



Parasitoids of the pepper weevil across North America

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Agriculture and
Agri-Food Canada

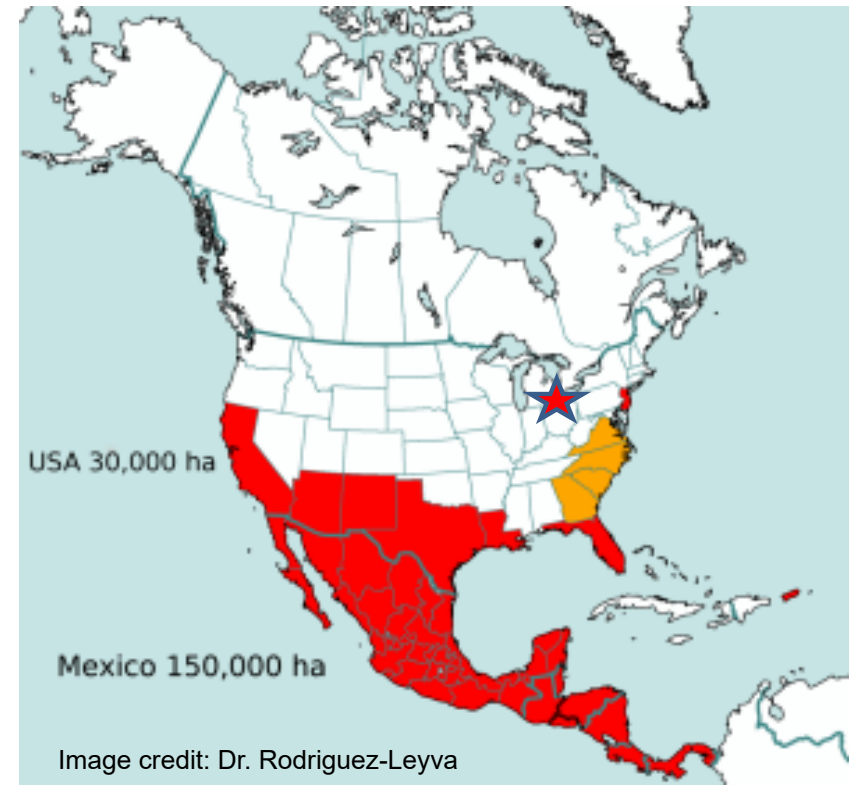
Pepper production in North America

- **1.8M tons** of bell peppers produced in Mexico in 2007 (FAOSTAT, 2009).
- **40K acres** of field bell peppers cultivated in the United States in 2015 (USDA, 2015).
- **150K tons (1.3K acres)** of bell peppers grown in **greenhouses** and **66K tons (5.9K acres)** in field in Canada in 2016. (StatsCan, 2017).
 - In wintertime, demand for peppers in Canada outstrips supply and must be imported from elsewhere.



Pepper weevil in Ontario

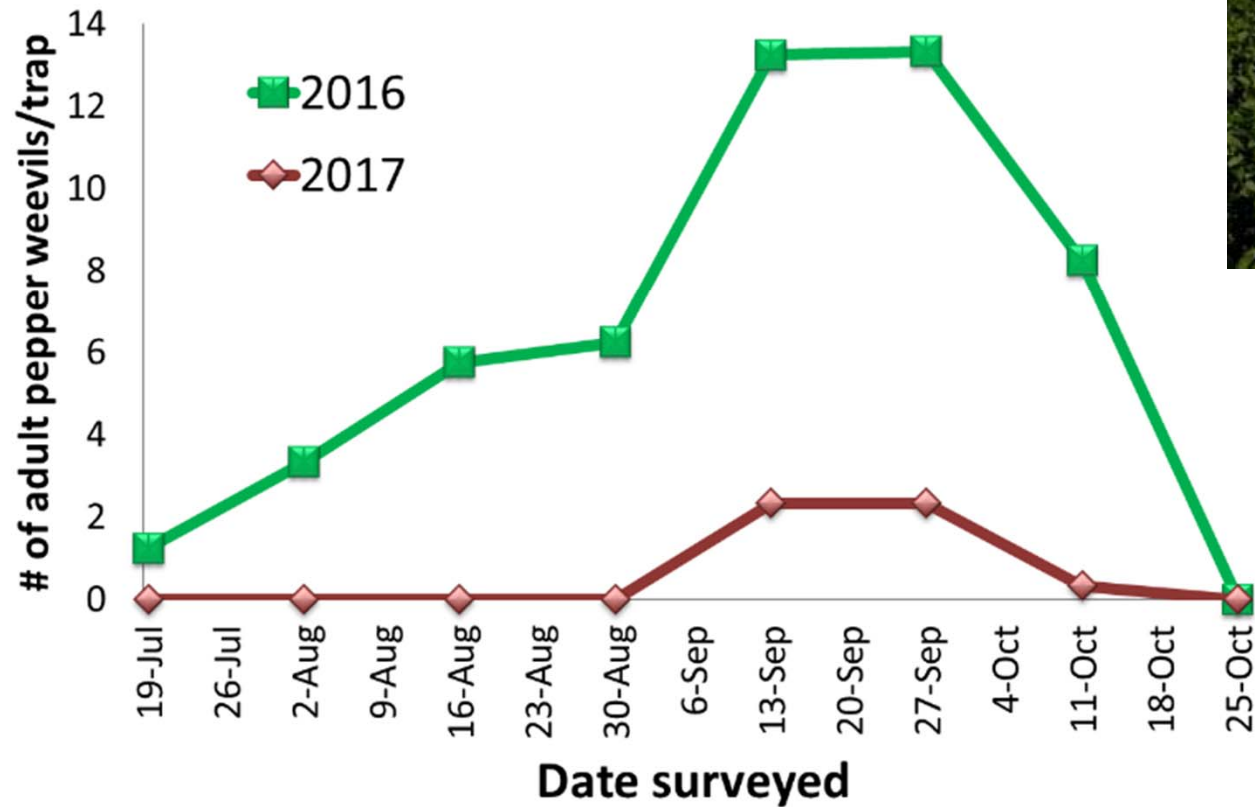
- At the end of summer in 2015 pepper fields in Southern Ontario experienced weevil infestation.
- A mild fall/winter in 2015/16 meant a new high for weevil presence, leading to significant crop losses in 2016.
- That year, pepper weevil was reported both in Essex and Chatham-Kent counties.



Pheromone trap with two lures



Average weekly number of pepper weevils/trap in Southern Ontario



Key management strategies now applied

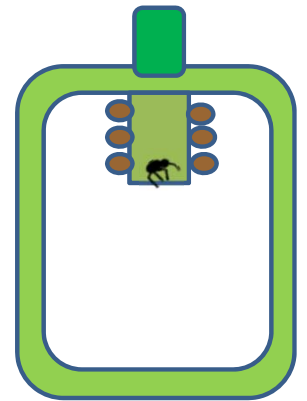
- **Screens** installed on most pepper greenhouses
 - **Proper disposal** of pepper biomass
 - **Packing** of imported peppers isolated from growing facilities
 - **High temperature treatment** for clean-up ($>20^{\circ}$ C for 2 wks)
 - **Intensive crop scouting** (2 scouts/acre/wk; bounties)
 - **Registration of new products** and development of BMPs.
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However, controlling immature pepper weevils remains a challenge.

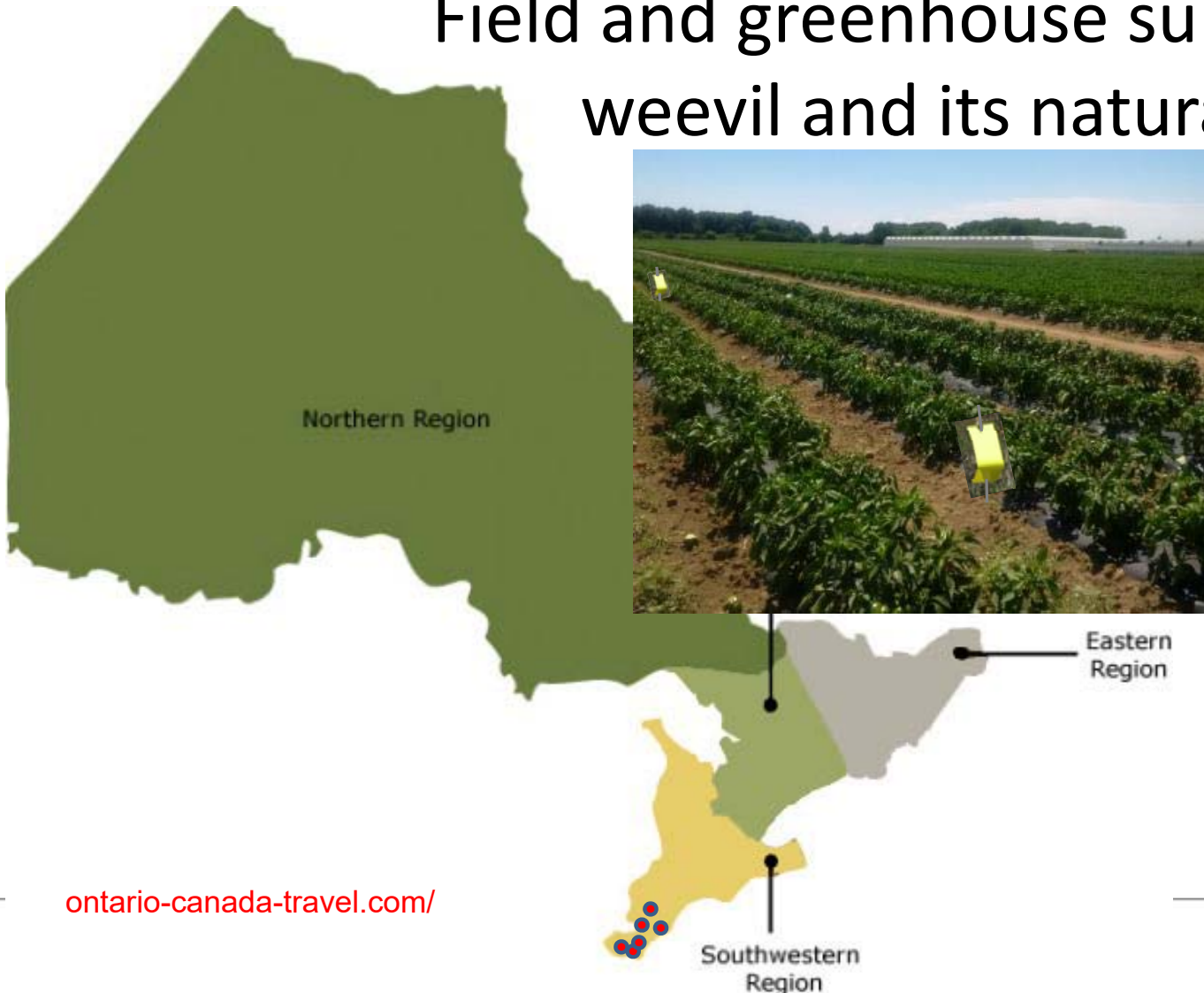
Can we better target these life stages?

Biological Control of Agricultural Pests A-1526:

- Assess **distribution** of the pepper weevil and identify its associated natural enemies.
- **Establish a rearing colony** of *A. eugenii* and candidate biocontrol agents.
- **Evaluate efficacy of agents** and report on potential for biological control.



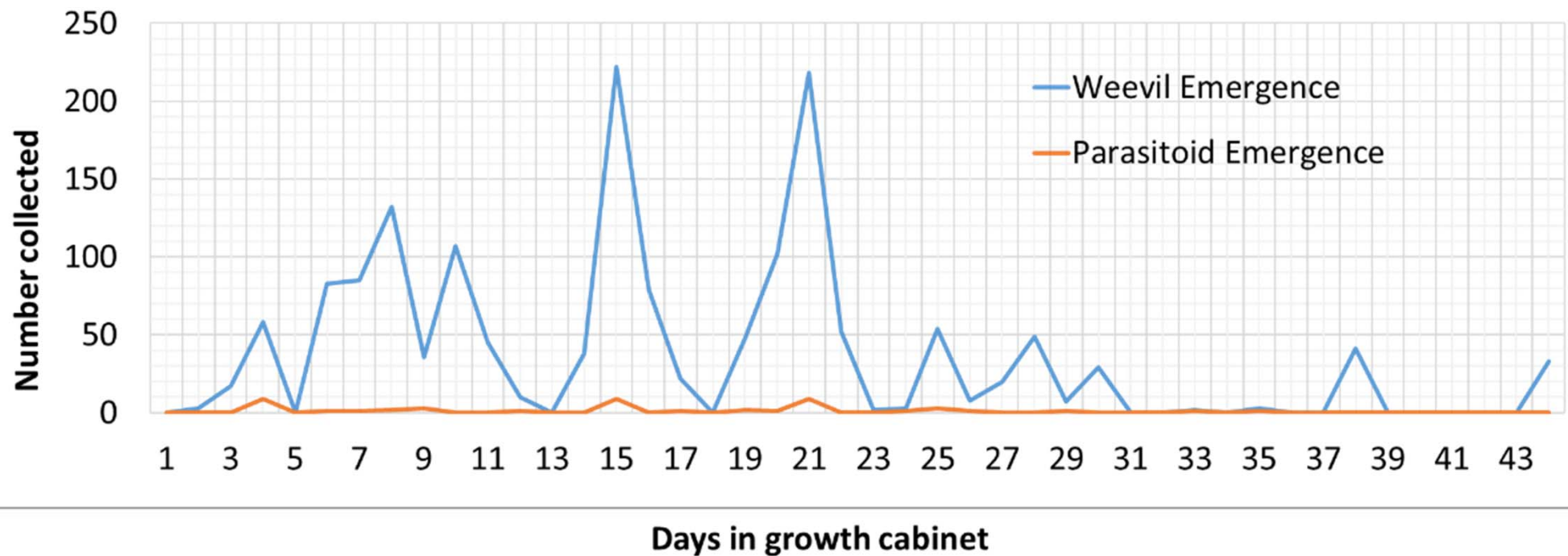
Field and greenhouse survey for pepper weevil and its natural enemies



Aborted peppers collected weekly and monitored in controlled environment chambers for up to 6 weeks.

When do parasitoids emerge?

Weevil and parasitoid emergence from 20 batches collected on varying dates



Percent parasitism at each location surveyed

Site	Pepper type	# peppers	# weevils	# Parasitoids	Parasitism rate (%)
Kingsville 1	jalapeno, chili	222	204	1	0.49
Kingsville 2	scotch bonnet, jalapeno	247	93	3	3.23
Kingsville 3	hot cherry, banana, jalapeno	311	652	2	0.31
Leamington 1	bell	28	11	0	0.00
Leamington 2	mini sweet	55	0	0	0.00
Leamington 3	bell	200	55	6	10.91
Dresden	banana	154	158	2	1.27
Wallaceburg	hot cherry	10	5	0	0.00
Cottam	hot cherry, mini sweet, bell, jalapeno, chili	642	710	45	6.34
Chatham	jalapeno	51	97	0	0.00
	Total number	1920	1985	59	

What parasitoid species are associated to the pepper weevil in Ontario?

3 *Bracon* spp. (16)



Photo credit: R. Labbe AAFC

B. mellitor considered the most important parasitoid of boll weevil, ***Anthonomus grandis*** in SE USA and likely also Mexico (Pierce 1908a; and Hunter and Hinds 1905).

3 *Nealiolus* spp. (10)



Photo credit: J. Fernandez-Triana AAFC

N. curculionis is a parasitoid of the sunflower stem weevil, *Cylindrocopturus adspersus*, a pest of sunflower in the Great Plains, USA (Rogers and Serda, 1982; Charlet et al., 2002).

Other **Heliconinae** known to parasitize the pepper weevil include ***Aliolus* spp.** in the USA and Mexico (Mariscal et al., 1998; Rodriguez-Leyva et al., 2007).

Pteromalus anthonomi (10)

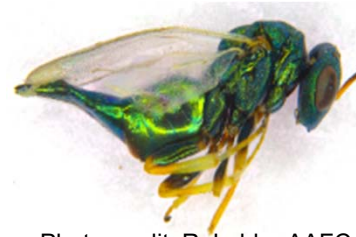


Photo credit: R. Labbe AAFC

Reared previously from beetles including the tobacco beetle, *Lasioderma serricorne* (Anobiidae) and four species of ***Anthonomus***, including ***A. grandis***, ***A. musculus***, ***A. nigrinus*** and ***A. signatus***, (Peck, 1963; Burks, 1979)

Eupelmus pulchriceps (10)

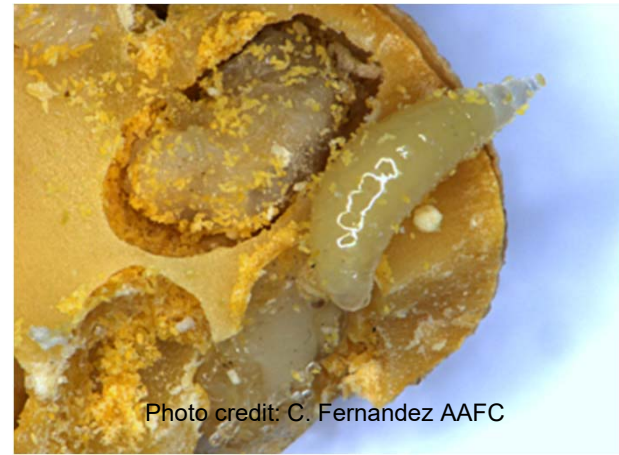


Photo credit: R. Labbe AAFC

Native to and distributed across North and South America (Noyes, 2010; Gibson 2011).

Primary or hyperparasitoid of at least 34 insect species typically developing within fruit, galls, cocoons or plant tissue (Gibson, 2011; Gibson, 1997).

Jaliscoa (Catolaccus) hunteri

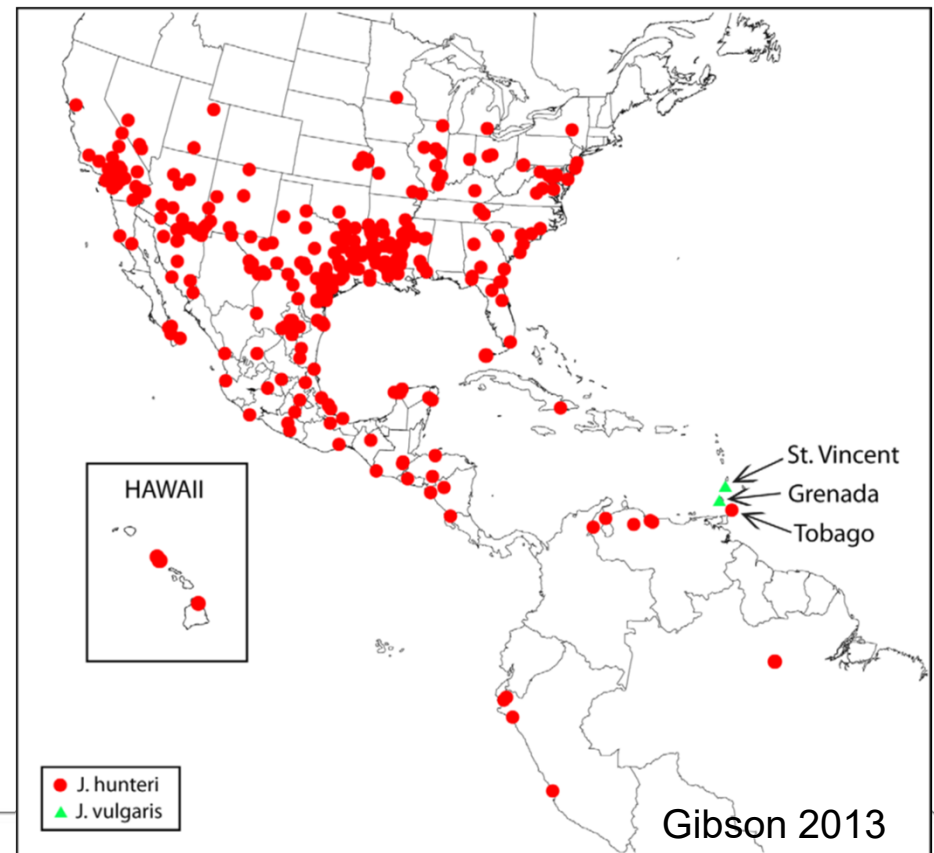


- Most widely distributed parasitoid of the pepper weevil in Mexico; Also present throughout the USA.
- Parasitizes the 3rd instar larvae: adult female responsiveness is correlated with this life stage.

Distribution of *Jaliscoa hunteri*

- Generalist ectoparasitoid
 - Known to attack the cotton boll weevil, *Anthonomus grandis*
 - Intrinsic rate of increase (0.18) greater than that of the pepper weevil (0.14)

Seal et al., 2002, Rodriguez-Leyva 2006.



What species are absent in Canada? *Triaspis eugenii* (Braconidae)

- Most abundant parasitoid in Nayarit Mexico.
Rodríguez-Leyva 2006
- Egg parasitoid
- Has greater reproductive potential ($r_m = 0.26$) than does the pepper weevil ($r_m = 0.14$). Seal et al. 2002, Rodríguez-Leyva 2006



Can *Jaliscoa hunteri* reduce pepper weevil infestation?

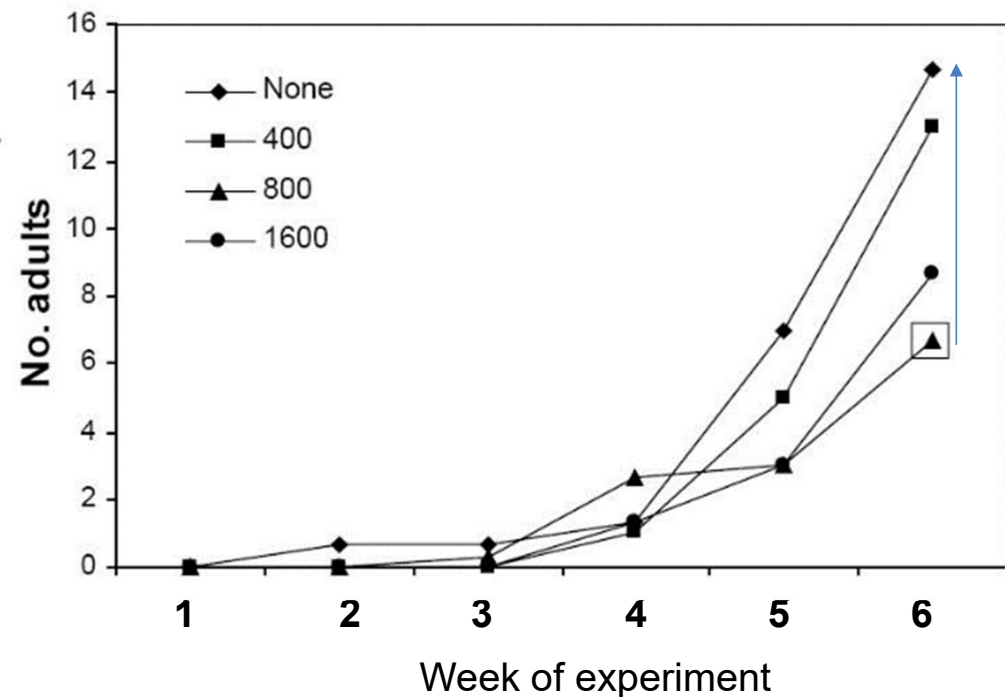
Biocontrol Science and Technology, 2007; 17(4): 345–351



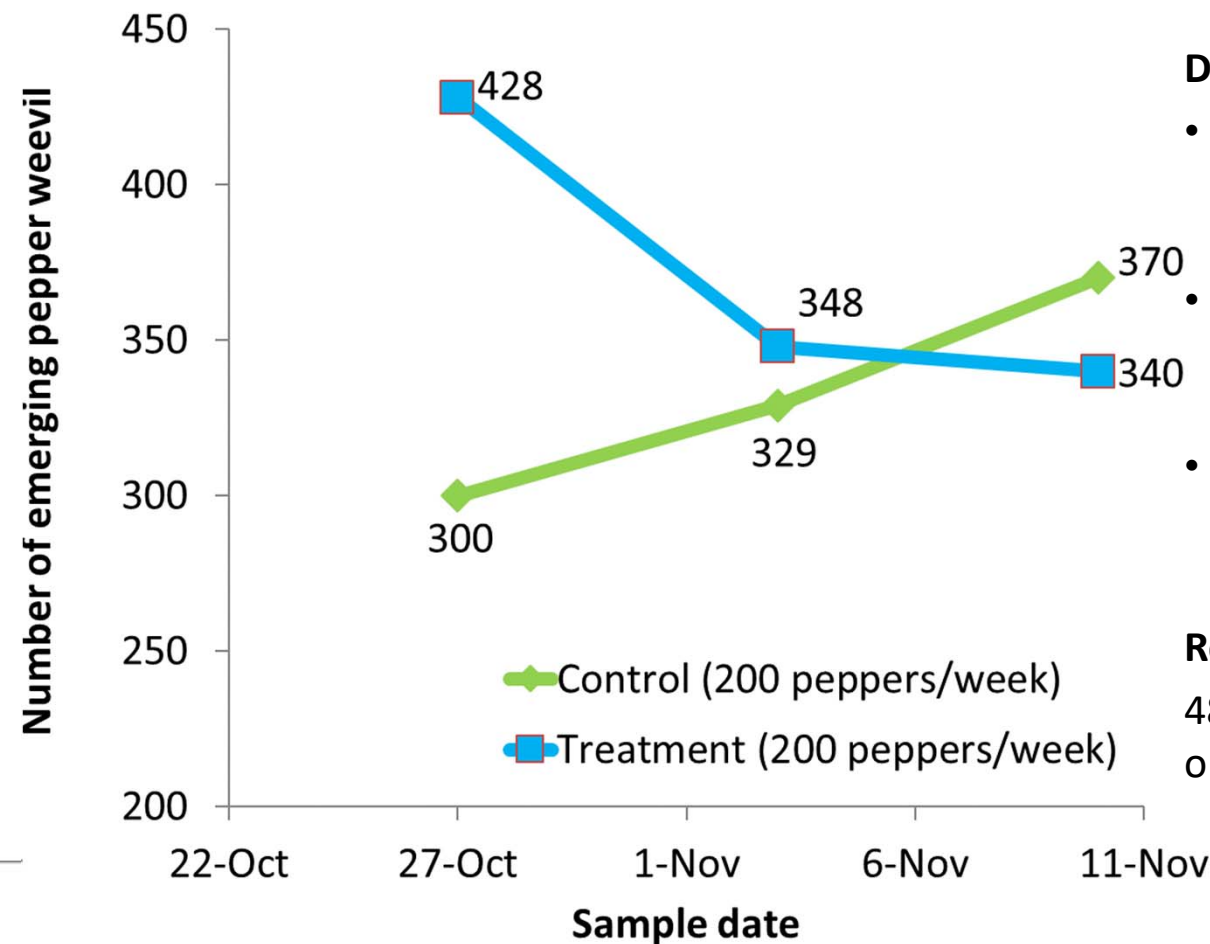
Suppression of *Anthonomus eugenii* (Coleoptera: Curculionidae) pepper fruit infestation with releases of *Catolaccus hunteri* (Hymenoptera: Pteromalidae)

DAVID J. SCHUSTER

Number of adult pepper weevil /200 pepper plants in response to releasing different number of *J. hunteri*/0.2 ha



Commercial greenhouse *J. hunteri* trial



Design:

- 30,000 adult *J. hunteri* wasps released in a 3 acre block (2.47 wasps/m²) vs. untreated 6 acre control.
- Three weekly releases of the parasitoid *J. hunteri*:
 - Oct 20, 27 and Nov 3rd.
- Collection and monitoring emergence from 200 infested peppers per range per week

Results:

- 48 % change in pepper weevil infestation levels observed between treatment and control.
- But only a few adult parasitoids emerged.

More questions to answer

- **How is *J. hunteri* affecting weevil emergence?**
 - Does host feeding occur often?
 - Behavioral studies led by PhD candidate, Catalina Fernandez
- **Why is overall recovery of pepper weevil parasitoids so low?**
 - Is host switching an important factor influencing successful parasitism?
- **Are there ways to improve parasitism by *J. hunteri*?**
 - Optimizing mass rearing of *J. hunteri* on other hosts, Felix Longpre, AAFC, London
- **Could other parasitoids identified be developed as possible biocontrol agents against the pepper weevil?**



Photo credit: C. Fernandez AAFC

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Pepper growers of Ontario



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KOPPERT
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1526: AAFC A-base: Biological control of agricultural pests

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