Specialised Metabolites in Floral Resources

Effects and Detection in Buff-Tailed Bumblebees

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Faculty of Science

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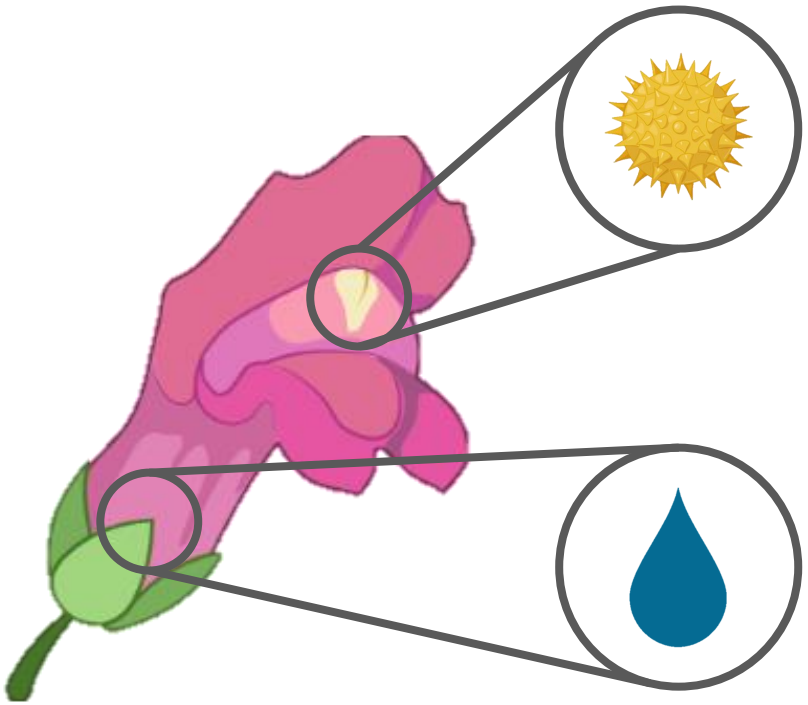
Bumblebees as major pollinators

>$150 billion

~ 25% species

What can bees taste?

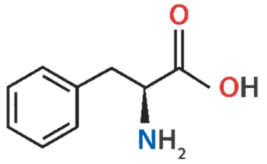
Notorious central metabolites



Central metabolites

Protein

Amino acid



Carbohydrate

Mineral

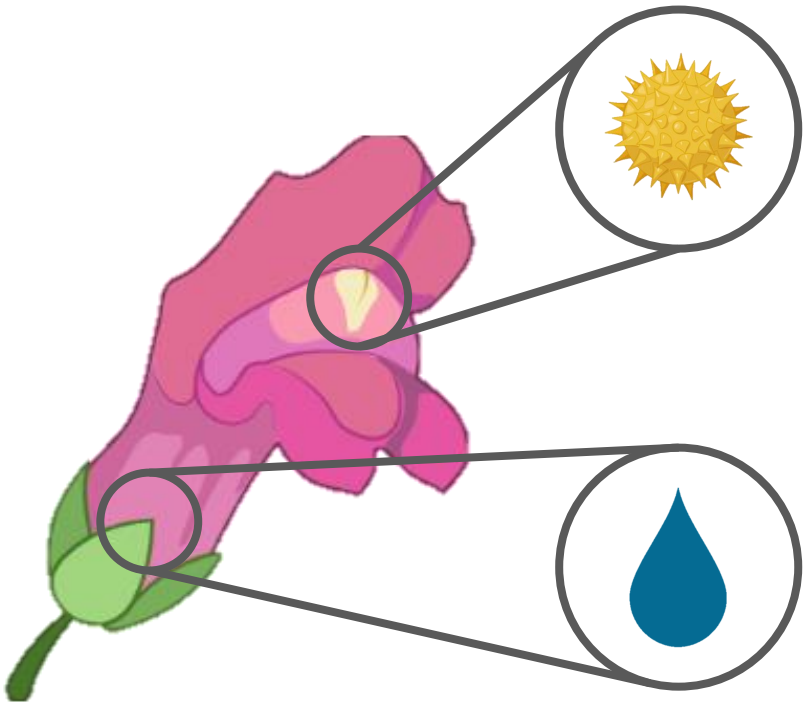
Lipid

$$\frac{\text{Protein}}{\text{Lipid}}\ \text{ratio}$$

Well Established

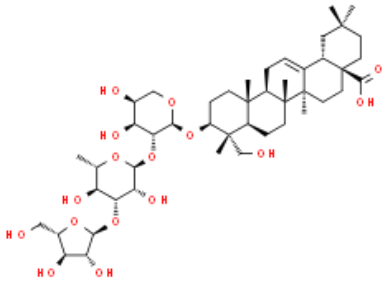
What can bees taste?

Neglected specialised metabolites

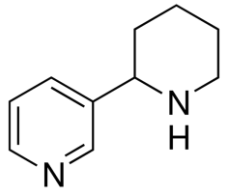


Specialised metabolites

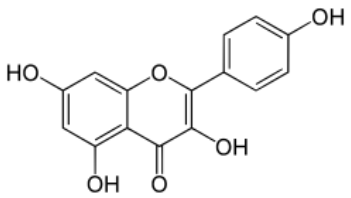
Terpene



Alkaloid



Phenolic



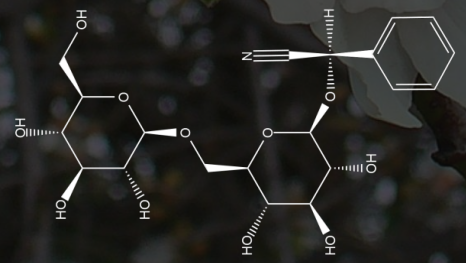
Poorly Established

Model systems

Bombus terrestris

Prunus dulcis
(Rosaceae)

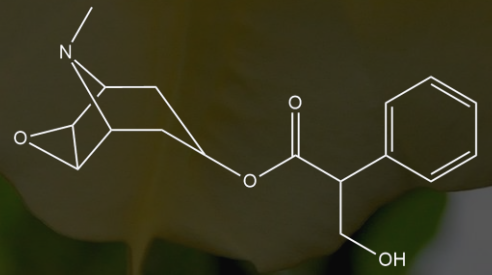
Amygdalin 1,889 ppm



50% / 100% / 200%

Brugmansia aurea
(Solanaceae)

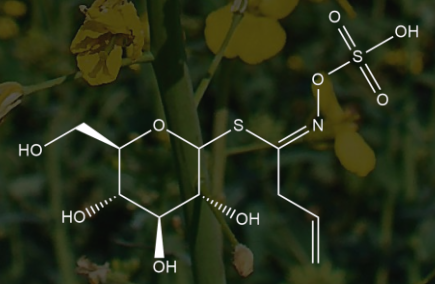
Scopolamine 20,014 ppm



50% / 100% / 200%

Brassica napus
(Brassicaceae)

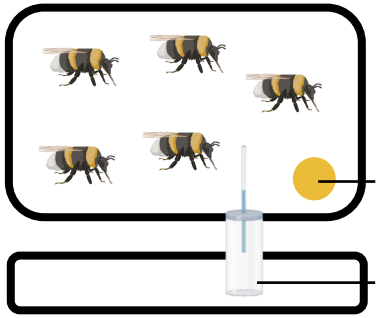
Sinigrin 1,892 ppm



50% / 100% / 200%

Metrics

Bioassays (35 days)

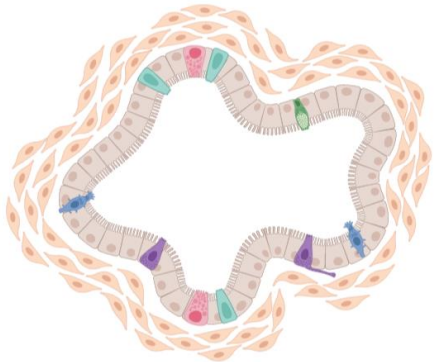


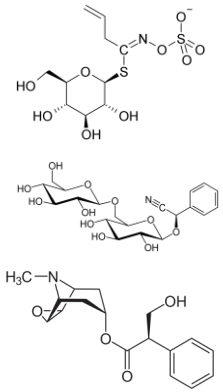
Treated pollen

Syrup

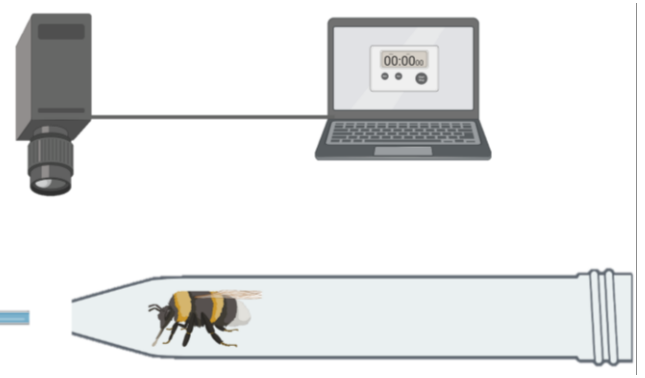
Development

Digestive damage



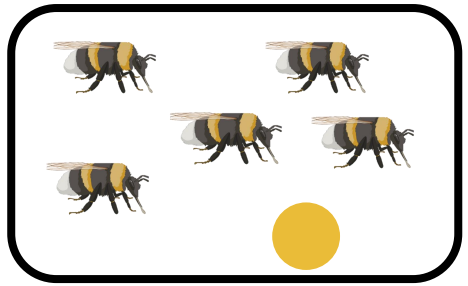


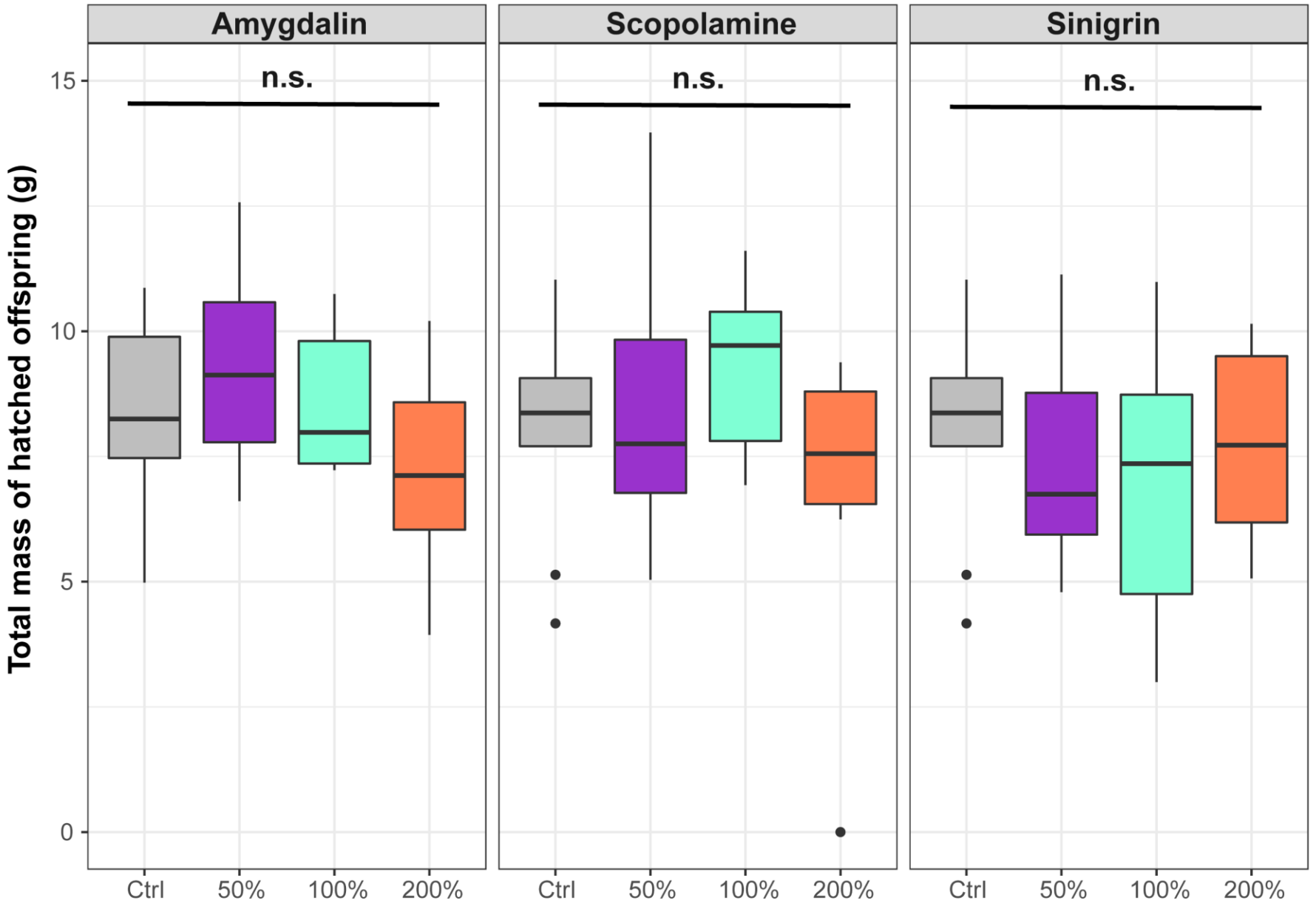
Behavioural assays



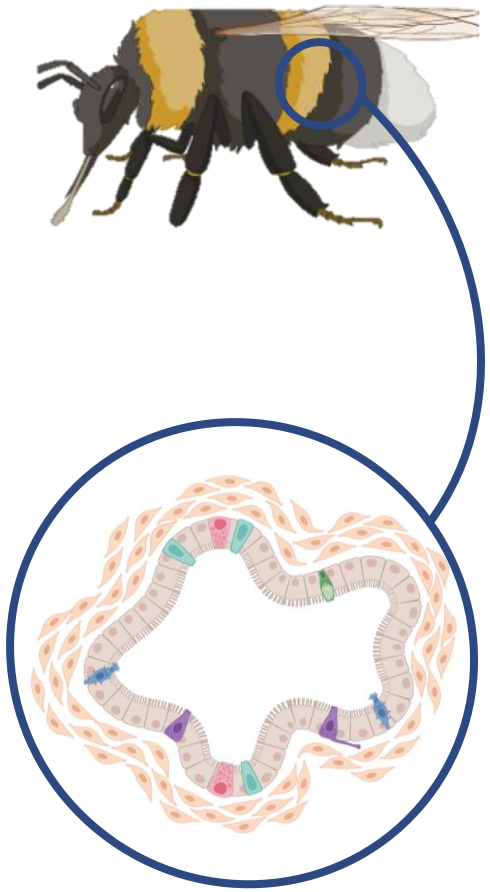
Duration of first contact

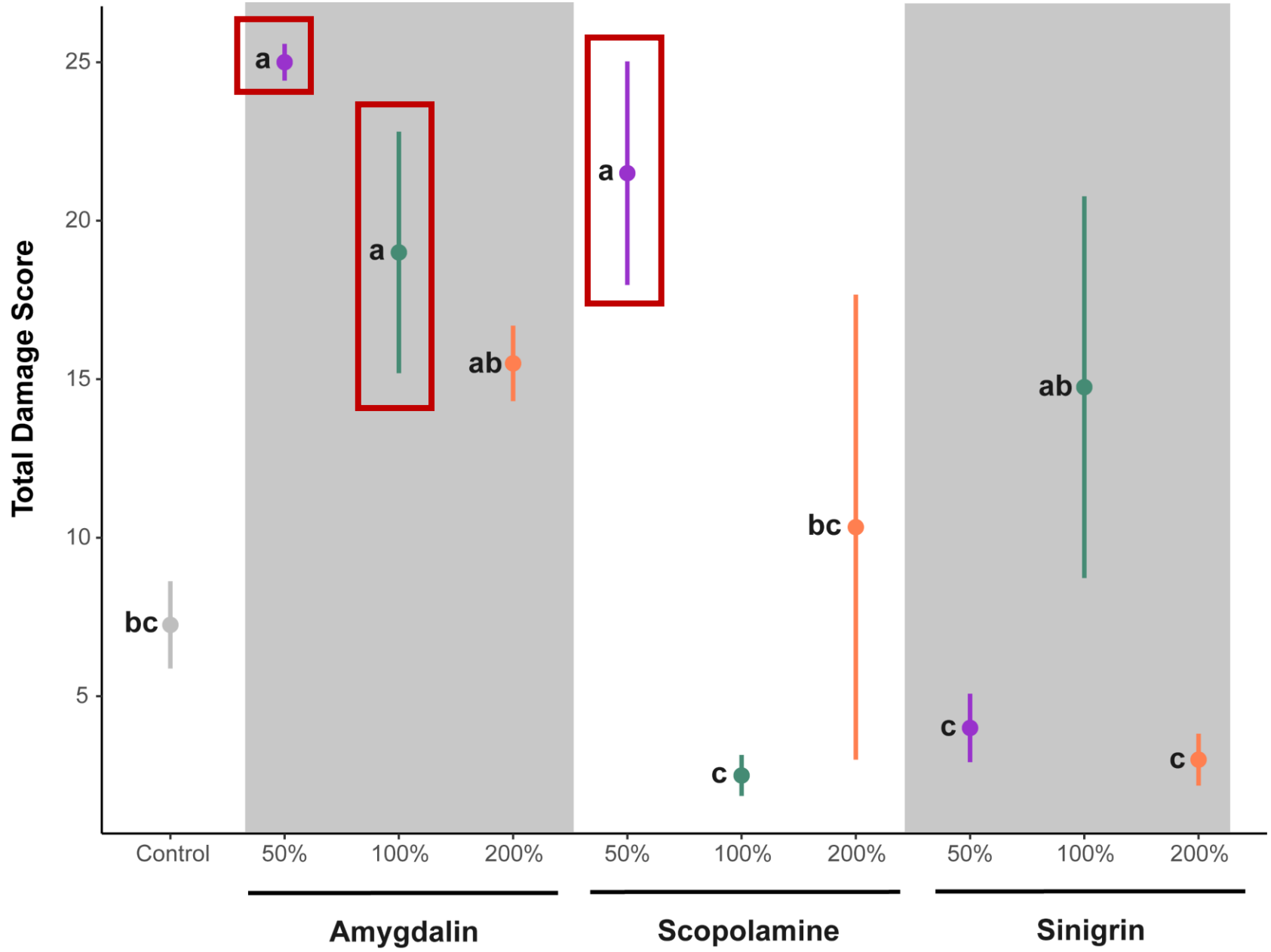
Bioassay – Microcolony development



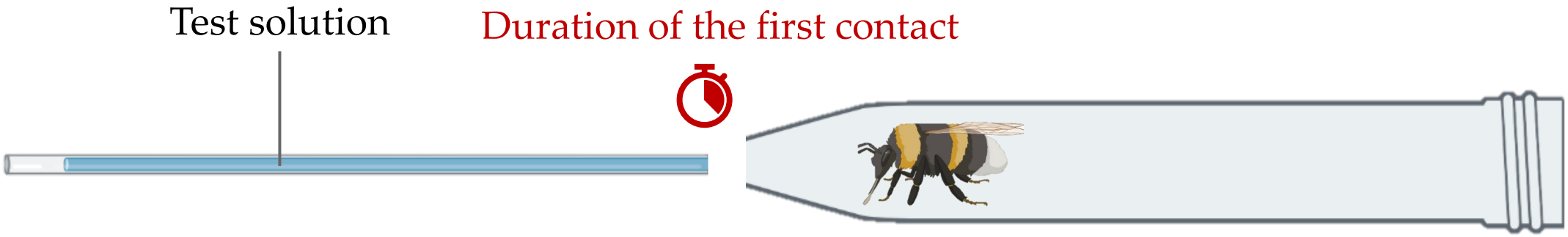


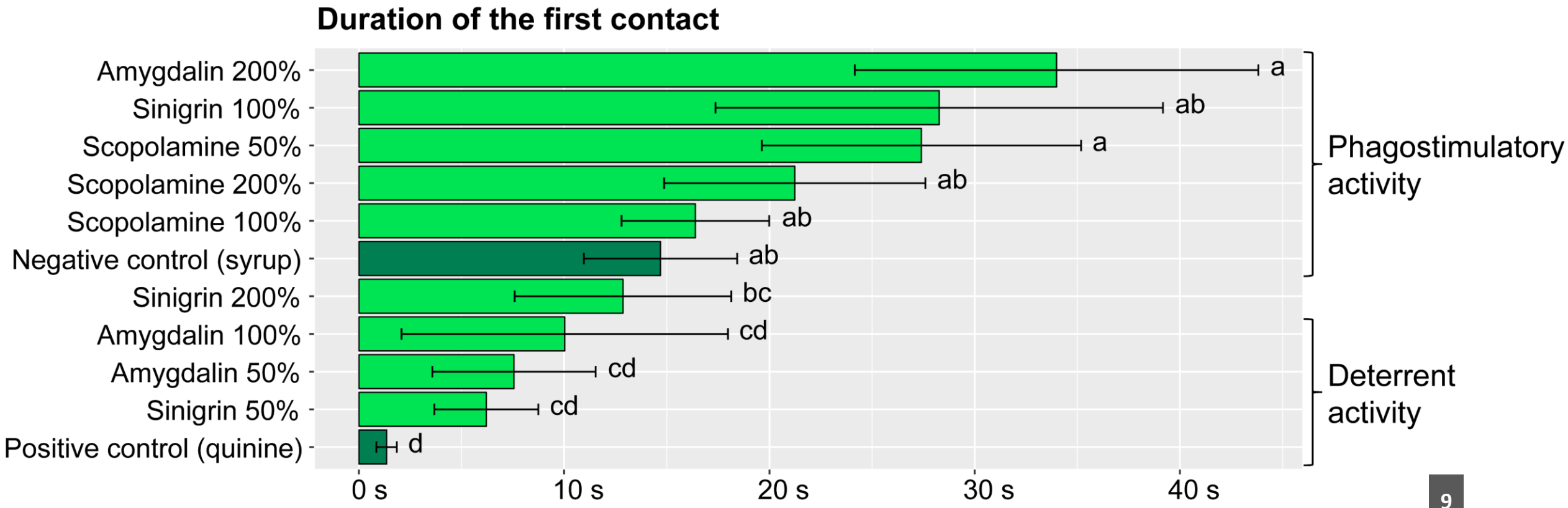
Bioassay – Gut damage





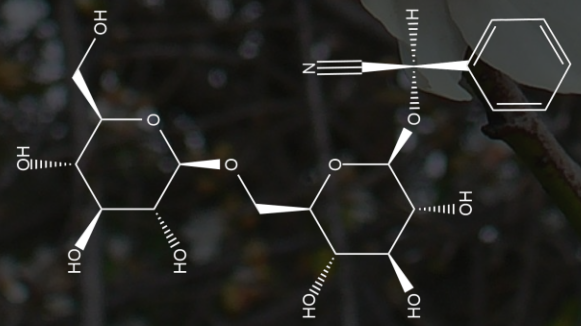
Behavioural assay – Detection of metabolites

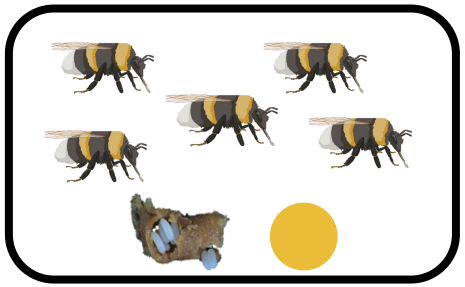
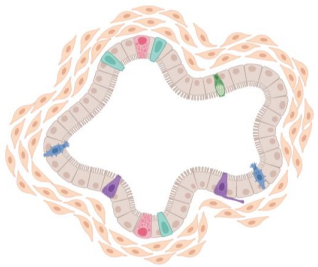




Prunus dulcis
(Rosaceae)

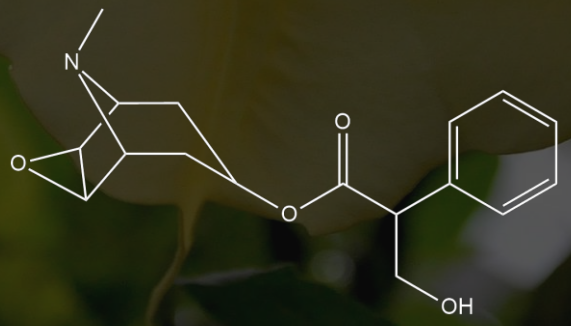
Amygdalin

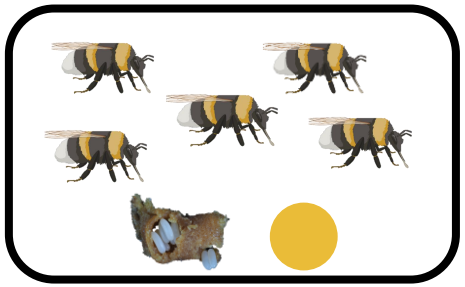
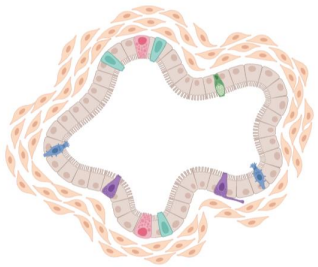


	✓	✓	✓
	✗	✗	✓
	✗	✗	✓
	50%	100%	200%

Brugmansia aurea
(Solanaceae)

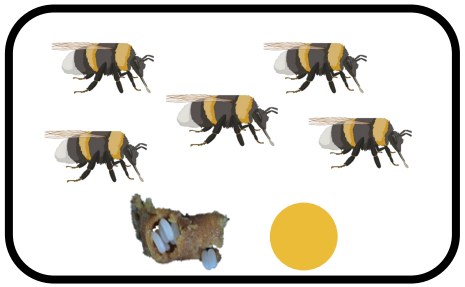
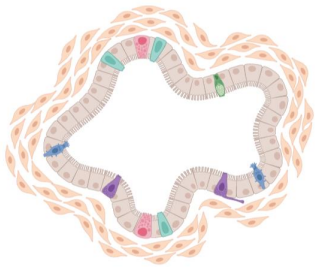
Scopolamine



	✓	✓	✓
	✗	✓	✓
	✓	✓	✓
	50%	**100%**	**200%**

Brassica napus
(Brassicaceae)

Sinigrin

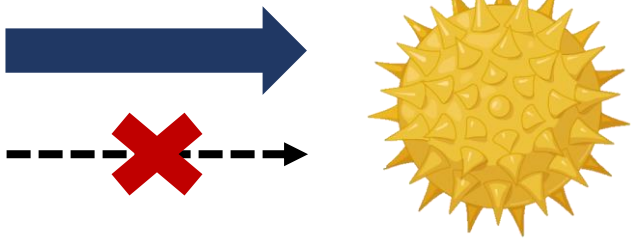
	✓	✓	✓
	✓	✓	✓
	✗	✓	✗
	50%	100%	200%

Microcolony vs. individual levels

Brood feedback

1

Nutrient required



Microcolony needs

Individual deterrence

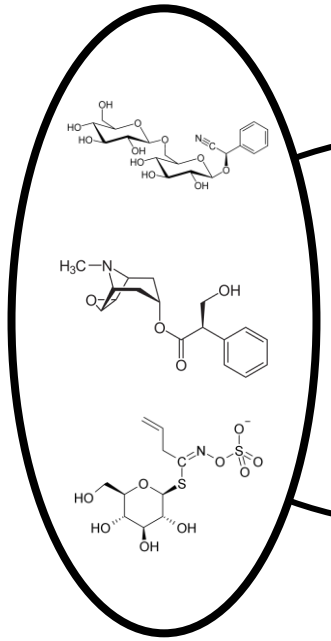
Microcolony vs. individual levels

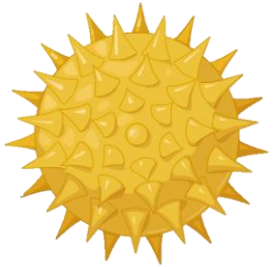
Pollen vs. syrup treatments

1

Nutrient required

2





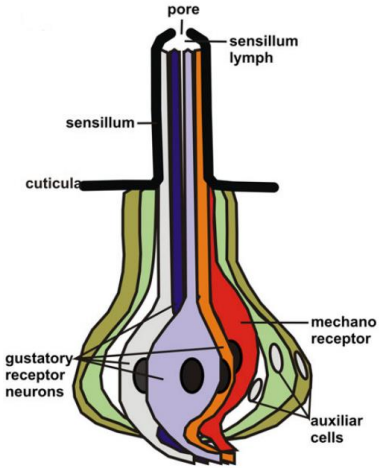
vs.

Complex mixture

↗↗↗ Info

↘↘↘ Info

Simple sugar solution

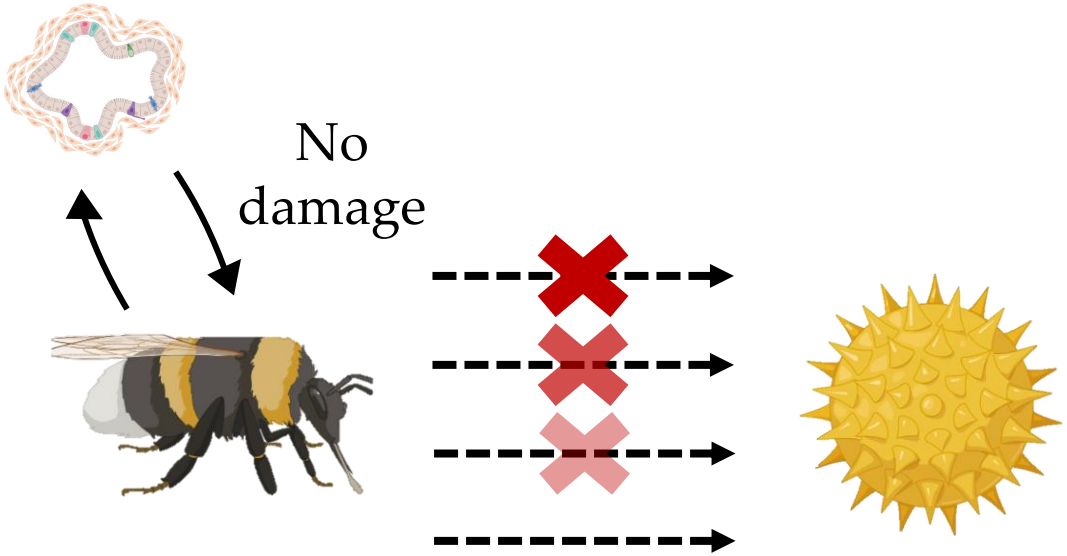


Gut damage vs. behaviour

‘Positive’ physiological feedback

1

Bumblebees consume deterrent but harmless substances



Gut damage vs. behaviour

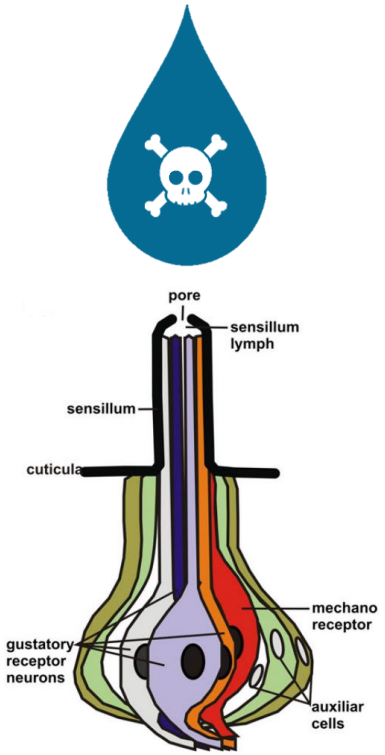
Lack of adequate taste neurons

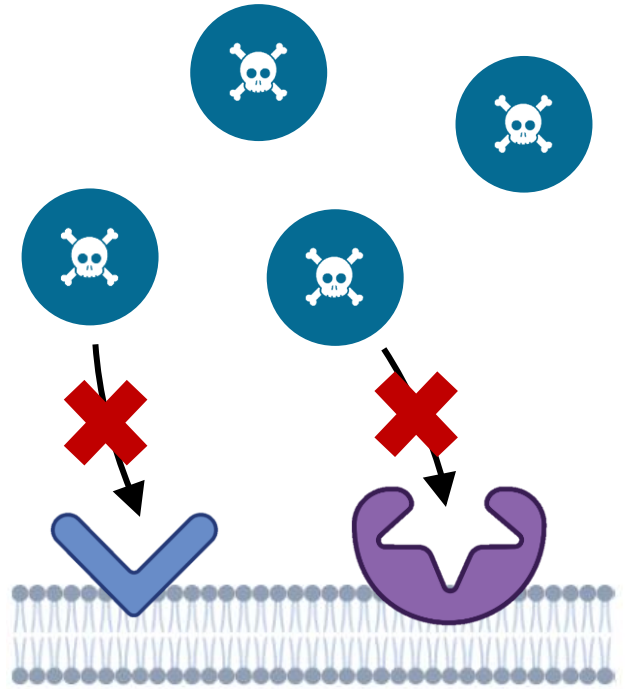
1

Bumblebees consume deterrent but harmless substances

2

Inability to detect harmful substances





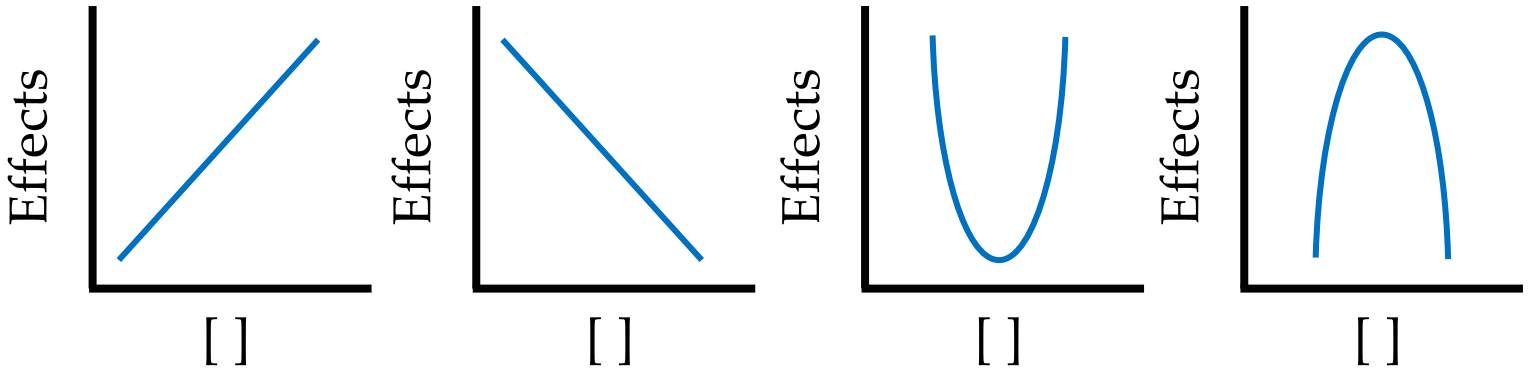
Gut damage vs. behaviour

Toxin & endogenous defence costs

3

↗ *concentration*
≠
↗ *effects*

Intuition	Amygdalin	Scopolamine	Sinigrin



Trade-off

Metabolite toxicity

Defence cost

Key Takeaways

1. Colony fitness vs. Individual fitness

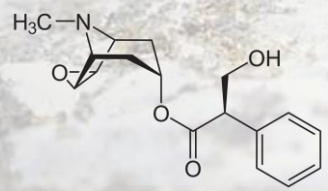
2. Inability to detect some harmful substances

3. Complex effect ~ dose relationship

Looking Further

Parasite

Metabolite — *Microbiota*



Thank you for your attention