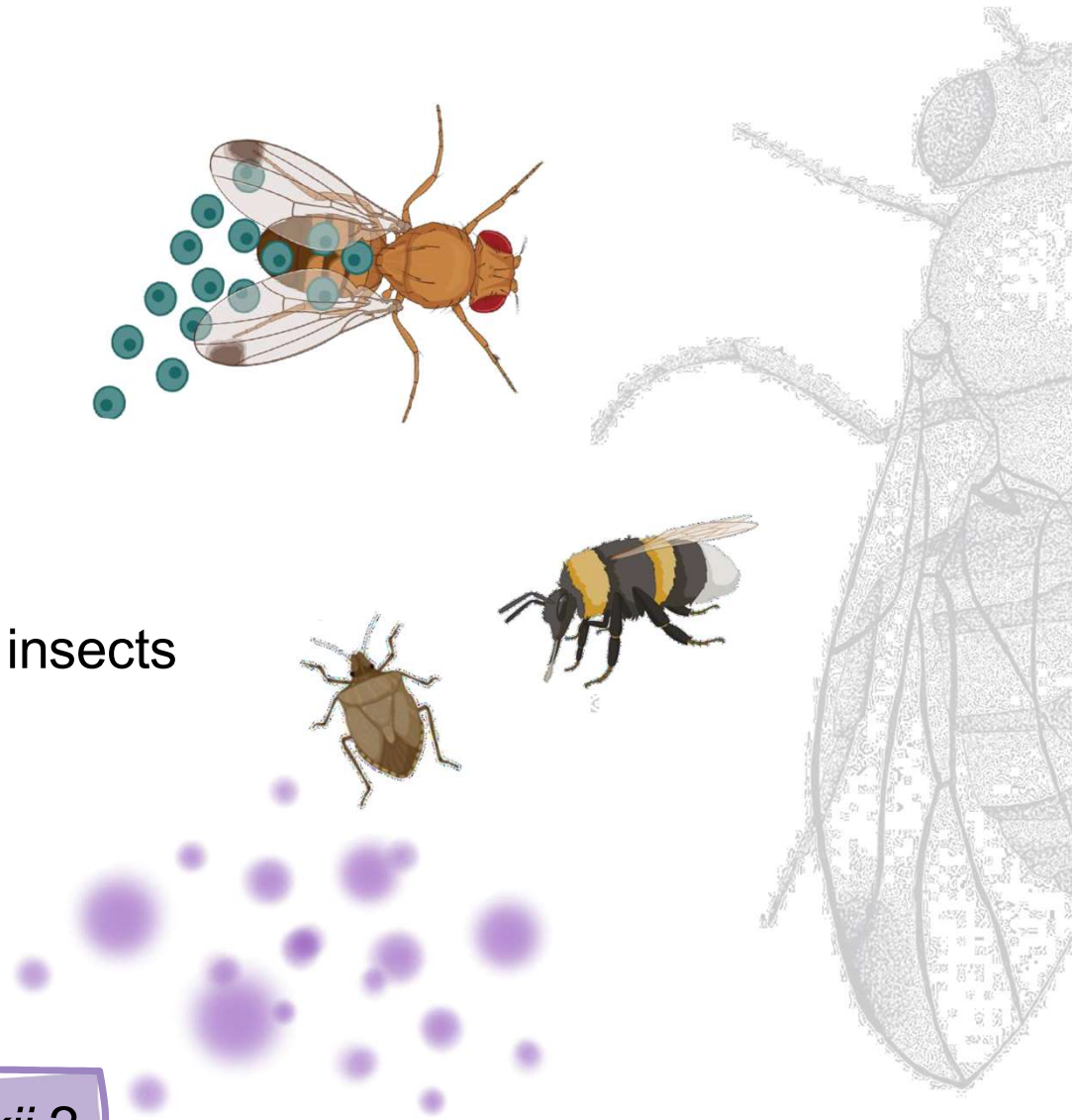
Test impact of EPF on non-target insects



3

Select semiochemicals

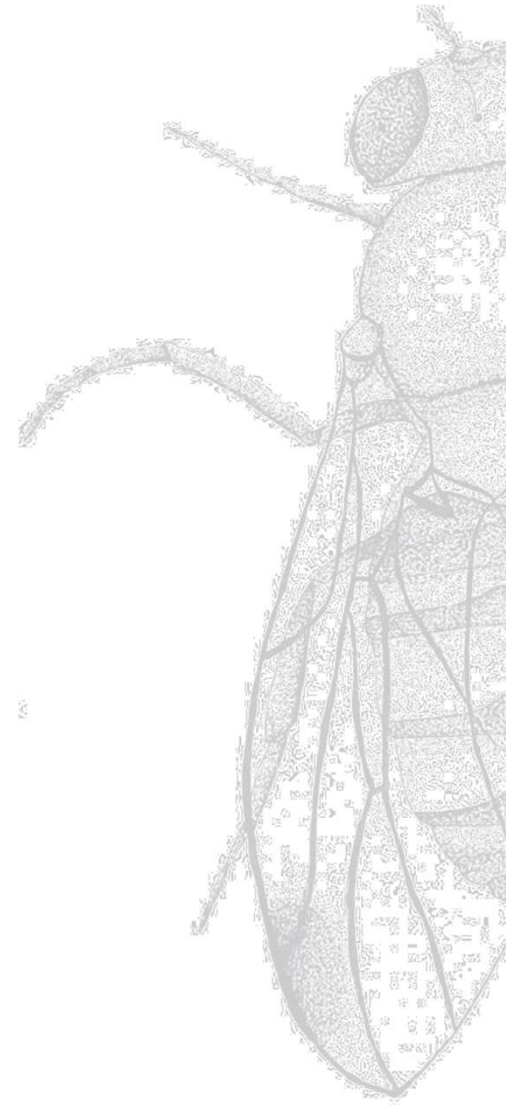
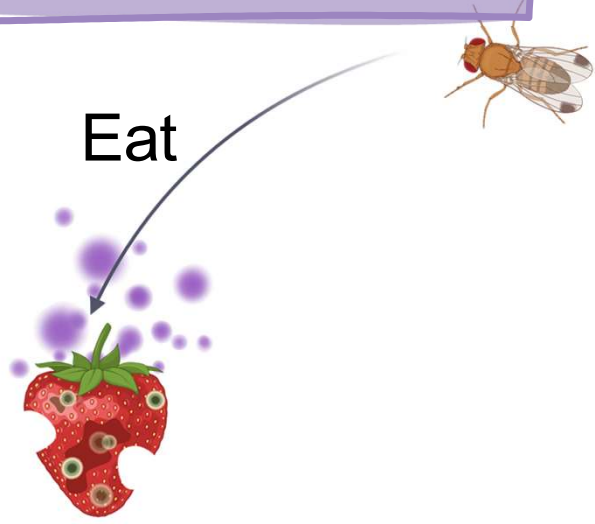
How to attract *D. suzukii* ?



How to attract *D. suzukii* ?

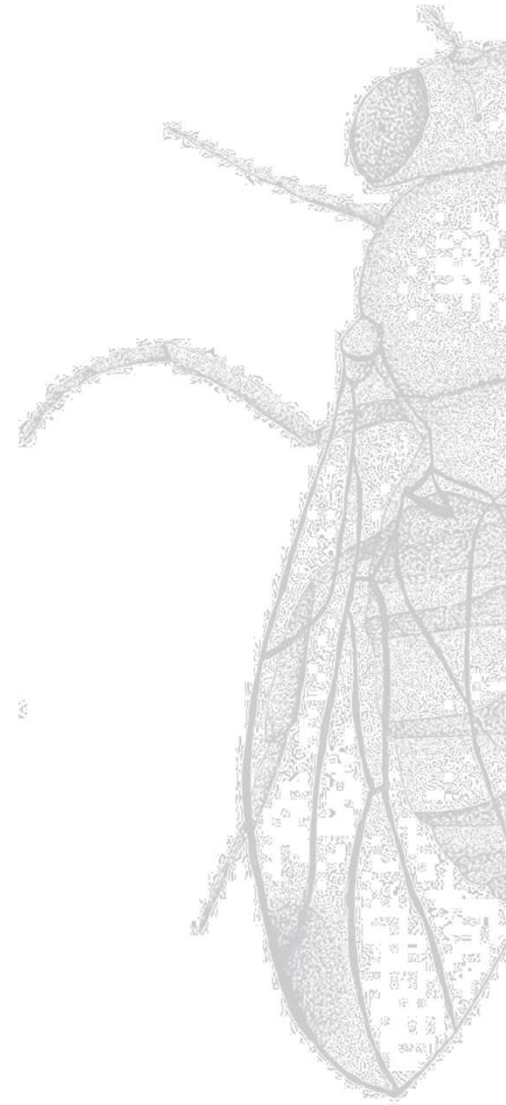
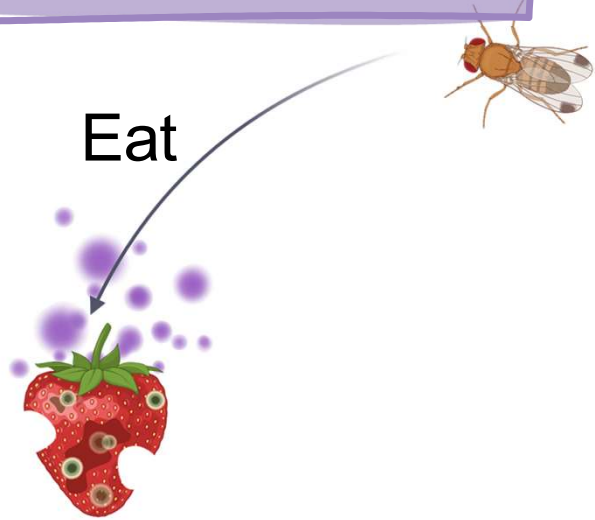


How to attract *D. suzukii* ?

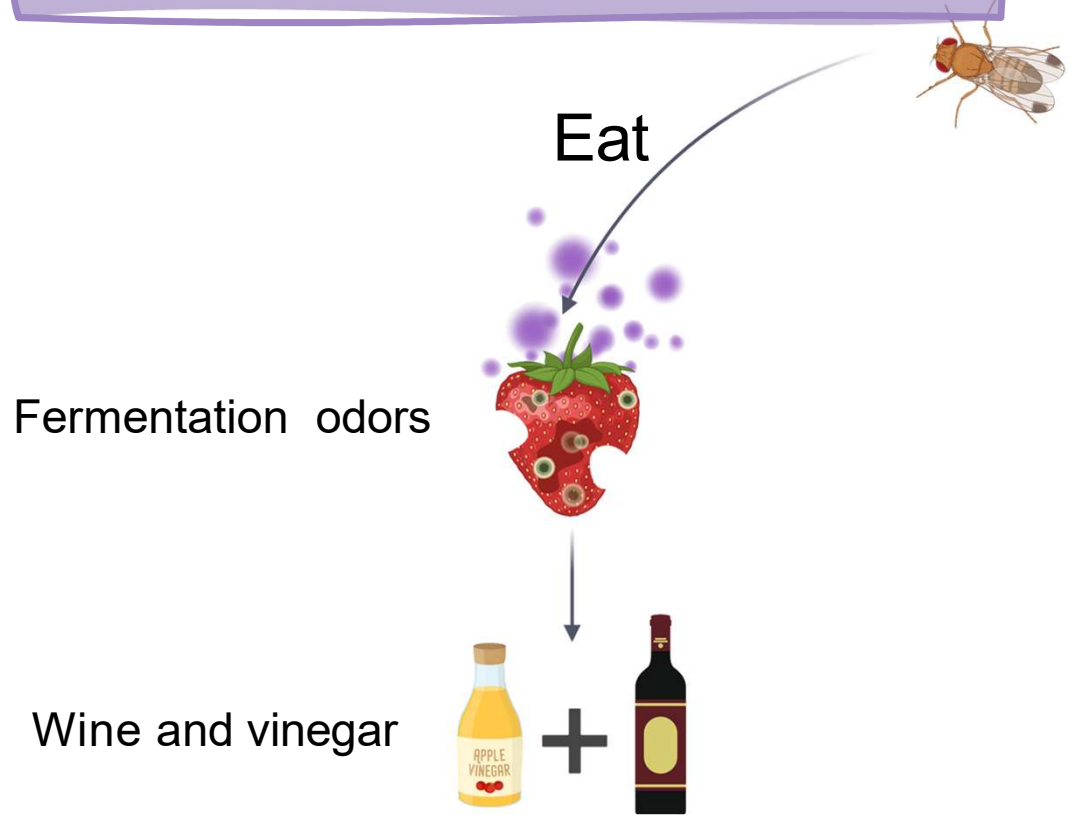


How to attract *D. suzukii* ?

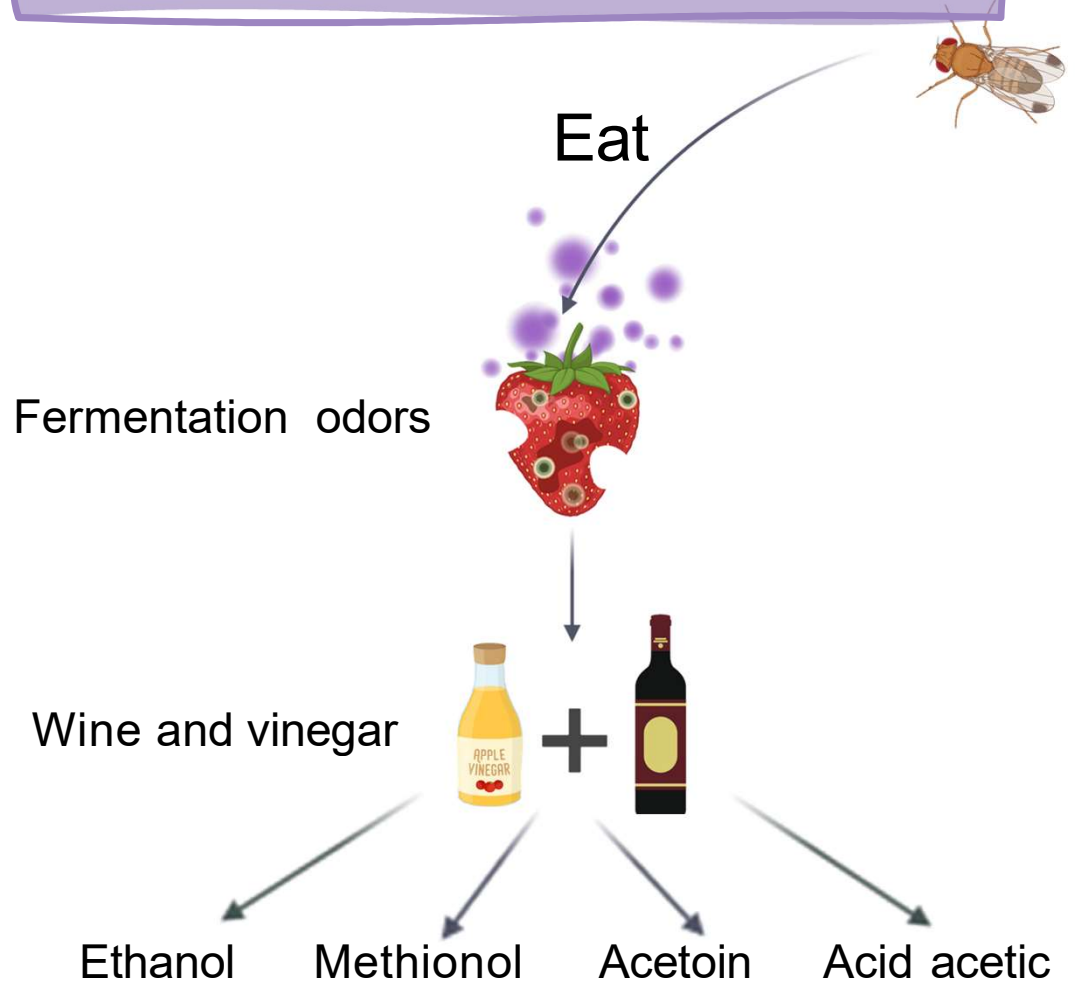
Fermentation odors



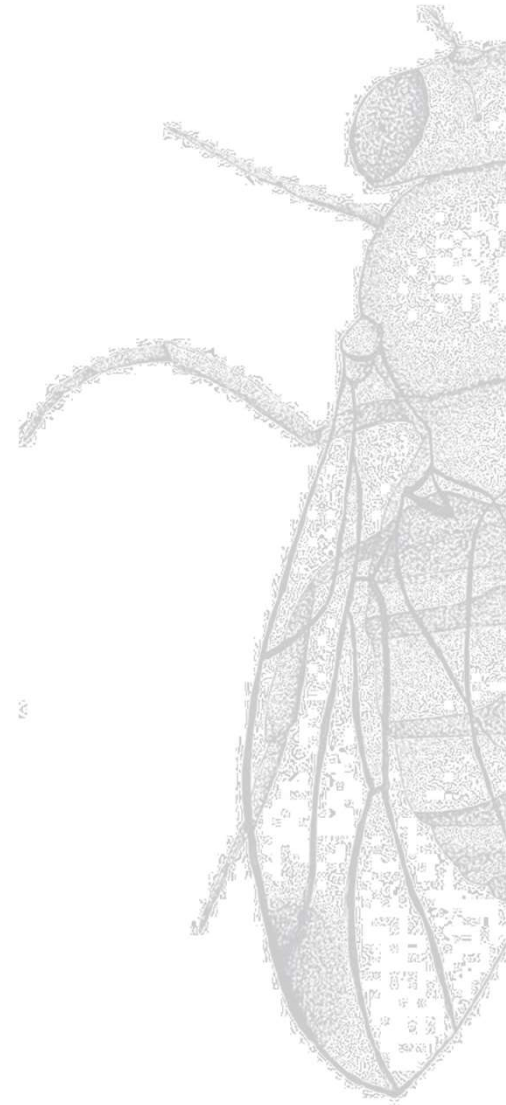
How to attract *D. suzukii* ?



How to attract *D. suzukii* ?

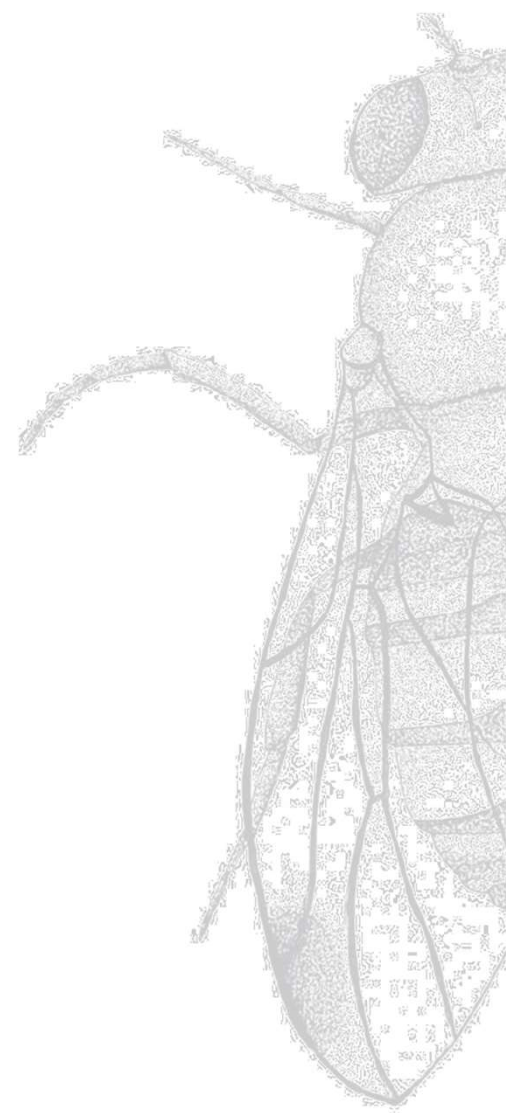
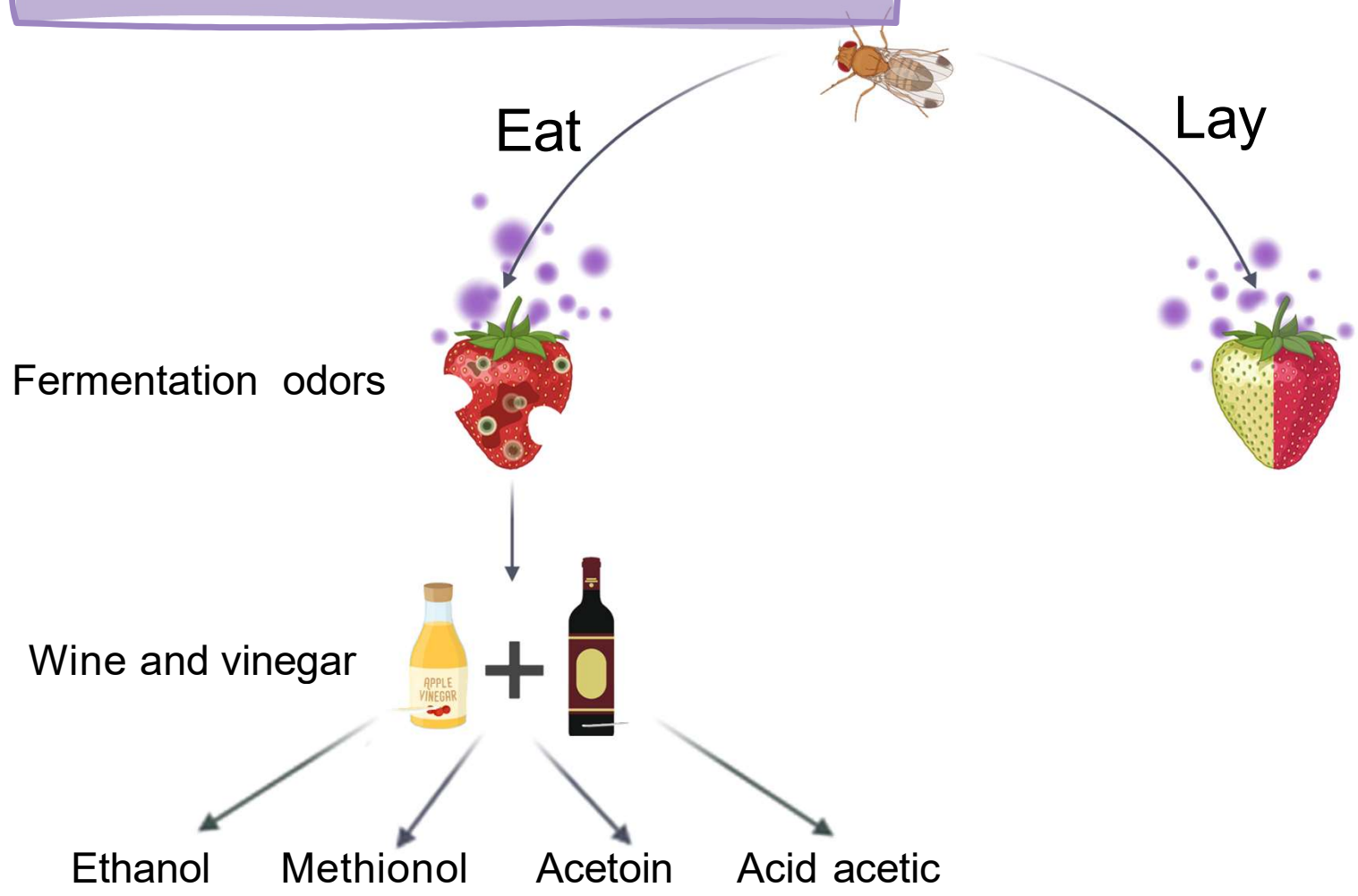


Lay

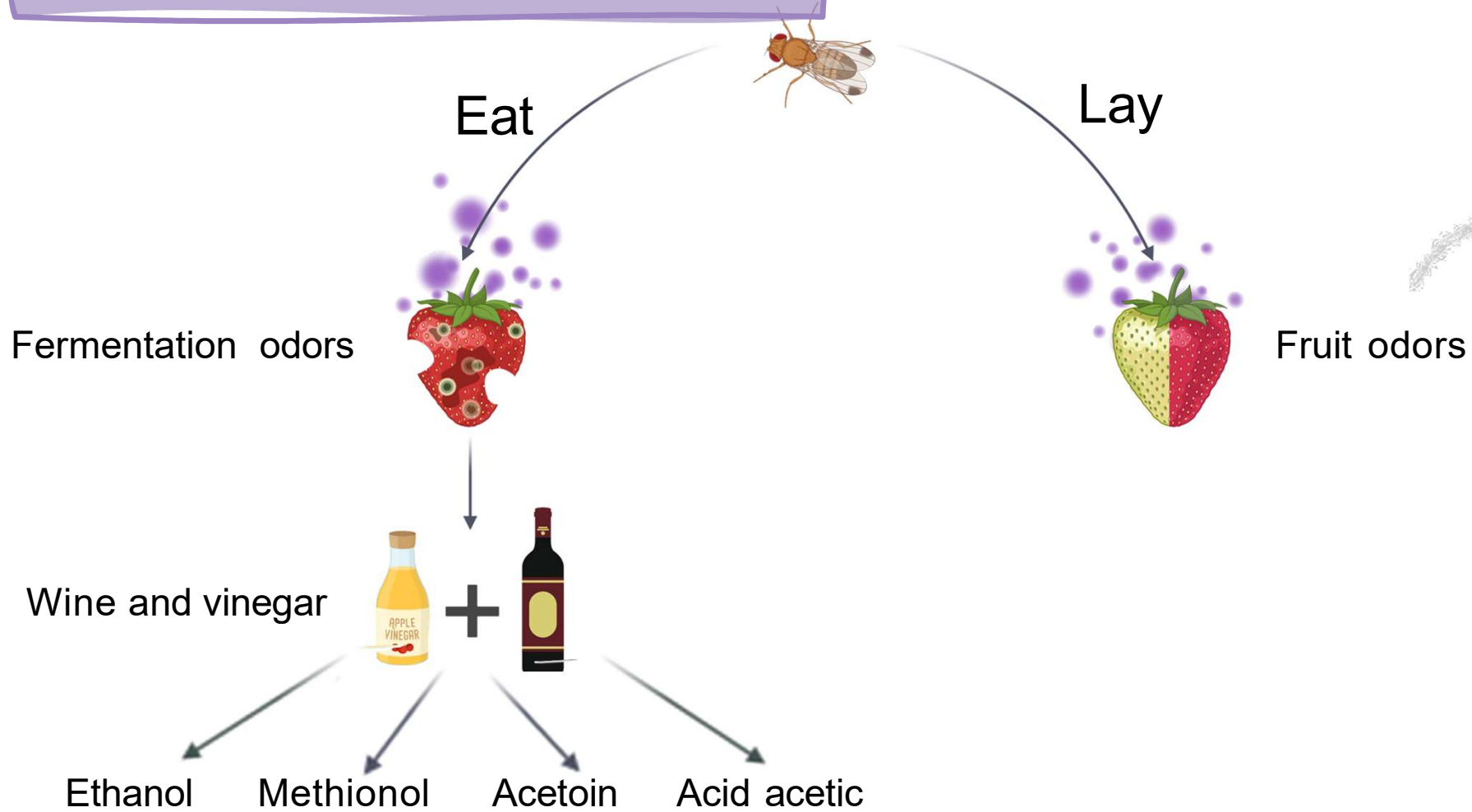


Raspberry ketone

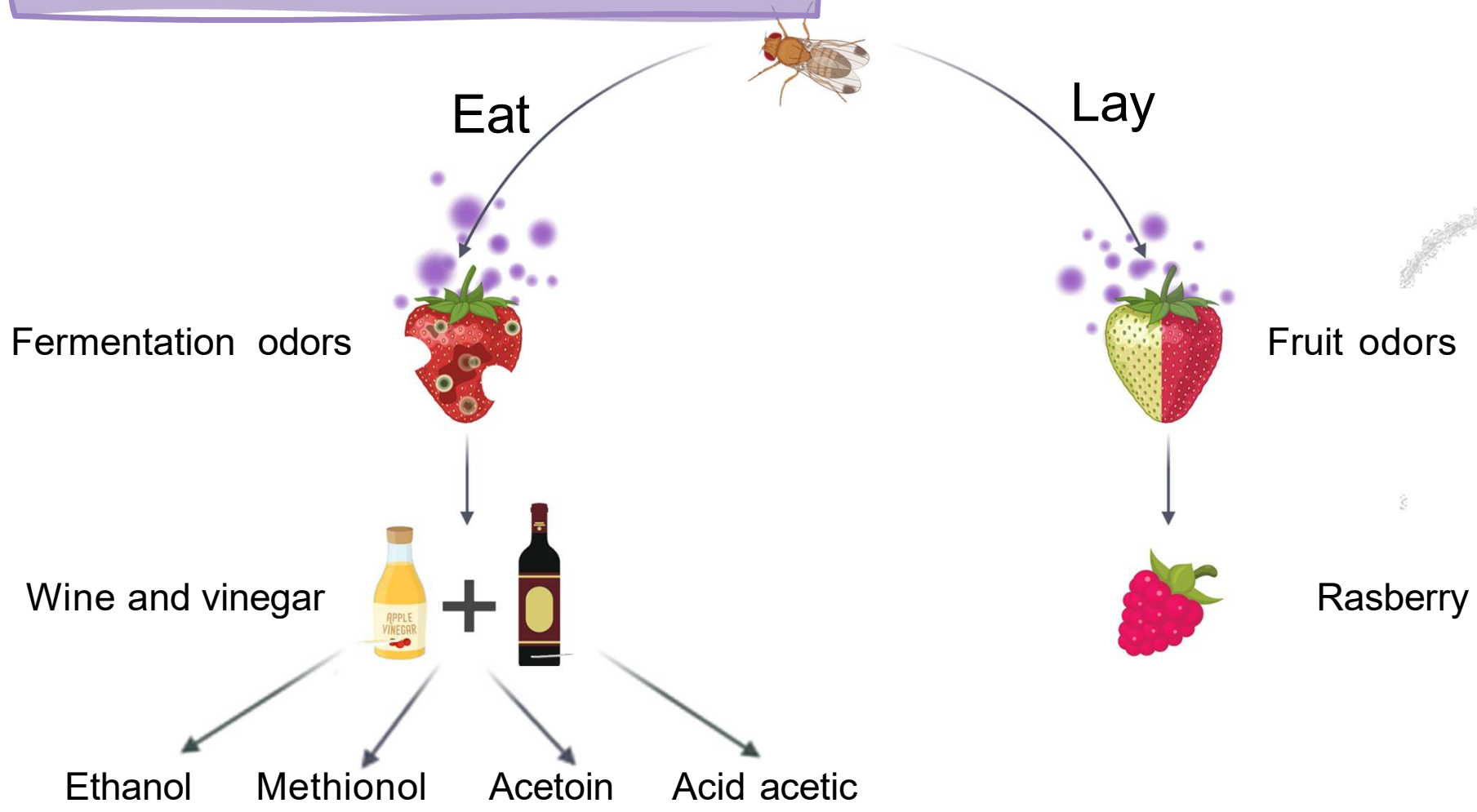
How to attract *D. suzukii* ?



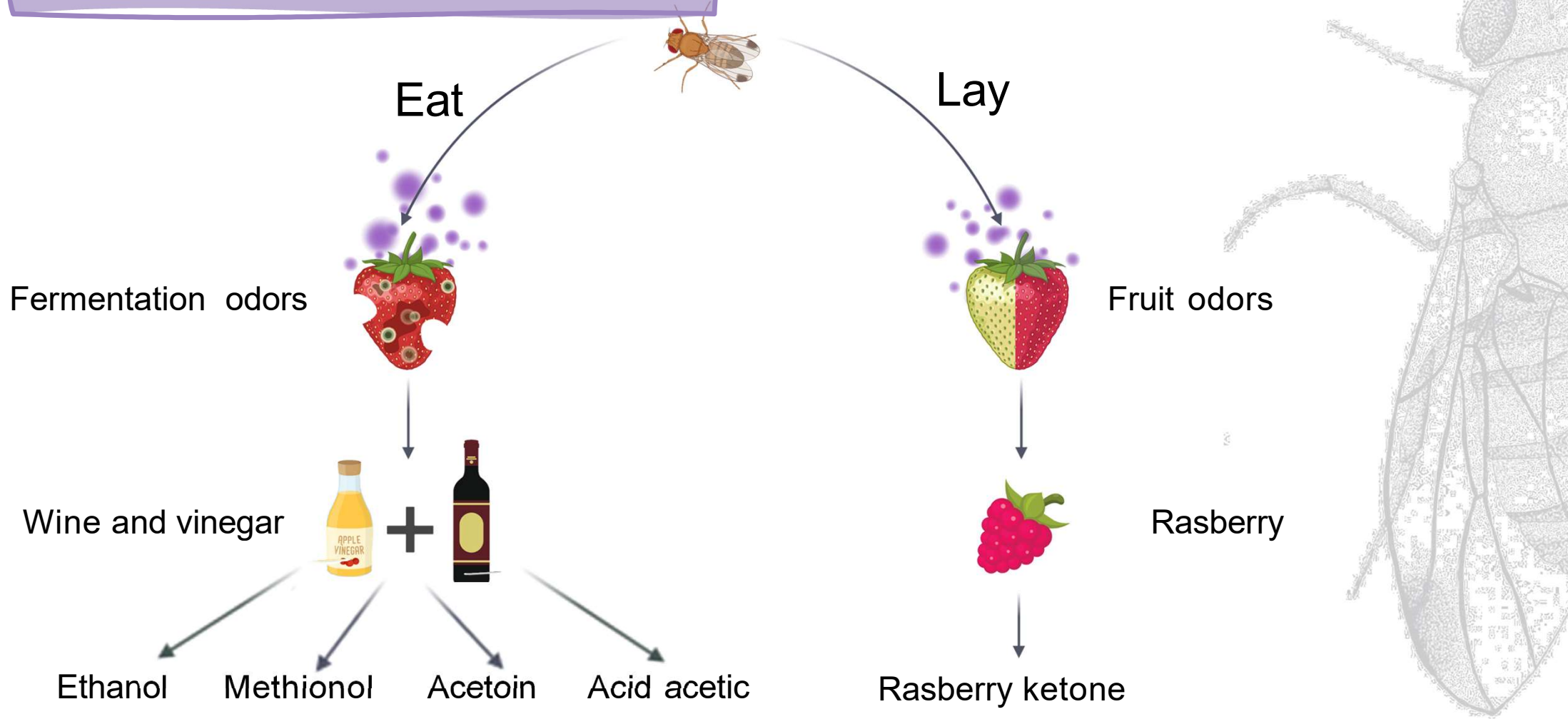
How to attract *D. suzukii* ?



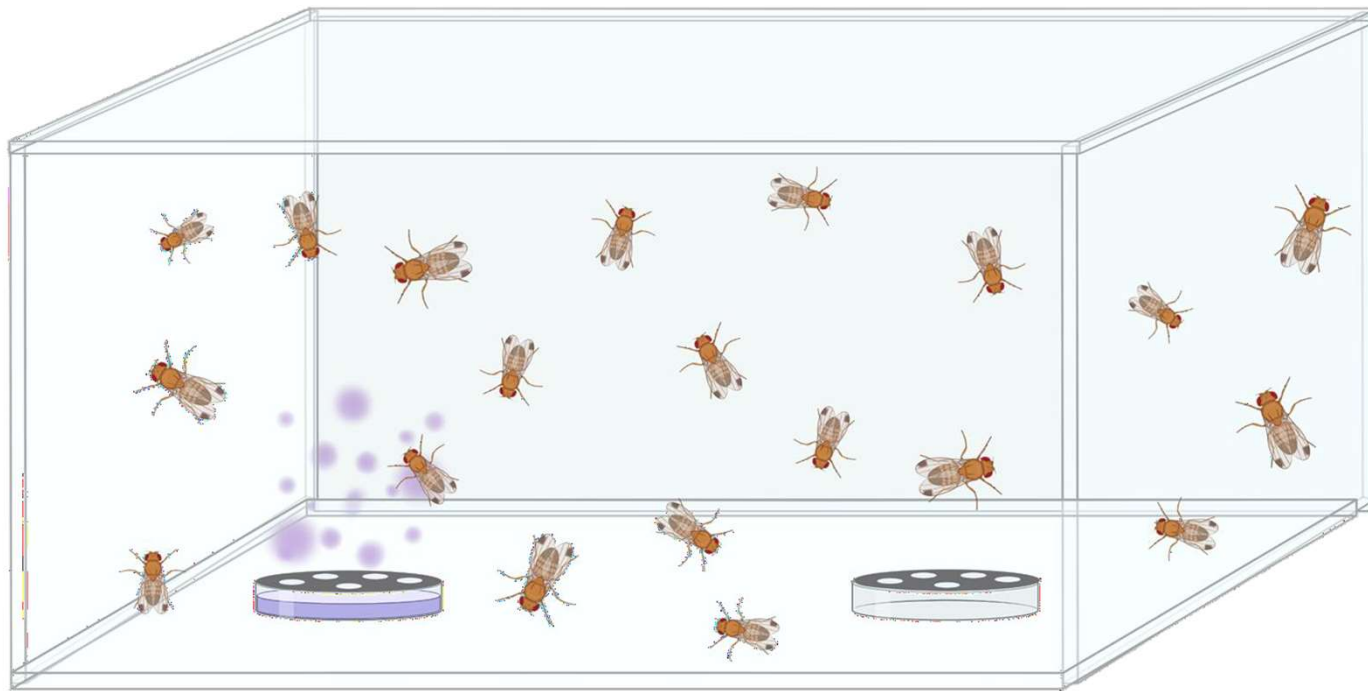
How to attract *D. suzukii* ?



How to attract *D. suzukii* ?



How to attract *D. suzukii* ?



Attractant

Control (water)



3 hours

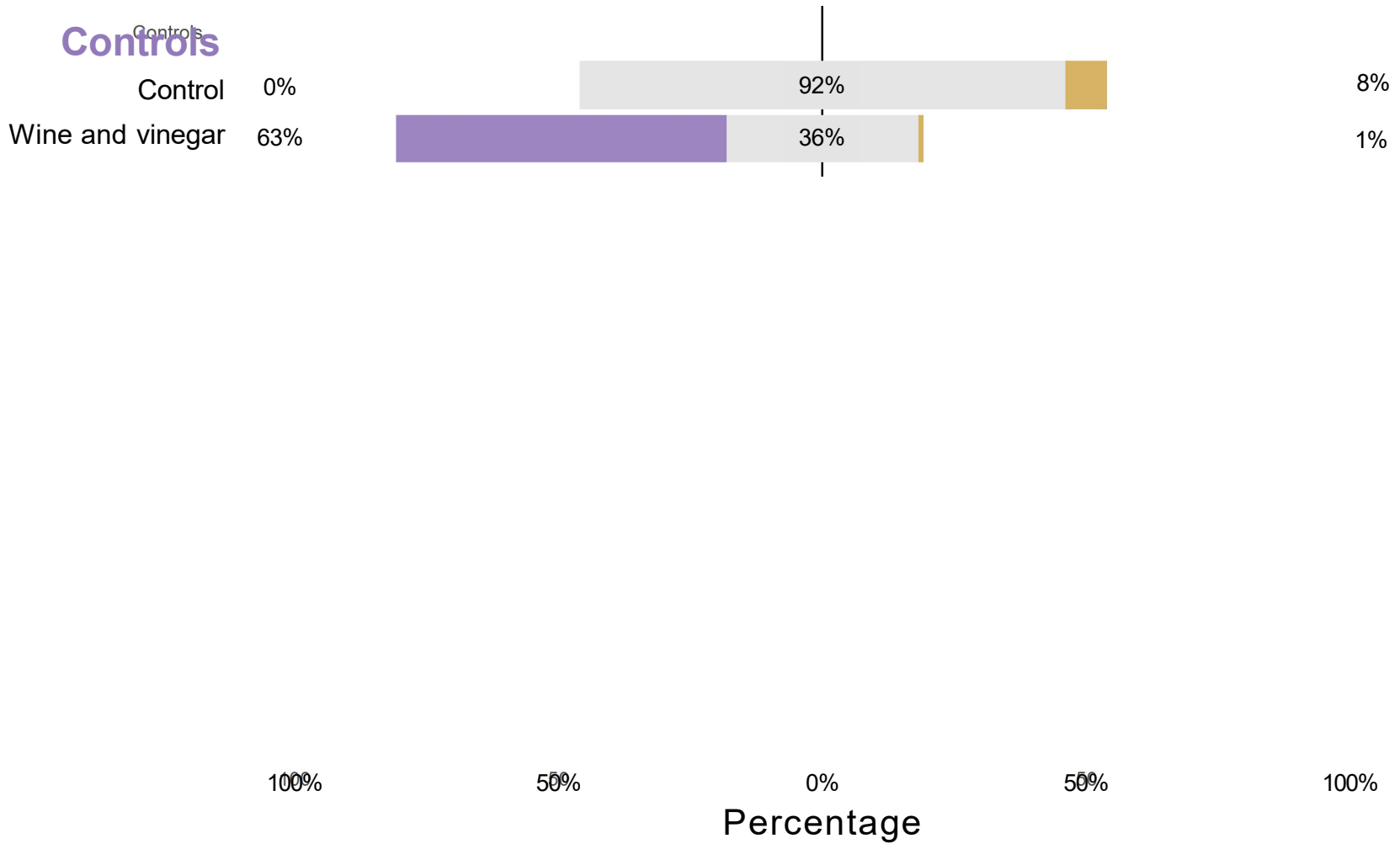


How to attract *D. suzukii* ?

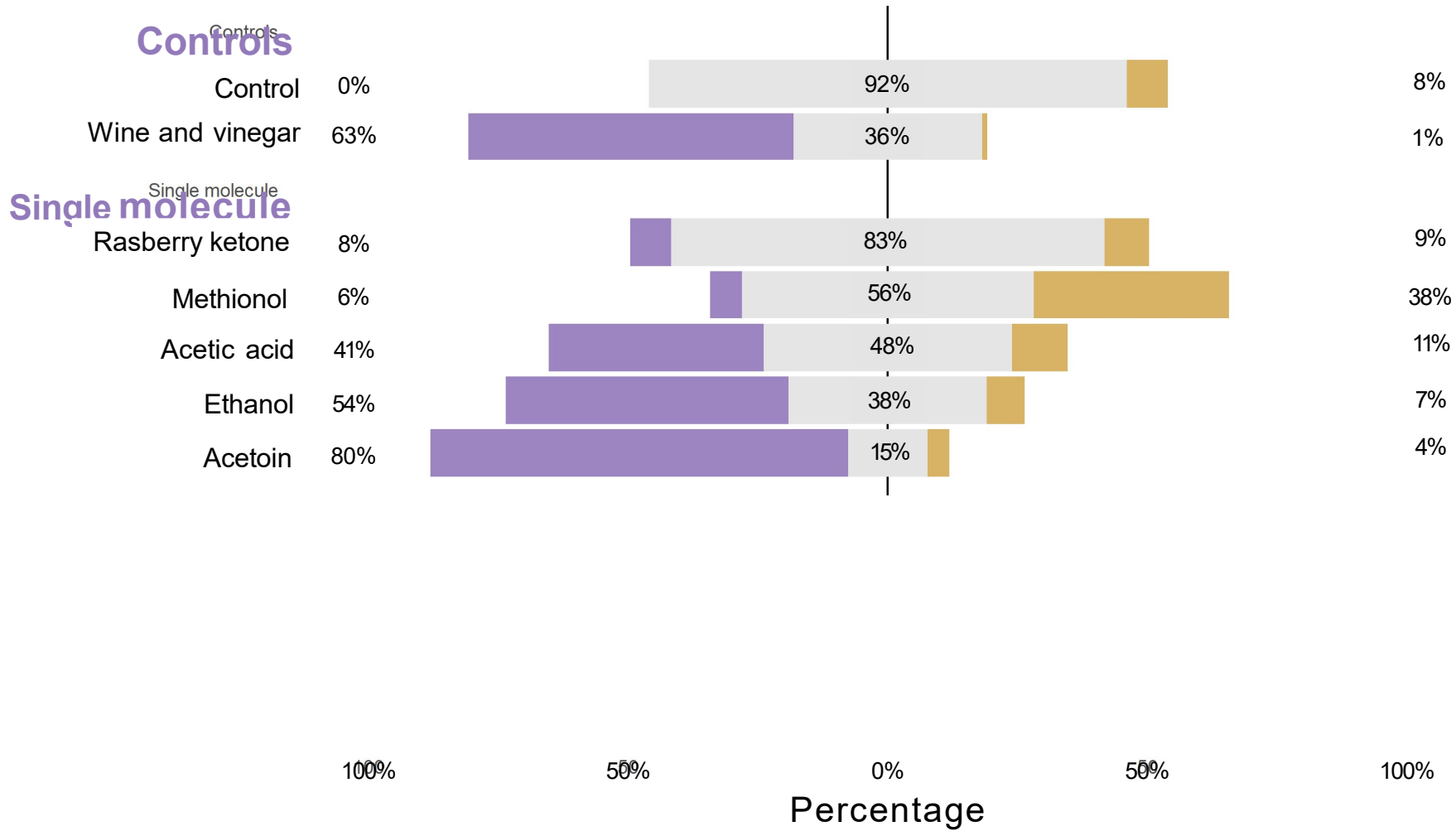


How to attract *D. suzukii* ?

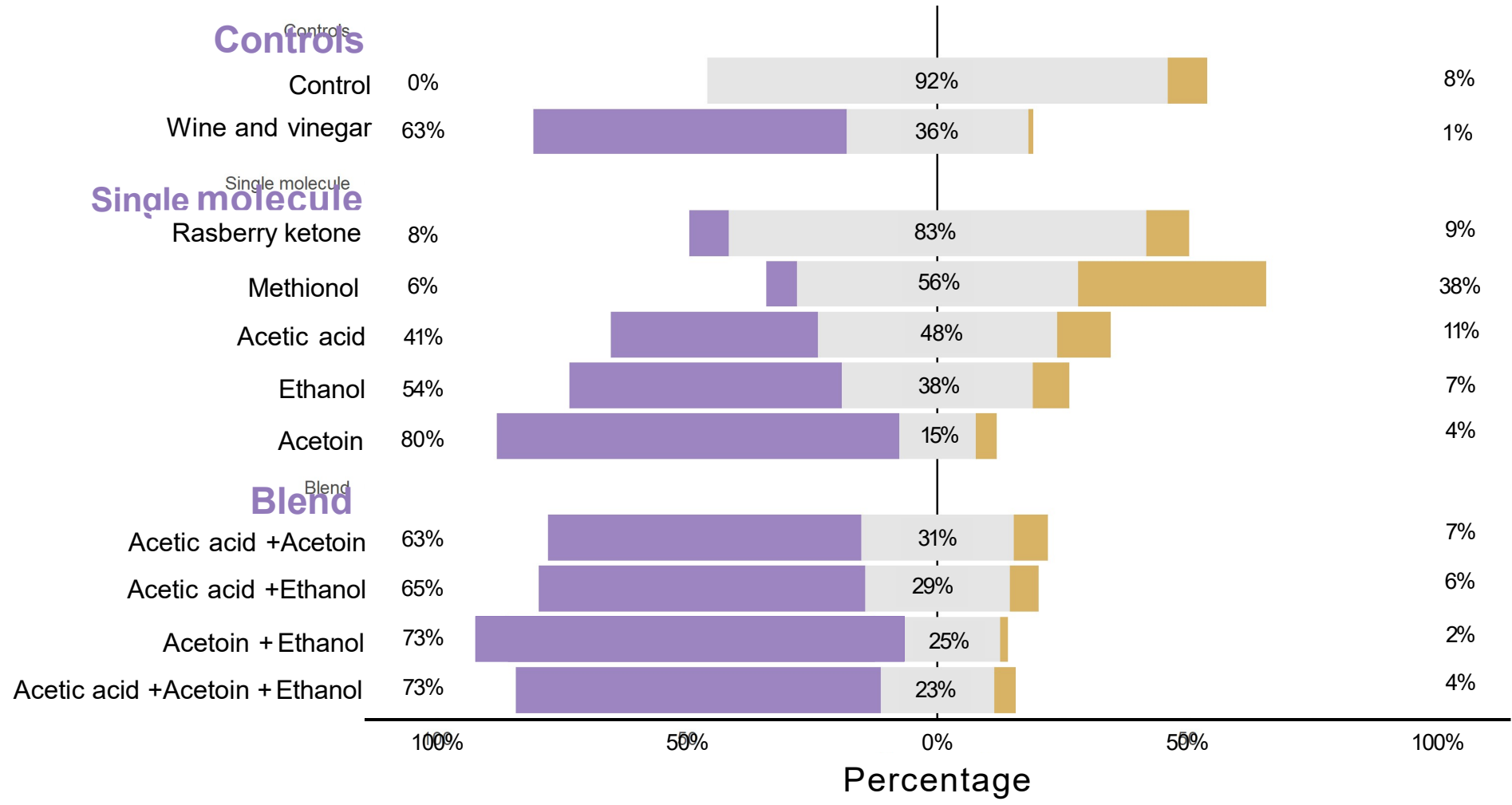
Attractant
 No choice
 Control



How to attract *D. suzukii* ?



How to attract *D. suzukii* ?



TAKE-HOME MESSAGE

1 | MUCL 1555 is lethal for *D. suzukii* after a 3hr-contact

2 | MUCL 1555 has an ability to adhere to insect cuticule quickly and to kill this insect

3 | MUCL 1555 is specific



TAKE-HOME MESSAGE

1 | MUCL 1555 is lethal for *D. suzukii* after a 3hr-contact

2 | MUCL 1555 has an ability to adhere to insect cuticule quickly and to kill this insect

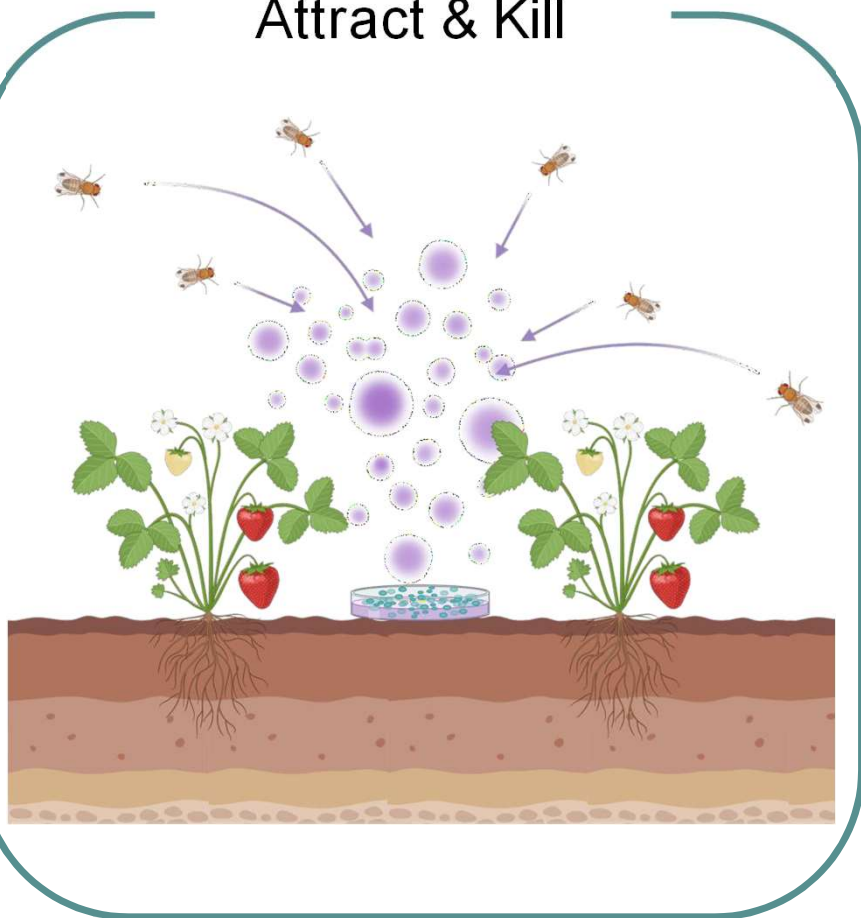
3 | MUCL 1555 is specific

4 | *D. suzukii* is attracted by ethanol and acetoin



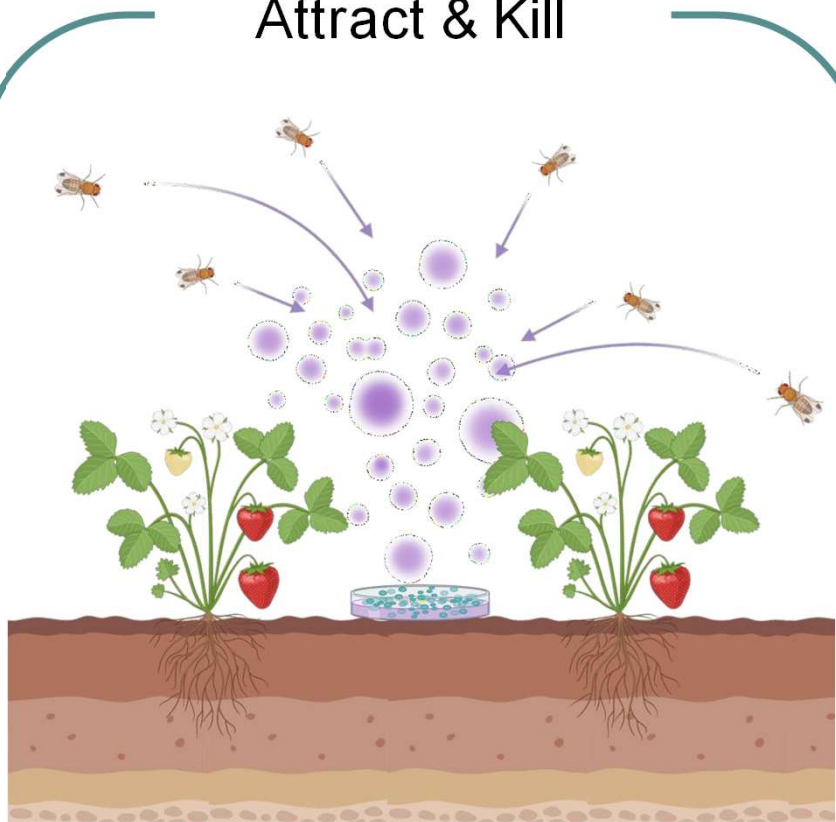
Perspectives

Attract & Kill

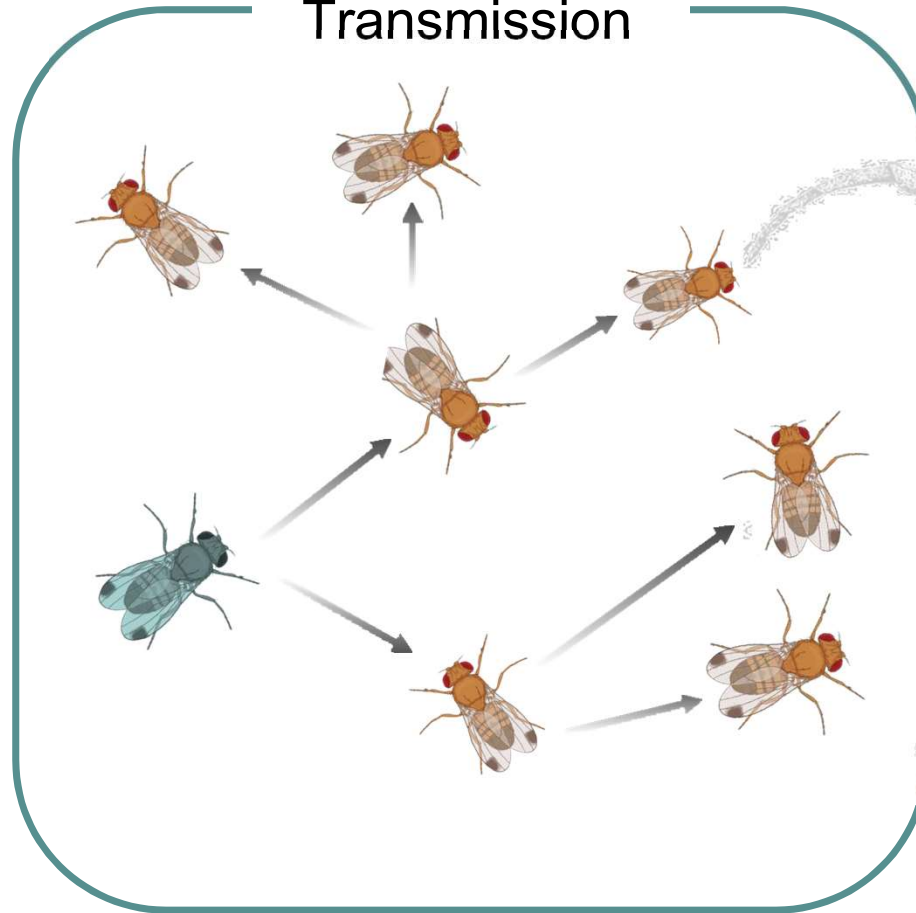


Perspectives

Attract & Kill

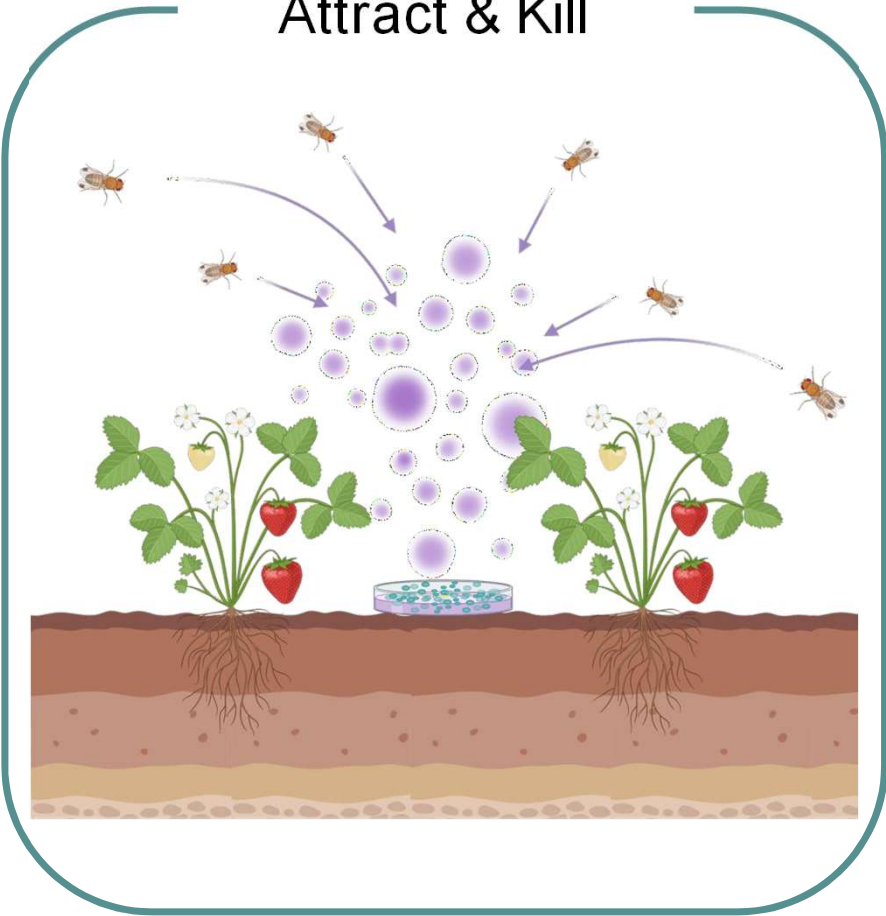


Transmission

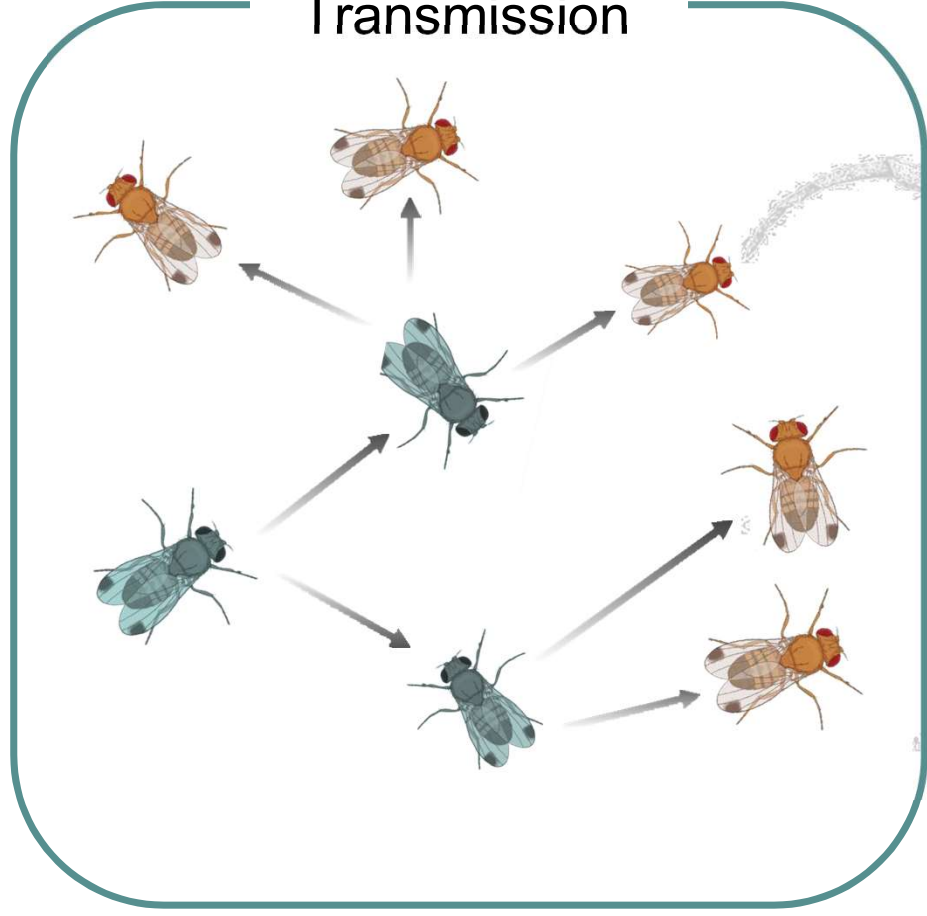


Perspectives

Attract & Kill

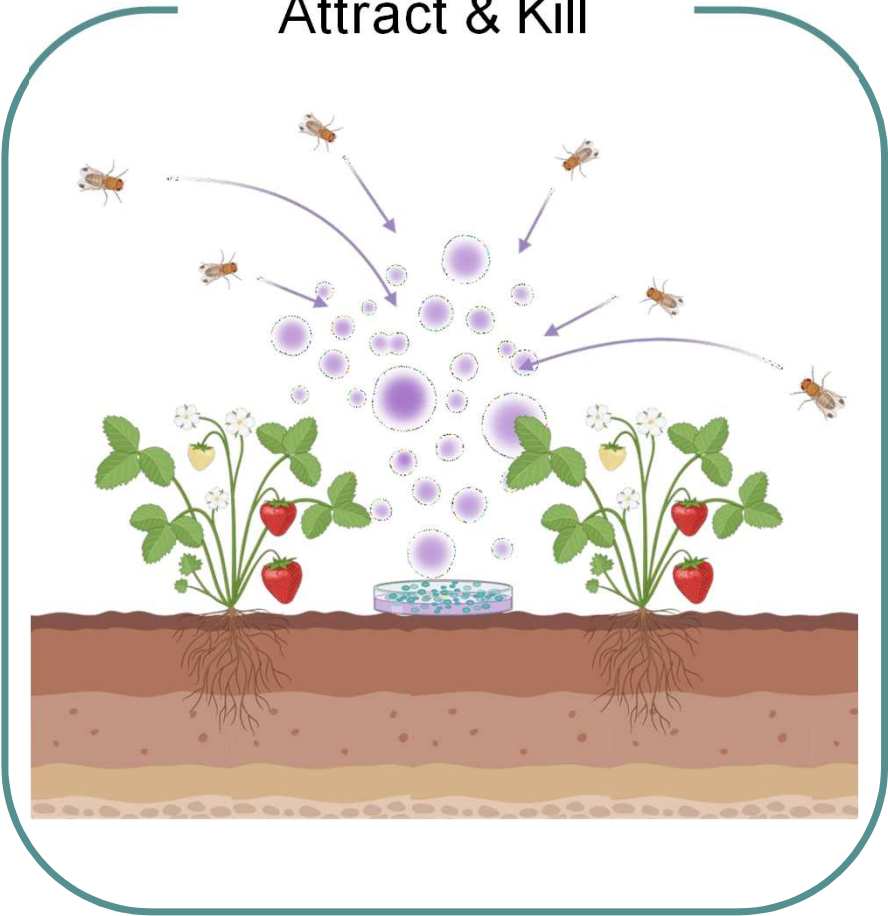


Transmission

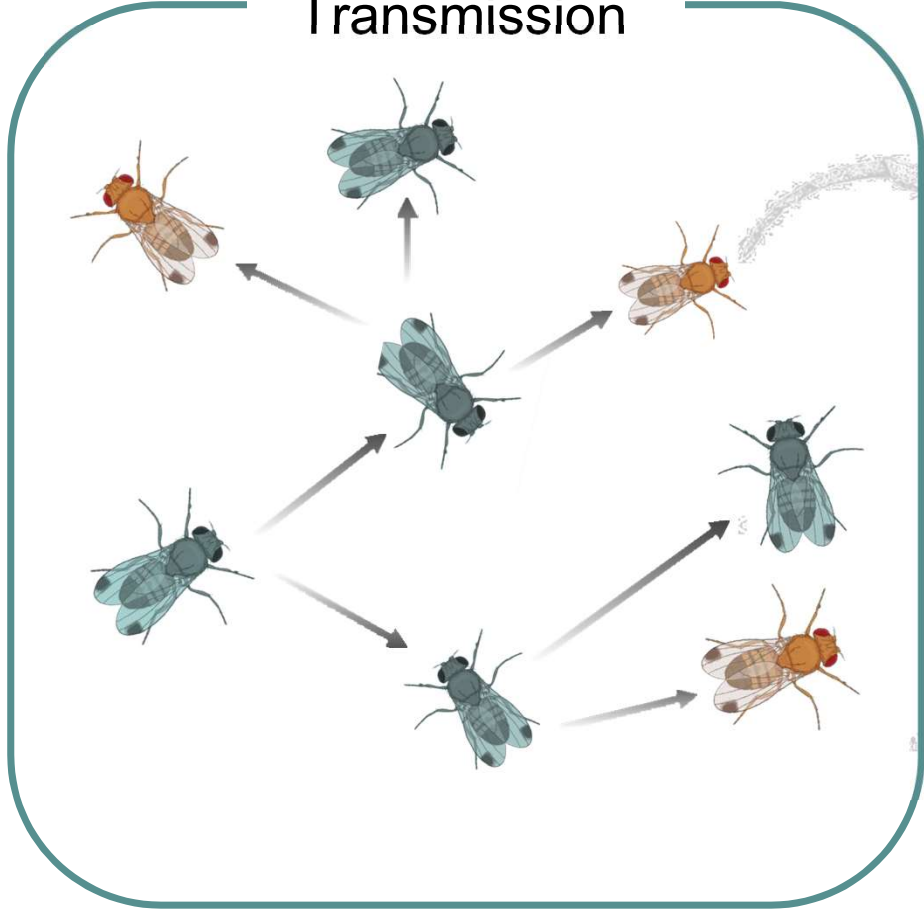


Perspectives

Attract & Kill



Transmission



Thank for your attention



François Verheggen
Clément Martin
Nicolas Leroy
Julie Bonnet
Andréa Chacon
Fanny Ruhland
Solène Travaillard



Stéphane Declerck
Ismahen Lalaymia
Virginie Moreau

“Insects become pests because of the monoculture structure of agricultural systems, and such structure responds to a capitalist economic model that destroys nature and displaces small farmers”

M. Altieri

