It's a Bug Eat Bug World:

Examining two *Dicyphus* species (Hemiptera: Miridae) for their potential use as biological control agents on greenhouse crops.

Carly Demers

Sherah VanLaerhoven, Lauren Des Marteaux, Rose Labbé

University of Windsor

Agriculture and Agri-Food Canada

https://www.gardeningknowhow.com/edible/vegetables/tomato/growing-tomatoes-in-greenhouse.htm

Greenhouse Tomatoes

- 250,000 tonnes, totalling $666 million
  - Most are exported
- 69% grown in Ontario greenhouses

https://www.nutraingredients-usa.com/Article/2021/03/02/Tomato-powder-beats-isolated-lycopene-in-study-but-expert-questions-scope-of-conclusions

AAFC, 2020

Greenhouse Strawberries

- Newer greenhouse crop
- 2,700 tonnes, totalling $18.5 million
- 321,000 m^2 in Ontario greenhouses
- Increasing every year

https://www.nutritionletter.tufts.edu/healthy-mind/improving-memory/pick-strawberries-to-benefit-your-heart-and-brain/

AAFC, 2021

Greenhouse Pests

- Agriculture and Agri-Food Canada recognizes 16 pest species for economic impact on production
  - Focus on three pests of significance
- Impact many crop species:
  - Physical damage
  - Vector diseases
- Invasive species are also a threat
  - Introduced via imports and range expansion

Greenhouse Whitefly | Green Peach Aphid | Two-Spotted Spider Mites

AAFC, 2020; Gorman *et al*., 2002; Gradish *et al*., 2010; Wan *et al*., 2021; Wintermantel, 2004

https://en.wikipedia.org/wiki/Greenhouse_whitefly
https://www.thehealingcanna.com/growroom-spider%20mites
https://www.greenhousecanada.com/meet-the-new-thrips-on-the-block/

Chemical Control

- Pesticides are an option for control, however:
  - Resistance is increasing
  - Detrimental effect on beneficial insects
  - Not viable for greenhouse systems
- Need to look for alternatives

AAFC, 2020; Gorman *et al*., 2002; Gradish *et al*., 2010; Wan *et al*., 2021; Wintermantel, 2004

Biological Control

The use of biological agent(s) to control pests

- *Parasites, pathogens, predation*

Benefits:

- Mitigate pesticide resistance
- Reduced impact on beneficial insects
- Defense against invasive species

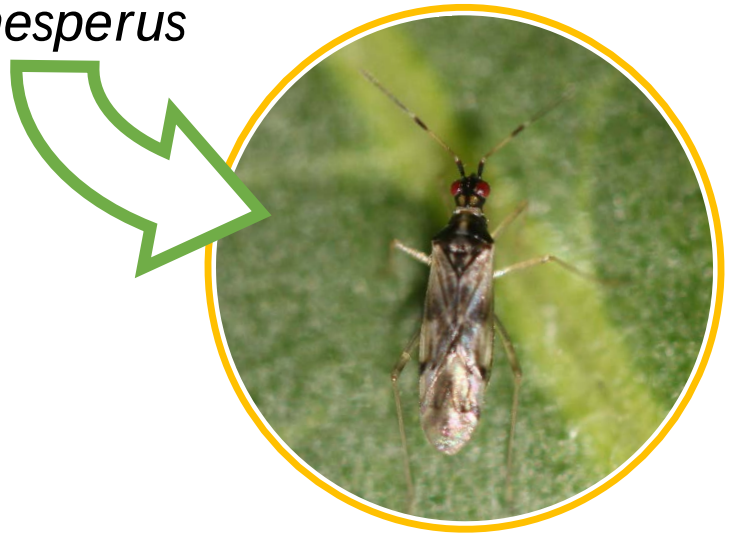

(Leah Land., 2010)

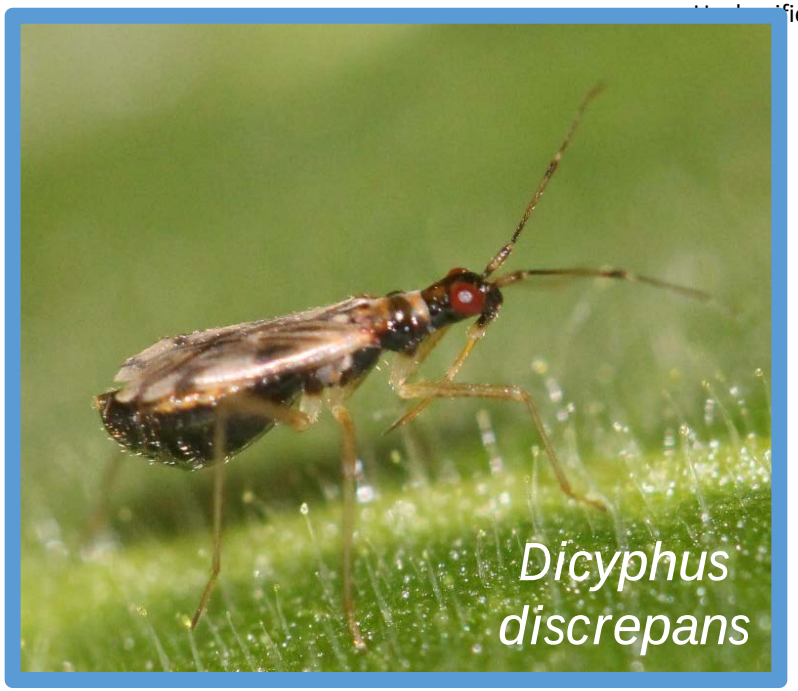

(Christian Musat, 2021)

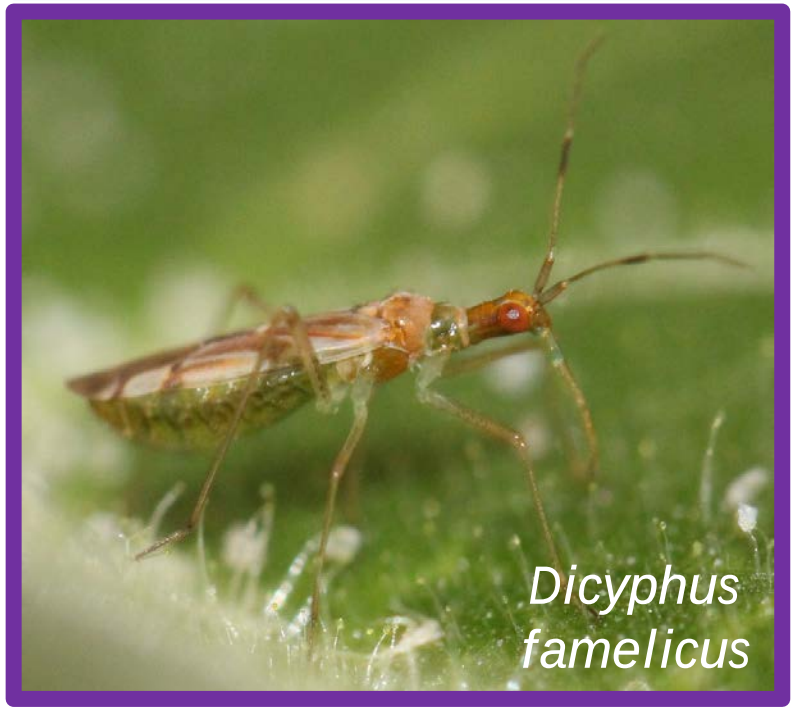
DeBach, 1964

Family Miridae

- Omnivorous generalists
- Many species are native to Canada
- Use in biocontrol:
  - Leg morphology and trichomes
  - Established biocontrol agents
    - *Dicyphus hesperus*







Kelton, 1980; McGregor *et al*., 1999

Objectives

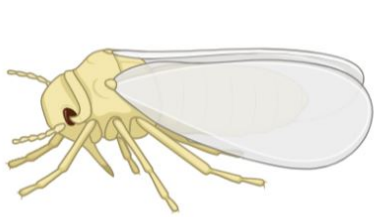
Determine the potential for *Dicyphus discrepans* and *D. famelicus* to control established Canadian greenhouse pests.

1. **Maximum feeding capacity** of mirids on common pests
2. **Life history** and host plant suitability

Maximum Feeding Capacity - Methods

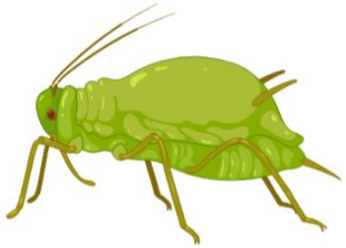
How many pests can one adult mirid consume in 24 hours?

1. Mirids starved - 24 hours
2. Feeding - 24 hours
3. Count individuals consumed

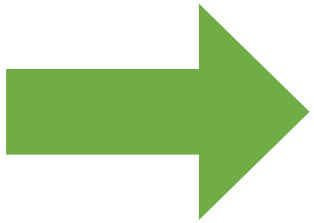


Whitefly OR

Spider mites OR



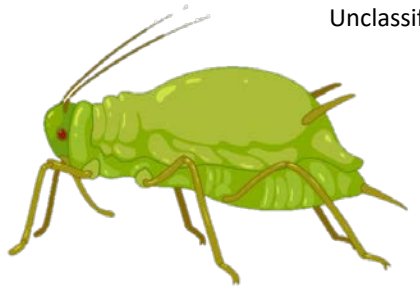
Aphids



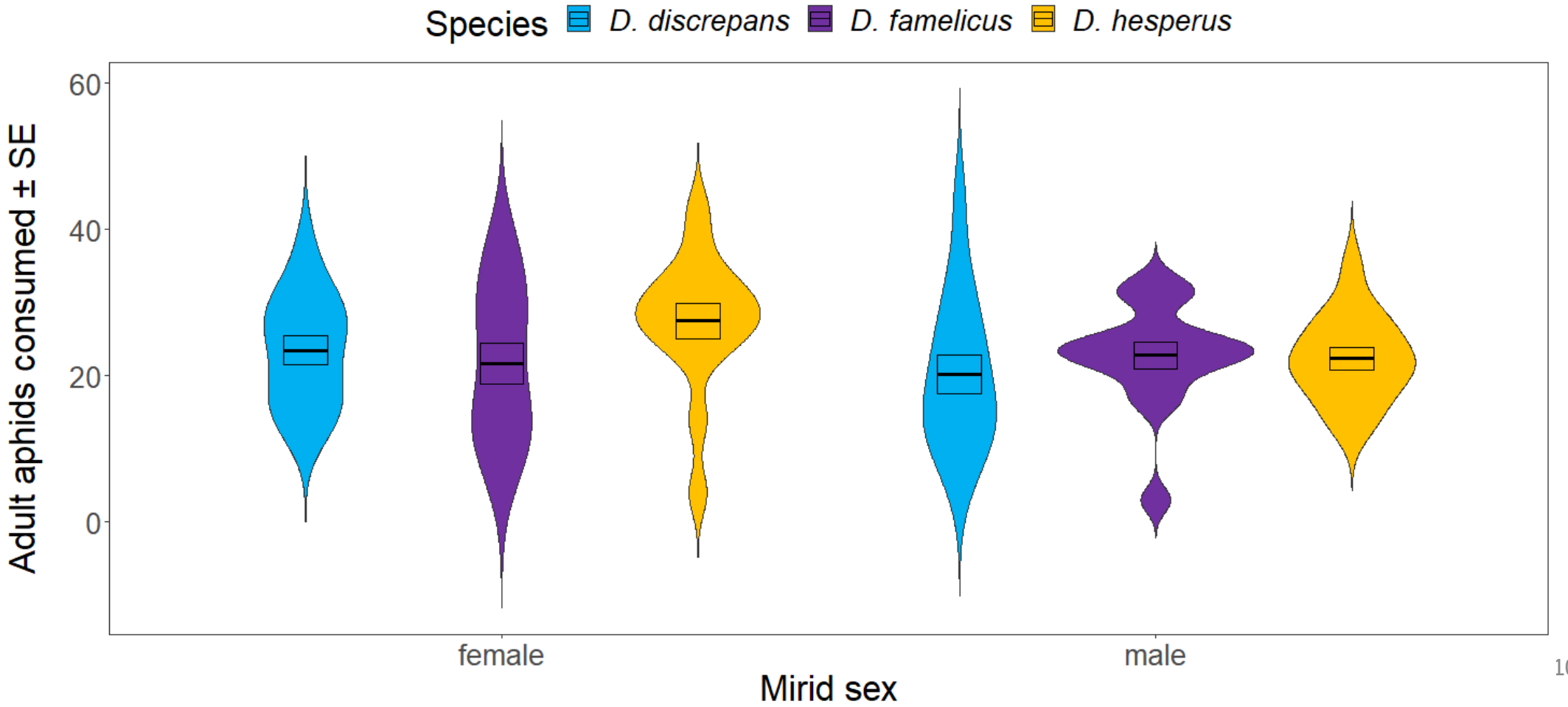
Gillespie *et al*, 2000

Biorender; Paige Desloges-Baril

Results – Green Peach Aphids

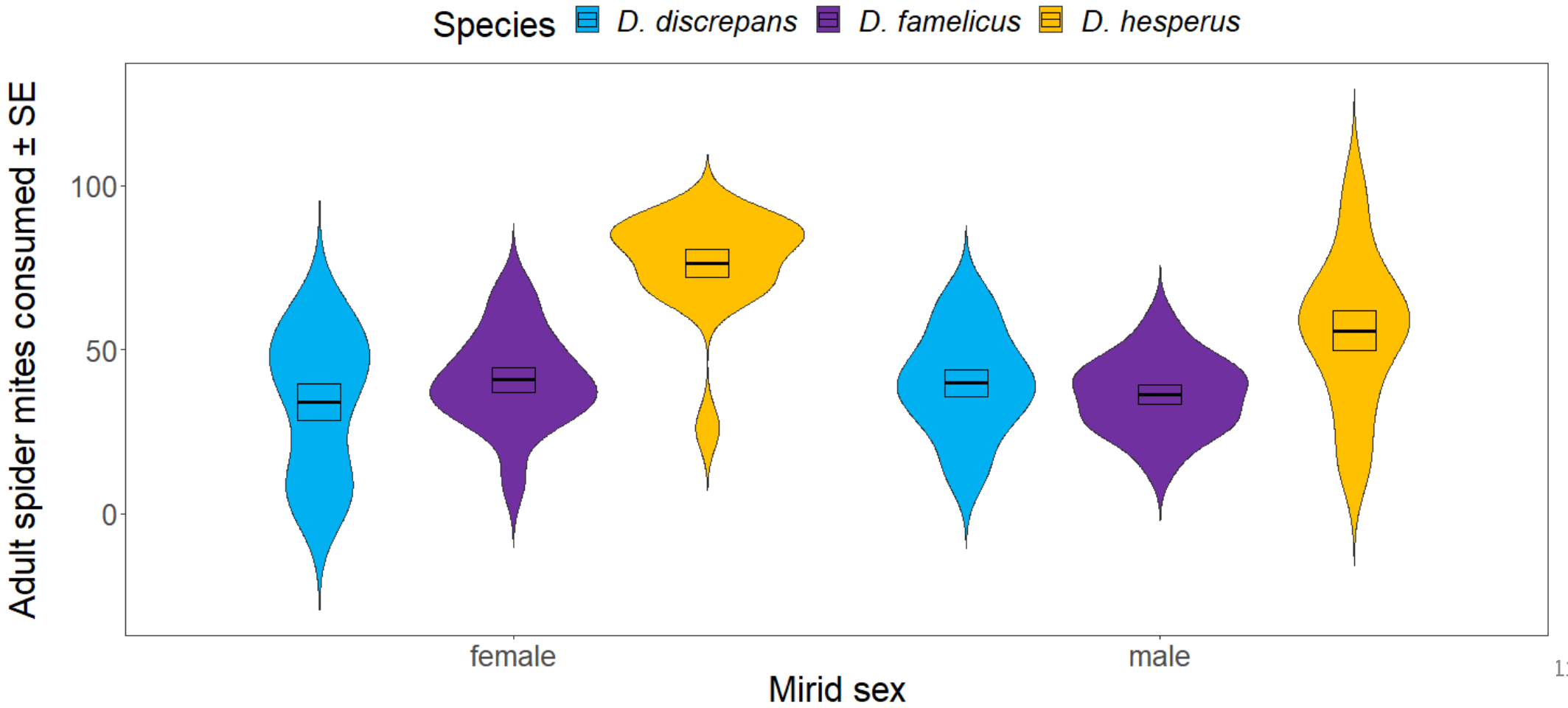


There are no differences in feeding between sex or species.

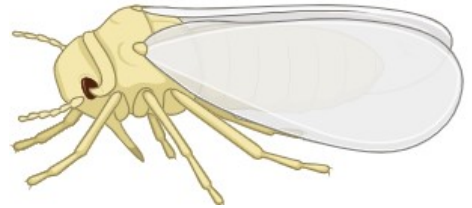


Results – Two Spotted Spider Mites

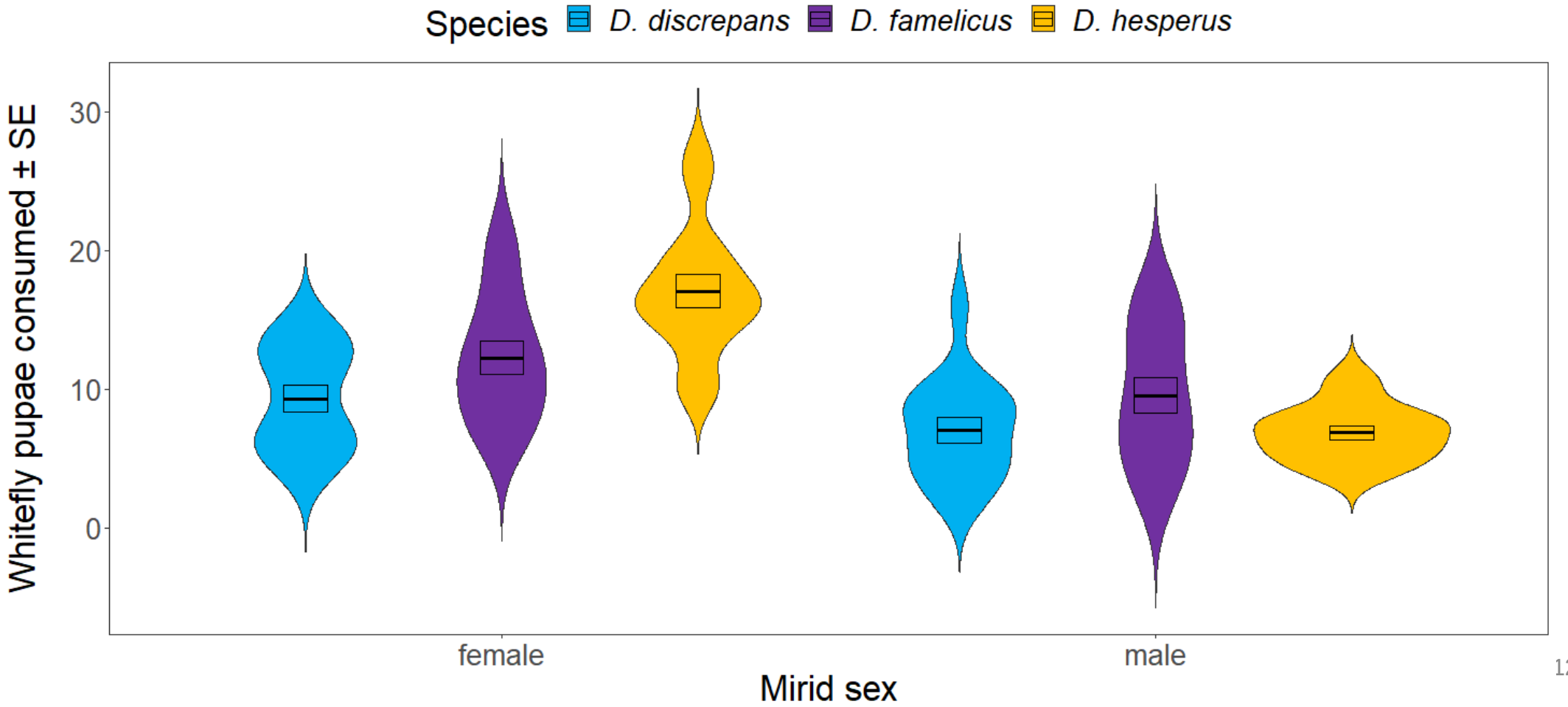
D. hesperus consumes more spider mites in 24 hours.



Results – Greenhouse Whitefly



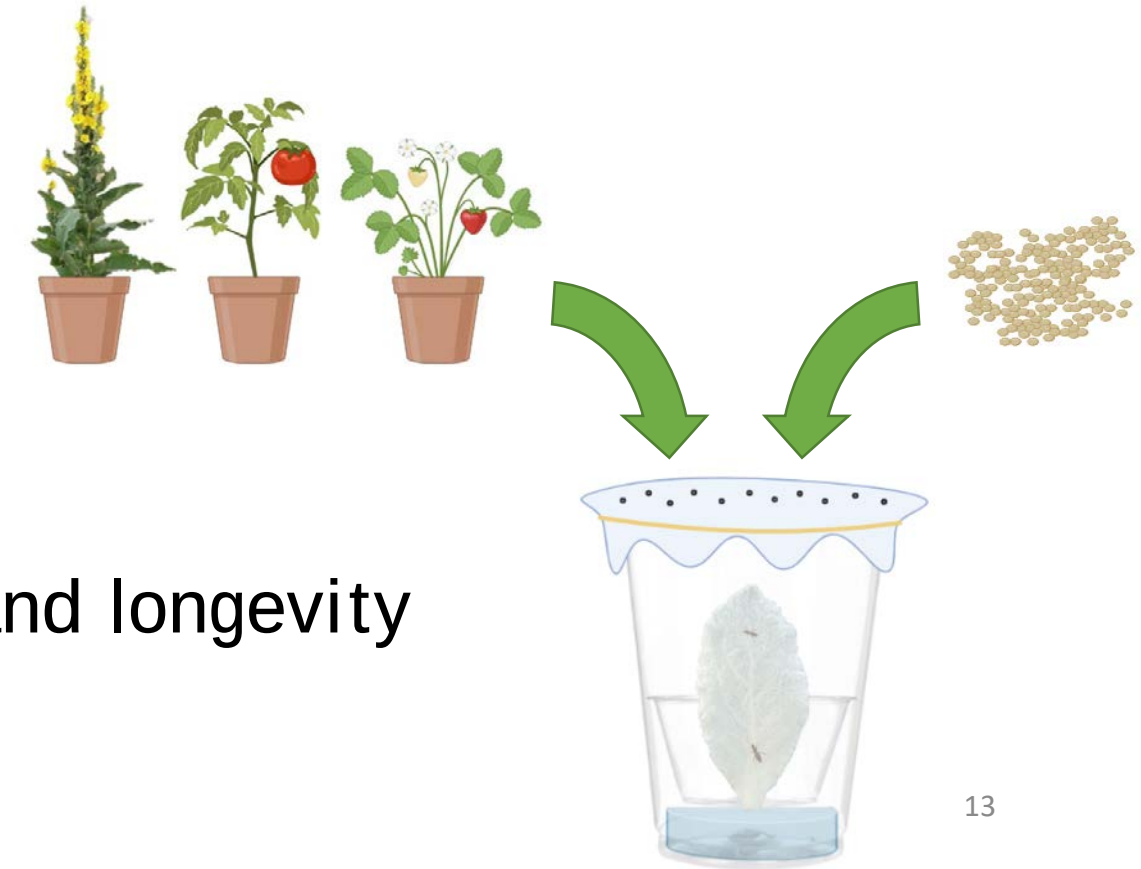
D. hesperus consumes more than *D. discepans*



Life History and Host Plant Suitability

What does D. famelicus need to survive and reproduce?
Does host plant impact longevity and fecundity?

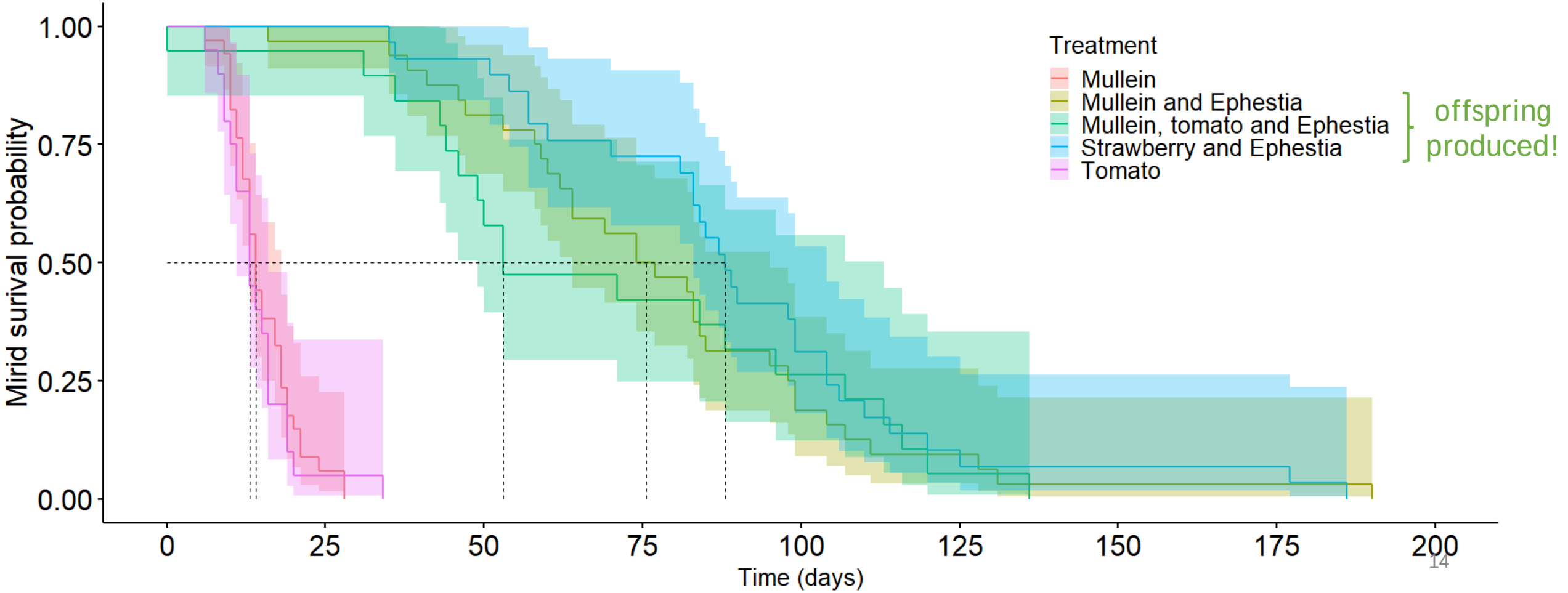
1. Rear mirids on host treatment
    1. Tomato
    2. Mullein
    3. Mullein and *Ephestia*
    4. Mullein, Tomato and *Ephestia*
    5. Strawberry and *Ephestia*
2. Isolate mating pairs in cups
3. Record egg laying, emergence and longevity



1

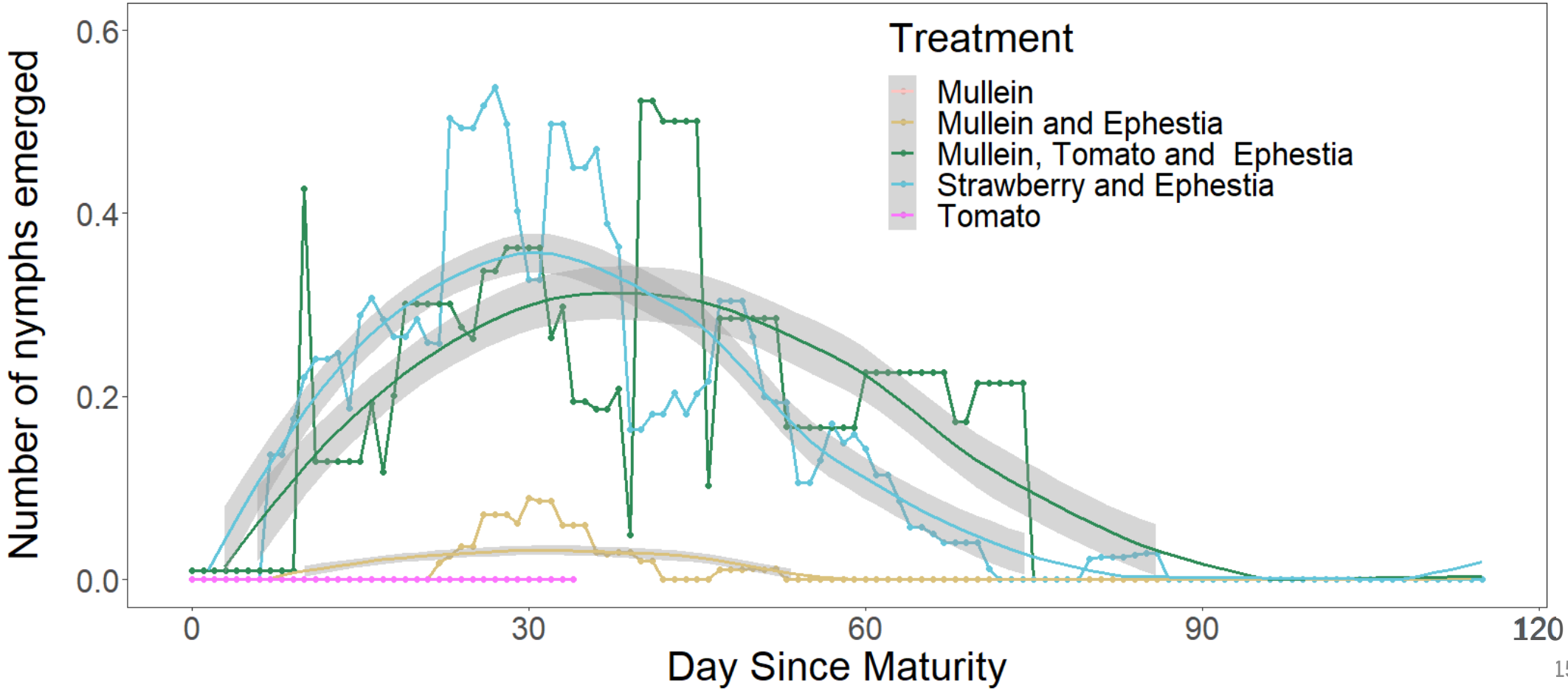
Preliminary Results - Longevity

D. famelicus survives longer when prey is available.



Preliminary Results - Fecundity

D. famelicus requires prey to reproduce.



Future Directions

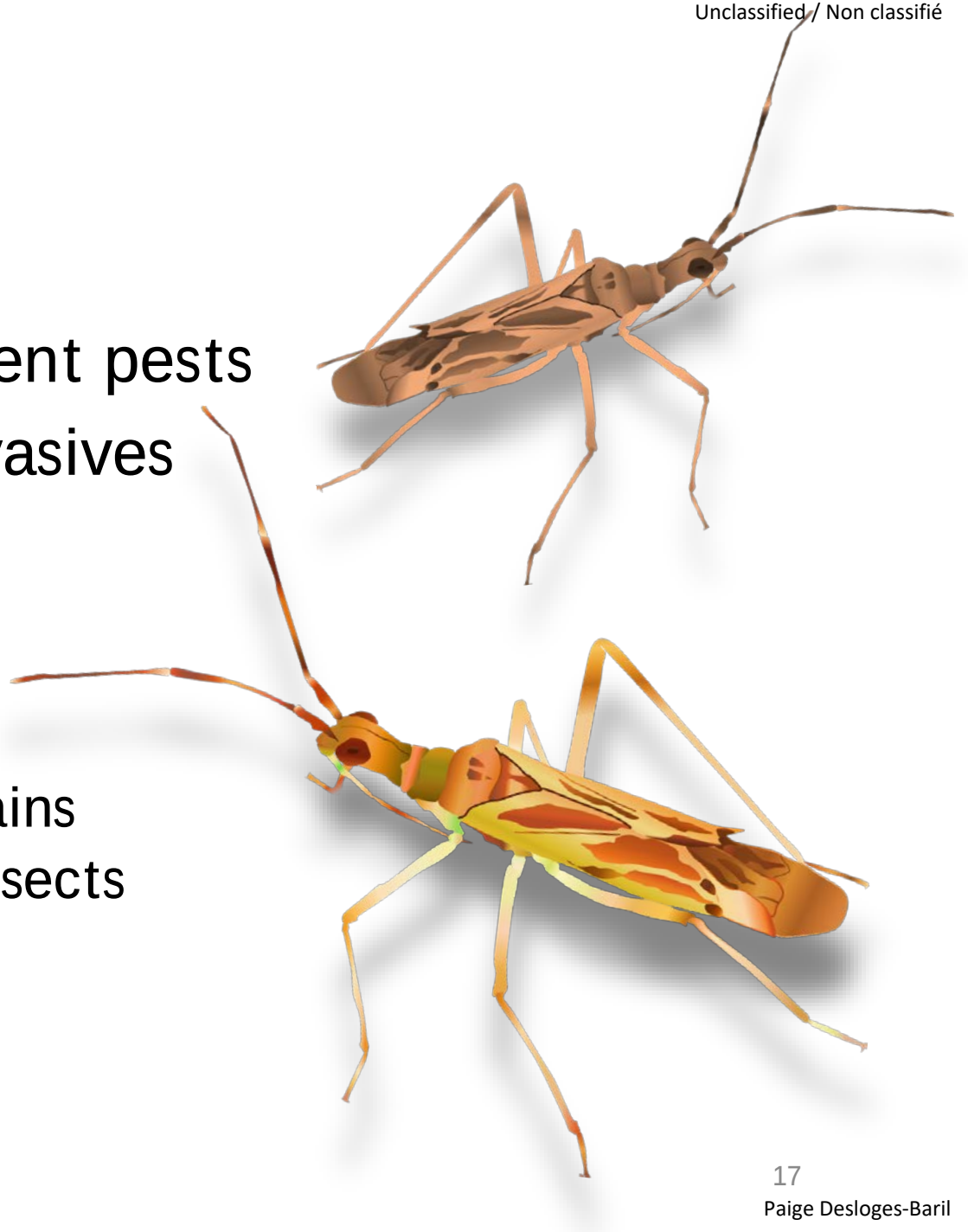
Breeding and selection for specific traits

Different host plant-pest-mirid combinations

Optimal mirid density for control

Significance

- Alleviates stress on crops from current pests
- A new line of defence for future invasives
- Use in greenhouse and field crops
- Potential benefits on other crops
- Reduced need for pesticides
  - Reduced chances of resistant pest strains
  - Reduced impact on other beneficial insects
  - Reduced environmental impacts



Acknowledgements

Agriculture and Agri-Food Canada

University of Windsor

FRUIT & VEGETABLE GROWERS OF CANADA | PRODUCTEURS DE FRUITS ET LÉGUMES DU CANADA

The AAFC Entomology & VanLaerhoven Labs

This project is generously funded through the Canadian Agri-Science Cluster for Horticulture 3, in cooperation with Agriculture and Agri-Food Canada's AgriScience Program, a Canadian Agricultural Partnership initiative, the Fruit and Vegetable Growers of Canada, and industry contributors to RL and LD.

https://www.gardeningknowhow.com/edible/vegetables/tomato/growing-tomatoes-in-greenhouse.htm

References

- Agriculture and Agri-Food Canada (2020). Crop Profile for Greenhouse Tomatoes in Canada, 2020. Prepared by the Pest Management Program.
- DeBach, P. (1964). Biological control of insect pests and weeds. Biological control of insect pests and weeds.
- Gillespie, D. R., & McGregor, R. R. (2000). The functions of plant feeding in the omnivorous predator Dicyphus hesperus: water places limits on predation. Ecological Entomology, 25(4), 380-386.
- Gorman, K., Hewitt, F., Denholm, I., & Devine, G. J. (2002). New developments in insecticide resistance in the glasshouse whitefly (Trialeurodes vaporariorum) and the two-spotted spider mite (Tetranychus urticae) in the UK. Pest Management Science: formerly Pesticide Science, 58(2), 123-130.
- Gradish, A. E., Scott-Dupree, C. D., Shipp, L., Harris, C. R., & Ferguson, G. (2010). Effect of reduced risk pesticides for use in greenhouse vegetable production on Bombus impatiens (Hymenoptera: Apidae). Pest Management Science: formerly Pesticide Science, 66(2), 142-146.
- Kelton, L. A. (1980). The insects and arachnids of Canada. Part 8. The plant bugs of the prairie provinces of Canada. Heteroptera: Miridae. Canadian Government Publishing Centre.
- Pandey, P., McAuslane, H. J., & Smith, H. A. (2020). Effects of plants and supplemental prey on establishment of Dicyphus hesperus (Hemiptera: Miridae). Florida Entomologist, 103(1), 64-67.
- Sanchez, J. A., Gillespie, D. R., & McGregor, R. R. (2003). The effects of mullein plants (Verbascum thapsus) on the population dynamics of Dicyphus hesperus (Heteroptera: Miridae) in tomato greenhouses. Biological Control, 28(3), 313-319.
- Shipp, J. L., & Wang, K. (2006). Evaluation of Dicyphus hersperus (Heteroptera: Miridae) for biological control of Frankliniella occidentalis (Thysanoptera: Thripidae) on greenhouse tomato. Journal of economic entomology, 99(2), 414-420.
- Wan, Y., Zheng, X., Xu, B., Xie, W., Wang, S., Zhang, Y., & Wu, Q. (2021). Insecticide resistance increases the vector competence: a case study in Frankliniella occidentalis. Journal of Pest Science, 94(1).
- Wintermantel, W. M. (2004). Emergence of greenhouse whitefly (Trialeurodes vaporariorum) transmitted criniviruses as threats to vegetable and fruit production in North America. APSnet Features. doi, 10.

1

Preliminary Results - Fecundity

D. famelicus requires prey to reproduce.