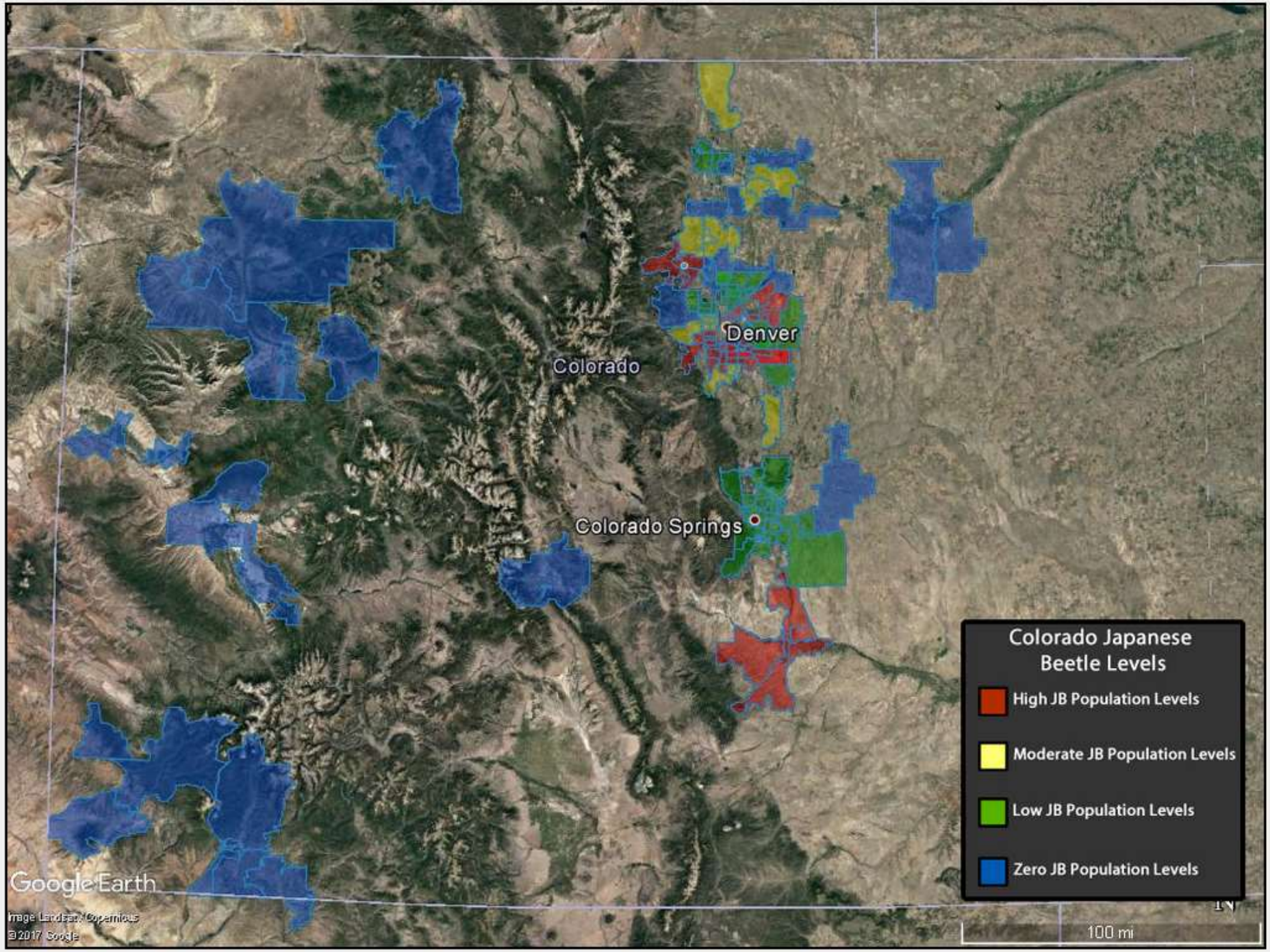
Japanese Beetle

Popillia japonica

207 Credit – Ornamental Insects

Distribution of Japanese beetle in Colorado based on CDA trapping



Japanese beetle damages plants in *two distinct ways*

Japanese beetle adults chew on leaves and flowers **of many plants**

Japanese beetle larvae (grubs) – *among the most damaging turfgrass insects in the US*

Japanese beetle affects yard/garden plants *in two distinct ways*

White grubs prune the roots, producing drought stress symptoms

Skunk digging damage associated with white grub infestations

Managing Japanese beetle in the larval (white grub) stage

Recommendations for Japanese Beetle Larval Control

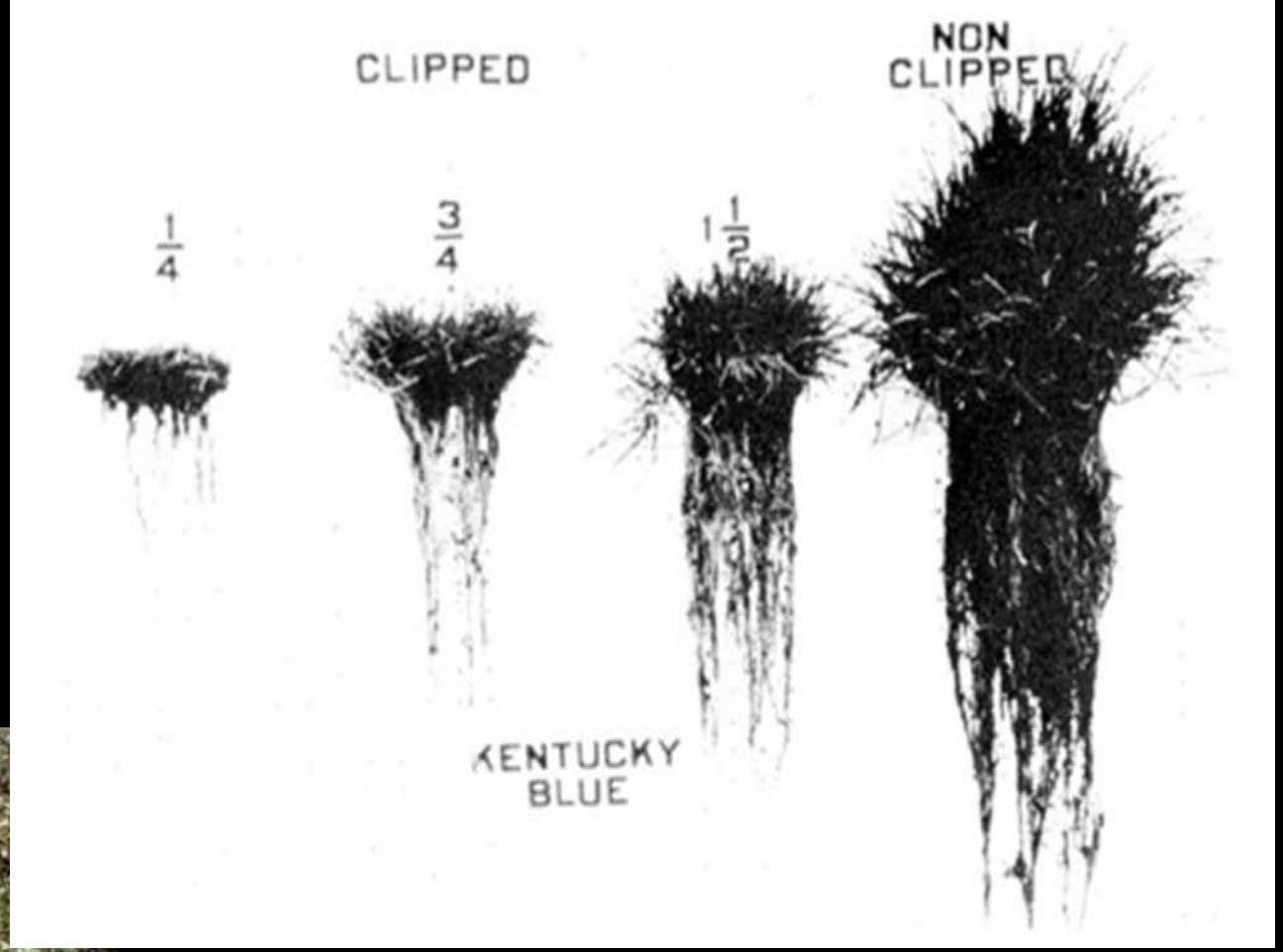
- Cultural Controls
- Biological Controls
- Chemical Controls

Recommendations for Japanese Beetle
Larval (Grub) Control

- **Cultural Controls**
  - **Promotion of root growth to tolerate larval feeding**
    - Allowance of some soil drying during critical JB life stages
    - Provision of water to allow tolerance and recovery from root loss

White grubs damage turfgrass by feeding on roots

Grasses with larger root mass are better able to tolerate effects of root pruning insects

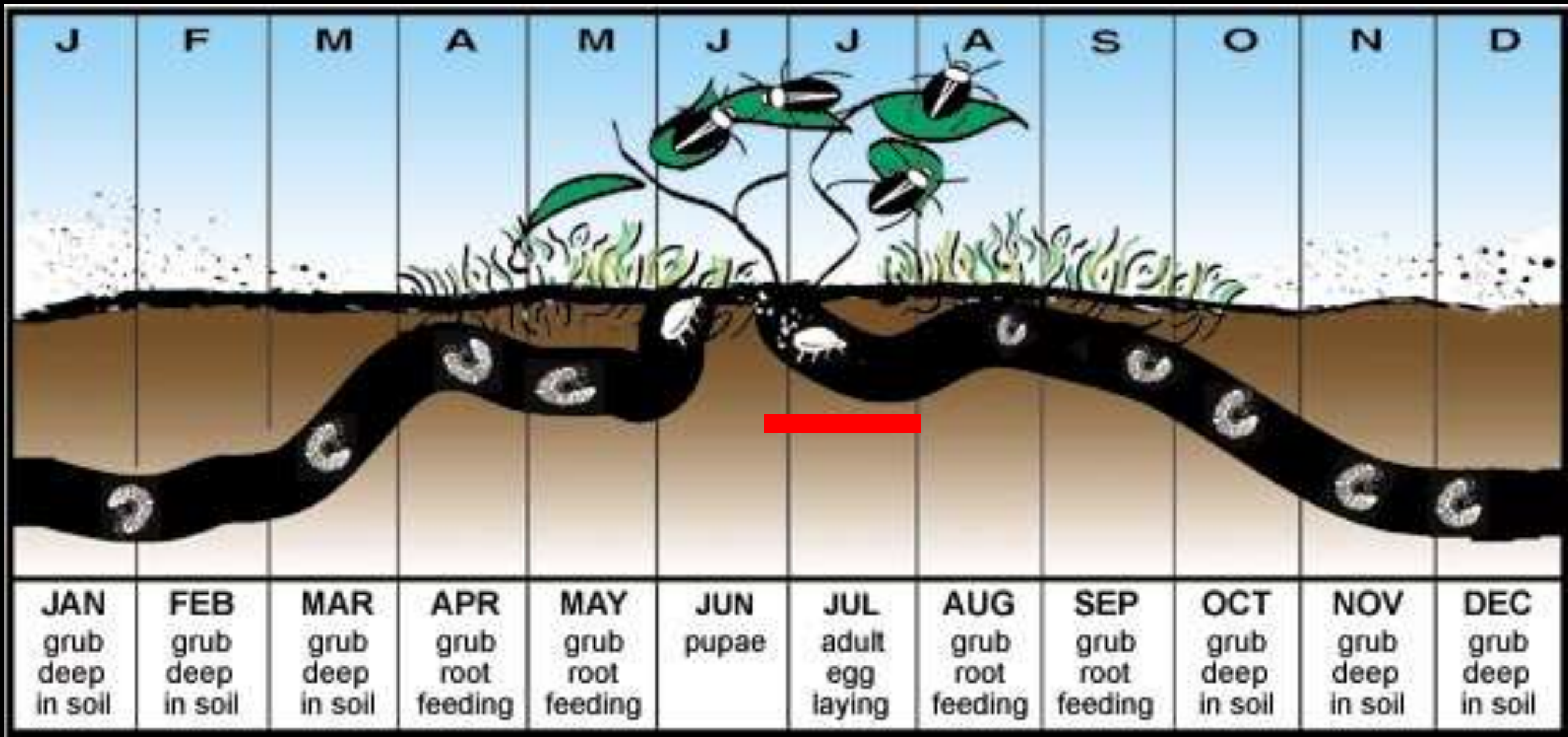


Mowing height greatly affects root mass of turfgrasses!

Recommendations for Japanese Beetle Larval Control

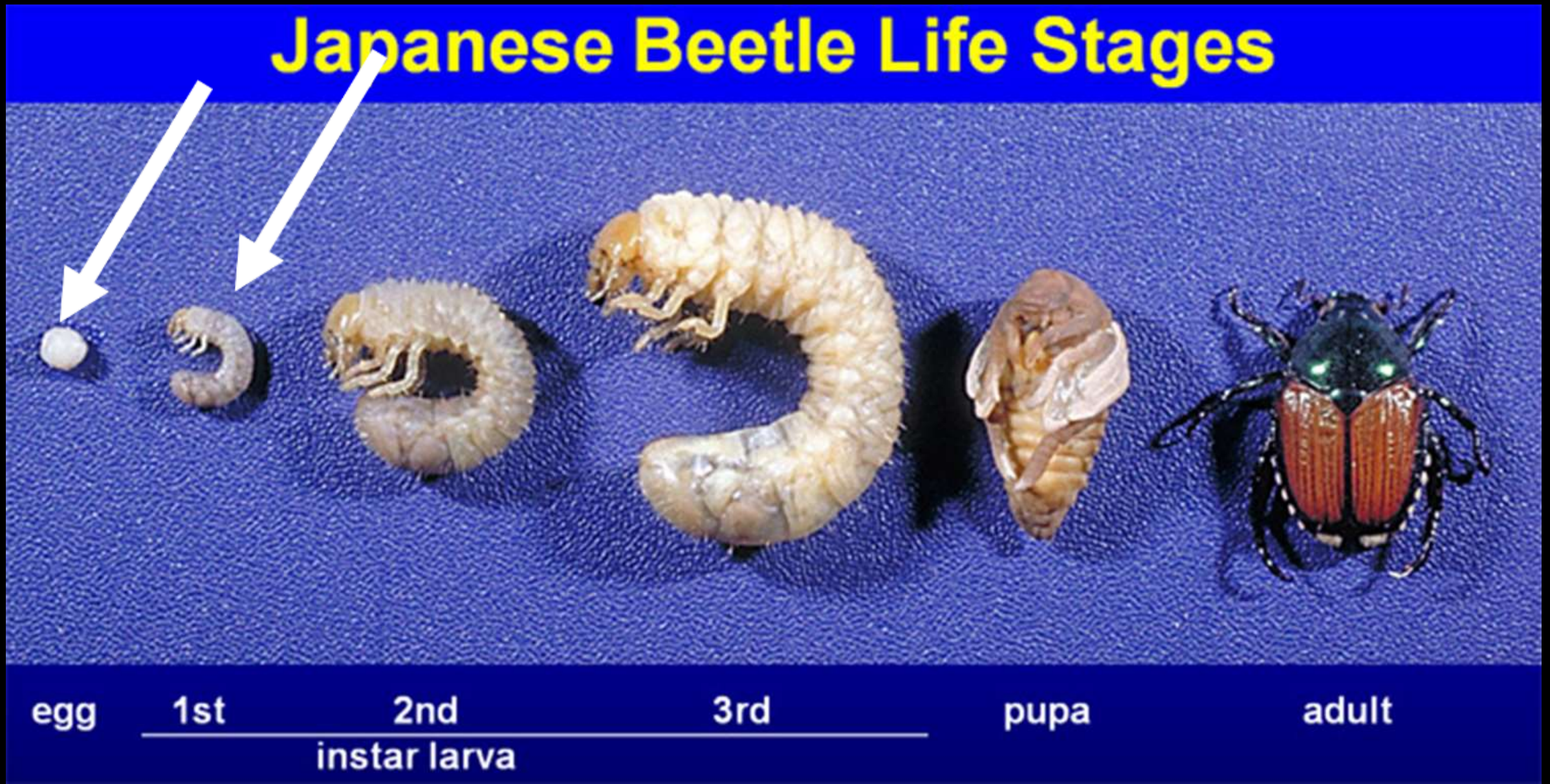
- **Cultural Controls**
  - Promotion of root growth to tolerate larval feeding
  - **Allowance of some soil drying during critical life stages**
  - Provision of water to allow tolerance and recovery from root loss

Generalized Life History Sequence of Japanese Beetle



Adults burrow into the ground to lay eggs. Eggs are only laid in soil that is suitably moist.

Eggs and 1st stage larvae are very sensitive to drying



Recommendations for Japanese Beetle Larval Control

- **Cultural Controls**
  - Promotion of root growth to tolerate larval feeding
  - Allowance of some soil drying during critical JB life stages
  - **Provision of water to allow tolerance of and recovery from root loss**

White Grub Larval Treatments

- **Insecticides**
  - Imidacloprid (Merit, Hi-Yield Insect & Grub Control, Hi-Yield Grub Control II, others)
  - Clothianidin (Arena)
  - Chlorantraniliprole (Acelepryn, Scott's GrubEx)
  - Trichlorfon (Dylox, Proxol, Bayer Advanced 24 Hour Grub Killer Plus Granules)
- **Biological Controls**
  - *Heterorhabditis* spp. parasitic nematodes
  - *Bacillus thuringiensis* var. *galleriae* (grubGONE!)

White Grub Larval Treatments

- **Insecticides**
  - Imidacloprid (Merit, Zenith, Mallet, Bonide Insect & Grub Control, Hi-Yield Grub Control II, others)
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  - Trichlorfon (Dylox, Proxol, Bayer Advanced 24 Hour Grub Killer Plus Granules)
- **Biological Controls**
  - *Heterorhabditis* spp. parasitic nematodes
  - *Bacillus thuringiensis* var. *galleriae* (grubGONE!)

Imidacloprid for White Grubs

- Trade Names: **Merit, Mallet, etc.**
- Neonicotinoid insecticide
  - Good systemic activity
  - Some hazard to bees through nectar
- Provides control for month or two
  - Fairly slow moving in soil and into plants

Optimal time for application: Early period of egg hatch
– typically late June through midJuly

Systemic insecticides and Pollinators – ***Should we be concerned about their use on turfgrass?***

A key risk to pollinators when using insecticides on turfgrass

Application to flowering weeds

Mowing before application >greatly< decreases hazard to pollinators!

Chlorantraniliprole for White Grubs

- Trade Names: **Acelepryn, GrubEx**
- Anthranilic diamide insecticide
  - Limited systemic activity
  - **Very low hazard to bees**
- Relatively slow acting
- Provides control for months

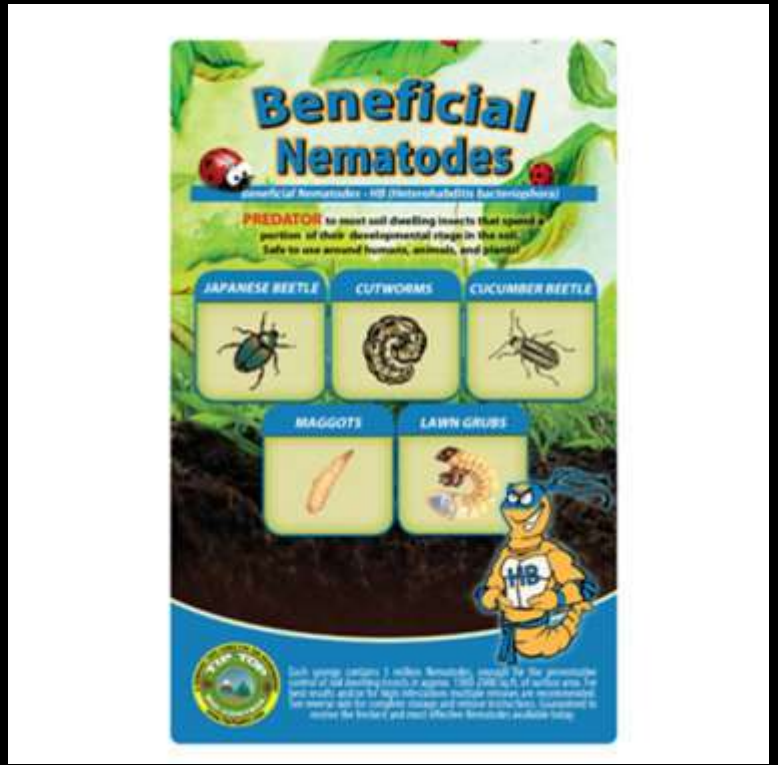
Optimal time for application: Early period of egg hatch
– ***typically mid-late June through midJuly***

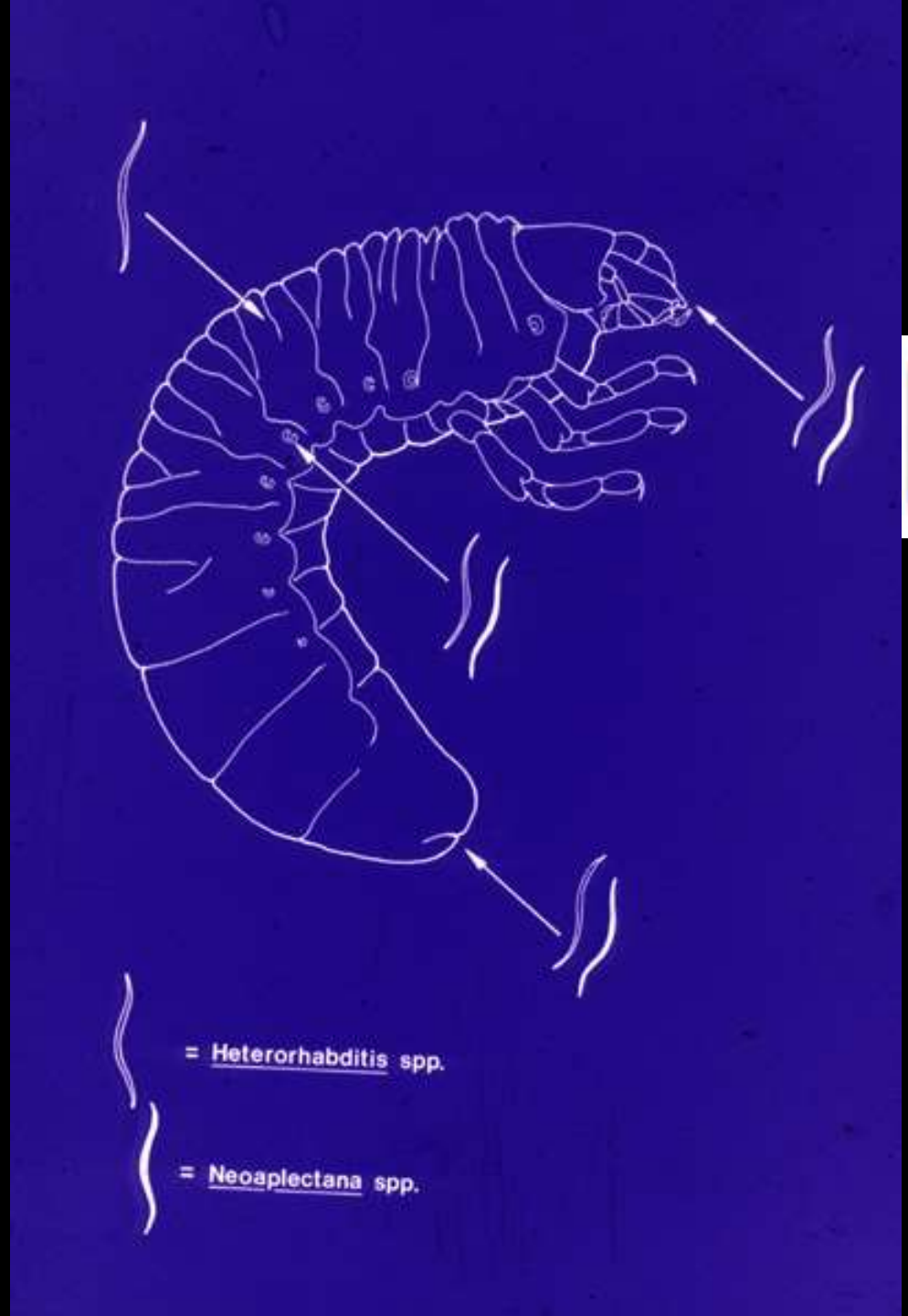
Recommendations for Japanese Beetle Larval Control

- Cultural Controls
- Chemical Controls
- **Biological Controls**
  - Insect parasitic nematodes (*Heterorhabditis* spp.)
  - *Bacillus thuringiensis* var. *galleriae*
  - Milky spore

Insect Parasitic Nematodes (“Beneficial Nematodes”, “Predator Nematodes”)

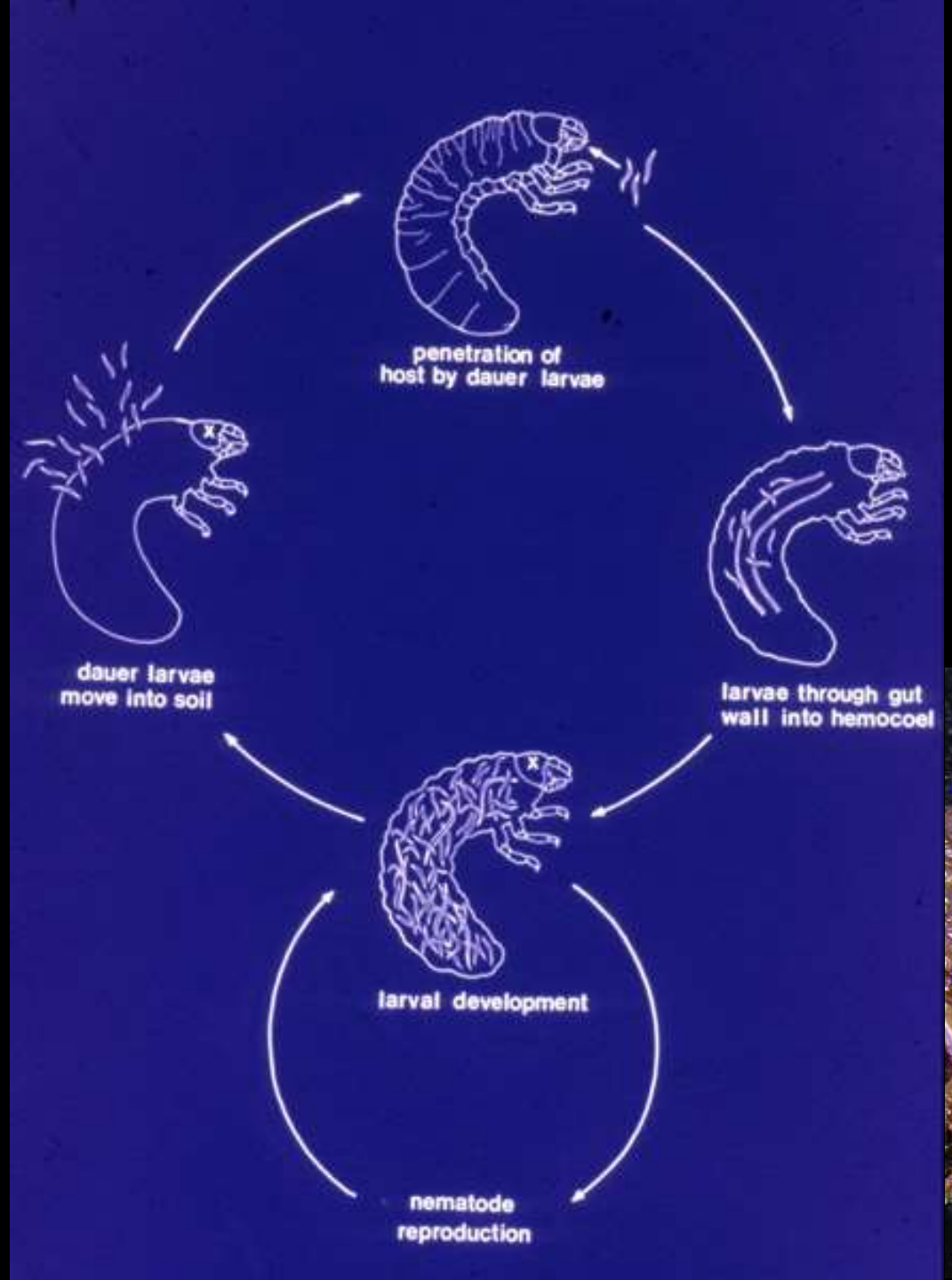
Photograph courtesy of Peggy Greb





Nematodes enter insects through natural openings

***Heterorhabditis* spp. nematodes can penetrate directly through the body wall**



Insect Parasitic Nematodes Can Control Many Turf Insects

White grubs

Billbugs

Cutworms and sod webworms

Mole crickets

Grubs turn a reddish color when killed by *Heterorhabditis* nematodes

White Grub Larval Treatments

- Imidacloprid (Merit, Zenith, Criterion, etc.)
- Clothianidin (Arena)
- Chlorantraniliprole (Acelepryn, Scott's Grub-Ex)
- Trichlorfon (Dylox, Proxol)
- *Heterorhabditis* spp. parasitic nematodes
- ***Bacillus thuringiensis* var. *galleriae* (grubGONE!)**

New biological control for Japanese beetle - *and other grubs?*

grubGONE!

Bacillus thuringiensis var. *galleriae*

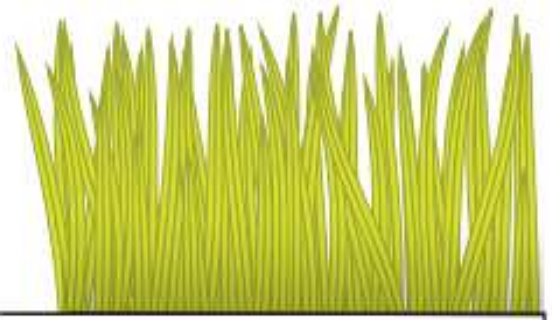
grubGONE!® G

BIOLOGICAL INSECT CONTROL

Biological Insecticide Granule Controls Annual White Grubs in Turf and Ornamentals

ACTIVE INGREDIENT: Bacillus thuringiensis subsp. galleriae, Strain SDS-502 fermentation solids, spores, and insecticidal toxins*	9.0% w/w
OTHER INGREDIENTS:	91.0% w/w
TOTAL:	100.0% w/w

*Contains a minimum of 1 x 10^{10} CFU per gram.



KEEP OUT OF REACH OF CHILDREN

CAUTION: See side/back panel for additional precautionary statements.

EPA Reg No.: 88347-2

EPA Est. No.: 9198-OH-1, 9198-OH-2

FIRST AID	
If on skin or clothing:	• Take off contaminated clothing. • Rinse skin immediately with plenty of water for 15-20 minutes. • Call a poison control center or doctor for treatment advice.
If inhaled:	• Move person to fresh air. • If person is not breathing, call 911 or an ambulance, then give artificial respiration, preferably mouth-to-mouth if possible. • Call a poison control center or doctor for further treatment advice.
If swallowed:	• Call a poison control center or doctor immediately for treatment advice. • Have person sip a glass of water if able to swallow. • Do not induce vomiting unless told to by a poison control center or doctor. • Do not give anything by mouth to an unconscious person.

HOT LINE NUMBER

Have the product container or label with you when calling a poison control center or doctor, or when going for treatment. For emergency information concerning this product, call the National Pesticide Information Center (NPIC) at 1-800-858-7378 seven days a week, 6:30 am to 4:30 pm. Pacific Time (NPIC website: www.npic.orst.edu). During other times, call your poison control center at 1-800-222-1222.

Manufactured for:
Phyllom BioProducts

made in USA

Phyllom BioProducts Corp.
484 Lake Park Ave #23
Oakland, CA 94610
Tel: 650.322.5000
Email: products@phyllom.com

Milky Spore for Japanese Beetle?

Used to permanently establish a biological control organism – ***not useful for immediate control.***

Milky Spore for Japanese Beetle?

Long term: ***May help*** **produce some reduction in numbers of larvae surviving to adulthood. However, infections typically only affect a small percentage of population.**

Question: Does control of larvae in a yard affect the number of adults in a yard?

????????

Answer: Very likely, NO

Some Highly Mobile Insects

Corn earworm (adults)

Crucifer flea beetles

Japanese beetle (adults)

Grasshoppers

Potato/tomato psyllid

Adult beetles feed on both flowers and leaves of many ornamental plants as well as garden vegetables and herbs

Skeletonizing injuries produced by Japanese beetle adults feeding on leaves

Flowers are often a favored plant part targeted by adult Japanese beetles

Issue of unusual concern with Japanese beetle

Overlap of adult feeding on flowers – *and use of those flowers by pollinators*

Uber-host Plants Favored by Japanese Beetle Adults in CO

- Roses**
- Linden*
- Virginia Creeper*
- Silver lace**

Other Plants Commonly Grown in CO that are Highly Favored by Japanese Beetle

Ornamentals

- Hollyhock*
- Gaura**
- Rose-of-Sharon**
- Crabapple
- Japanese maple
- Peking cotoneaster

Food Crops

- Beans (green, edamame)
- Basil
- Raspberry*
- Grape

- * JB populations overlap with flowering
- ** JB populations overlap >*alot*< with flowering

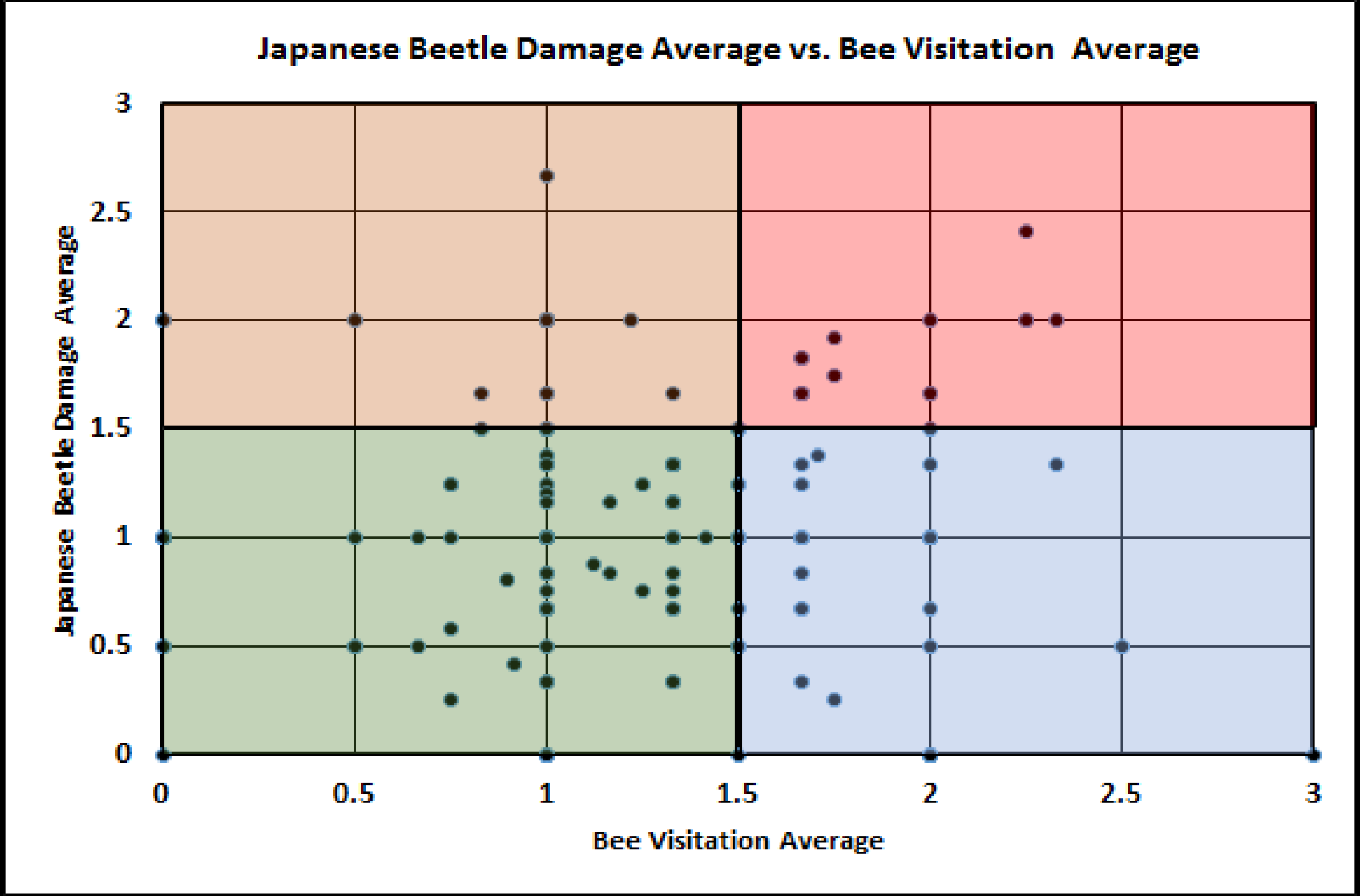
Evaluations of roses at the War Memorial Garden in Littleton, 2016-2017

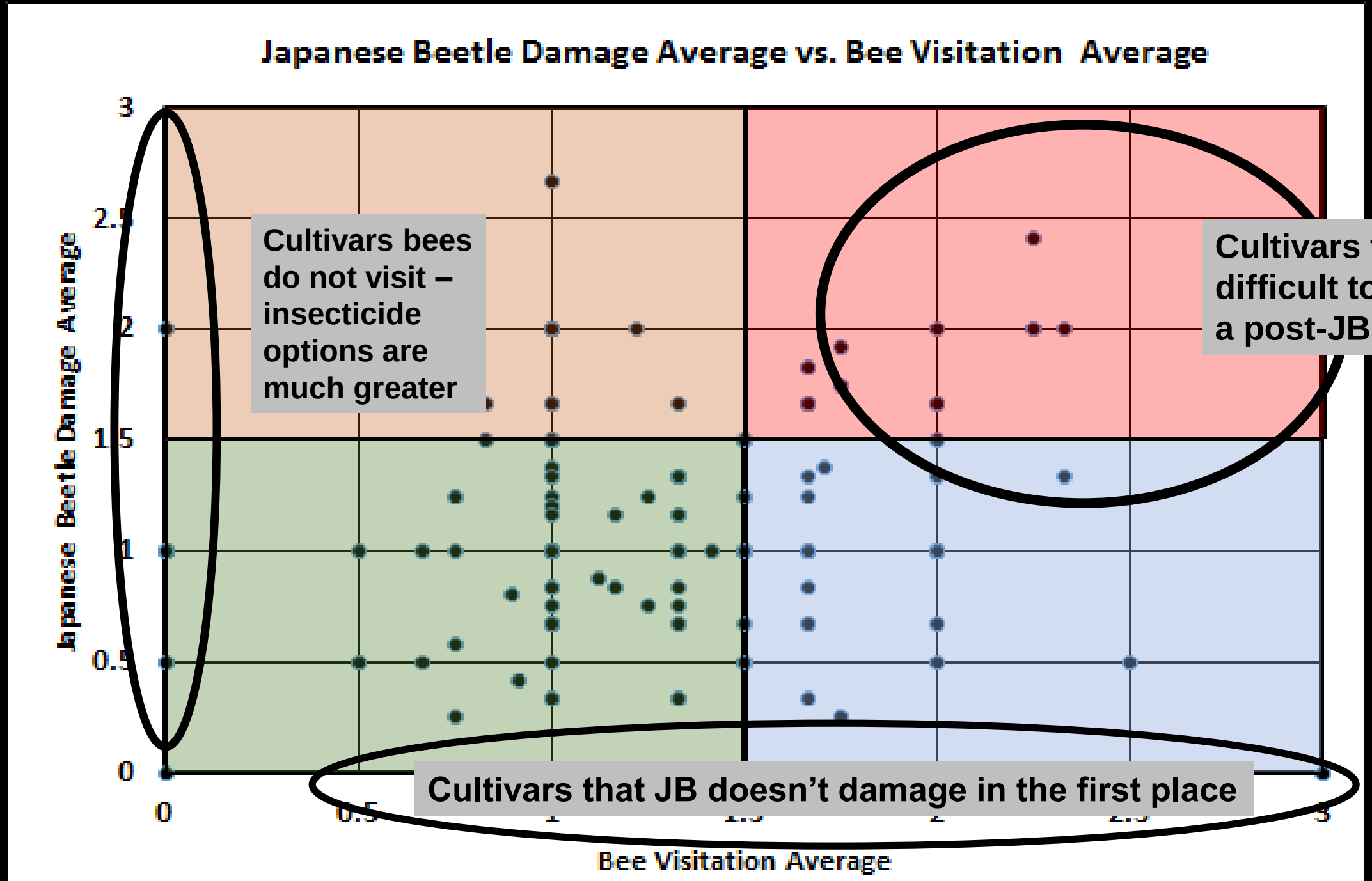
Japanese Beetle Damage Evaluations on Roses – War Memorial Rose Garden

- Seven observations were made during season
- Damage by Japanese beetle ranked on a **0 to 3 scale (no damage to heavy damage)**

Japanese Beetle Damage Evaluations on Roses – War Memorial Rose Garden

- Seven observations were made during season
- Damage by Japanese beetle ranked on a 0 to 3 scale (no damage to heavy damage)
- Observed flower visitation by bees ranked on a 0 to 3 scale (no visitation to high visitation)


Japanese Beetle Damage Average vs. Bee Visitation Average
Japanese Beetle Damage Average
3
2.5
2
1.5
1
0.5
0
0
0.5
1
1.5
2
2.5
3
Bee Visitation Average


Japanese Beetle Damage Average vs. Bee Visitation Average
Japanese Beetle Damage Average
Bee Visitation Average
3
2.5
2
1.5
1
0.5
0
0
0.5
3
Cultivars bees do not visit – insecticide options are much greater
Cultivars that will be difficult to maintain in a post-JB world
Cultivars that JB doesn't damage in the first place

The curious phenomenon of geranium toxicity to Japanese beetle

Geranium Toxicity to Japanese Beetle

- Beetles become paralyzed within a couple of hours after feeding on flowers of zonal geraniums
  - Often recover in lab, rarely outdoors
- Toxin is present in flowers, but not leaves

Recommendations for Japanese Beetle Adult Control

- Physical/Cultural Controls
  - –Traps
  - –Hand Picking
- Chemical Controls

Japanese beetle controls

Hand Picking

Primary benefit from handpicking

Reduction in volatile attractants produced by plant wounding

Handpicking may be more effective for infestations on foliage versus flowers

Some flowers (e.g., rose) *can produce high levels of volatile attractants - without wounding* - and may possess attractive colors

Japanese beetle traps are excellent for detecting presence of the insect in an area

Japanese beetle traps *are minimally useful - at best -* for control of existing Japanese beetle infestations!

If you insist on using a Japanese beetle trap

- Do not place them anywhere near (at least 30 feet away from) any plant on which Japanese beetles feed
- Avoid placing them in a site where they are likely to draw beetles from long distances

If you insist on using a Japanese beetle trap

- **Do not place them anywhere near (at least 30 feet away from) any plant on which Japanese beetles feed**
- **Avoid placing them in a site where they are likely to draw beetles from long distances**

….and preferably give the trap to your neighbor!

Chemical Controls Most Effective for Control of Japanese Beetle Adults

- Most pyrethroids (e.g., cyfluthrin, permethrin, bifenthrin)
- Carbaryl
- Acetamiprid
- Imidacloprid
- Chlorantraniliprole

Do not treat plants with flowers in bloom!

Overlap of adult feeding on flowers – *and use of those flowers by pollinators*

Never apply persistent insecticides to plants that are in flower and attractive to pollinators!!

Chemical Controls Most Effective for Control of Japanese Beetle Adults

- ~~Most pyrethroids (e.g., cyfluthrin, permethrin, bifenthrin)~~
- ~~Carbaryl~~
- ~~Imidacloprid~~
- ~~Acetamiprid~~
- Chlorantraniliprole
  - Acelepryn

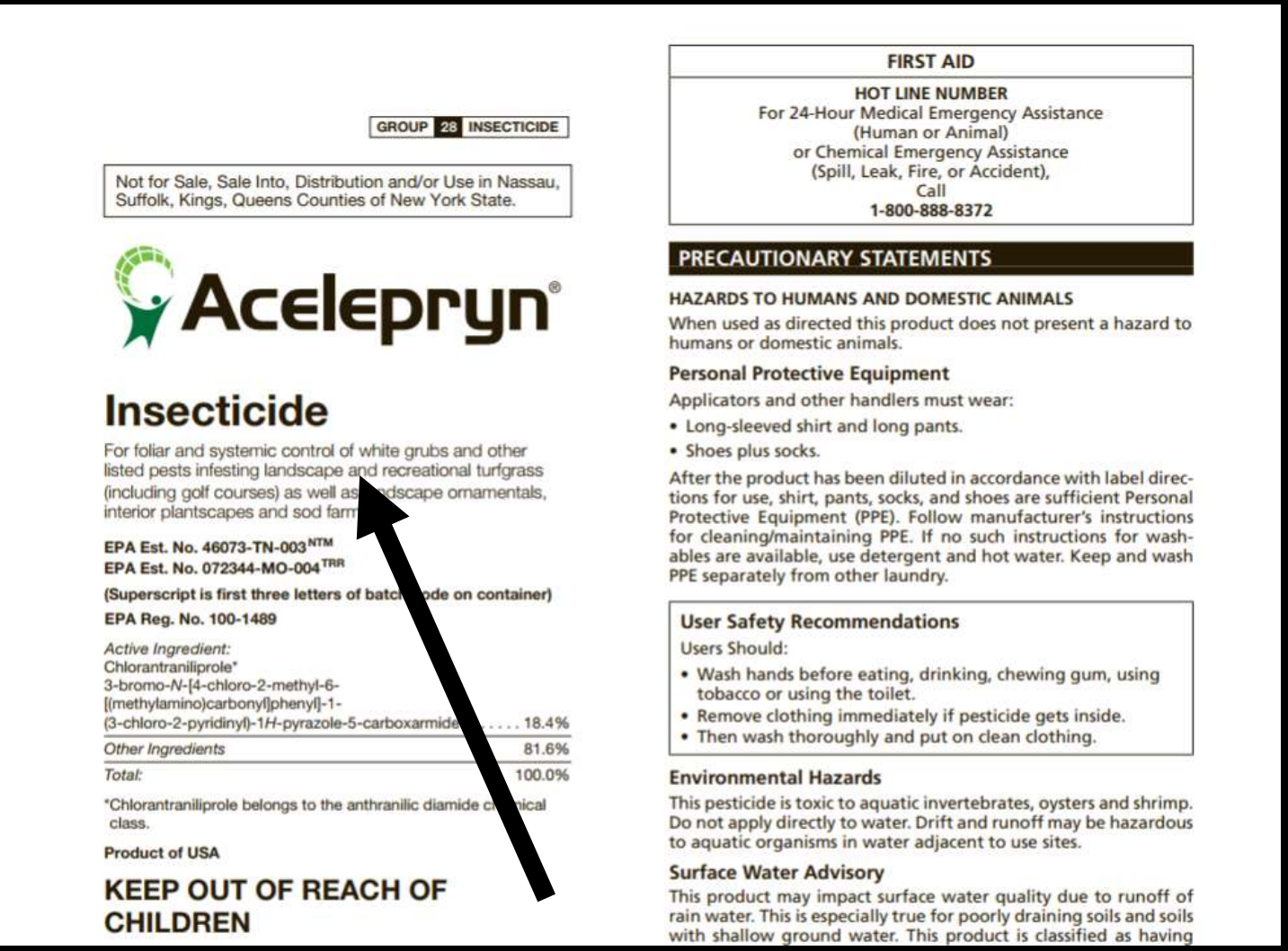
Do not treat plants with flowers in bloom!

Pollinator hazard warning statement regarding use of Tristar 8.5 SL (acetamiprid)

ENVIRONMENTAL HAZARDS

This product is toxic to wildlife. This product is toxic to bees and other pollinating insects exposed to direct treatment. Do not apply this product while bees or other pollinating insects are actively visiting the treated area. Risk to managed bees and native pollinators from contact with pesticide spray or residues can be minimized when applications are made at dawn or dusk or when temperature is below 55°F at the site of application. Do not apply directly to water, or to

This type of warning statement allows use of this product on a plant in flower *only during times of day when pollinators are not visiting the plant*



GROUP 28 INSECTICIDE

Not for Sale, Sale Into, Distribution and/or Use in Nassau, Suffolk, Kings, Queens Counties of New York State.

Acelepryn®

Insecticide

For foliar and systemic control of white grubs and other listed pests infesting landscape and recreational turfgrass (including golf courses) as well as ndscape ornamentals, interior plantscapes and sod farm

EPA Est. No. 46073-TN-003[NTM]
EPA Est. No. 072344-MO-004[TRR]
(Superscript is first three letters of batch ode on container)
EPA Reg. No. 100-1489

Active Ingredient:
Chlorantraniliprole*
3-bromo-*N*-[4-chloro-2-methyl-6-[(methylamino)carbonyl]phenyl]-1-(3-chloro-2-pyridinyl)-1*H*-pyrazole-5-carboxamide 18.4%
Other Ingredients 81.6%
Total: 100.0%

*Chlorantraniliprole belongs to the anthranilic diamide c nical class.

Product of USA

KEEP OUT OF REACH OF CHILDREN

FIRST AID

HOT LINE NUMBER
For 24-Hour Medical Emergency Assistance
(Human or Animal)
or Chemical Emergency Assistance
(Spill, Leak, Fire, or Accident),
Call
1-800-888-8372

PRECAUTIONARY STATEMENTS

HAZARDS TO HUMANS AND DOMESTIC ANIMALS

When used as directed this product does not present a hazard to humans or domestic animals.

Personal Protective Equipment

Applicators and other handlers must wear:

- Long-sleeved shirt and long pants.
- Shoes plus socks.

After the product has been diluted in accordance with label directions for use, shirt, pants, socks, and shoes are sufficient Personal Protective Equipment (PPE). Follow manufacturer's instructions for cleaning/maintaining PPE. If no such instructions for washables are available, use detergent and hot water. Keep and wash PPE separately from other laundry.

User Safety Recommendations

Users Should:

- Wash hands before eating, drinking, chewing gum, using tobacco or using the toilet.
- Remove clothing immediately if pesticide gets inside.
- Then wash thoroughly and put on clean clothing.

Environmental Hazards

This pesticide is toxic to aquatic invertebrates, oysters and shrimp. Do not apply directly to water. Drift and runoff may be hazardous to aquatic organisms in water adjacent to use sites.

Surface Water Advisory

This product may impact surface water quality due to runoff of rain water. This is especially true for poorly draining soils and soils with shallow ground water. This product is classified as having

Labeled for use on turfgrass and landscape ornamentals

Environmental hazards statements do include warnings for aquatic organisms.

They do not have any pollinator warning statements

TABLE 3: Foliar Ornamental Application Rates

Acelepryn Ornamental Foliar Application Rates					
Target Pests	Product (fl oz) per 100 Gallons	Lb AI per 100 Gallons	PPM	Percent AI (wt/vol)	Maximum Gallons per Acre per Year
Leaf-feeding caterpillars (such as bagworms and tussock moth caterpillars [including whitemarked tussock moth])	1	0.013	15.6	0.00156	3840
	2	0.026	31.3	0.00313	1920
	4	0.052	62.5	0.0625	960
	8	0.104	125	0.0125	480
For maximum residual control of the pests listed above	16	0.208	250	0.025	240

Soil Applications:

Acelepryn is a systemic product and will be translocated upward into the plant from root uptake. Soil treatment application rates are listed in Table 4. To assure optimum effectiveness, the product

The original federal label just includes certain caterpillars as target pests

Section 2(ee) Recommendation

Effective: 07/10/2015 **Expires:** 11/19/2018

AK1489002BC0715 Additional Pests of Ornamental Plants (Exterior Landscapes and Interior Plantscapes) in AK, AL, AR, AZ, CO, CT, DC, DE, FL, GA, IA, ID, IL, IN, KS, KY, LA, MA, MD, ME, MI, MN, MO, MS, MT, NC, ND, NE, NH, NJ, NM, NV, OH, OK, PA, RI, SC, SD, TN, UT, VA, VT, WA, WI, WV and WY

For Use Against: Banded ash clearwing, Fall webworm, Gypsy moth caterpillars, Hemlock Wooly Adelgid, Japanese beetle (adult), Lesser peachtree borer, Magnolia scale, Rhododendron borer, Rhododendron lace bug, Sawfly, Viburnum borer, Zimmerman pine moth

Section 2(ee) recommendation indicates uses for control of many other insects – ***including Japanese beetle adults***

New biological control for Japanese beetle *- and other grubs?*

Bacillus thuringiensis var. *galleriae*

Sold as ***beetleGONE!*** in commercial/ag markets

Sold as ***beetleJUS*** in gardener market

Adult control

Grub control

Bacillus thuringiensis (Bt)

- Derived from a widely distributed soil bacterium
- Active ingredient a toxic protein crystal that destroys cells of the midgut
- Used as a stomach poison
- Several different strains – each effective against different insects

Several Bt strains are present, each with specific activity

Caterpillars – kurstaki, *aizawi* strains

Leaf beetles – *tenebrionis* strain

Gnat, mosquito larvae – *israelensis* strain

Treated Foliage Consumed

Feeding Inhibition (1 Hour)

- Toxin Crystals Dissolve in Gut.
- Larvae Stop Feeding.
- Growth Stops.

Death（2-5 Days）

- Starvation
- Gut Disruption

New biological control for Japanese beetle ***- and other grubs?***

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Sold as ***beetleJUS*** in gardener market

beetleJUS treated

Water check

beetleJUS for adult Japanese beetle?

Provides **good reduction in feeding** injury by Japanese beetle

Provides **fair mortality** of Japanese beetles and mortality is slow

Persistence of effects probably a few days

Bee hazard warnings and use restrictions?

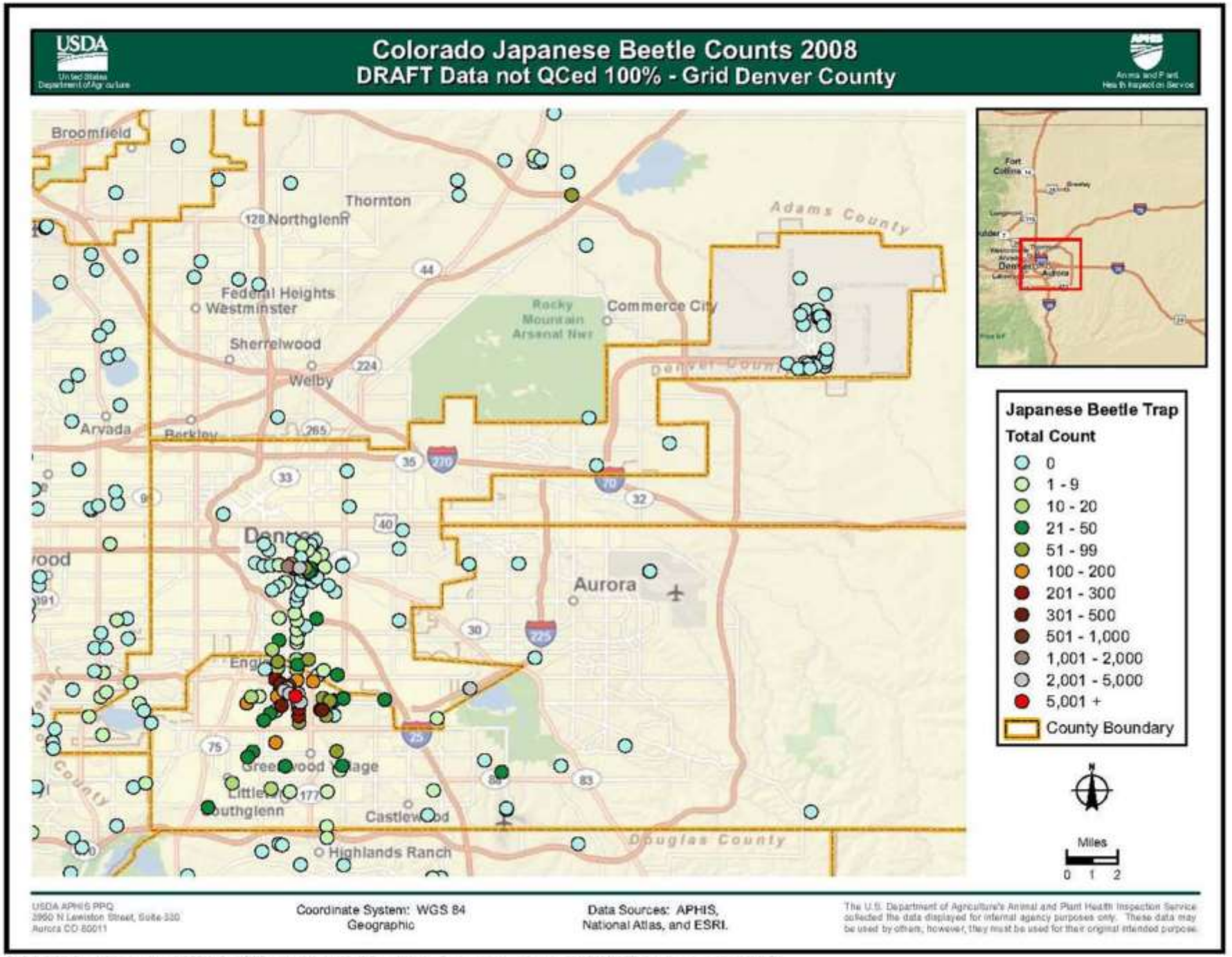
None. You can apply this product to plants in bloom when bees are visiting.

After application:

Are they dead?
(probably not)
Are they still feeding?
(probably not)

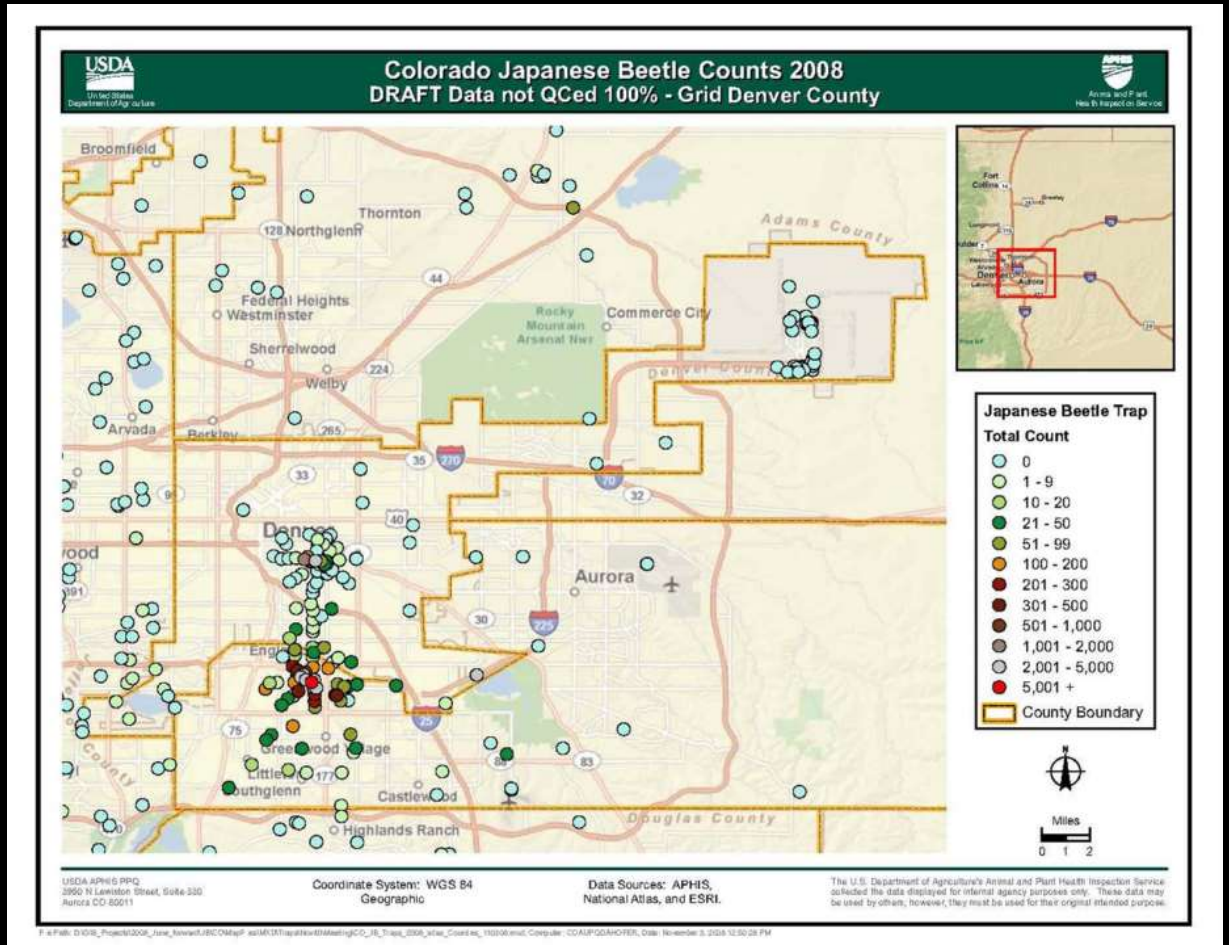
Japanese beetle traps are excellent for detecting presence of the insect in an area

This is a map of the JB situation in the Denver metro area ten years ago



Proposed Project for 2019

Repeat/Expand the 2008 Japanese beetle survey to define the present situation with Japanese beetle in eastern Colorado



Japanese Beetle Trapping Program for 2019

- **Establish a network of Japanese beetle traps throughout the Front Range areas of eastern Colorado**

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- **Traps will be maintained throughout the season (late June-Labor Day) to determine a total number of beetles at the site during 2019**
- Most cooperators will be identified and coordinated by County Extension offices (e.g., Master Gardeners)
- Some traps can be provided directly
  - whitney.cranshaw@colostate.edu

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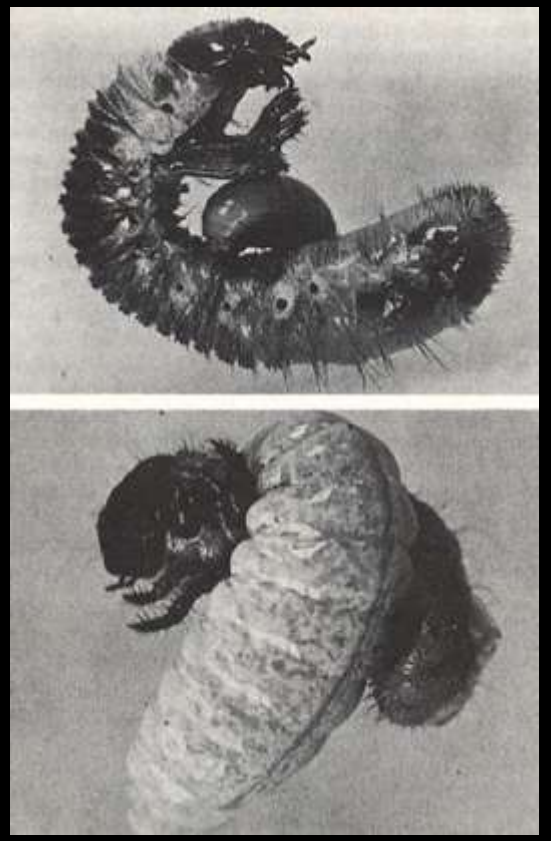
Should we now consider trying to introduce – for permanent establishment - natural enemies of Japanese beetle into Colorado?

Yes!



Natural Enemies of Japanese Beetle Exist Elsewhere in the US

- ***Paenibacillus popilliae*** **(Milky spore)**
  - Bacterium
- ***Istocheta aldrichi***
  - Tachinid fly
- ***Tiphia vernalis***
  - Parasitoid wasp
- ***Ovavesicula popilliae***
  - Fungus (microsporidium)

Milky Spore for Japanese Beetle?

Anyone can purchase this product and try to establish it on their property. If successfully established once, it will then spread by itself.

Natural enemies of Japanese Beetle that were introduced once and now established elsewhere in the United States

- *Paenibacillus popilliae* (Milky spore)
  - Bacterium
- ***Ovavesicula popilliae****
  - Microsporidium (fungus)
- ***Istocheta aldrichi****
  - Tachinid fly
- ***Tiphia vernalis****
  - Parasitoid wasp

* Species involved in Colorado Japanese Beetle Biological Control Program

Natural Enemies of Japanese Beetle for Potential Introduction into Colorado?

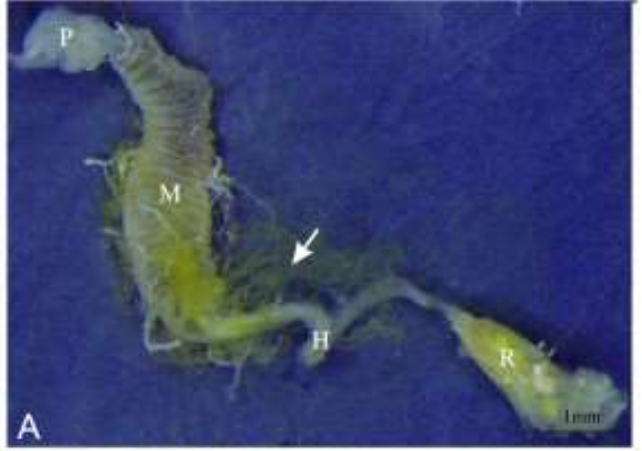
Ovavesicula popilliae – a fungal disease of Japanese beetle larvae

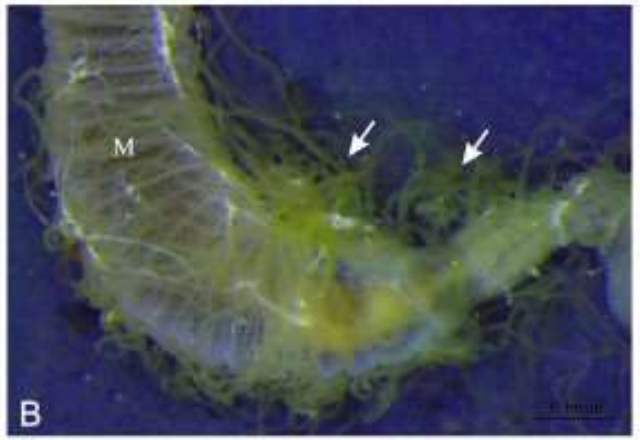
Ovavesicula infection of Malpighian tubules of Japanese beetle larva

Main observed effects from infection – reduced fecundity, reduced winter survival

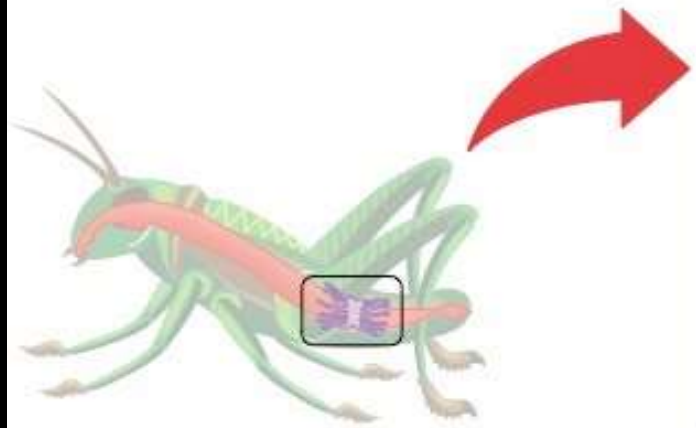
O. popilliae infects the Malpighian tubules of Japanese beetle larvae and adults

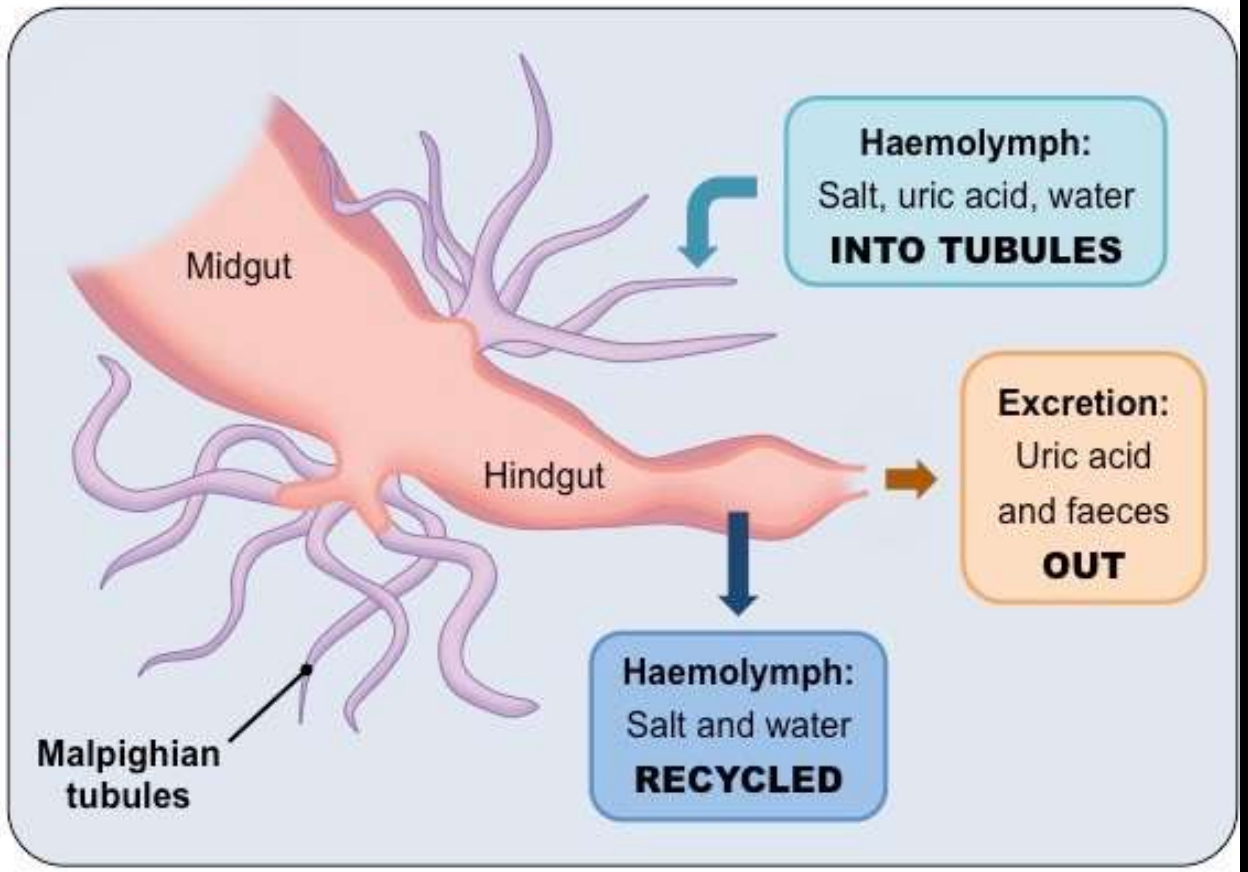
Source: David Smitley, Michigan State University





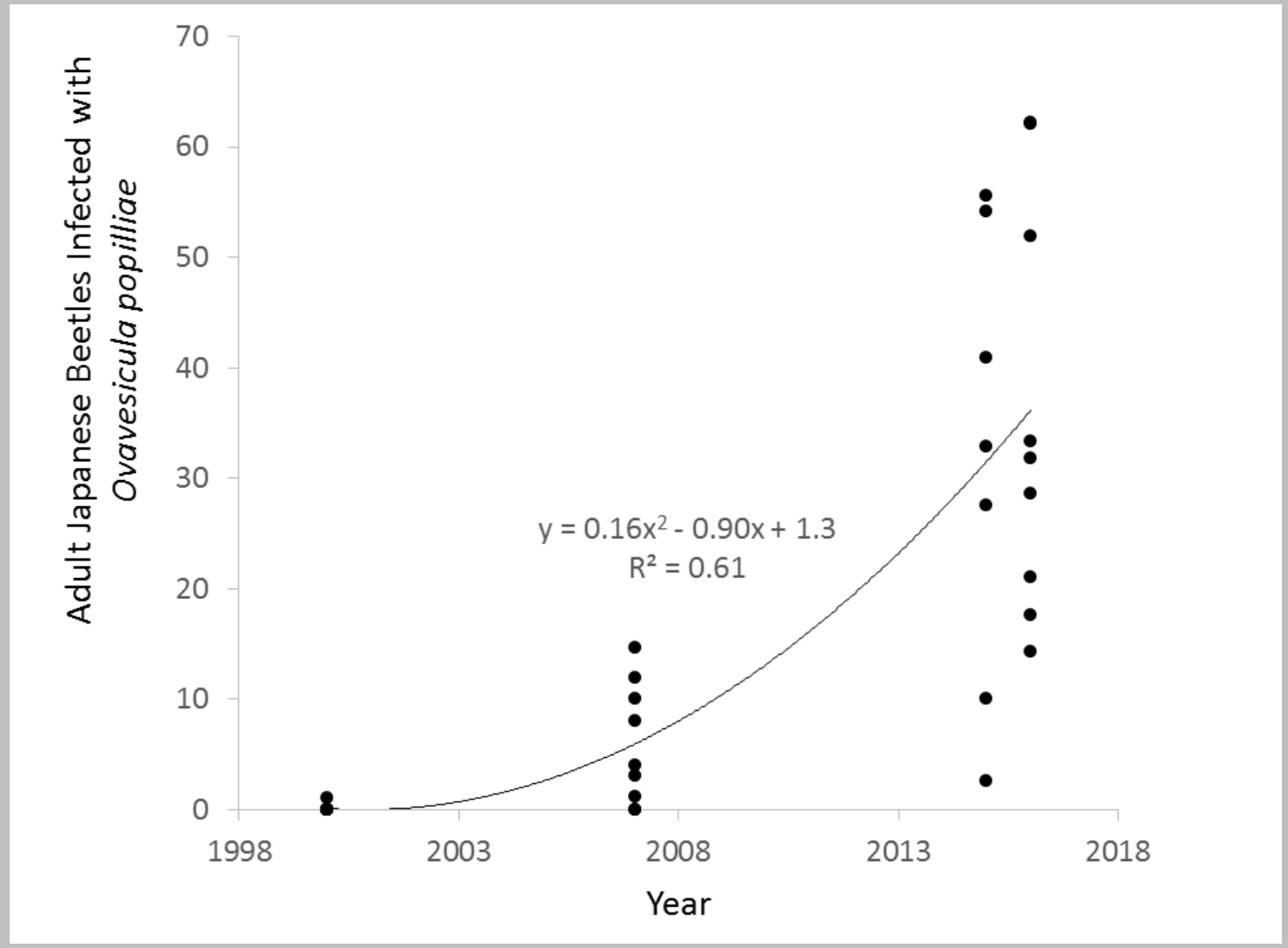
The **Malpighian tubules** of insects filter wastes from the blood, functioning somewhat like what the kidney does in humans





Infected malpighian tubule packed with *O. popilliae* sporophorous vesicles
Source: David Smitley, Michigan State University

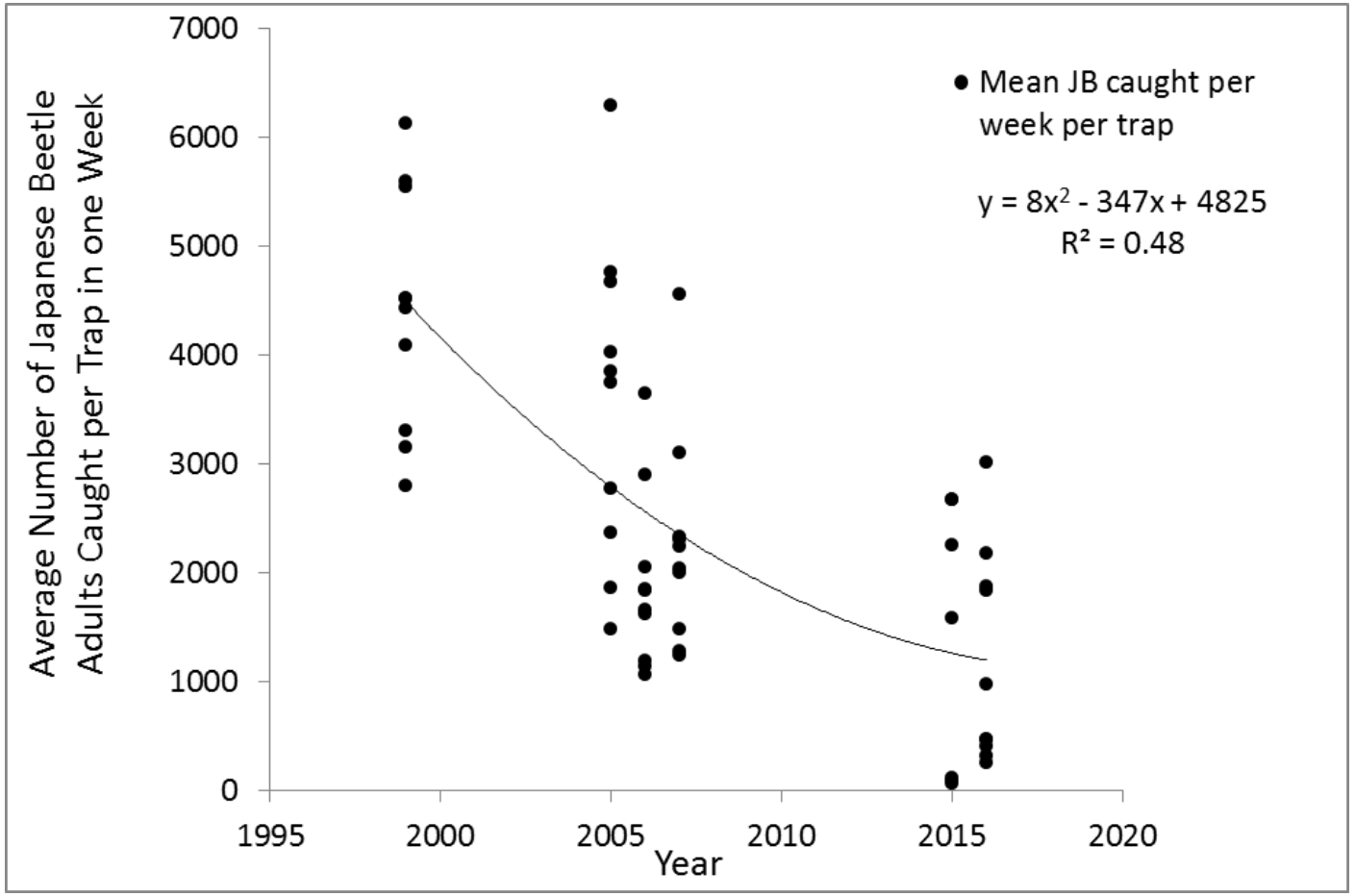
Ovavesicula popilliae: % infection of adult Japanese beetles at ten golf courses in Michigan from 2000 to 2016.



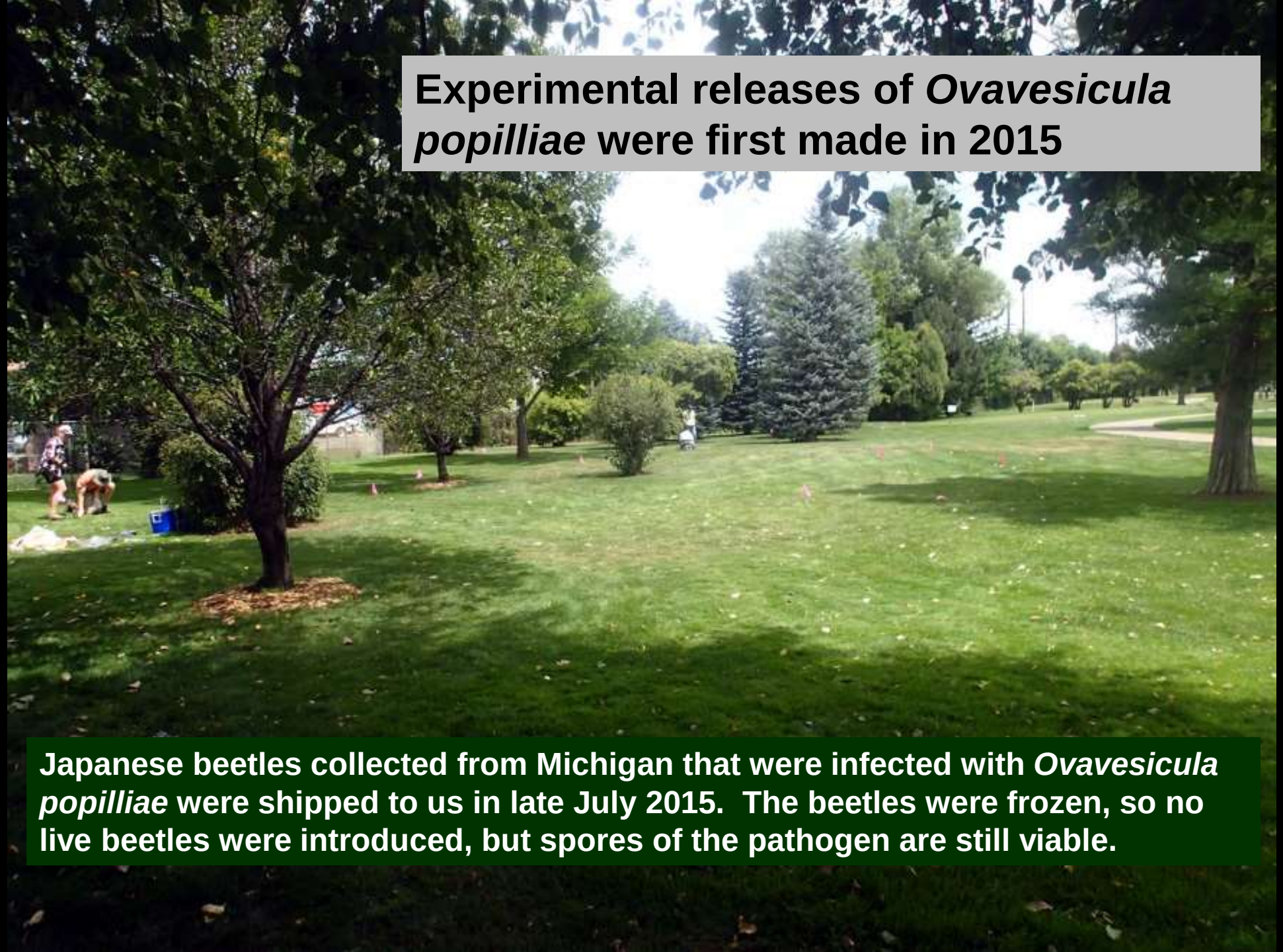
Source: David Smitley, Michigan State University

Japanese beetle trap catches at ten golf courses in southern Michigan from 1999 to 2016.

Data are mean beetles/trap/week.



Source: David Smitley, Michigan State University



Experimental releases of *Ovavesicula popilliae* were first made in 2015

Japanese beetles collected from Michigan that were infected with *Ovavesicula popilliae* were shipped to us in late July 2015. The beetles were frozen, so no live beetles were introduced, but spores of the pathogen are still viable.

The infected (but dead and frozen) beetles were applied in several ways

2015 releases of *Ovavesicula popilliae* – It took!

Positive infections confirmed in 2017 from both Flatirons Golf Course (Boulder) and Pueblo Zoo release sites!!!!

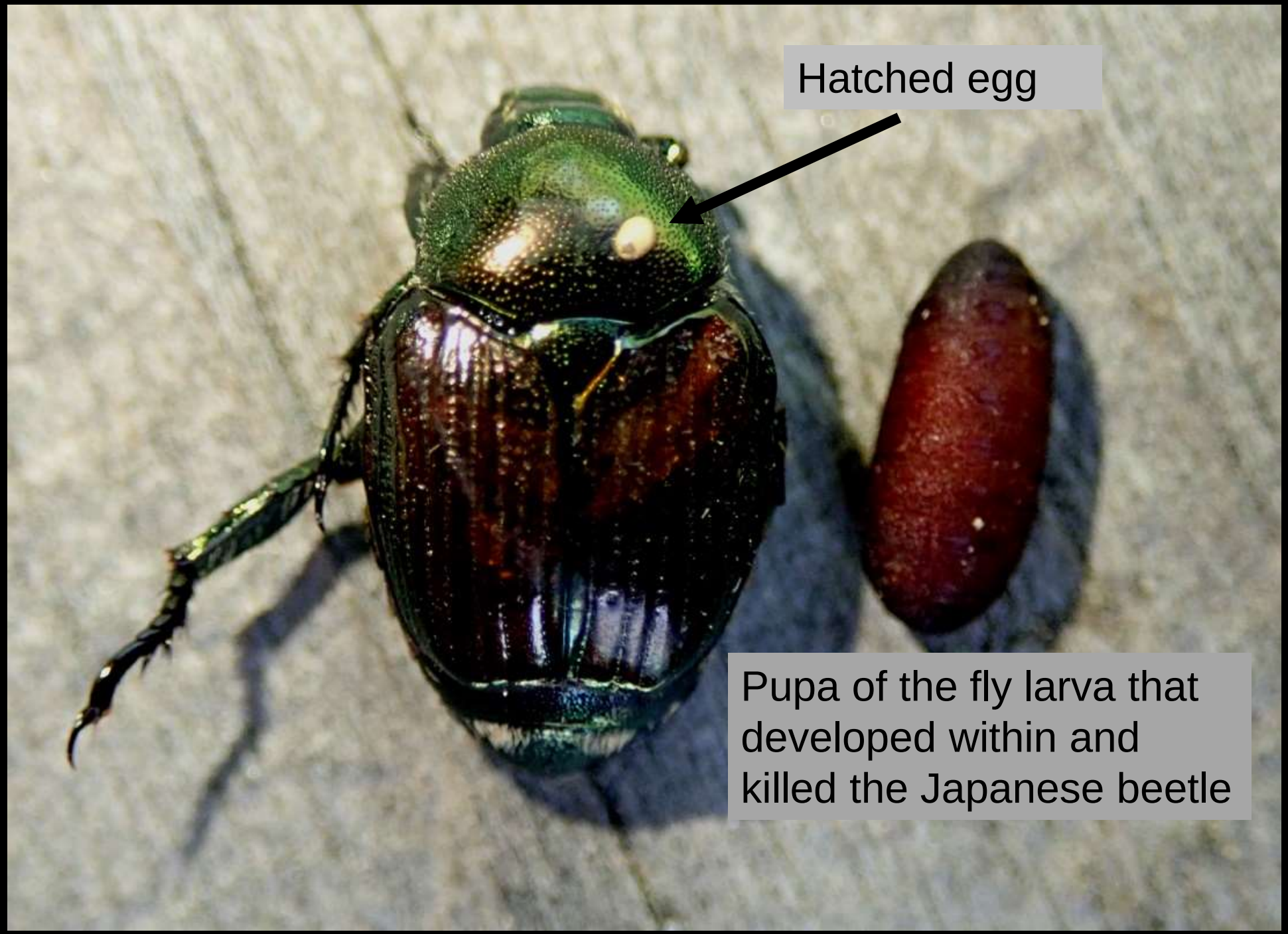
Ovavesicula popilliae as a JB Biocontrol Agent

- **Colorado release sites as of today**
  - Pueblo (2), Boulder (1), Littleton (2), Cherry Hills (1), Denver (3)
- **Characteristics needed for future release sites**
  - Site must have high numbers of JB grubs
  - Site must be at least 1 mile from any previous release site
  - Someone must commit to maintaining a JB trap at the site for the first year of the release

Istocheta aldrichi – the "winsome fly"

Diptera: Tachinidae

The adult flies glue their eggs onto adult Japanese beetles. The larva tunnels into and kills the beetle.


Hatched egg
Pupa of the fly larva that developed within and killed the Japanese beetle

Istocheta aldrichi as a JB Biocontrol Agent

- **Colorado release sites as of today**
  - Pueblo (1), Littleton (1), Denver (1)
- **Characteristics needed for future release sites**
  - Site must have high numbers of JB adults
  - **Site must have abundant amounts of suitable flowering plants during July**
  - Site must be at least 1 mile from any previous release site
  - Someone must commit to maintaining a JB trap at the site for the first year of the release

Tiphia vernalis spring tiphia

Hymenoptera: Tiphiidae

The adult wasps dig into the soil and lay their eggs on late stage Japanese beetle grubs

Photographs courtesy of David Shetlar, the Ohio State University

Tiphia vernalis as a JB Biocontrol Agent

- **Colorado release sites as of today**
  - Littleton (1)
- **Characteristics needed for future release sites**
  - **Site must have high numbers of JB larvae**
  - **Site must have abundant amounts of suitable flowering plants during May**
  - Site must be at least 1 mile from any previous release site
  - Someone must commit to maintaining a JB trap at the site for the first year of the release

What can we hope for with the Japanese Beetle Biological Control Program?

- One or more of the organisms will establish and reproduce at the release site
- The organism(s) will then spread on their own over time to cover a wide area
- As the organisms establish and increase, populations of Japanese beetle will decrease
  - These reductions will be permanent

These projects need Green Industry Support!

- **Rocky Mountain Regional Turfgrass Association**
- **Colorado Agricultural Experiment Station**
- **Colorado Nursery and Greenhouse Association**
  (pending support from other sources)

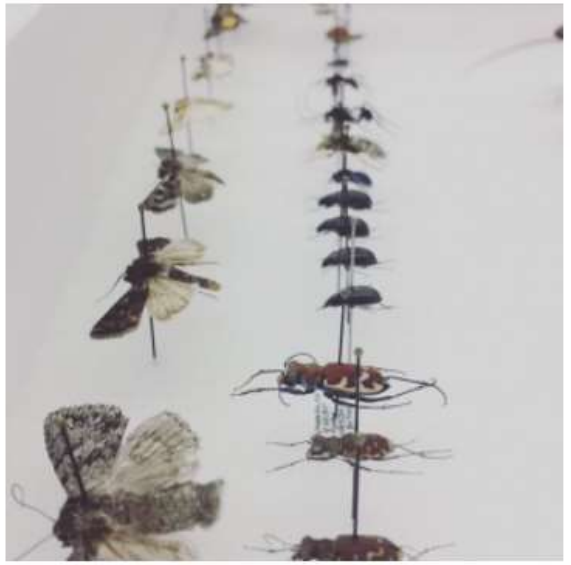
Thank you!!!!!

This is found in the middle of the Insect Information Website Home Page

Emerald Ash Borer Information

This is a listing of downloadable publications, web links and other resources related to the presence of emerald ash borer in Colorado.

Information



Japanese Beetle Information

This is a listing of publications and other resources to assist with understanding and managing Japanese beetle in Colorado.

Hitting the “Resources” button brings up this menu

Resources

- Biology and Management of Japanese Beetle (Potter and Held, 2002)
- Biology of Japanese Beetle (Fleming, 1972)
- Insecticide and Biological Control Options for Control of Japanese Beetle Larvae (White Grubs) in Lawns
- Insecticide Options for Control of Adult Japanese Beetle on Leaves and Flowers
- Japanese Beetle Extension Fact Sheet 5.601
- Questions and Answers about Japanese Beetle in Colorado
- Relative Susceptibility of Landscape Plants to Japanese Beetle (Held, 2004)

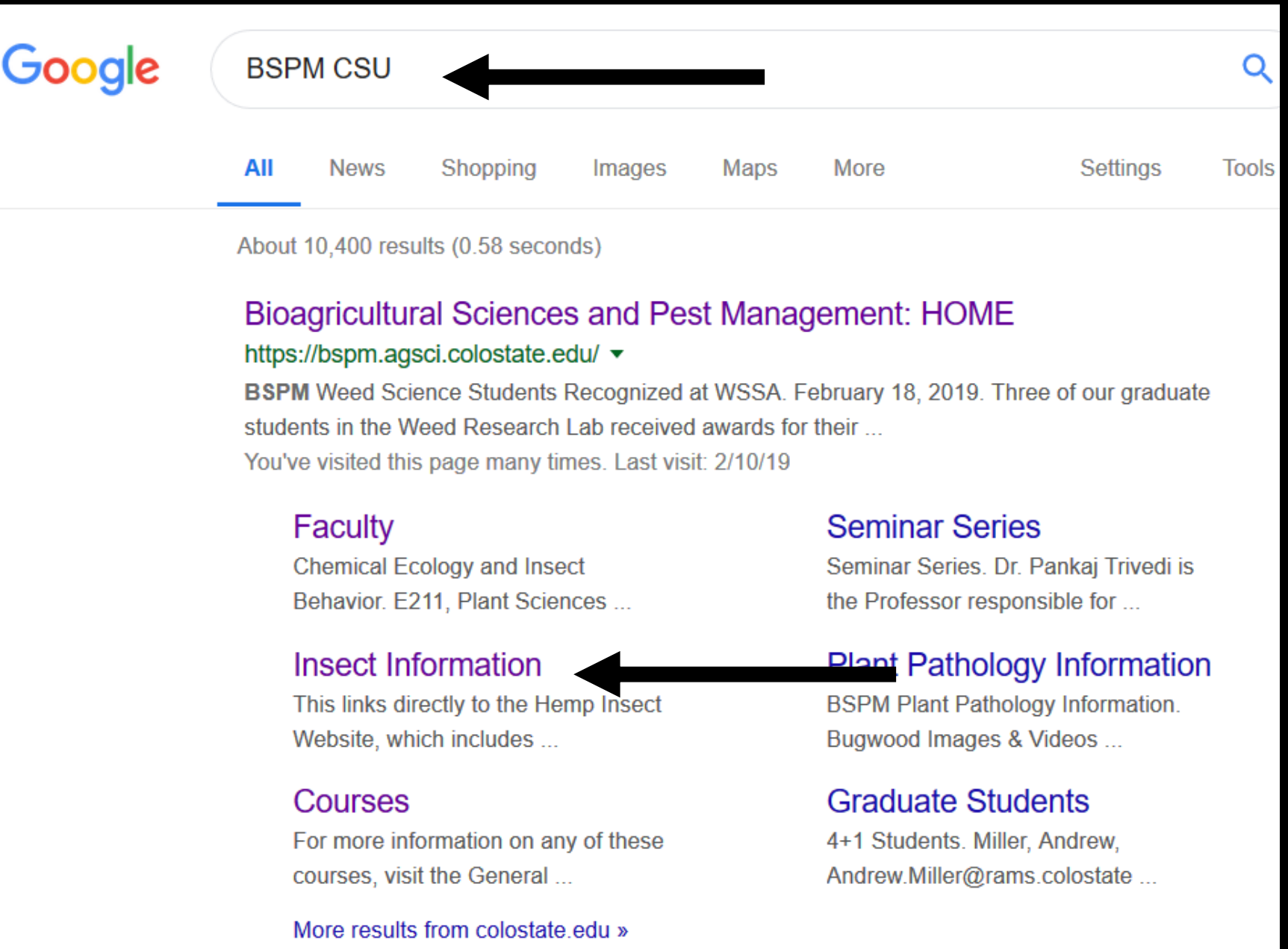
Bed Bug Information

This is a listing of downloadable publications, web links, and other resources that can be used for helping manage bed bugs.

This presentation will be posted at the Insect Information Web Site

- Housed at Department of Bioagricultural Sciences and Pest Management
  - Search BSPM CSU
- Click on Entomology
- Insect Information
  - Extension presentations for 2019 posted at bottom of page

This should pop up with a web search on BSPM CSU



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