I see you
Sebastian Mortimer
REACCH 2013
Cereal Leaf Beetle

- A pest of Wheat, Barley, Corn, Rye; also feeds on numerous wild grasses
- Univoltine (One generation per)
- Life Cycle
  - Eggs – Larvae – Pupa – Adults
  - Adults overwinter in protective foliage, perennial grassy stands, tree bark, and hay bales
Feeding damage

Egg

Larva

Fecal shield

Pupa

Adult

Pictures: Nate Foote
US CLB History

- First detection 1962 - Michigan
- Attempts of control: Pesticides & quarantine
- Utah, Montana, Idaho, and Washington by 2003
- Biological control success story
CLB Feeding 2013

Green = Positive (27/39)
Red = Negative (12/39)
Key Biological Control Agent: Tetrastichus julis

- Specialist parasitoid wasp
- Emerges from CLB pupal cases
- (Bivoltine) two generations per year
Fig. 3. Phenology of *T. julis* in southern Alberta and Saskatchewan

- **Overwintered Adults**
- **CLB larvae attacked:** First cycle of parasitization
- **Second Phase of parasitization**
- **Overwintering in soil inside CLB pupa**
- **T. julis larval pupation in soil**

<table>
<thead>
<tr>
<th>Mid-May</th>
<th>June</th>
<th>July</th>
<th>August</th>
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SOURCE?
CLB and Phenology

- **MAR, APR, MAY**
  - Over-wintering adult
  - Mature adult
  - Immature adult

- **APR, MAY, JUN**

- **JUL, AUG, SEP, OCT**

- **OCT, NOV, DEC, JAN, FEB, MAR**

Legend:
- EGG
- LARVA (INSTAR 1)
- LARVA (INSTAR 2)
- LARVA (INSTAR 3)
- LARVA (INSTAR 4)
- PUPA
- ADULT
Overlapping phenology of CLB and *T. julis*

Days of overlap ≈ Relative potential biocontrol impact

Required for *T. julis* overwintering
WHAT ARE THE POTENTIAL EFFECTS OF PROJECTED CLIMATE CHANGE ON CLB BIOLOGY AND BIOLOGICAL CONTROL?
Projections show increased temperatures

Increased CLB suitability in the next 50 years

John Abatzoglou, UI
What does this mean for Bio-control?

Complex system – Each interaction affected by climate
  – Cereal Crops
  – Cereal Leaf Beetle
  – T. julis
HYPOTHESES

Direct
1. Increased temperatures negatively effect the survivorship of CLB adults

Fecal Shield
1. Removal of the CLB fecal shield negatively effects the survivorship of larvae before reaching pupation
2. The volume, generation and regeneration of the fecal shield differs for CLB larvae fed on host plants under water-stressed and unstressed conditions
3. The composition of the fecal shield differs for CLB larvae fed on unstressed and water-stressed host plants

Predation and Bio-control
1. The CLB fecal shield provides protection against attack by generalist predators
2. The CLB fecal shield is a means of host localization by *T. julis*.
3. Natural enemies of CLB react differently to isolated fecal shield from CLB fed on unstressed and water-stressed host plants.
Expected Results

• Increased daytime temperatures would increase mortality
• Differences in shield mass and composition
• Slower regeneration time on drought stressed plants
• Organic compounds picked up by SPME
Method development

- Establish working colony of CLB and parasitoid
- Develop methods for handling and measuring fecal shields
- Controlled temperature regime treatments
Hypothesis 1 - Heat Stress – Direct

- Newly emerged Adults in July and August
  - Subject to warmest temperatures of the year
- Effects of extreme heat on Adults going into diapause
Hypothesis 1 - Heat Stress – Pilot Test Methods
Subject CLB adults to four temperature regimes
Assess survival
Hypothesis 1 - Heat Stress – Pilot Test Results

Survivorship
Hot-Hot: 14/20
Cold-Hot: 15/19
Hot-Cold: 17/18
Cold-Cold: 17/17

![Graph showing hours living for different treatments: hot-hot, cold-hot, hot-cold, cold-cold]
Hypothesis 2. Fecal Shield Removal

What exactly is it?
• Chrysomelidae
Chrysomelidae Fecal Shield

- Physical or chemical defense?
- Insulator for temperature and humidity?
- Localization for specialist parasitoid *T. julis*?
Hypothesis 2. Fecal Shield Removal

- The fecal shield provides physical or chemical protection against generalist predators.
- Its composition changes under differing water treatments.
- Regeneration time or mass change under differing water treatments.
Hypothesis 2 – Pilot Test - Fecal Shield Removal - Methods

- 1st instar larvae
  - Drought and Replete
- At 3rd instar shields were collected
  - Shield mass differences
  - Survivorship (an afterthought)
Hypothesis 2 – Pilot Test - Fecal Shield Removal - Results

No adults emerged after pupating
Other tests and activities

• Assessing % parasitism by dissection
  – Cutler farm (Nine Mile Falls, WA)
• Collecting beetles for colony establishment
• Bio-assay design
• Exploratory: SPME samples of fecal shield
Method development challenges

• Collecting large numbers
• Keeping steady numbers of larvae alive
  – Life span
  – Fragility
• *Tetrastichus julis*
  – Lab conditions for emergence
  – Total < 10
• For hypotheses addressed with pilot studies
• 1. Heat stress – evidence for heat stress related mortality at a regime that can occur in our region
• 2. Fecal shield there may be differences in regeneration mass of Fecal shield
• 3. Analyzable compounds in fecal shield include...
• 4. Parasitism is identifiable in fresh or frozen samples
• Based on the pilot results, full experiments are to be conducted with improved methods include:
  • Heat stress simulations
    – Increase temp in growth chambers and extend time
    – Thermal limit - Isolation chambers in water bath
  • Fecal Shield removal
    – Control treatments
    – Higher repetition
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