



Agriculture and
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Beneficial insects and control of crop pests

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Soils and Crops Conference
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Canada 

Beneficial Insects

- What makes an insect beneficial?

Beneficial Insects

- What makes an insect beneficial?
 - its “benefit” to humans
- Predators
- Parasitoids
- Pollinators

Beneficial Insects

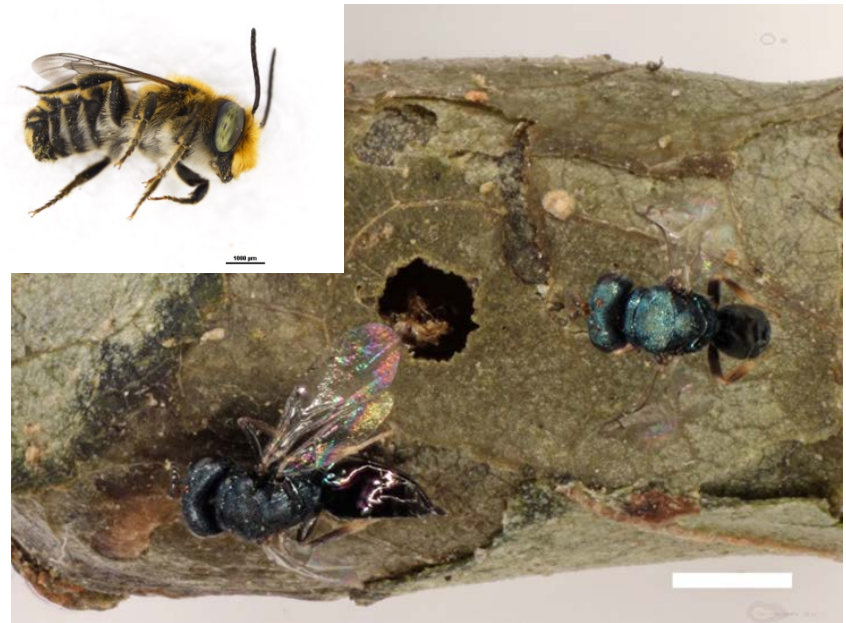
Parasitoid: "beneficial"

Aphidius avenaphis stings a red morph *Sitobion avenae*



Parasitoid: not "beneficial"

Pteromalus venustus kills alfalfa leafcutter bees



Instead of a ladybug, get a ladybug killing wasp:
Dinocampus coccinellae



Sampling techniques

1. Transects: whole plant counts
2. Trapping with sticky cards or traps.



3. Sweep netting



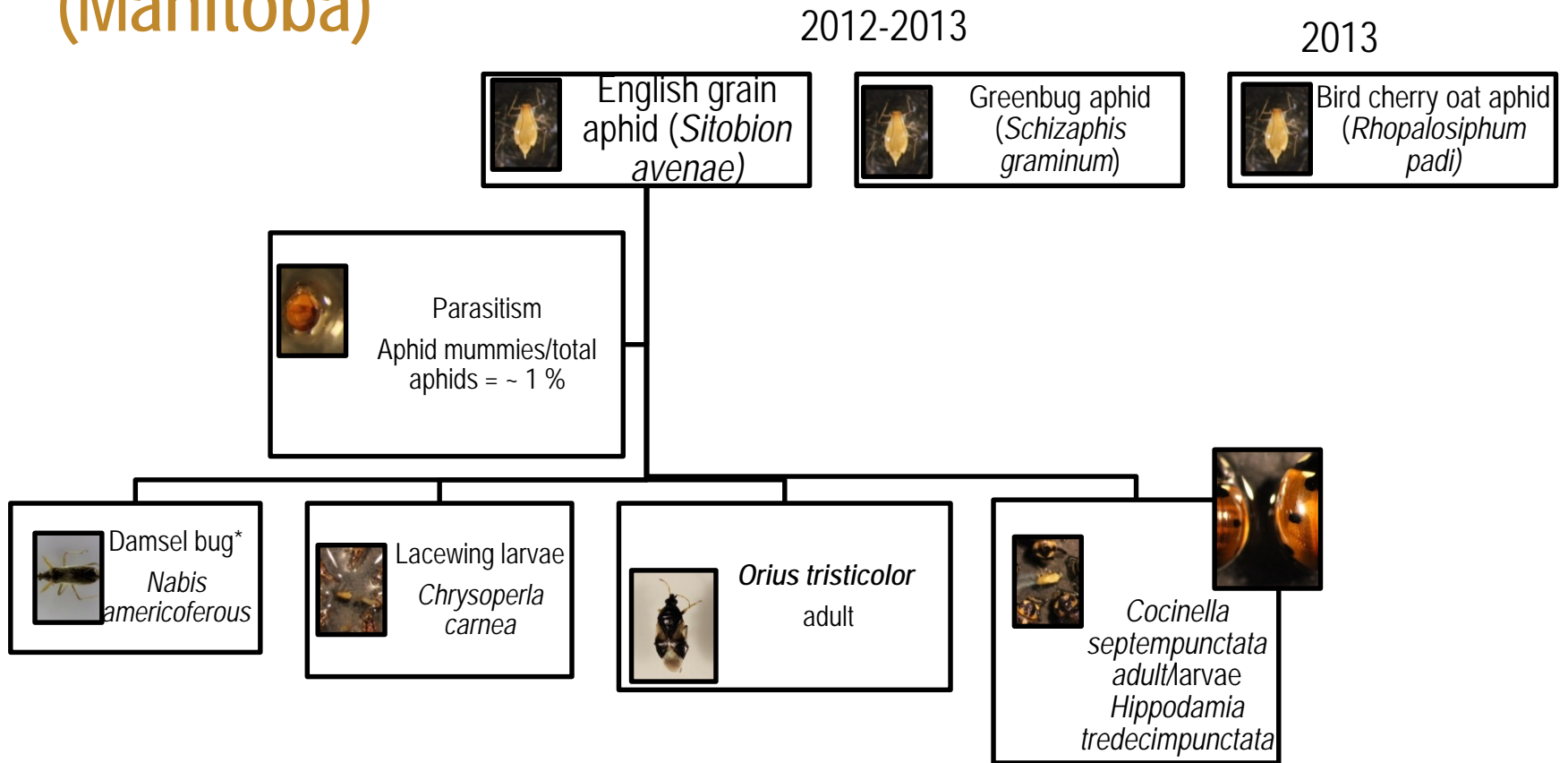
PREDATORS

Eat "pest" insects.

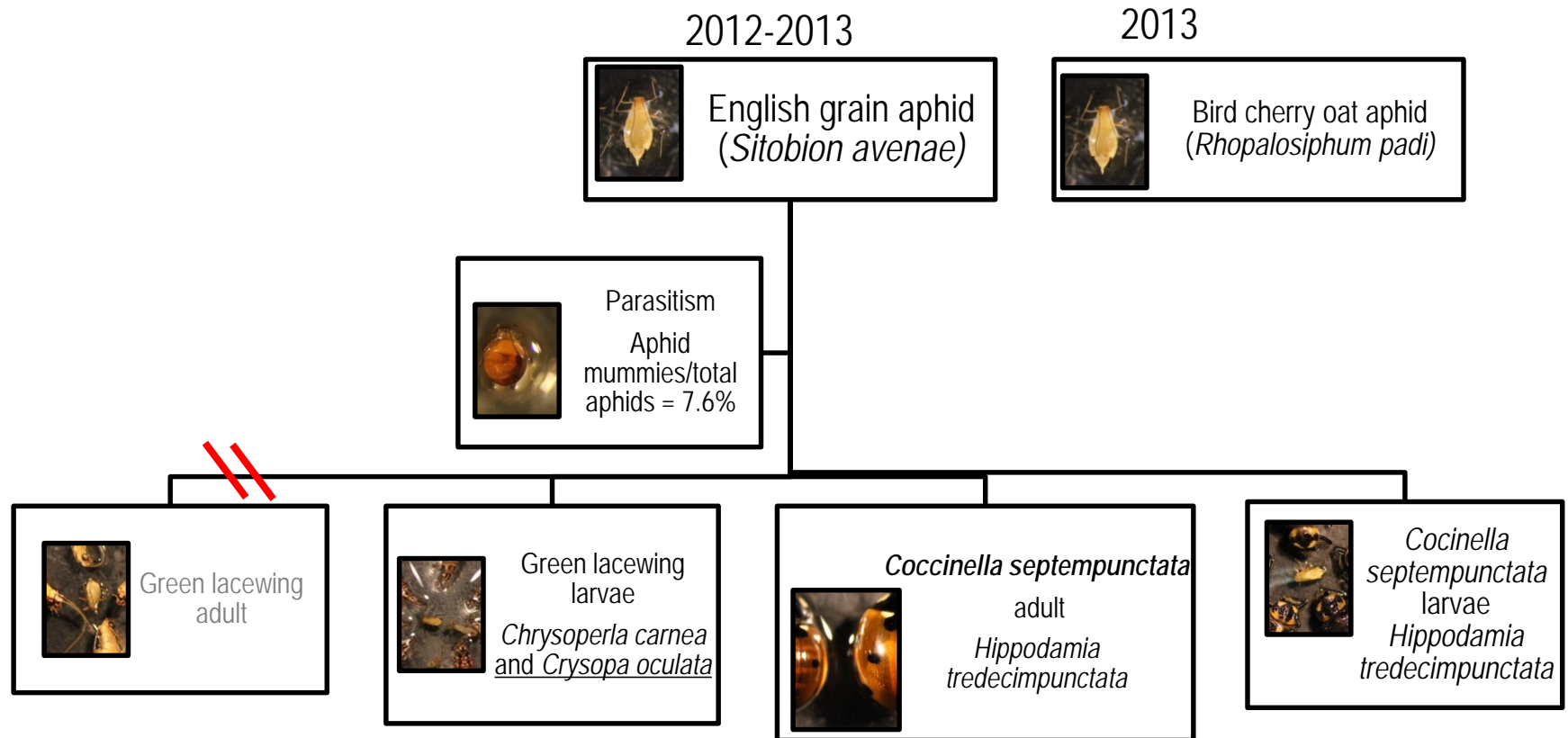
Chewing or sucking...but the end result is the same...one dead insect pest.

Insect composition: year and location differences

Ex. Beneficial insect web: Aphid predator web (Manitoba)



Ex. Beneficial insect web: Saskatchewan English Grain Aphid predator web



No damsel bugs and no Minute pirate bugs in the Saskatchewan survey, + higher parasitism...

Lady beetles, bugs, birds (Coleoptera: Coccinellidae)

Adults



Larvae



Both adults and larval lady beetles are aphid predators

Predatory insects

- Ladybug adults
- generalist feeder...but prefers aphids



Ladybugs can be purchased online and released in greenhouses, yards etc.

Predatory insects

- Ladybug larva and pupa (below)
- Larva is a generalist feeder
- Pupa does not feed



Predatory insects



C7 larva vs. an English grain aphid

In the field...



Green lacewings (Neuroptera: Chrysopidae)

Larvae: (aphid lions)

Chrysoperla carnea and *Chrysopa oculata*

C. carnea: common green lacewing



C. oculata: golden-eyed lacewing

Green lacewing larvae (aphid lions) are voracious aphid predators.

Green lacewings (Neuroptera: Chrysopidae)

- (aphid lions)



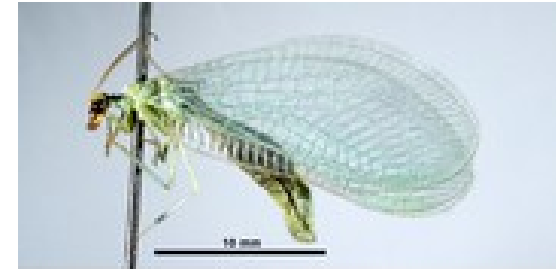
Green lacewing larvae (aphid lions) are voracious aphid predators.

Predatory insects

- Green lacewing larvae *Chrysoperla carnea* (left) and *C. oculata* (right) (Neuroptera)
- "Aphid lions"
- A generalist predator...but likes aphids



Adult



Chrysoperla oculata Say (female)
CANADA, Alberta, Edmonton, July 1, 1879
COLLECTED by Leston, G. & M. A. G. (British Museum)



Green lacewings (Neuroptera: Chrysopidae)

- aphid lion attacking a ladybug larva



Green lacewing larvae (aphid lions) are voracious aphid predators AND are generalist predators.

Predatory insects

- Predatory ground beetles

Rove beetle
(Staphylinidae)



Ground beetle (Carabidae)

Minute Pirate Bugs

Orius tristicolor (White)
(Hemiptera: Anthocoridae)



- *Orius tristicolor* *
 - Minute pirate bug
 - Also in Eastern Canada, but often confused with *O. insidiosus* (same size, colour, habits and behaviour)
 - On the prairies we have *O. tristicolor* (clavus is all black)

See Kelton 1978 The Anthocoridae of Canada and Alaska

Damsel bug (Hemiptera: Nabidae)

- Damsel bug: Nabidae, most are *Nabis americanoferus* on the Prairies

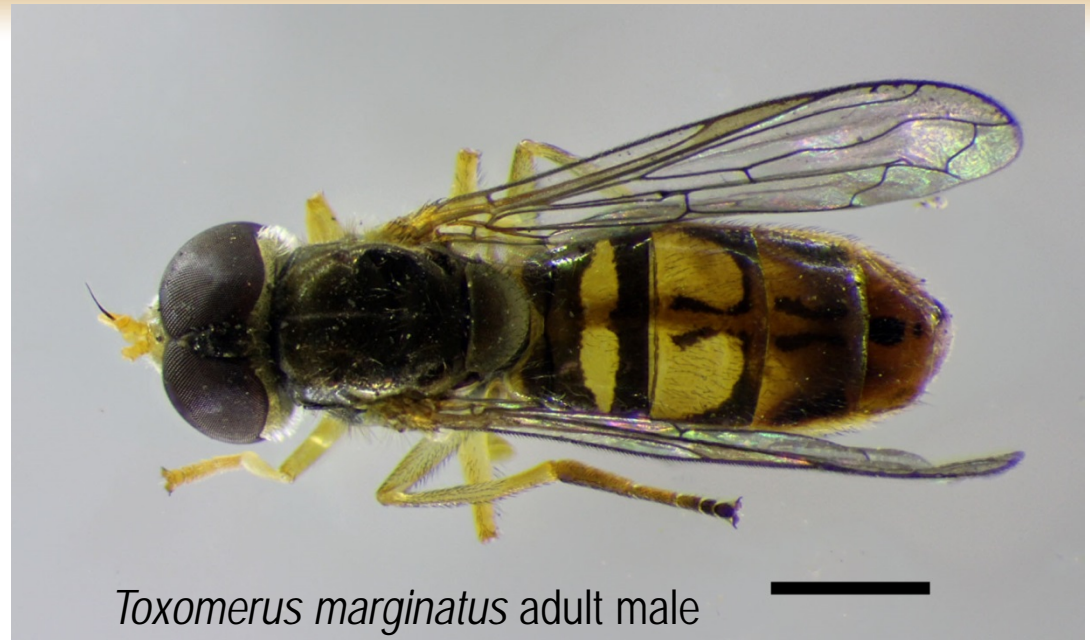


Has slightly raptorial front legs like a praying mantis and a "beak" for piercing and sucking insect prey. Similar to assassin bugs (Reduviidae)

Beneficial insects

Predator and pollinator

- Hover, flower or syrphid fly (Syrphidae)
- Adult is a pollinator
- Larvae (below) are aphidophagous (eats aphids)



Beneficial "insects"

- Spiders



1000 µm



Beneficial insects?

- Damselflies

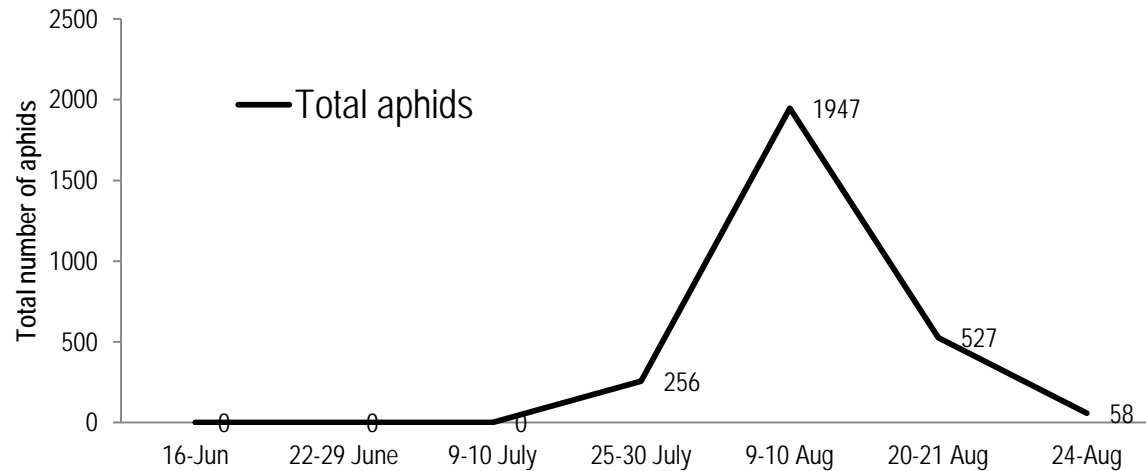


- Dragonflies

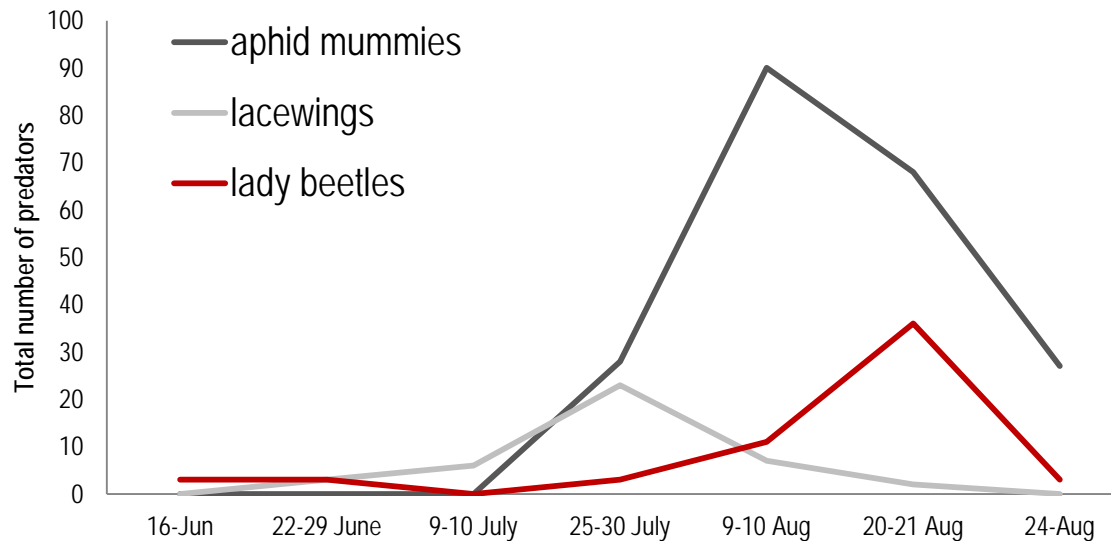


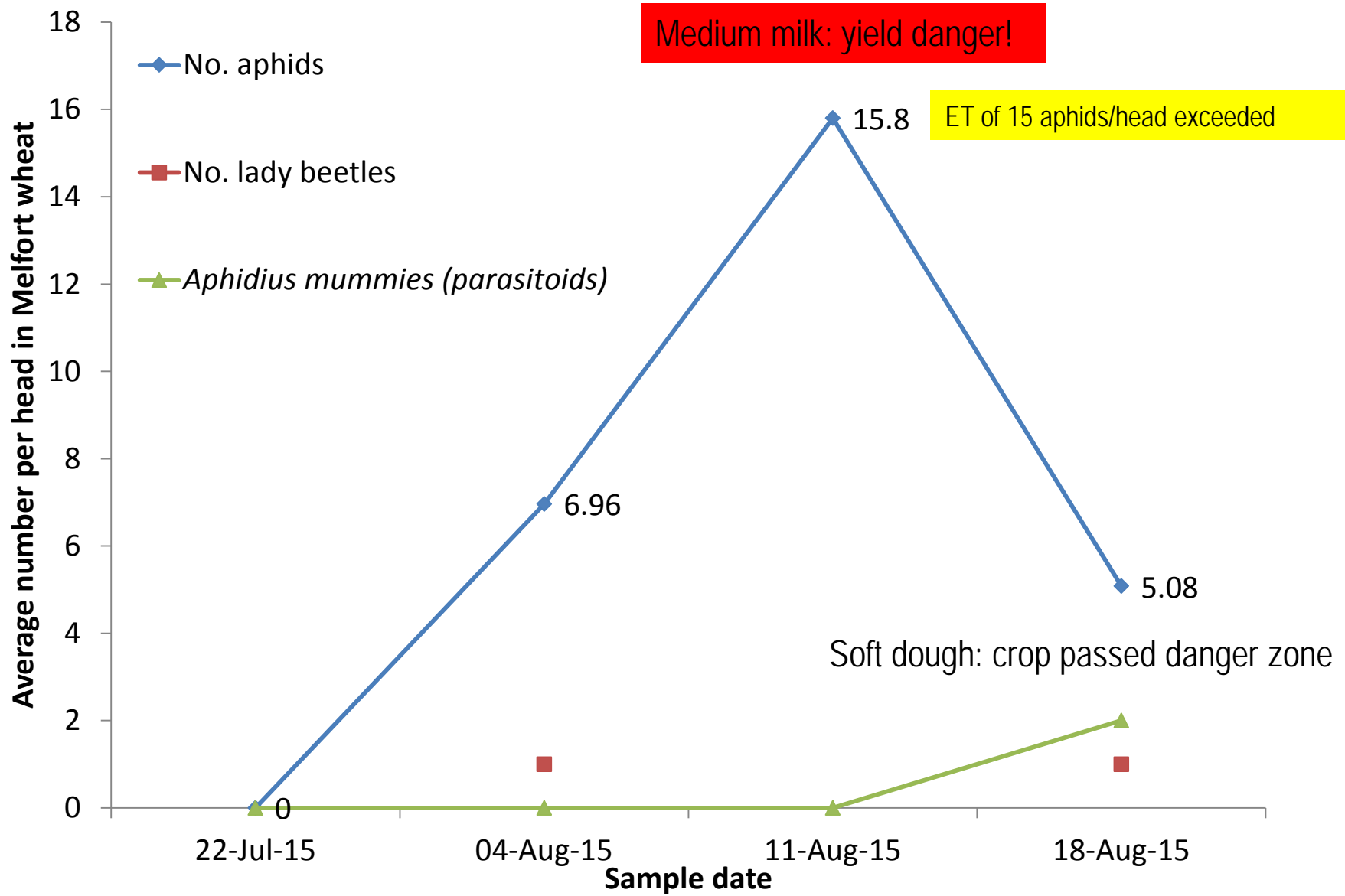
Predators follow their prey into crops

Aphid population over time (Sask)



Predators over time





A special type of predator. Female adult finds the prey but the larva kills it!

PARASITOIDS

“A parasite that kills its host”.

Parasitic insects

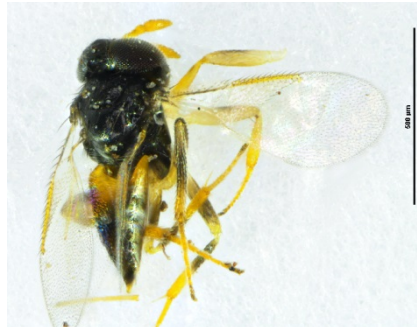
- Parasitoids of crop insects are usually wasps (Hymenoptera)
- Parasitoid = "a parasite that kills its host"
- Each insect pest has its own complex of parasitoids



Aphid parasitoids can be purchased online and released into greenhouses for aphid control.

Parasitic insects

- Aphid parasitoids create dead aphid "mummies" stuck to plants
 - Brown mummies = *Aphidius* spp. parasitism
 - Black mummies = *Aphelinus* spp. Parasitism (Powell 1982, Pike et al. 1997)



Leafhopper parasitoid

- *Epigonatopus plesius*



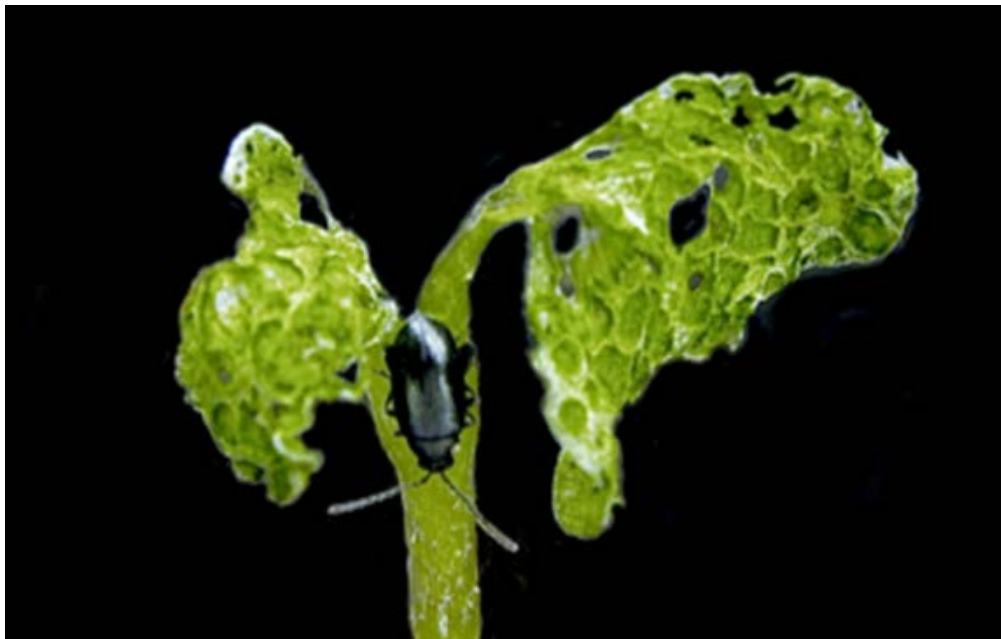


Flea beetle parasitoid



A native parasitic wasp *Microctonus vittatae* parasitizes both *Phyllotreta cruciferae* and *P. striolata*

M. vittatae parasitizes *P. cruciferae* at $\leq 5\%$ - Wylie



Flea beetle parasitoid



A native parasitic wasp *Microctonus vittatae* parasitizes both *Phyllotreta cruciferae* and *P. striolata*. *M. vittatae* parasitizes *P. cruciferae* at $\leq 5\%$ - Wylie, $\leq 2.5\%$ in Sask (Soroka 2012)

Parasitism of a bertha armyworm by the braconid parasitic wasp *Cotesia vanessae*

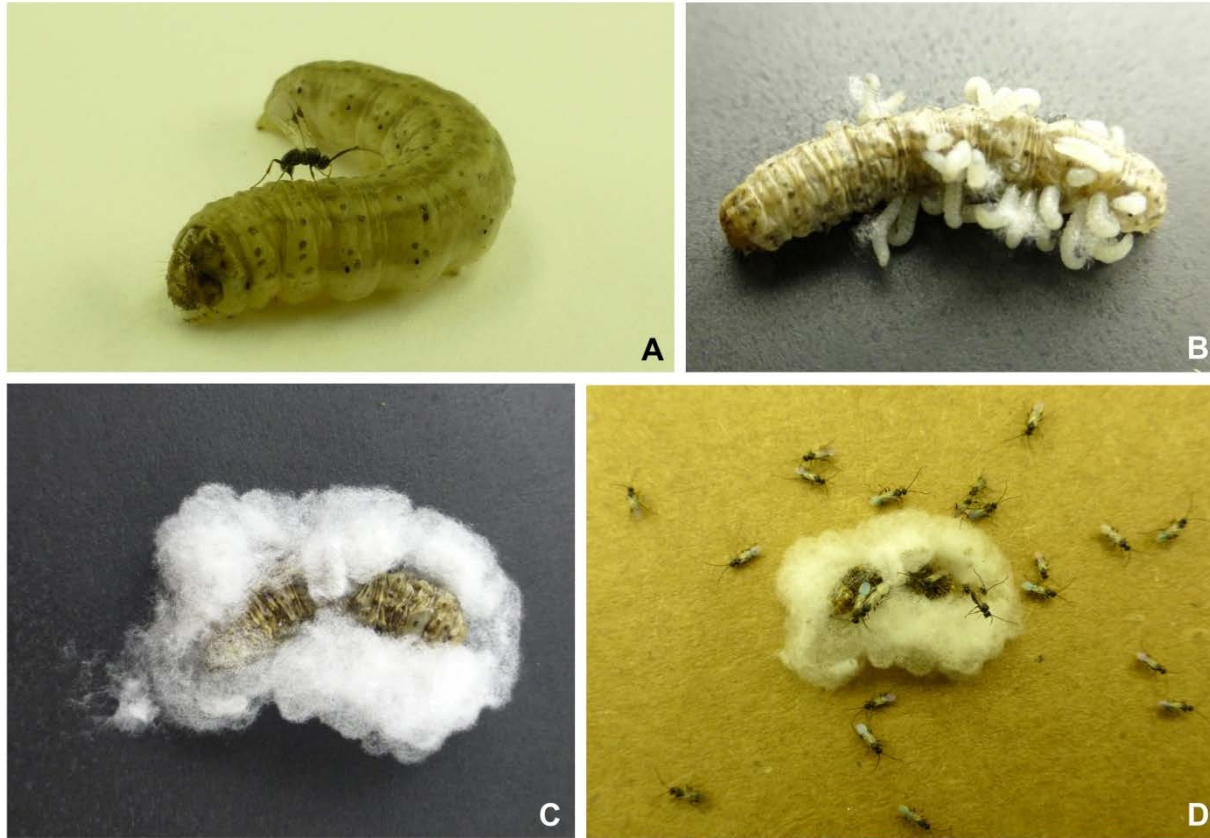


Figure 2. Parasitism of the early cutworm by a braconid wasp. **A:** Day 1, a wasp parasitizes a cutworm larva. **B:** Day 20, wasp larvae emerging from their host for pupating, thus killing the host. **C:** Day 20 to 30, pupal mass (made of tens of wasps cocoons) around dead host. **D:** Day 30, new generation of wasps emerging as adults. (Indicated development time when reared at 20°C)

The cereal aphid Dynamic Action Threshold project

Conventional action threshold (CAT)

The population of aphids this week that will



Economic threshold

And trigger an insecticide treatment

The **CAT** does not account for controlling pressure of natural enemies

...current recommendations are often to “look around for natural enemies and parasitoid mummies” ...with no quantification or measure of their impact (my personal opinion)

So, the **Dynamic Action Threshold (DAT)** incorporates predators and parasitoids into the action threshold as Natural Enemy Units (**NEUs**)

- The basic prediction equation

Aphid population growth at t_1 = No. aphids at t_0 – predation pressure x time

- Validated with real-world survey data (newest project)
- build it into a smartphone app to use in field surveying! (ongoing project!)

Natural Enemy Units

- What and how many natural enemies are out there?
- How many aphids do they kill per day?

$$\text{NEU}_{\text{total}} = \sum_{i=1}^N n_i V_i$$

Dynamic action threshold (DAT) incorporates predators and parasitoids as one number of the total Natural Enemy Units (NEUs)

For example:

one C7 ladybug = 0.95 NEUs on soybean aphid

One *Aphelinus* parasitoid = 0.08 NEUs

$0.95/0.08 = 11.88$

So, one ladybug is worth 12 parasitoids

(Hallett et al. 2013 Pest Manag Sci)

V_i = Voracity of a predator

- I.e. How many aphids can one of these predators kill in one day?
- In Saskatchewan, 98% of parasitoids were *Aphidius avenaphis* (Wist, Tourgeron and Van Baaren unpublished, 2015)
- Voracity was unknown, so I fixed that (refining the equation)
- One female (60% of emerged) *A. avenaphis* kills 30 aphids per day for about four days



Insect pollinators

- Transfer pollen between flowers
 - Plants offer nectar and pollen as “rewards” to attract insect pollinators
- Essential to seed set in non-wind pollinated, obligate outcrossing crops
- Boost yield in canola, and lead to faster seed set

Butterflies



Painted lady, *Vanessa cardui*, on *Echinacea purpurea*



Painted lady larvae, on Canada thistle
Sometimes butterfly larvae are also
beneficial

Butterflies (Lepidoptera: Pieridae)



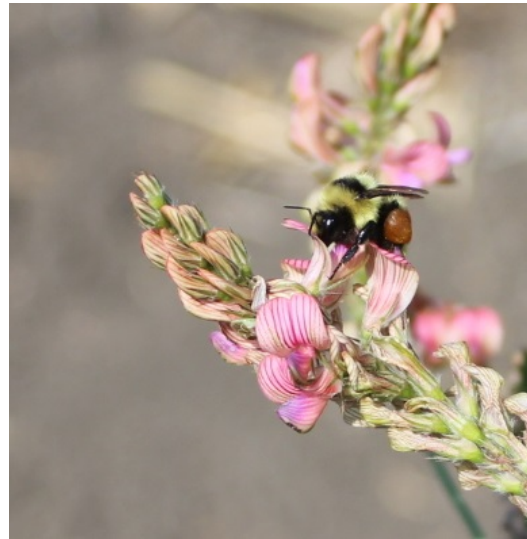
Small cabbage white *Pieris rapae*, large cabbage white *P. brassicae*, yellow sulphurs *Colias spp.* etc.

But, larvae are cruciferous vegetable and canola pests...

Bees (Apidae)

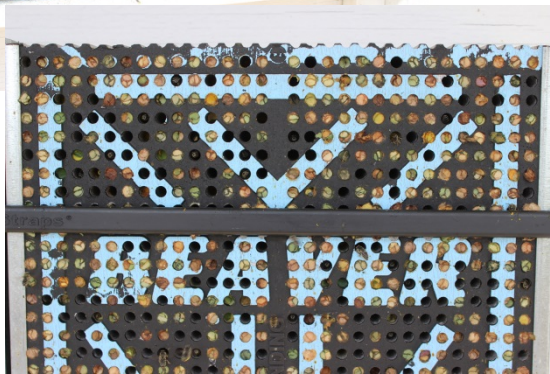


Honey bee (managed pollinator) , *Apis mellifera*



Bumble bee (native pollinator): red tailed, *Bombus ternarius*, is common.

Bees: leafcutters (Megachilidae)



Alfalfa leafcutter bee (managed pollinator), *Megachile rotundata*: look for “bee huts” on fields

Look for scopa (pollen basket) on abdomen and cut leaves on surrounding plants.

Similar species, the Sunflower leafcutter bee (native pollinator), *Megachile pugnata*

Beeflies (Diptera: Bombyliidae)

- Occasionally found depending on the year.
- Abundant during and after a grasshopper outbreak because their larvae are grasshopper egg predators.



Blister beetles (Coleoptera: Meloidae)



Field Crop...etc. etc. (#AAFCbugbook)



Field Crop and Forage Pests and their Natural Enemies in Western Canada

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Questions?

