

Using biocontrol in vegetable & fruit crops



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Topics

- Cast of characters
- Types of biocontrol
 - Conservation
 - Augmentation
- Examples
 - Greenhouse
 - Field

Biological Control

= control of pest by other organisms
that act as natural enemies

- Term used since 1930s

Biological 'Control'?

- Control = maintaining pest population below the EIL
- Sometimes preventive
- Sometimes rescue
 - Might not do the whole job
- But can be 'free'

Natural enemy categories



- Predators
- Parasitoids
- (Microbes)



Natural enemy categories:

Predators



- Consume the entire prey
- Develop at expense of more than one prey item
- Prey usually killed & consumed quickly
- Predator often larger than prey

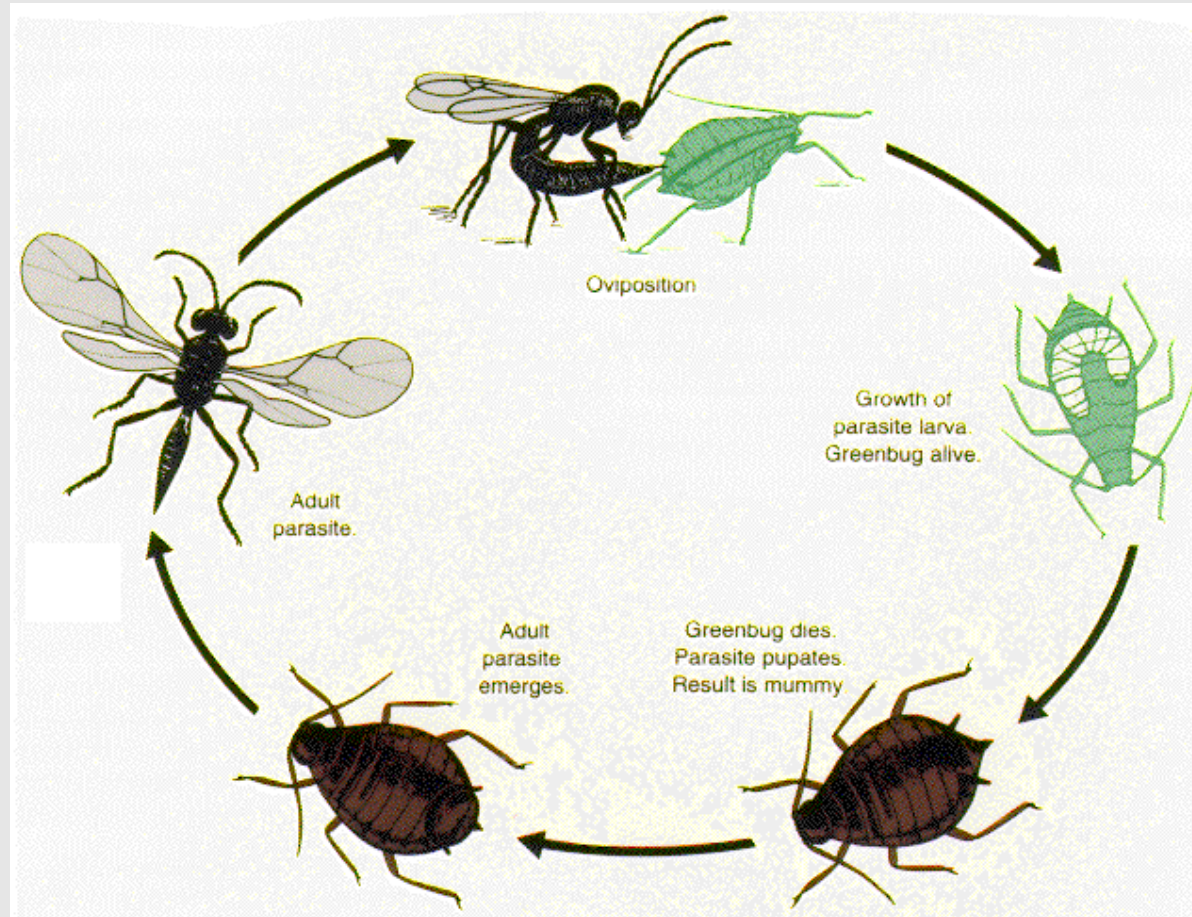
Natural enemy categories:

Parasitoids



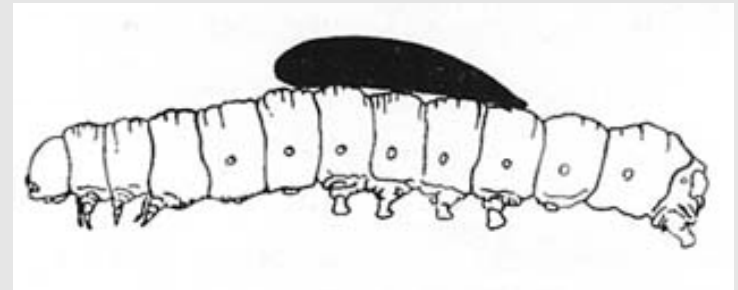
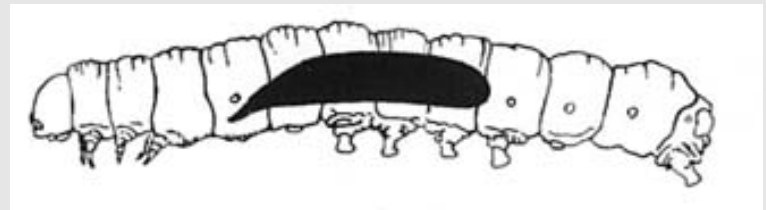
- Lay egg in or on host insect
- Develop at expense of a single host
- Host is usually killed slowly
- Enemy usually smaller than host

Parasitoids: typical life cycle



Categories of parasitoids

- Endoparasites
 - Develop inside body of host
- Ectoparasites
 - Feed externally, attach to outside of host



Microbes (micro-organisms)

- Categories
 - Bacteria
 - Fungi
 - Viruses
 - Nematodes
 - Protozoans
- Cause disease in insect
- Applied by same methods as chemical control
- Not included in today's workshop

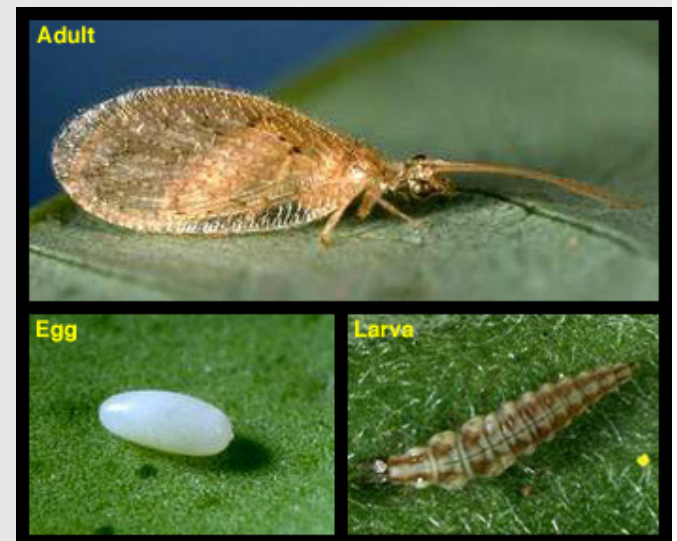
Predatory Arthropods

- Lacewings
- Some beetles
- Some bugs
- Some flies
- Some wasps
- Some thrips
- Some mites

Lacewings

Two families:

- Green lacewings
- Brown lacewings



Predatory Beetles

- Lady beetles
- Ground beetles
- Rove beetles
- Soldier beetles



Predatory Bugs



- Stink bugs

- Spined soldier bug
- Twospotted stink bug



- Flower bugs

- Minute pirate bug
- Insidious flower bug



- Damsel bugs

- Assassin bugs

- Big-eyed bugs



Predatory Flies

- Hover flies
(flower flies)
(syrphid flies)



- Aphid midges

- Robber flies



Other Predators

- Wasps:

- Yellowjackets



- Thrips:

- Black hunter thrips



- Mites:

- Phytoseiid mites



Parasitoids

- Some wasps
- Some flies



Parasitoids

- Some wasps

- Braconids

- On hornworm: *Cotesia congregata*

- On imported cabbageworm: *Cotesia glomerata*

- On aphids: *Diaeretiella rapae*

- Ichneumonids

- On diamondback: *Diadegma insulare*

- Other families

- On whiteflies: *Encarsia*

- On eggs: *Trichogramma*



Parasitoids

- Some flies

- Tachinids

- On squash bug:

Trichopoda pennipes



- On striped cucumber beetle:

Celatoria setosa



Parasitoids

- Some species attack eggs **
- Some species attack larvae
- Some species attack pupa
- Some species attack adults

** prevent the most damage

& Vertebrate predators eat insects!

- **Bats**
- **Toads**
- **Birds**
- **Geese**
- **Hogs**



Categories of Biological Control

- 'Natural' (local species)
- Importation (exotic species)
- Conservation (local species)
- Augmentation (local species)

Categories of Biological Control: 'Natural'

- Happens without intervention of humans
- Very common in structuring populations in nature
- Assumes that a normal biotic component keeps population suppressed

Categories of Biological Control: Importation

- Also known as 'classical biocontrol'
- Used to control pests of exotic origin
- Assumption that in native zone, pest has natural enemies

Importation biocontrol

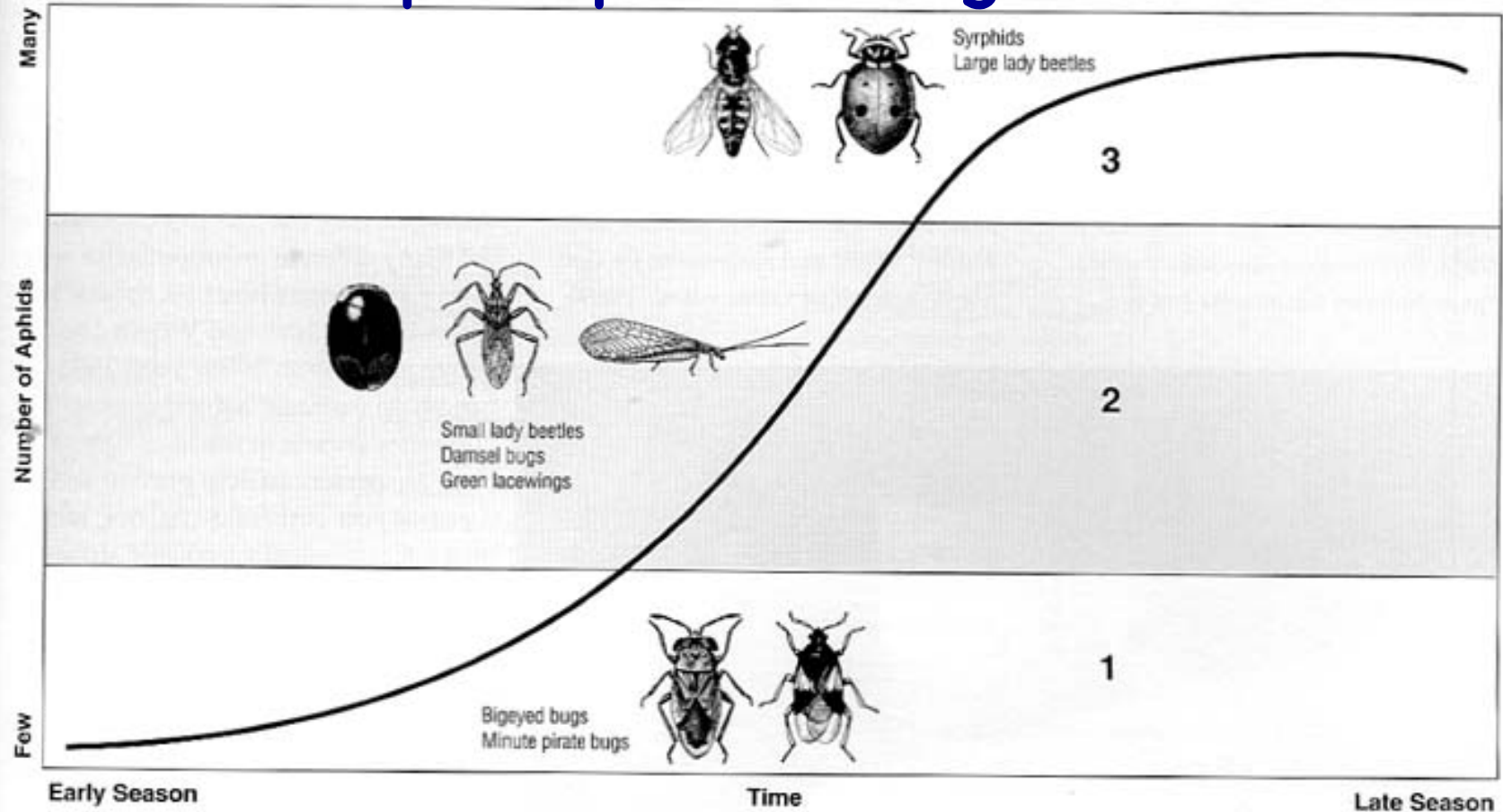
- Steps (by USDA):
 - Foreign exploration
 - Quarantine
 - Release
 - Evaluation
- Strict permits used
- Can spread after release

Categories of Biological Control: Conservation

- For pests with natural enemies present, but not enough enemies to keep pest suppressed
- Enhance enemy activity
 - by practices not to do
 - by practices to do

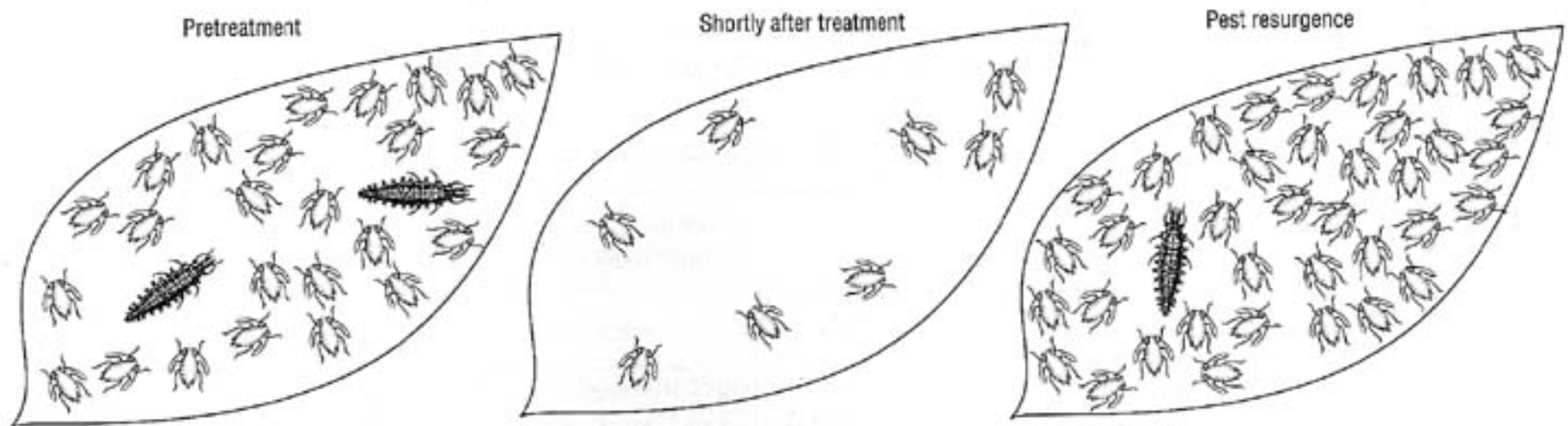
Conservation: typically involves multiple local species

- Example: aphids in sugarbeet



Conservation of local species

- What not to do?
 - Do not use broad-spectrum insecticides



Conservation of local species

- What to do? Provide resources to enhance enemy activity:
 - Add pollen source
 - Add nectar source
 - Spray sugar/protein mix
 - Provide winter shelter
 - Release alternate prey (or nursery crop)



Insectary planting: refuge for natural enemies

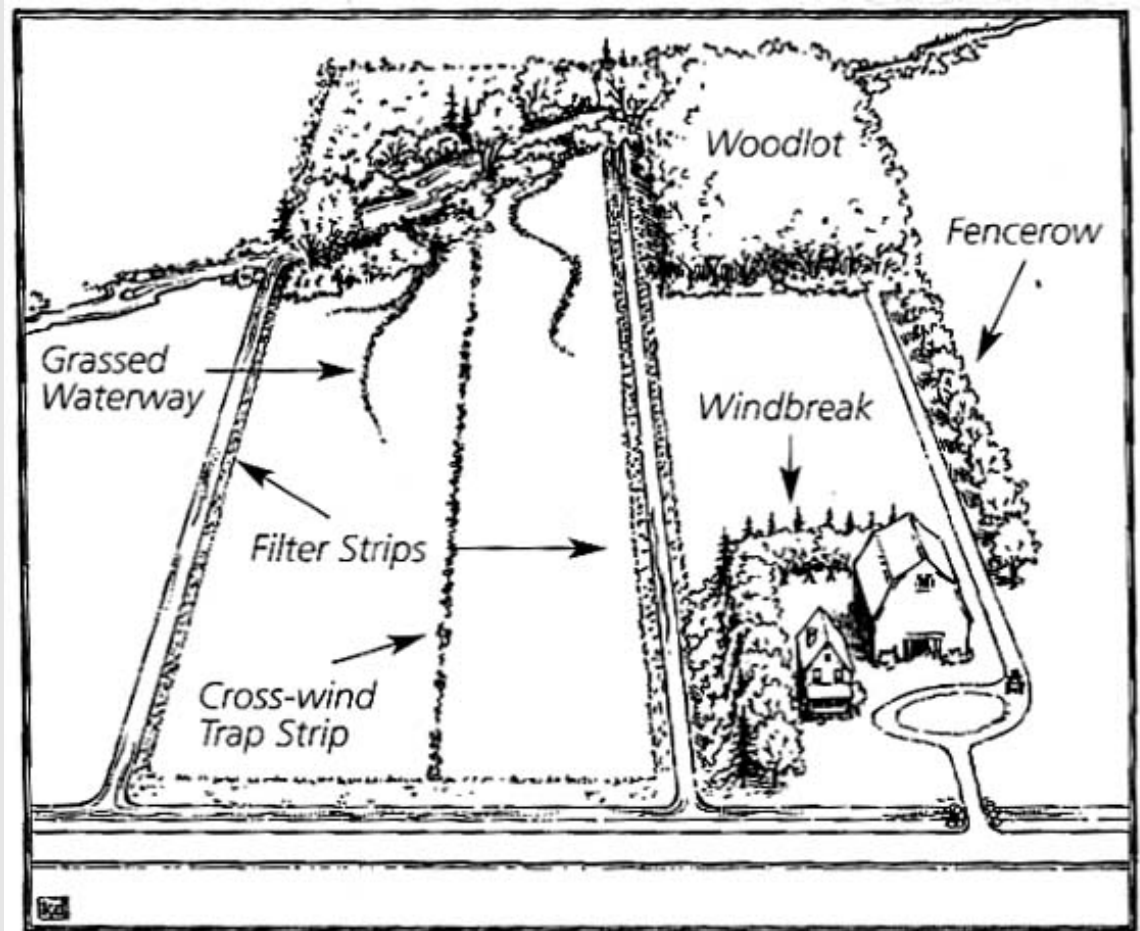


Conservation of local species

- sugar/protein food source:
 - 'Pred Feed'
 - 2.5 kg/hectare in cotton
 - 'Insect Food' from Rincon-Vitova
 - 0.5 – 1 lb per gallon water

Conservation of local species

- Provide diversity of habitats
 - Hedgerows
 - Windbreaks



Farm with many types of conservation buffers

Conservation of local species

- Commercial lures
 - Spined soldier bug
 - Ladybug
 - General



Categories of Biological Control:

Augmentation

- For pests with local natural enemies present but not enough enemies to keep pest suppressed
- Buy & release additional natural enemies

Conservation & augmentation: banker plants



- Provide a 'nursery' of alternate food for the natural enemy
- = A plant infested by a pest
- Must be a very host-specific pest!
- Example: hanging baskets of wheat infested with grain aphids in greenhouse tomatoes

Augmentation: guardian plants

- Used in greenhouse
- Dual-purpose:
 - Pull pests
 - like an indicator plant or trap crop
 - Support natural enemies
 - like banker plants
- Benefits
 - Saves scouting time
 - Need fewer shipments from insectary
- Example: marigolds in pepper;
beans in tomato; lantana in herbs



How to start a biocontrol program

- Focus on one crop
- Select natural enemy
 - Do before season starts
 - Learn biology & ecology
- Decide on protocol
 - Monitor pest
 - Use threshold to plan releases
 - Place orders early
- Release
 - Observe quality control
- Evaluation

Ratio of enemy to pest??

- 1:10 a general rule
- 'Safe balance ratio':
 - 1-7 pests/enemy
- 'Unsafe balance ratio'
 - 10-20 pests/enemy

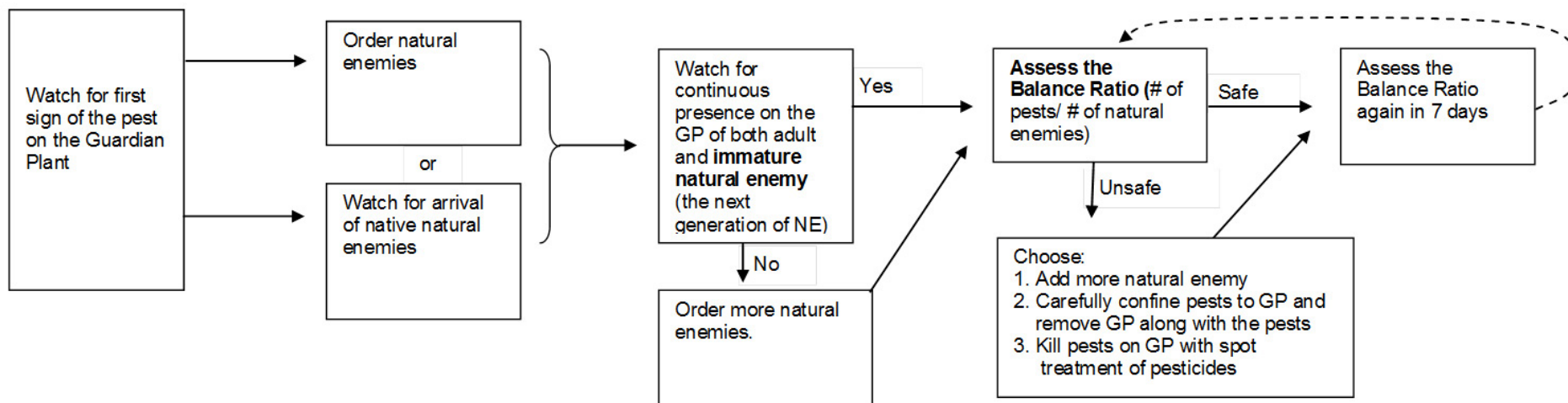
Augmentation flow chart from IPM Labs Inc.

Guardian Plant (GP)

Natural Enemy (NE)

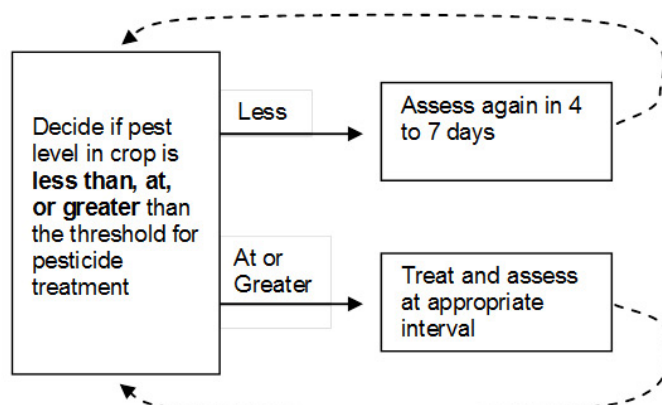
Safe Balance Ratio Tipping Point

The **Safe Balance Ratio** is yet to be determined through measurement and experience. In our studies, the balance ratios were less than 7 pests per natural enemy. Loss of natural enemies causes division by zero, which is an infinitely huge number. A tipping point toward an **Unsafe Balance Ratio** might be considered between 10 and 20 pests per natural enemy.



Pest Levels in Crops

In an ideal Guardian Plant System, the Guardian Plant will hold the pests and the crop plants will be free of pests. Even the crop plants next to the Guardian Plant will be free of pests. Pest levels will stay low enough on the crop that pesticides will be unnecessary on the crop. However, crops must still be regularly checked for pests.



Examples

- Augmentation
 - Sweet corn & peppers for European corn borer control
- Conservation
 - Cabbage for caterpillar control

Trichogramma

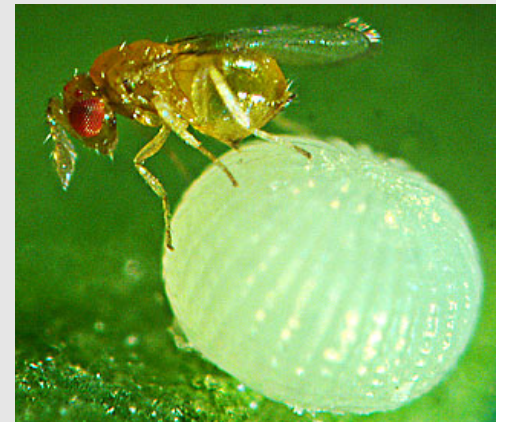
(say: *TRICK* – o – gram – ma)



- Tiny wasps
- Lay their eggs in pest eggs

Trichogramma egg parasitoids

- As of 1985, the most widely augmented enemy in the world
- Older all-purpose species:
 - *Trichogramma minutum* (trees; East)
 - *T. pretiosum* (row crops, vineyards)
 - *T. platneri* (orchards; west)
- Newly discovered specialists:
 - *T. brassicae* = *T. maidis*
 - *T. nubilalis*
 - *T. ostriniae* *



Biocontrol of European corn borer

- Egg parasitoid
- *Trichogramma ostriniae*
- Research trials
 - Sweet corn: since 1991
 - MA, NY
 - Peppers: since 2002
 - VA, NY, PA, ME, MA, MD, DE



Trichogramma ostriniae on sweet corn

- 1st: inundative, every 2–3 days
- Later: inoculative, early
 - Eggs glued on cards
 - Inoculative: One release of 30,000 wasps per acre when crop is knee-high
 - Place on plants or on wood stakes
 - Place at 1 or more sites per acre
 - Parasitism up to 52 days after release
- Does not overwinter in NY



Trichogramma ostriniae on peppers



- VA, PA, MA, 2002-03
 - 4 to 5 inundative releases/year
 - Average 49% parasitism
- VA, PA, MD, DE 2005-06
 - 3 releases/year cost \$50/ha
- KY 2005-06
 - 4 releases/year; only 4.4% parasitism
- Mass. 2012
 - 4 releases, 1 week apart, midJul-midAug
 - 1st 90,000/A then 120,000/A



Trichogramma ostriniae

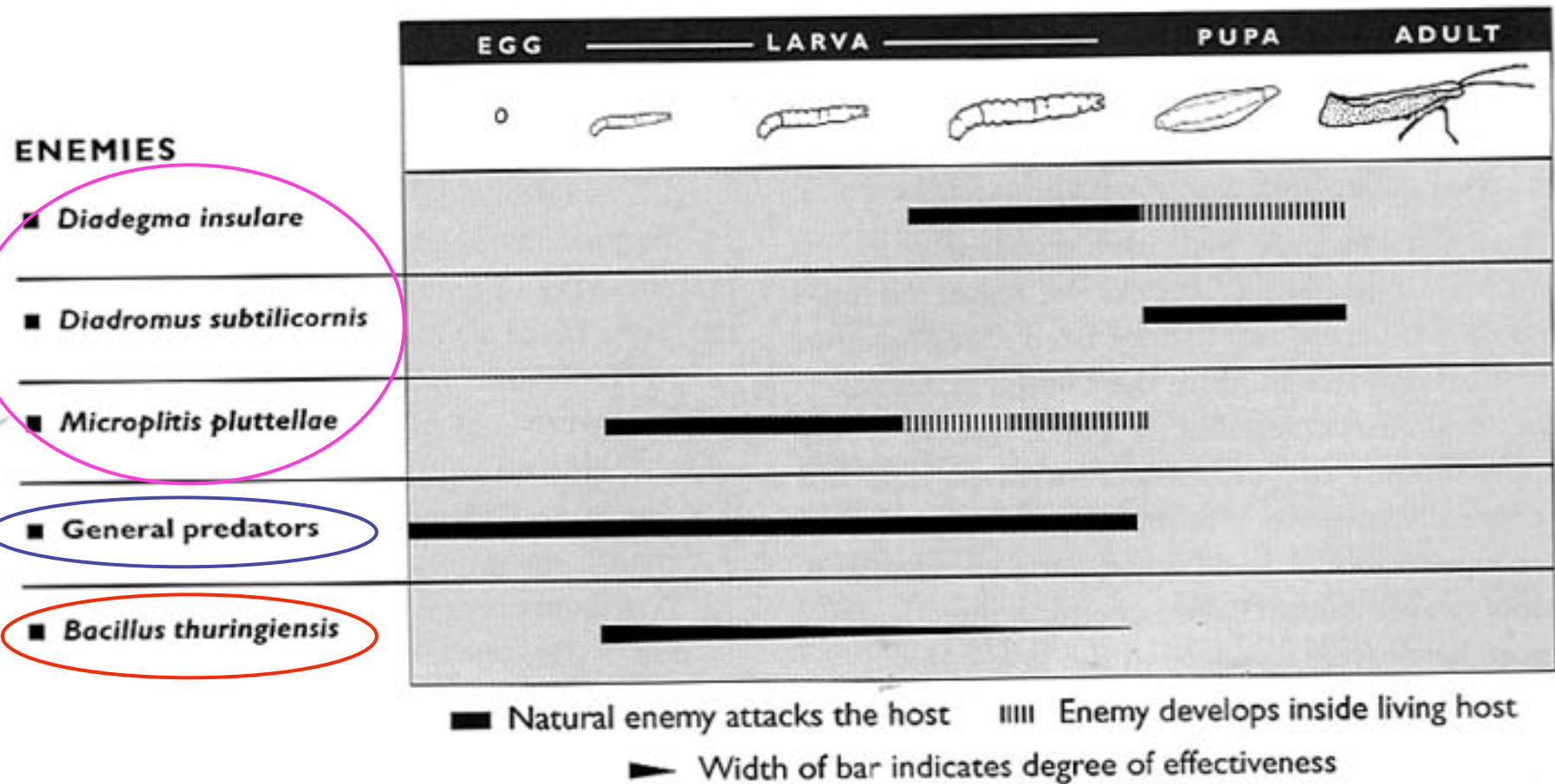
- **References:**

- **Cornell Univ. fact sheet, 2008**, 'Using *Trichogramma ostriniae* to help manage European corn borer in sweet corn, peppers, and potatoes'
- **U. Mass. Article, 2012**, 'Peppers: Biological control of ECB'

- **Source:**

- **IPM Labs, Locke NY (ipmlabs.com)**

Diamondback moth on cabbage



Diadegma insulare, Parasitoid of Diamondback Moth Larvae

Adult
wasp



Diamond-
back
larvae



Photo by Andrei Sourakov

Diamondback & Biocontrol

- *Diadegma insulare*
 - small wasp, 1/4" long
 - black body, red/brown marks
- Life cycle:
 - adult wasp lays egg in older caterpillar
 - wasp larva develops inside caterpillar
 - new adult wasp emerges from pupa



Diamondback pupae



← Healthy pupa

← Parasitized pupae

Photo by J. Ogradnick

Diamondback & Biocontrol

- % of diamondback larvae attacked:

- 53 to 88% in Wisconsin study
- 46 to 69% in Virginia study

- Helps to provide flowers:

- Nectar source for wasp
- Wasps live longer, lay more eggs, sting host faster
- Wild: yellow rocket, wild mustard
- Cultivated: sweet alyssum



Integrated bio & chemical control in cabbage

- Early & mid-season (April to July)
 - if imported cabbageworm &/or diamondback dominant
 - use only B.t.
- Mid- to late-season (August)
 - if cabbage looper dominant pest
 - use Confirm, SpinTor, or Proclaim
- Late season (Sept.-October)
 - if cabbage looper dominant pest
 - use pyrethroids

New resource: a smartphone app!



- Name: **Good Bugs +**
- Platforms:
 - For iPhone now
 - Coming soon for Android
- \$2.99 (via the App Store)
- Topics:
 - Natural enemies: i.d., biology, mgmt
 - Pollinators
 - Native plants that support them



The End