



**FOR AUDIENCE PARTICIPATION, PLEASE GO TO:
SIXLEGGEDAGGIE.COM/POLL**

Landscape and Ornamental Integrated Pest Management

**Erfan Vafaie
Extension Program Specialist IPM-II**

sixleggedaggie.com

facebook.com/sixleggedaggie

NATURAL "CORN", 7000 B.C.

PEEL IT BY HAMMERING
REPEATEDLY WITH A
HARD OBJECT

TASTES LIKE VERY
DRY, RAW POTATO

19 MM

5-10 VERY HARD KERNELS

 8 KNOWN VARIETIES



ONLY FOUND
IN CENTRAL
AMERICA

ARTIFICIAL CORN, 2014

STEAM COOKS IN
MINUTES

*Sweet,
refreshing
and juicy*



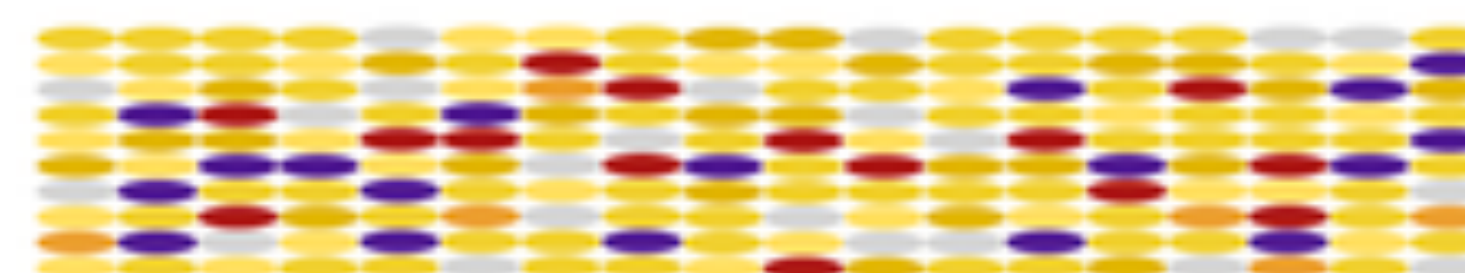
190 MM

EASY TO PEEL
No Hammer Required!

~1000 Times Larger

AVAILABLE IN
FIVE COLOURS:

WHITE
YELLOW
DARK RED
DEEP PURPLE
BLUE-BLACK



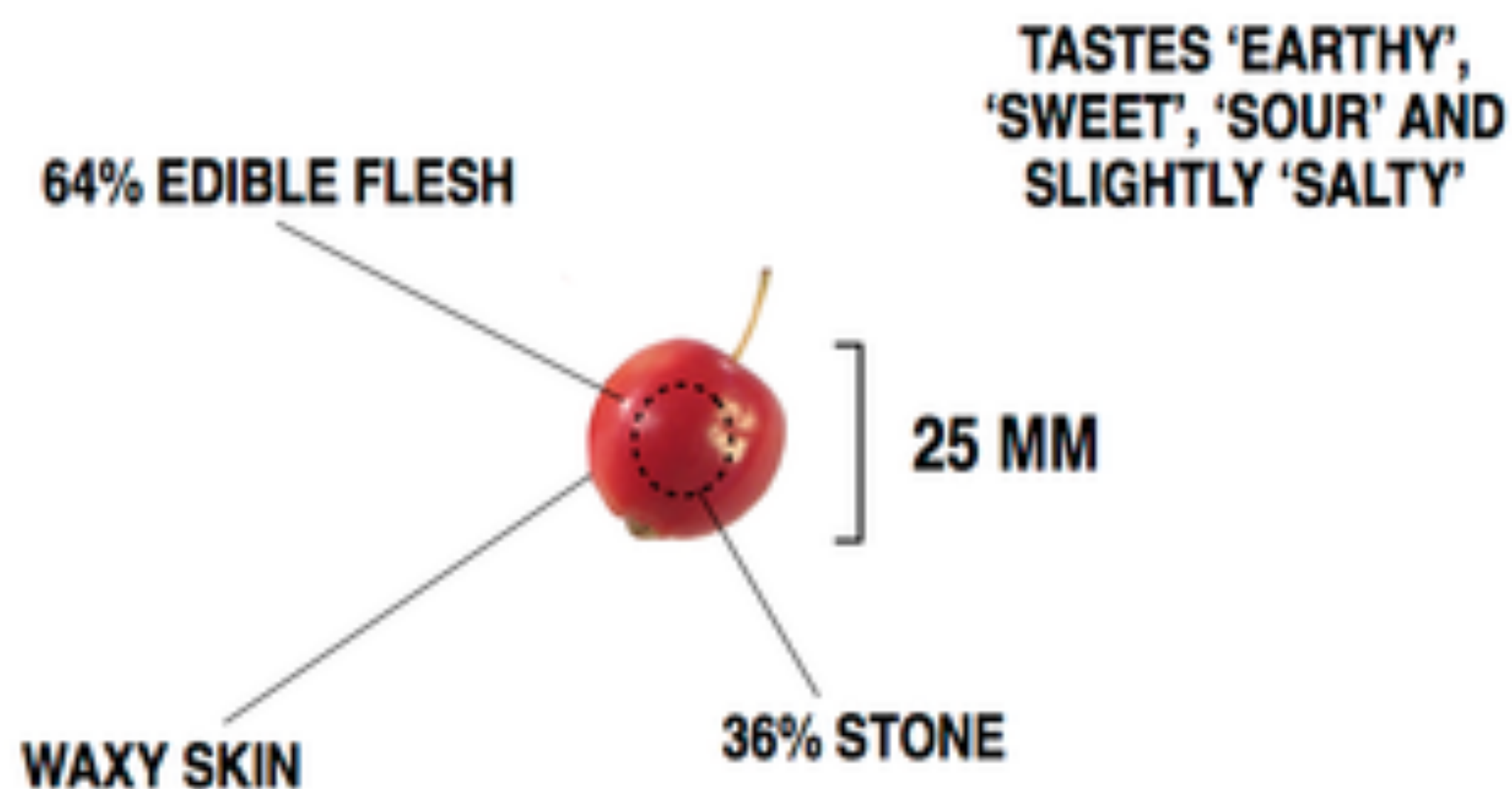
~200 VARIETIES
67-Fold Increase

*Annual Production:
790 Million Tonnes*



*Grown in 69
Countries*

NATURAL PEACH, 4000 B.C.

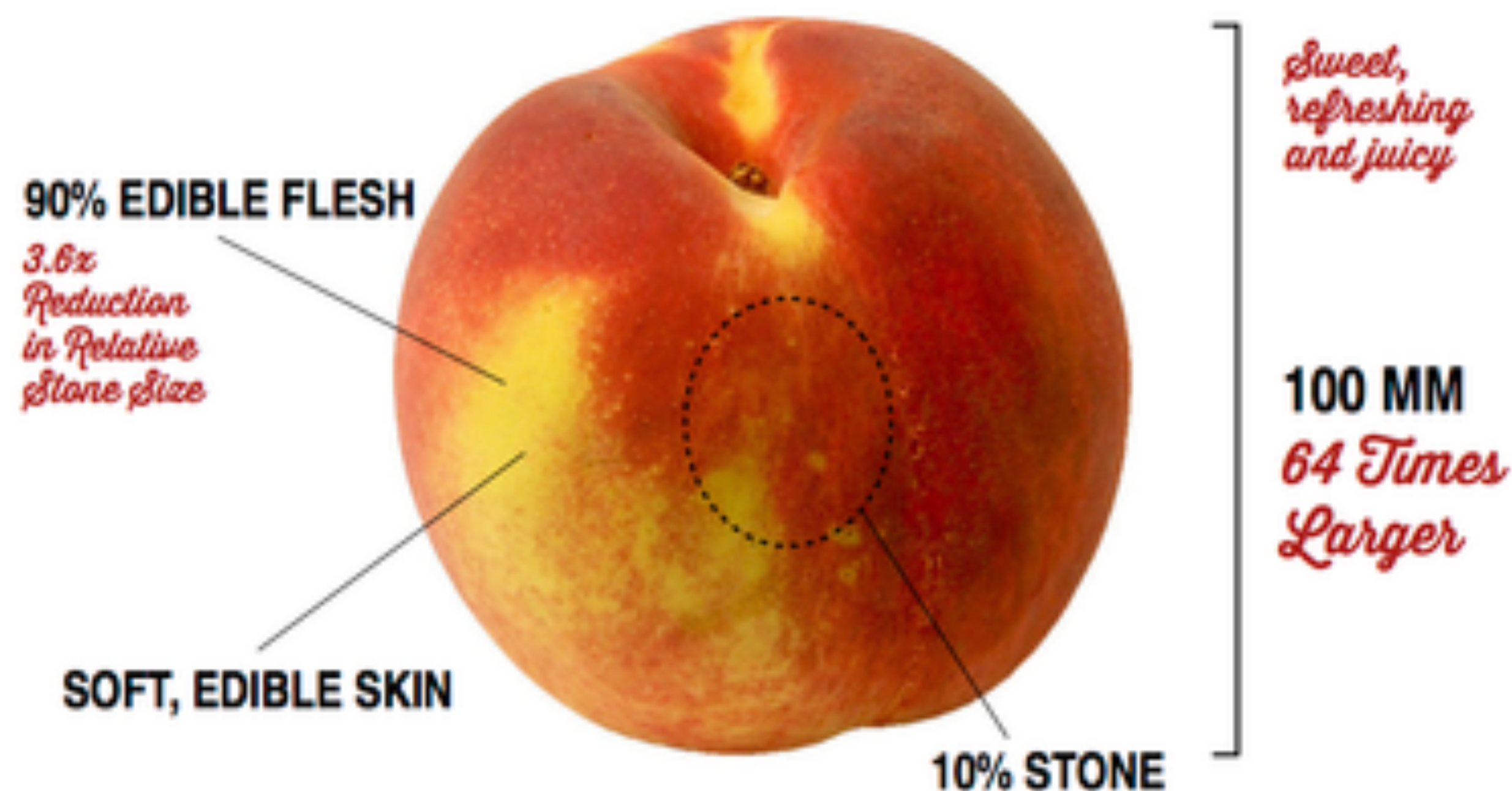


●●● 3 KNOWN VARIETIES



ONLY FOUND
IN CHINA

ARTIFICIAL PEACH, 2014

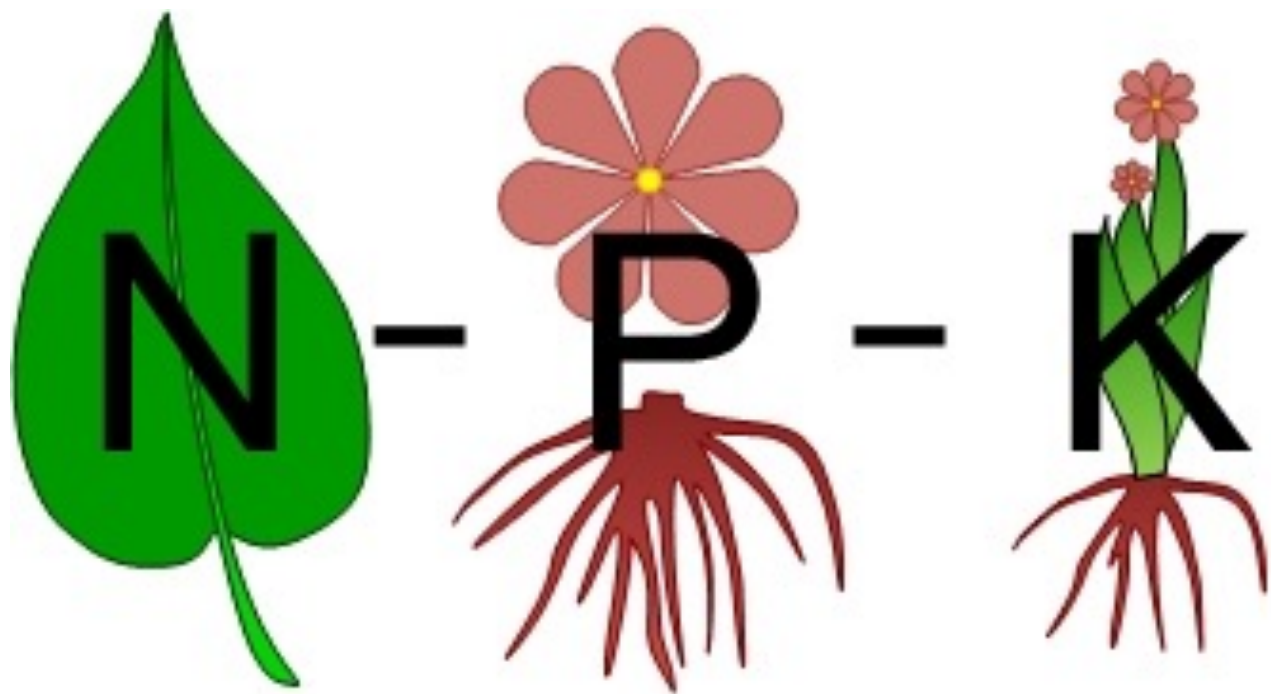
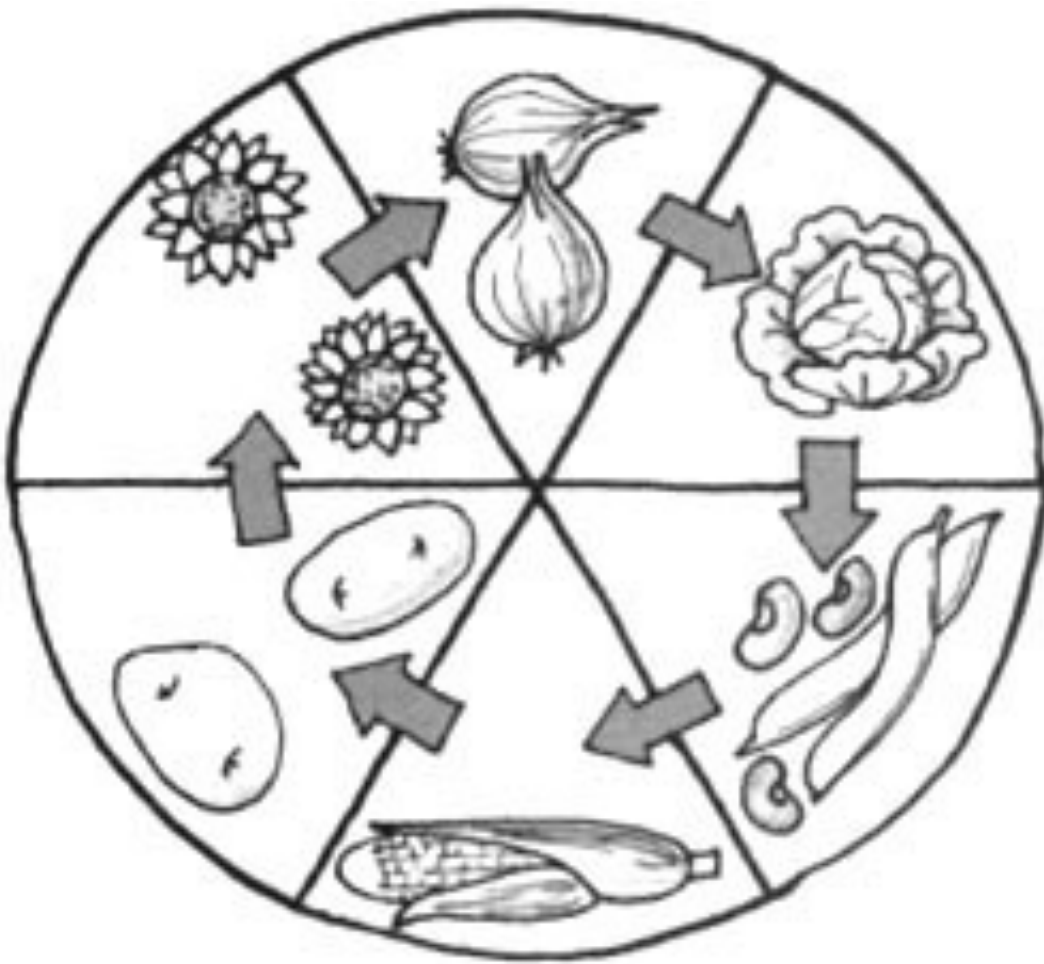
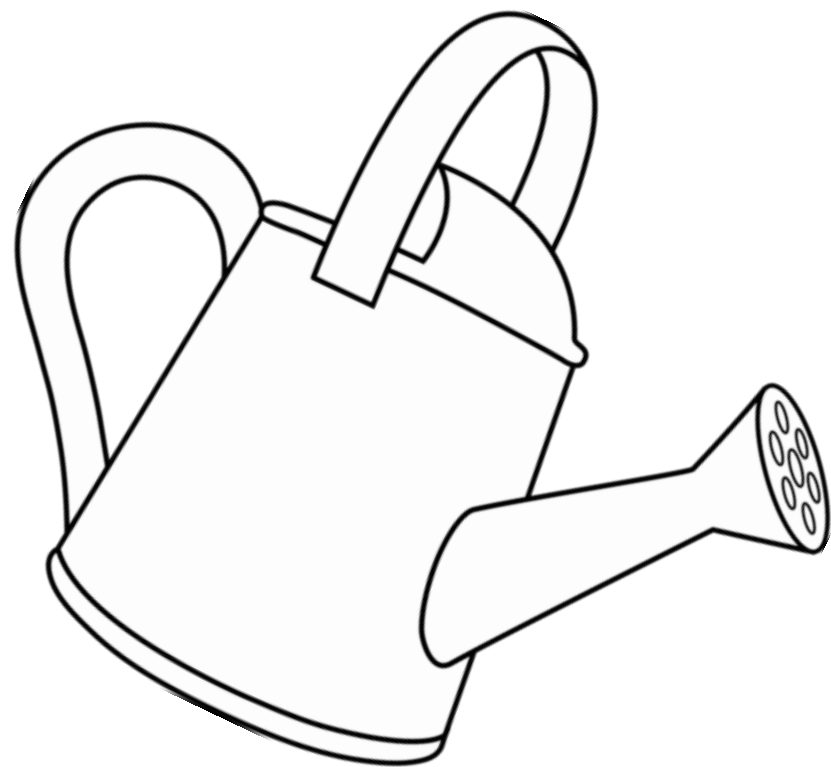


~200 VARIETIES
67-Fold Increase

*Annual Production
17 Million Tonnes*



*Grown in 13
Countries*



Nitrogen

Phosphorous

Potassium

The Green Revolution

- Between 1940's - 1960's
- “saved over a billion people from starvation”
- high-yielding varieties of cereal grains
- Expansion of irrigation infrastructure



- Modernization of management techniques
- Distribution of hybridized seeds, synthetic fertilizers, and pesticides to farmers

Norman Borlaug

EPISODE 43

Dr. Norman Borlaug with Julie Borlaug, Dr. Ronnie Coffman,
and Dr. Ed Runge

[Field, Lab, Earth](#)

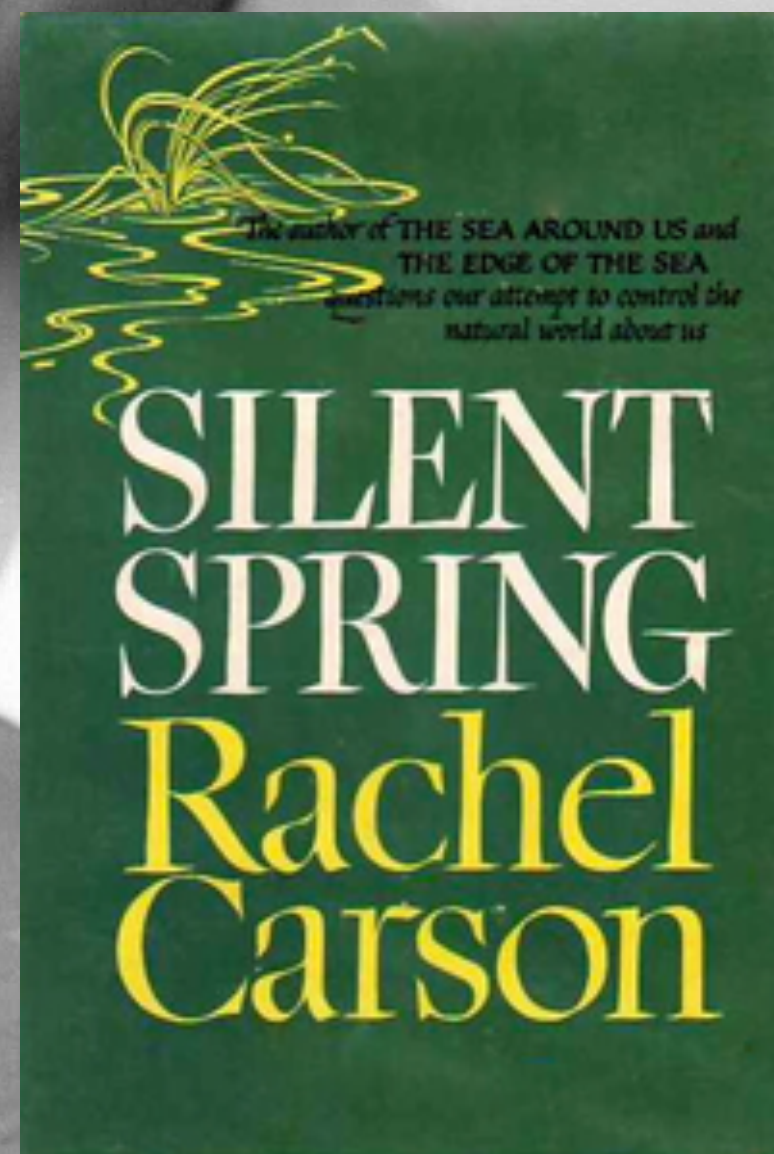
Dr. Norman Borlaug was an American agronomist who specialized in wheat breeding. Known as the Father of the Green Revolution, he helped other hunger fighters save millions of lives in Mexico, India, Pakistan, and more. He won the Nobel Peace Prize in 1970 and founded the World Food Prize to celebrate other food fighters worldwide. This episode we speak with his granddaughter and colleague Julie Borlaug and fellow colleagues Dr. Ronnie Coffman and Dr. Ed Runge to discuss the “Man who Fed the World.”

502 Records
\$ billions in economic impact

Spotted Wing Drosophila
Estimated revenue loss in 2008
\$511.3 million

“WHY SHOULD WE TOLERATE A DIET OF WEAK POISONS, A HOME IN INSIPID SURROUNDINGS, A CIRCLE OF ACQUAINTANCES WHO ARE NOT QUITE OUR ENEMIES, THE NOISE OF MOTORS WITH JUST ENOUGH RELIEF TO PREVENT INSANITY? WHO WOULD WANT TO LIVE IN A WORLD WHICH IS JUST NOT QUITE FATAL?”

Rachel Carson, Silent Spring (1962)

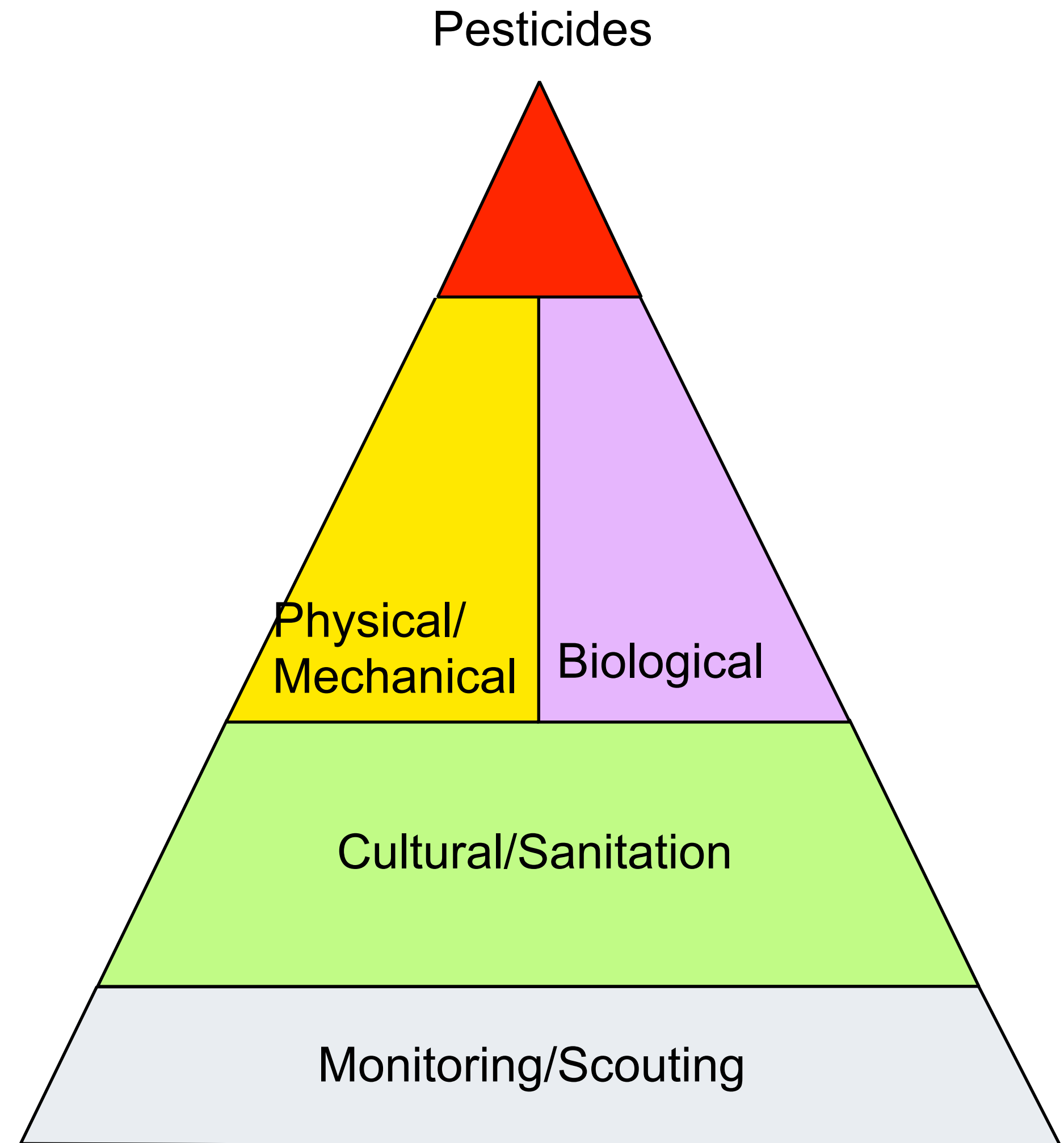


1970's

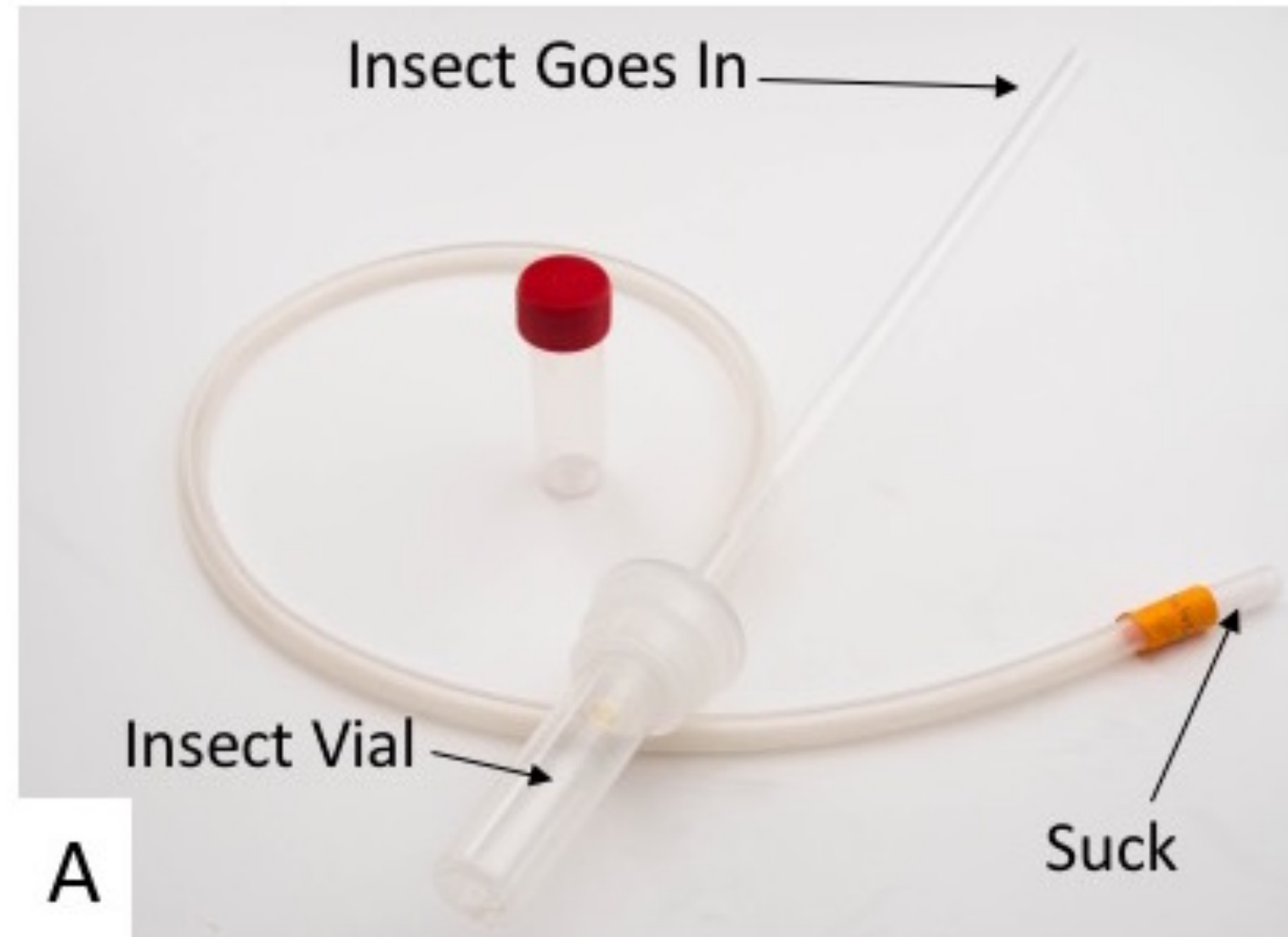
USDA creates nationwide IPM program in Land Grant Universities

The IPM Pyramid

- Minimize impact on the environment
- Minimize impact on human health
- Maintain or increase soil fertility
- Long-term pest management
- Prevent pesticide-resistant pests
- Strives to maximize long-term returns/savings



Monitor | Tools of the trade



Monitor | Tools of the trade

Sweep net



Photo: NC State University

Figure 15. Proper use of a sweep net.

Monitor | Tools of the trade

Slap/Beating technique



Scot Nelson

Monitor | Tools of the trade

Pheromone Traps | Sweet potato weevil



Monitor | Tools of the trade

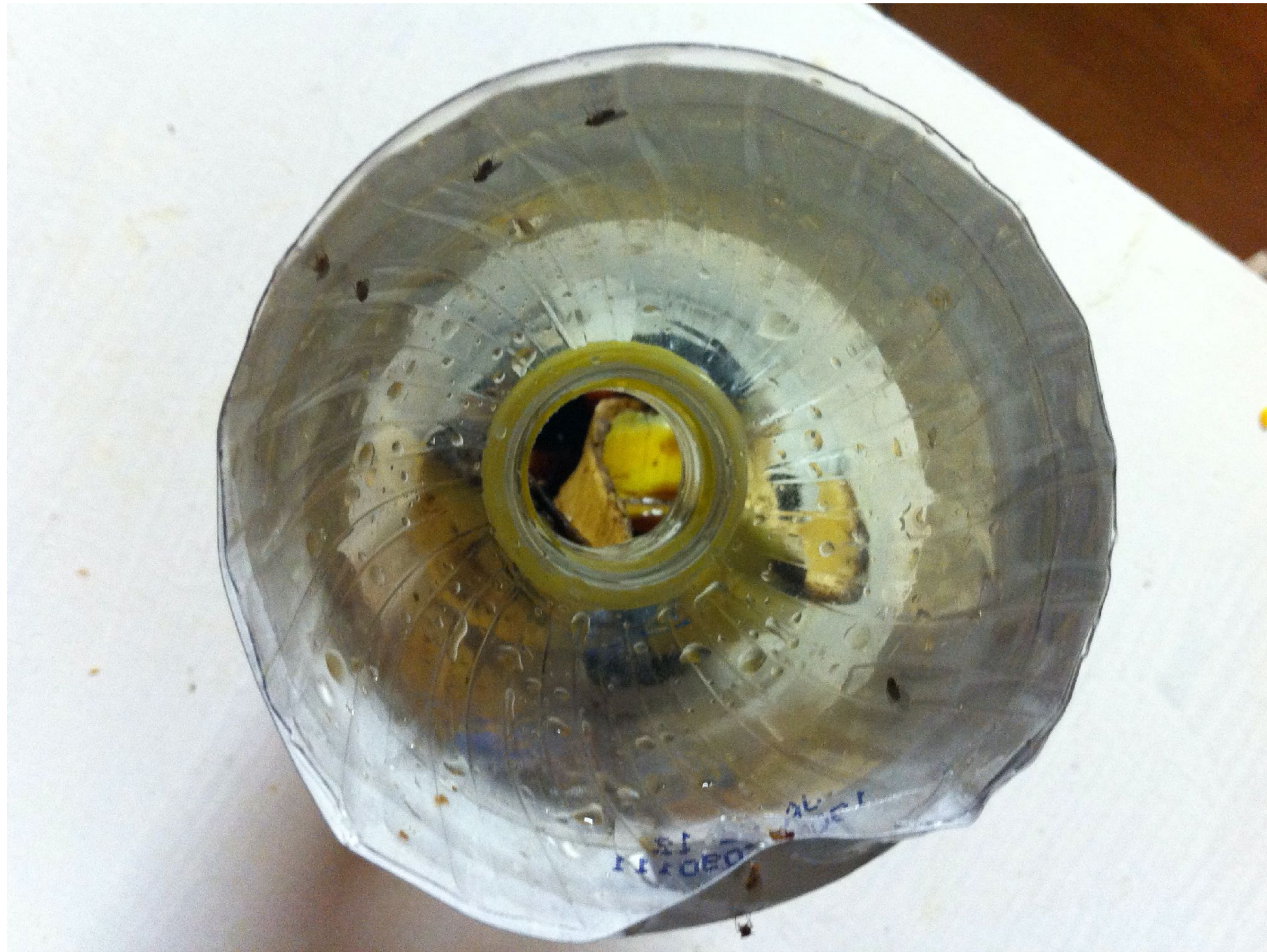
Pheromone Traps | Sweet potato weevil



Juliana Cardona-Duque, University of Puerto Rico, Bugwood.org

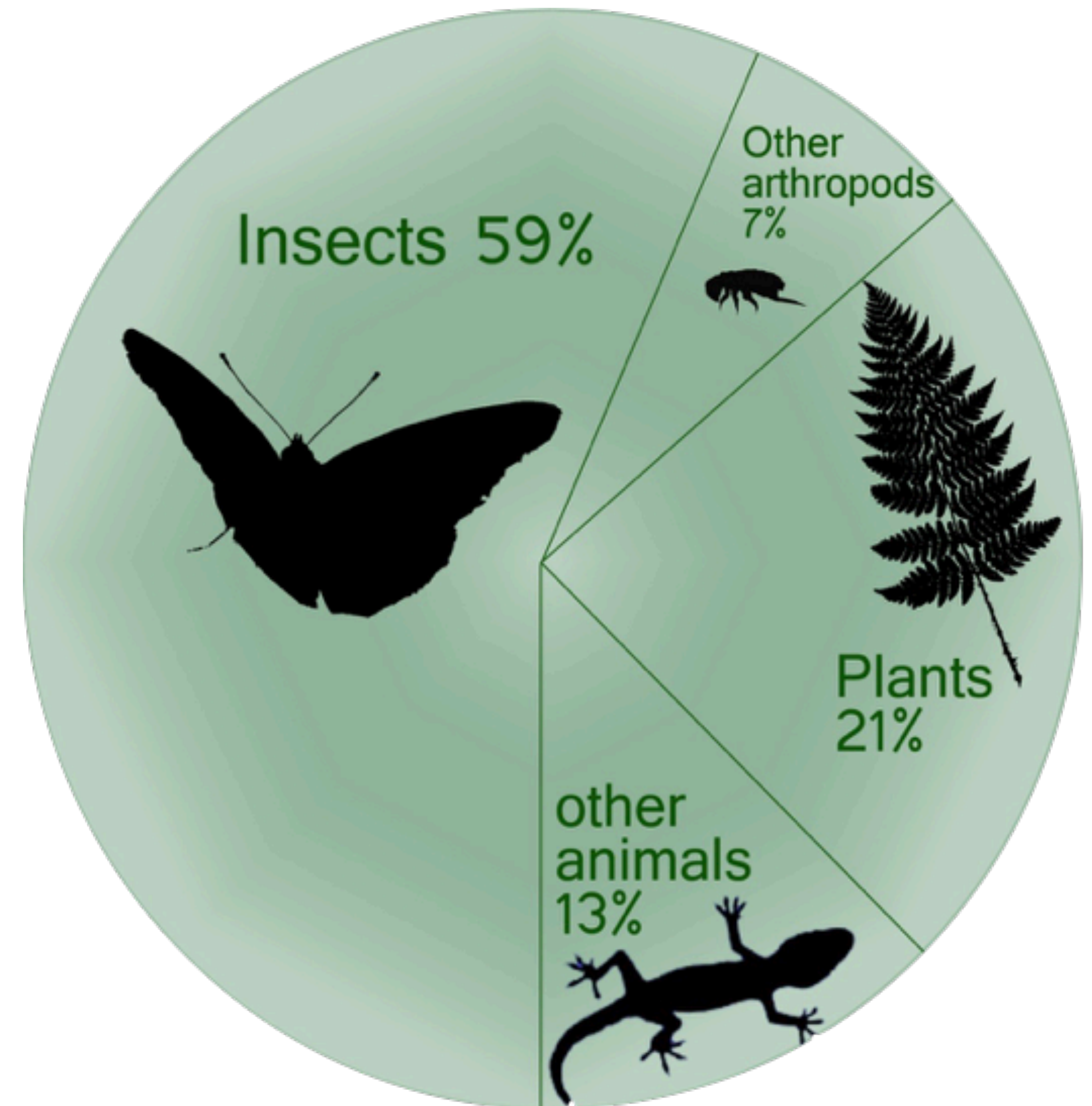
Monitor | Tools of the trade

General Lures/Traps

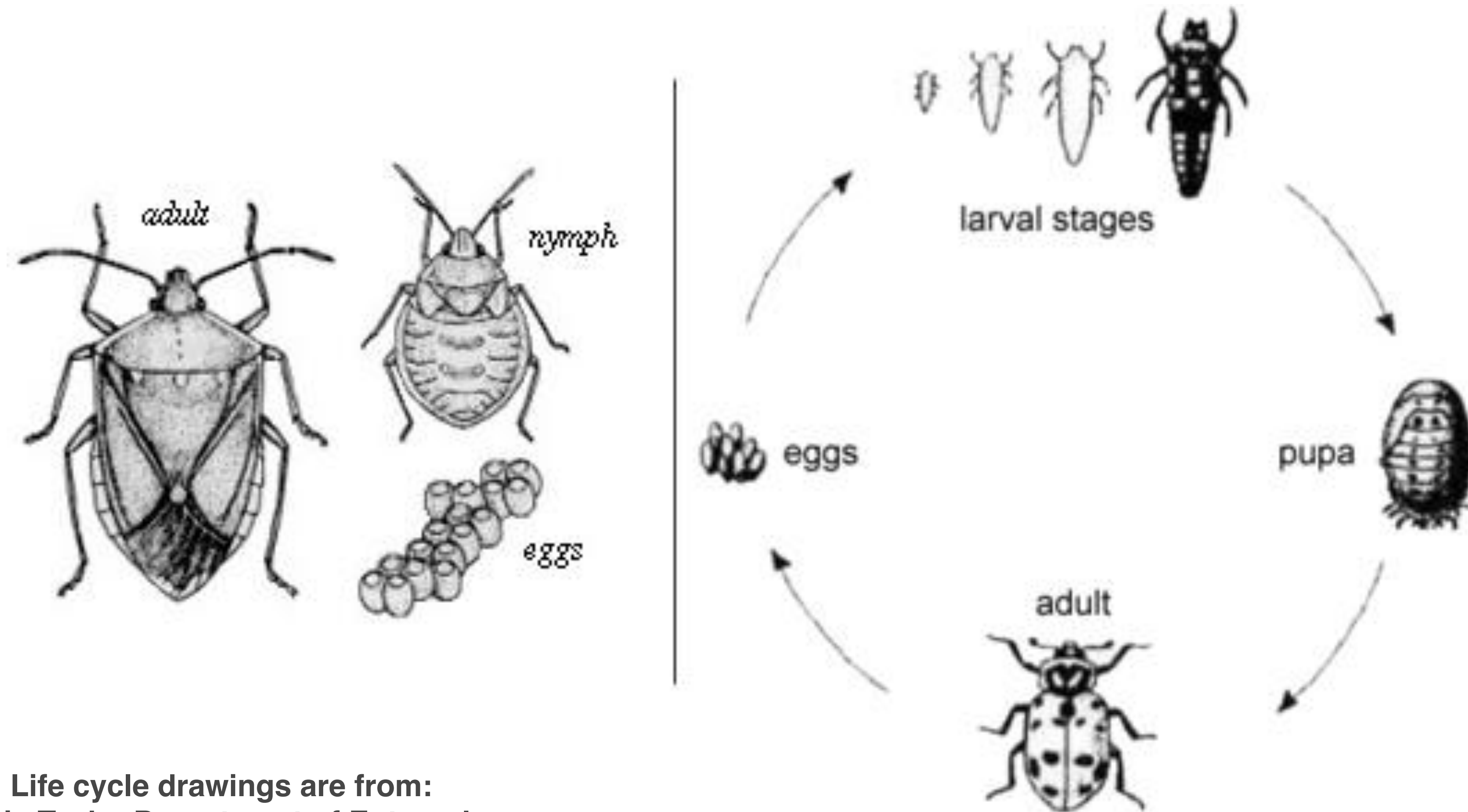


Insect Identification

- Recent estimates of species diversity
- Total estimated species count: 8.7 million (Eukaryotes)
- 2.2 million marine
- 1.2 million species described
- 86% of existing species undescribed (96% of marine species)
- (Mora et al. 2011)



Larva

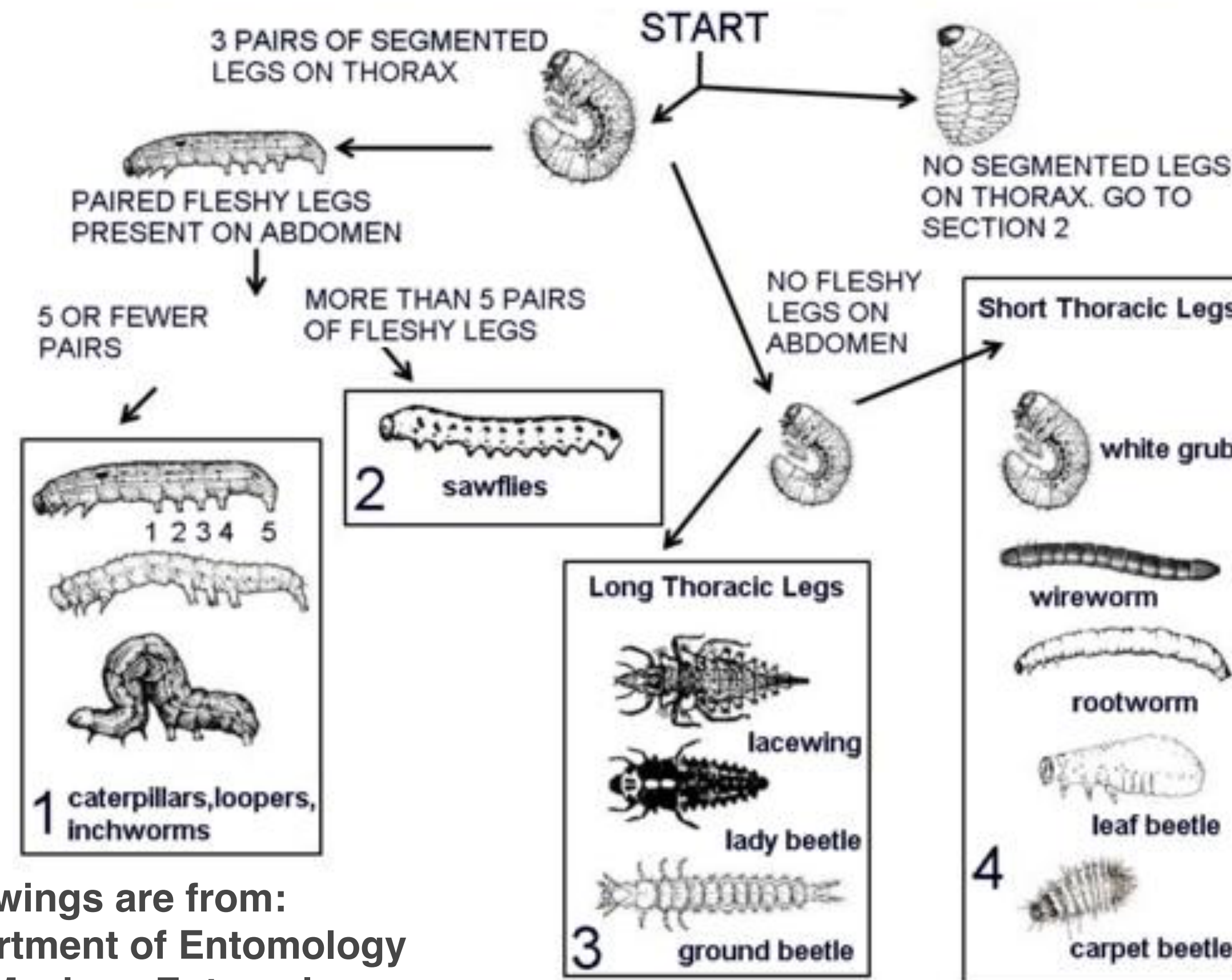


Life cycle drawings are from:
Virginia Tech - Department of Entomology
University of New Mexico - Entomology

Lee Townsend, Extension Entomologist, University of Kentucky College of Agriculture

Larva

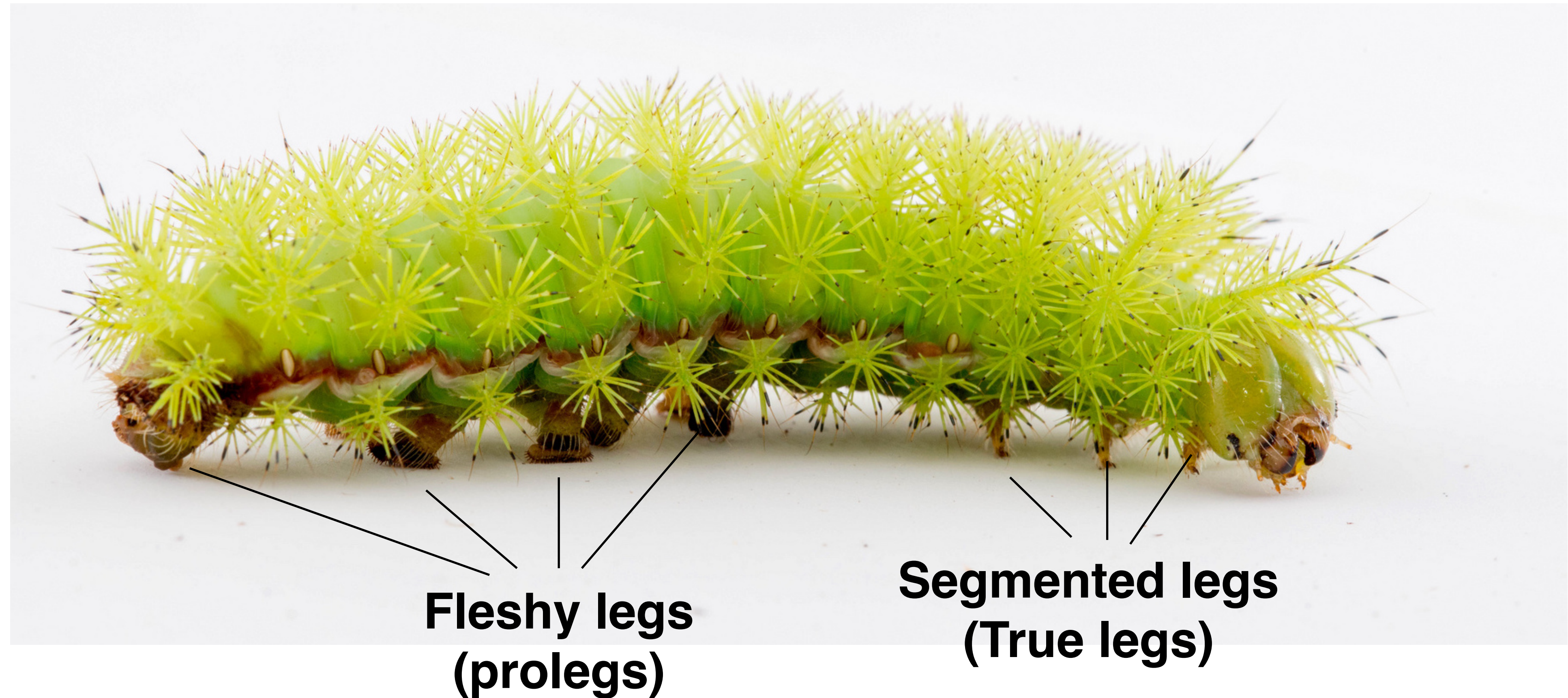
PICTURE KEY TO INSECT LARVAL TYPES: SECTION 1



Life cycle drawings are from:
Virginia Tech - Department of Entomology
University of New Mexico - Entomology

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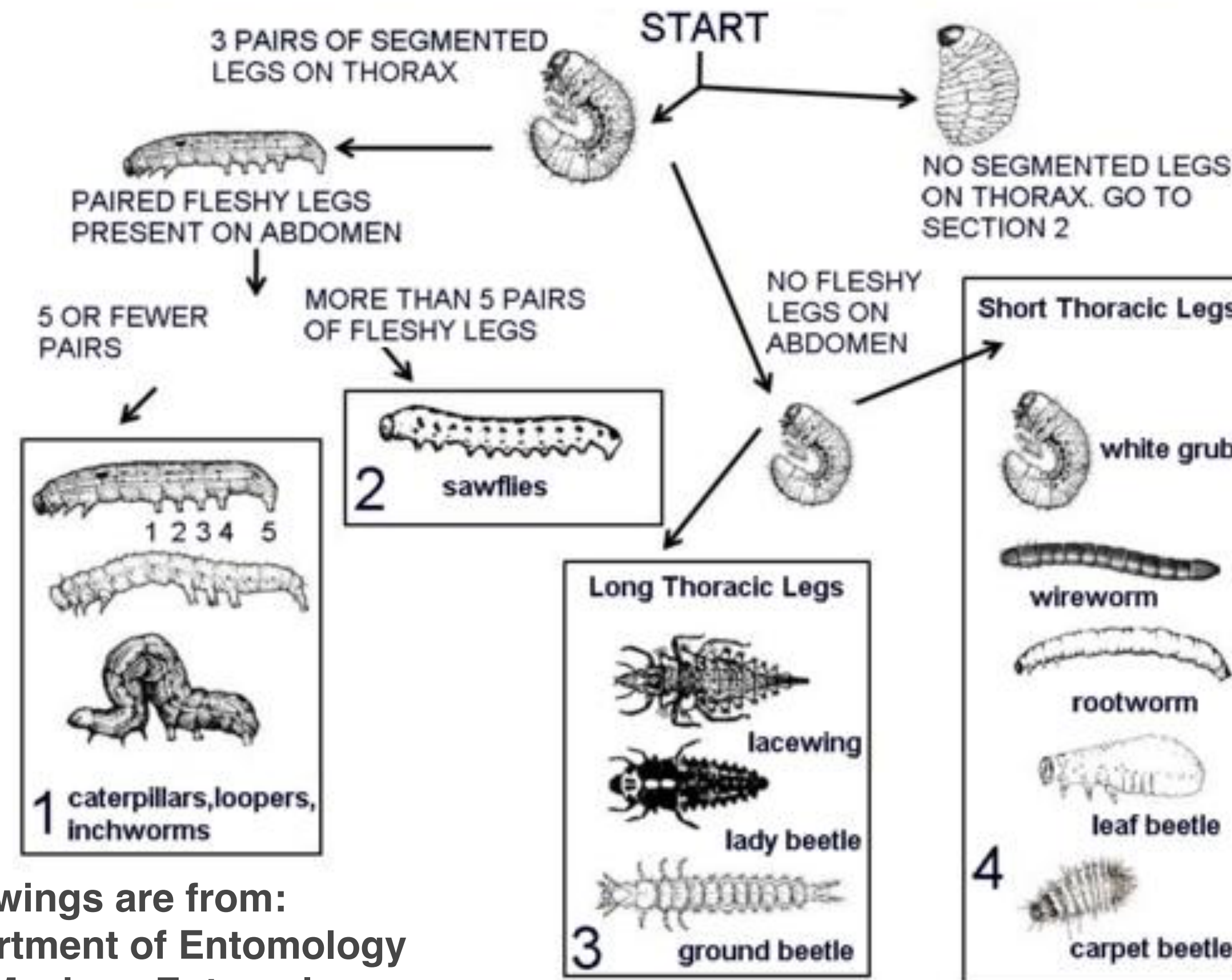
Larva



Io moth caterpillar, *Automeris io* (Erfan Vafaie, Texas A&M AgriLife Extension)

Larva

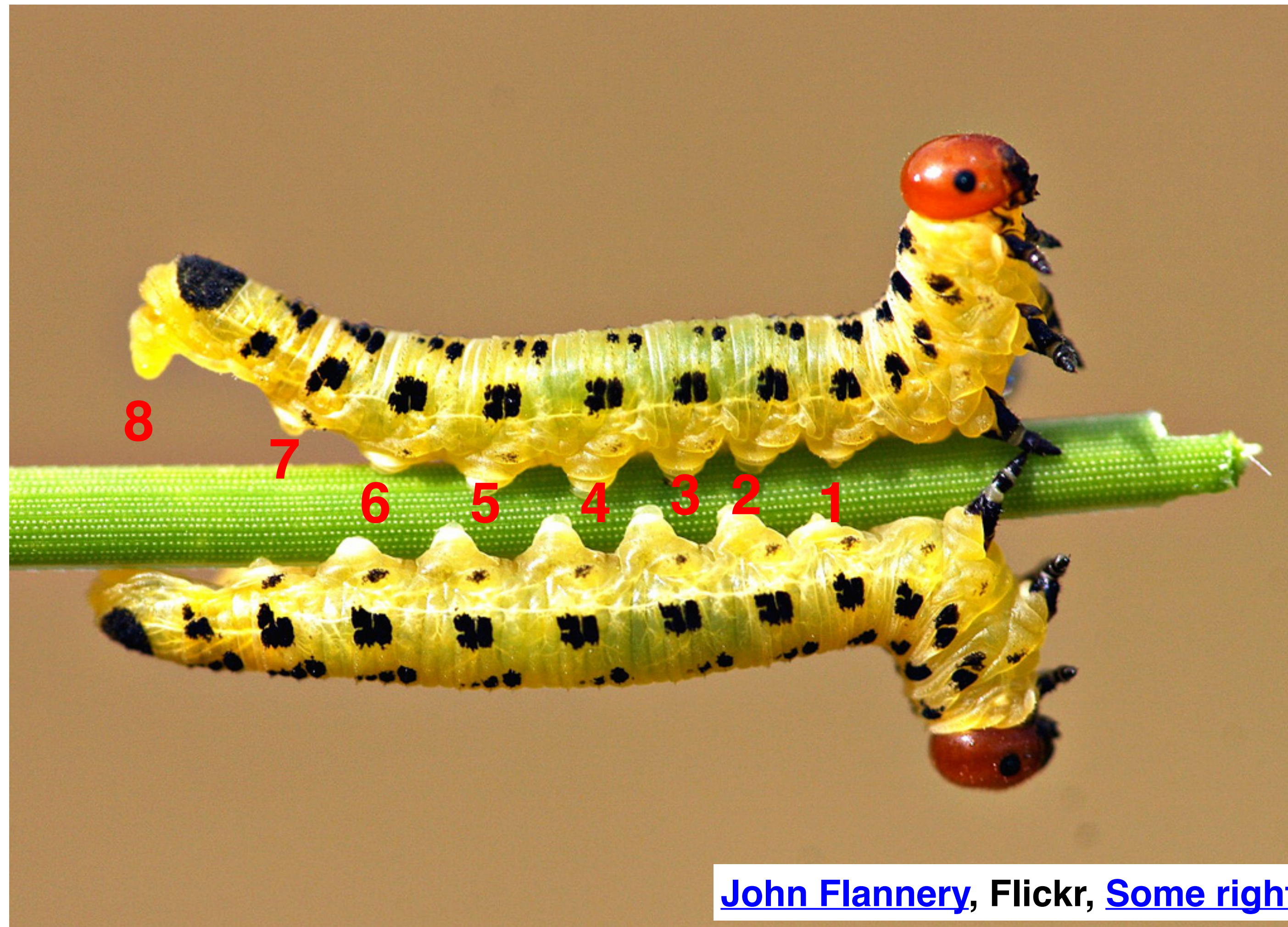
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Larva

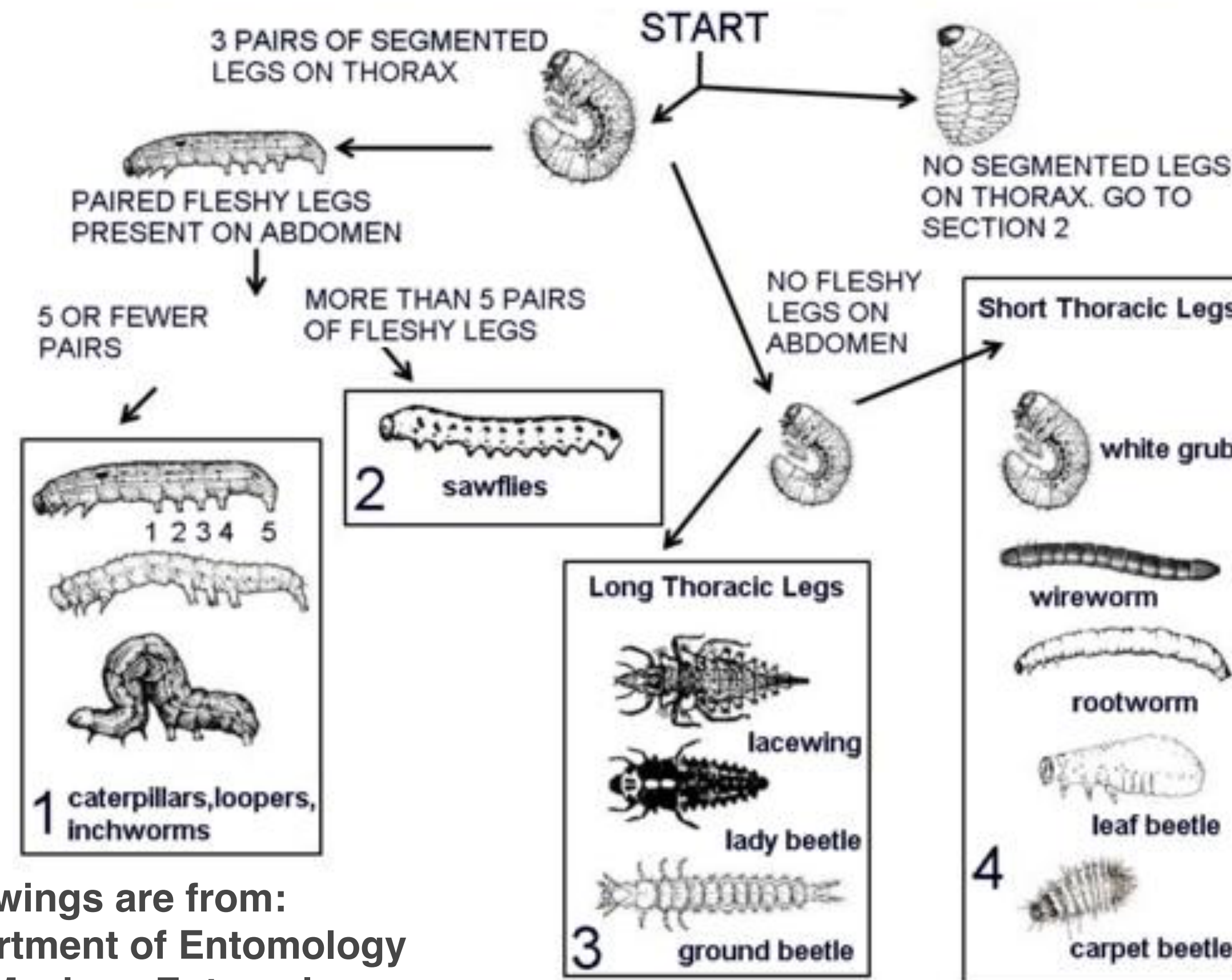


[John Flannery](#), Flickr, [Some rights reserved](#)

Sawfly, Family: Symphyta

Larva

PICTURE KEY TO INSECT LARVAL TYPES: SECTION 1



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Virginia Tech - Department of Entomology
University of New Mexico - Entomology

Lee Townsend, Extension Entomologist, University of Kentucky College of Agriculture

Larva



[Derek Parker](#), Flickr, [Some rights reserved](#)

Lady beetle larva, Family: Coccinellidae

Scott Bauer, USDA Agricultural Research Service, Bugwood.org



Larva



[AJ Cann](#), Flickr, [Some rights reserved](#)

Ground beetle larva, Family: Carabidae

Larva

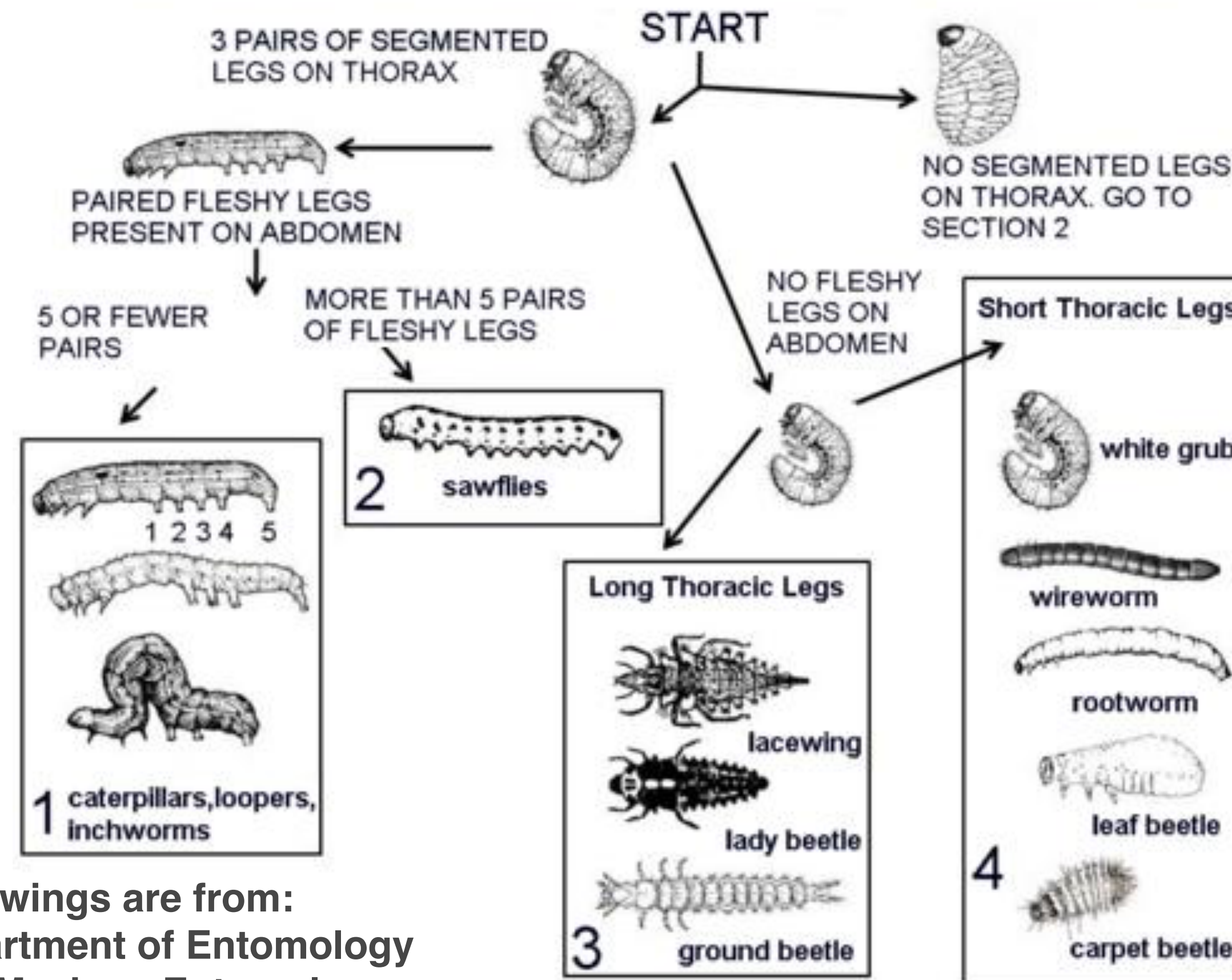


[Katja Shultz](#), Flickr, [Some rights reserved](#)

Ground beetle adult, Family: Carabidae

Larva

PICTURE KEY TO INSECT LARVAL TYPES: SECTION 1



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University of New Mexico - Entomology

Lee Townsend, Extension Entomologist, University of Kentucky College of Agriculture

Larva



David Cappart, Bugwood.org

White grubs, Family: Scarabaeidae

Larva

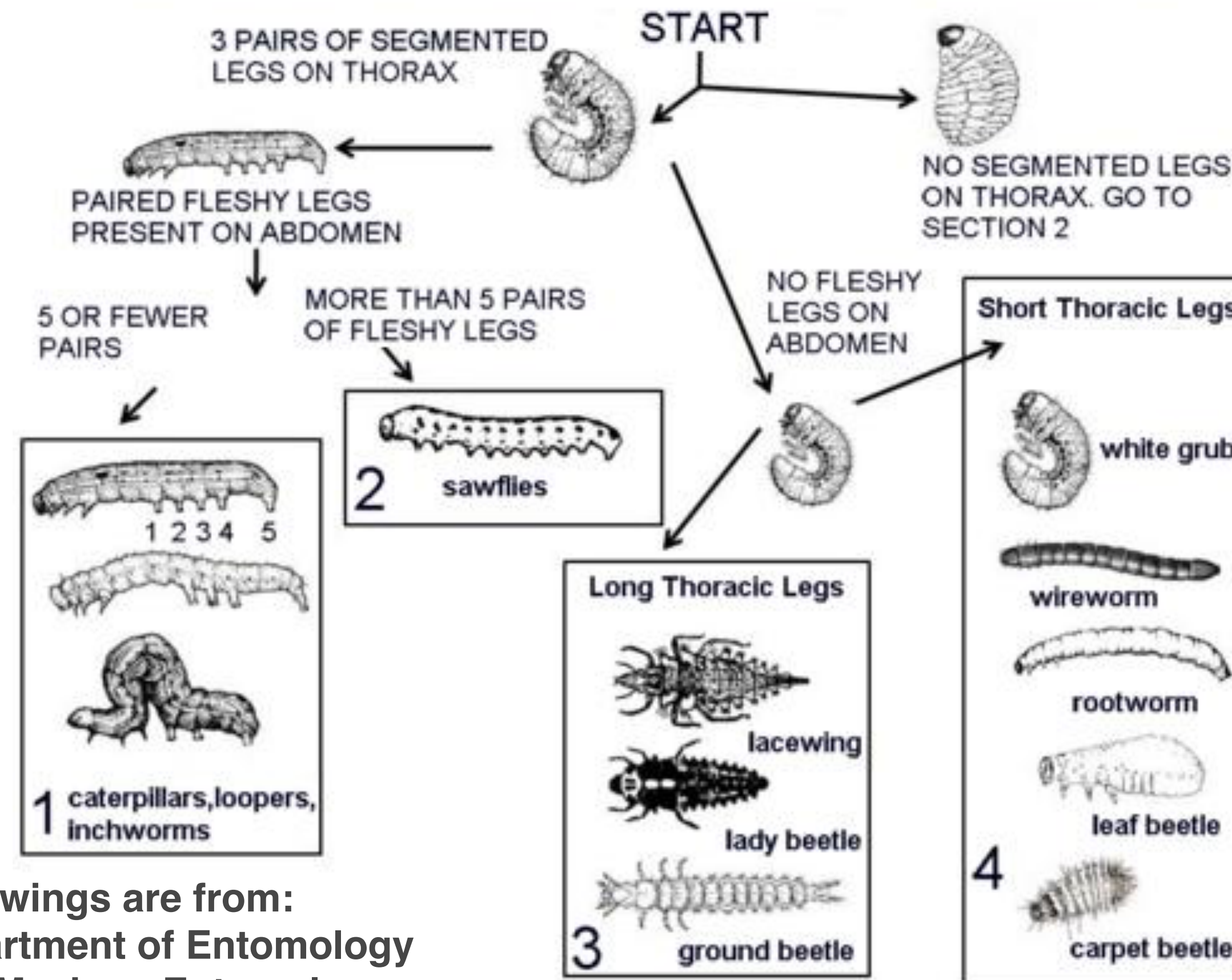


Clemson University – USDA Cooperative Extension Slide Series, Bugwood.org

Tobacco wireworm, *Conoderus vespertinus*

Larva

PICTURE KEY TO INSECT LARVAL TYPES: SECTION 1

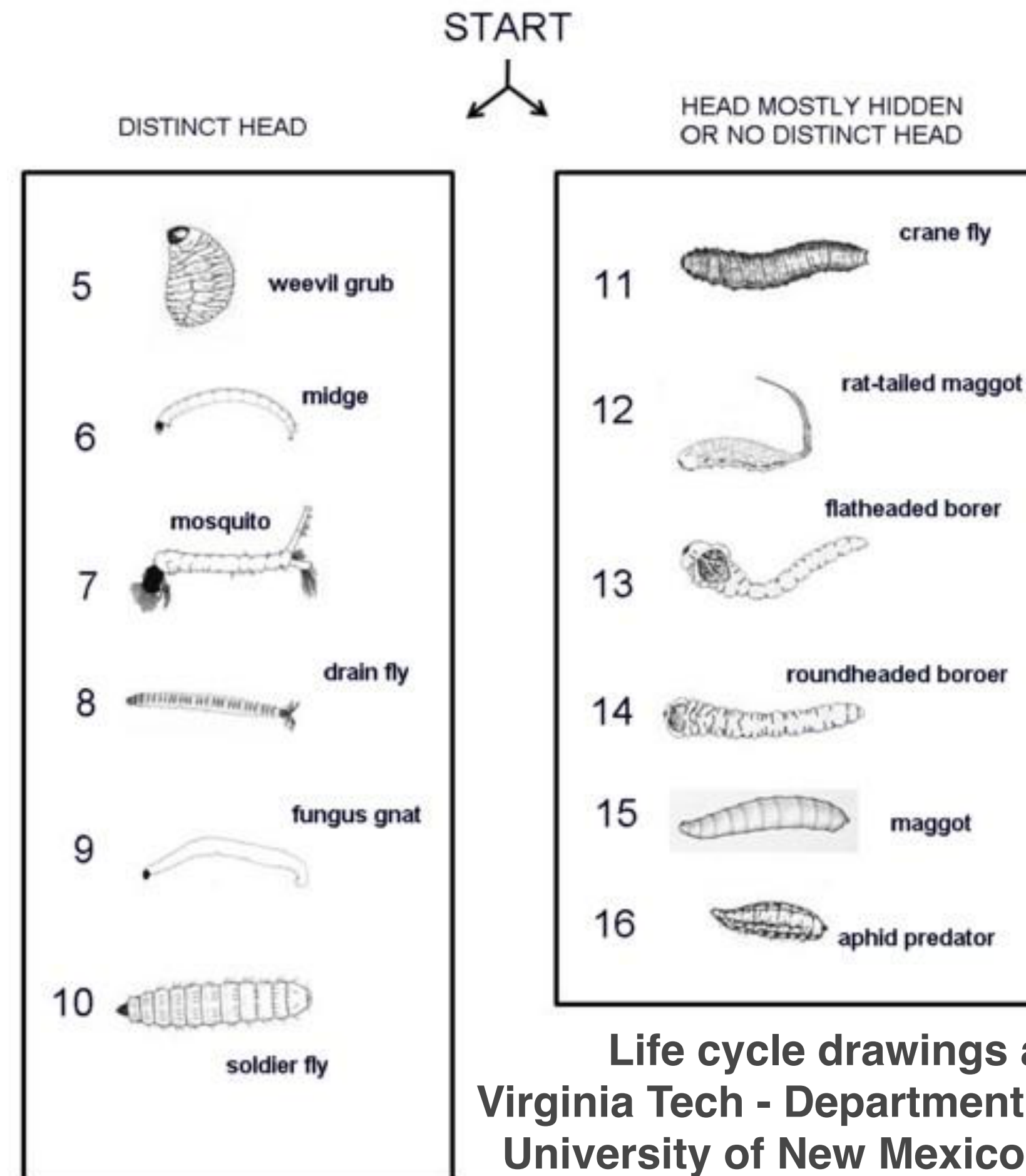


Life cycle drawings are from:
Virginia Tech - Department of Entomology
University of New Mexico - Entomology

Lee Townsend, Extension Entomologist, University of Kentucky College of Agriculture

Larva

PICTURE KEY TO LARVAL INSECT TYPES: SECTION 2



Life cycle drawings are from:
Virginia Tech - Department of Entomology
University of New Mexico - Entomology

Larva



David Cappaert, Bugwood.org

Darkwinged fungus gnat larva, *Bradysia* sp.

Larva

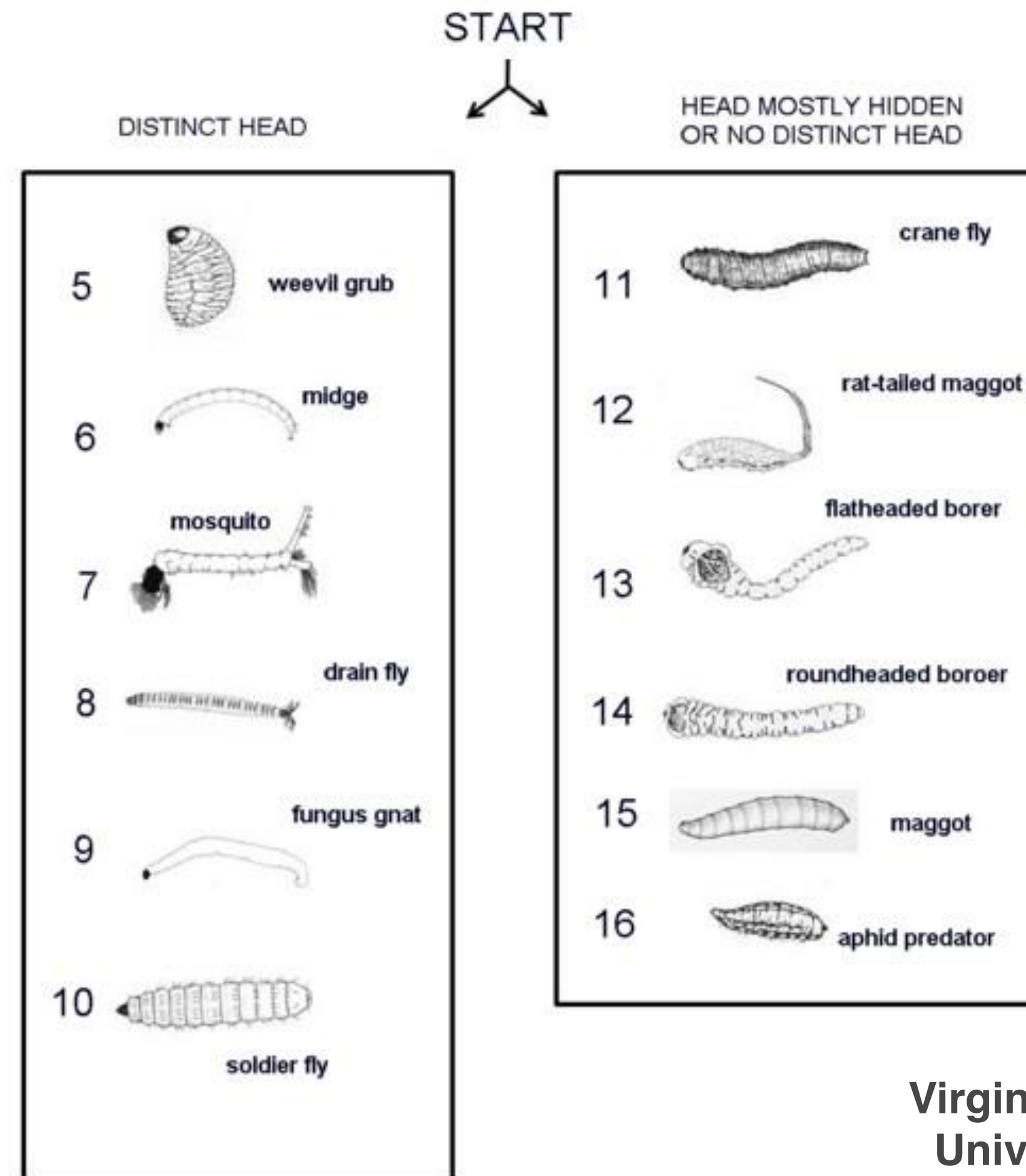


Wayne N. Dixon, Florida Department of Agriculture and Consumer Services, Bugwood.org

Pitch-eating weevil, *Pachylobius picivorus*

Larva

PICTURE KEY TO LARVAL INSECT TYPES: SECTION 2



Life cycle drawings are from:
Virginia Tech - Department of Entomology
University of New Mexico - Entomology

Larva



John C. French Sr., Retired, Universities:Auburn, GA, Clemson and U of MO, Bugwood.org

House fly, *Musca domestica*

Larva

[Andrew Hoffman](#), Flickr, [Some rights reserved](#)



Andrew Hoffman 2013

Crane fly larva, Family: Tipulidae

Thrips

Greenhouse thrips



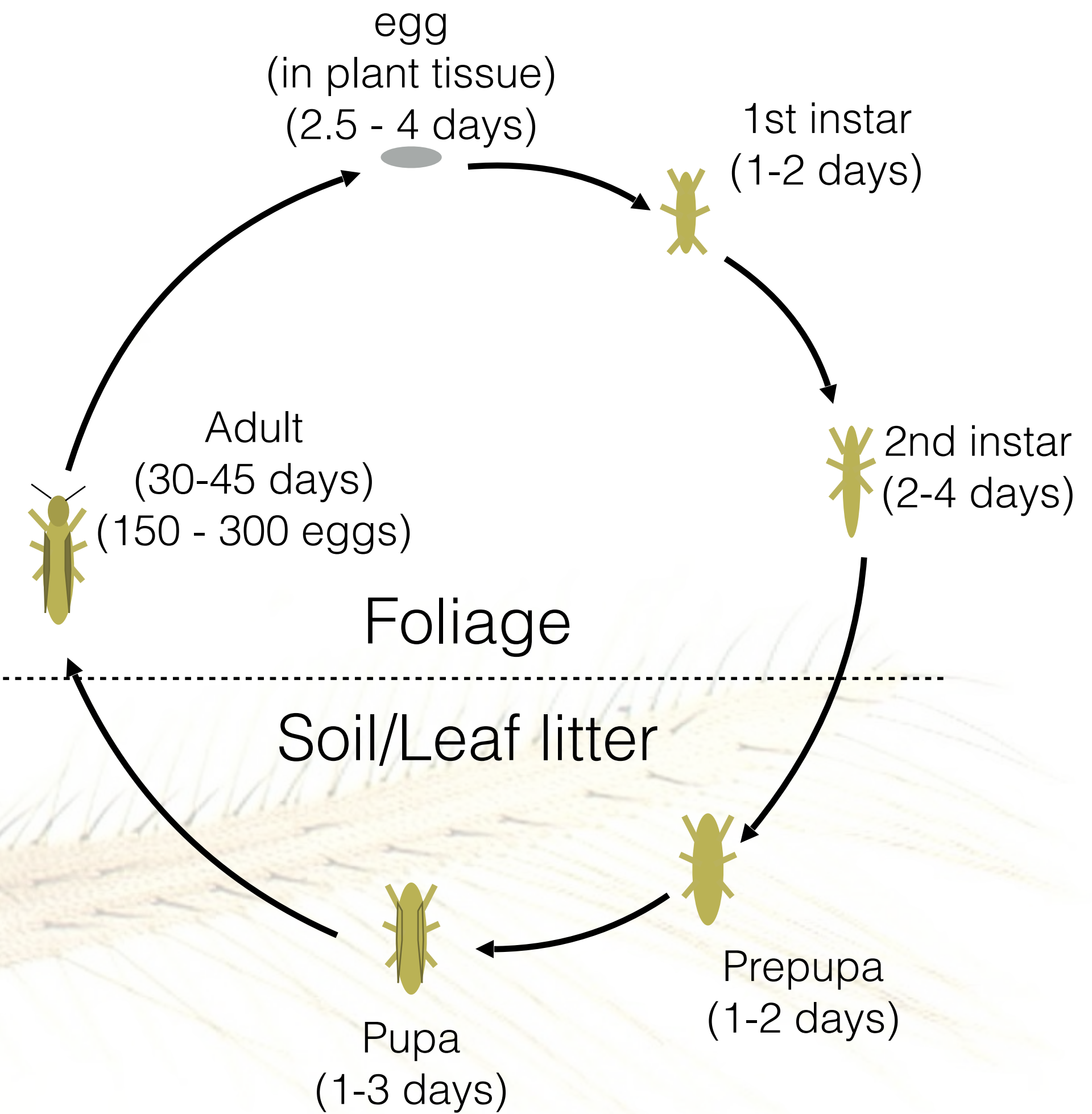
Adult western flower thrips



Chili Thrips



Thrips



Thrips



UGA1327079

Thrips



UGA1402111 0008

Thrips



UGA0176007 008

Thrips



Scot Nelson

Thrips

Oak Tatters



Erfan Vafaie, Texas A&M AgriLife Extension Service, bugwood.org

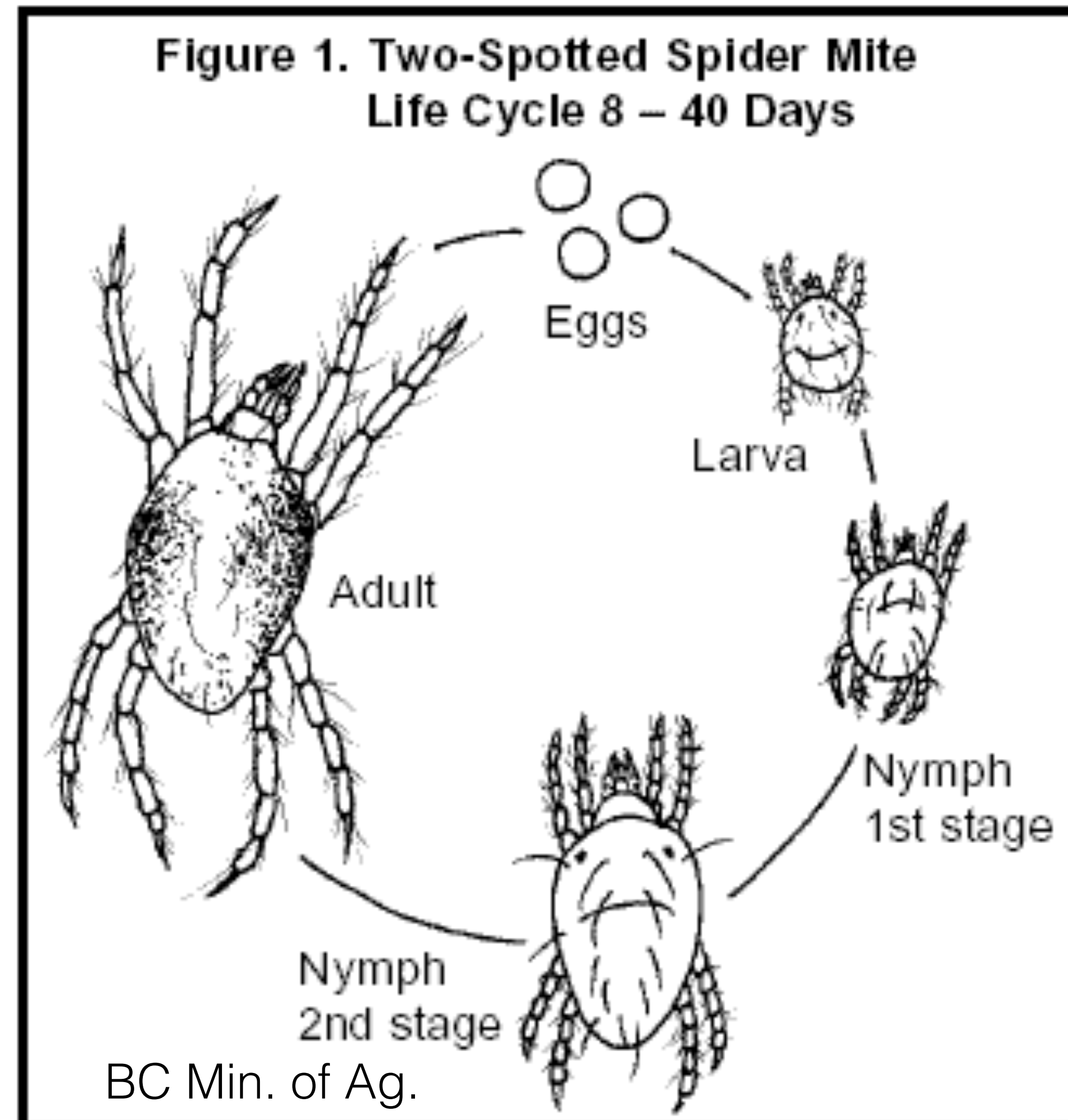
Twospotted spider mites



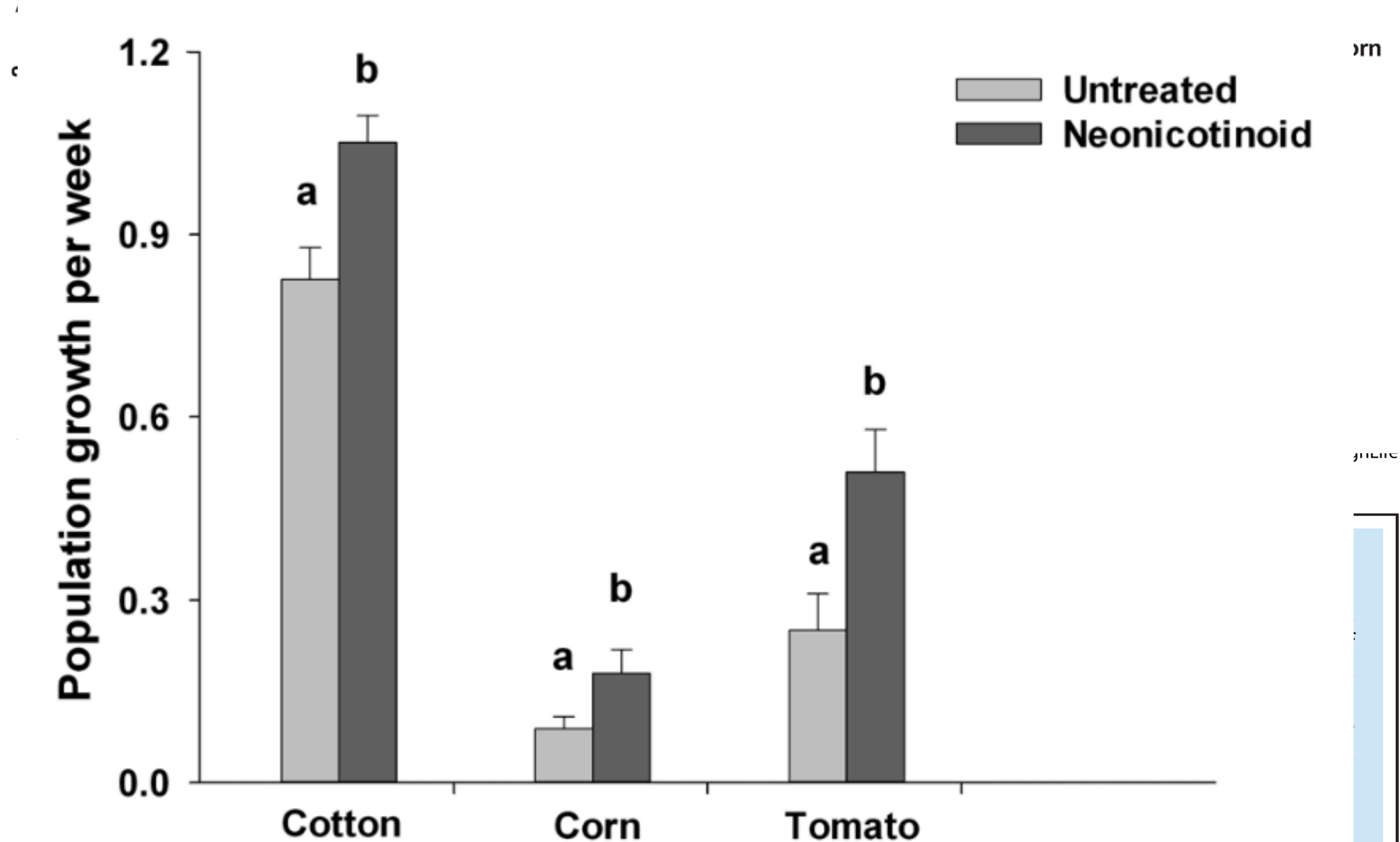
Twospotted spider mites



Twospotted spider mites



Twospotted spider mites | Pesticides



Twospotted spider mites | Fertilizer

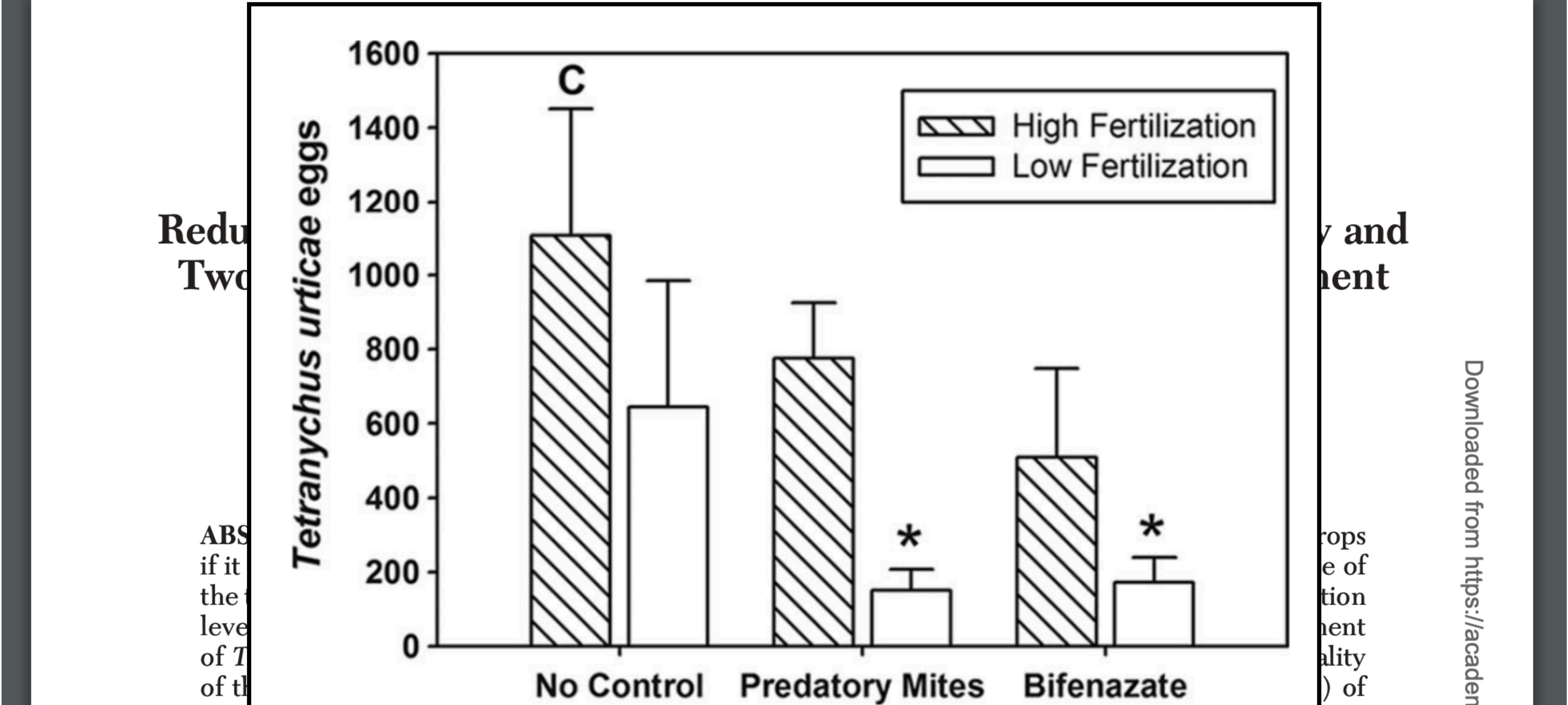
HORTICULTURAL ENTOMOLOGY

Reducing Fertilization for Cut Roses: Effect on Crop Productivity and Twospotted Spider Mite Abundance, Distribution, and Management

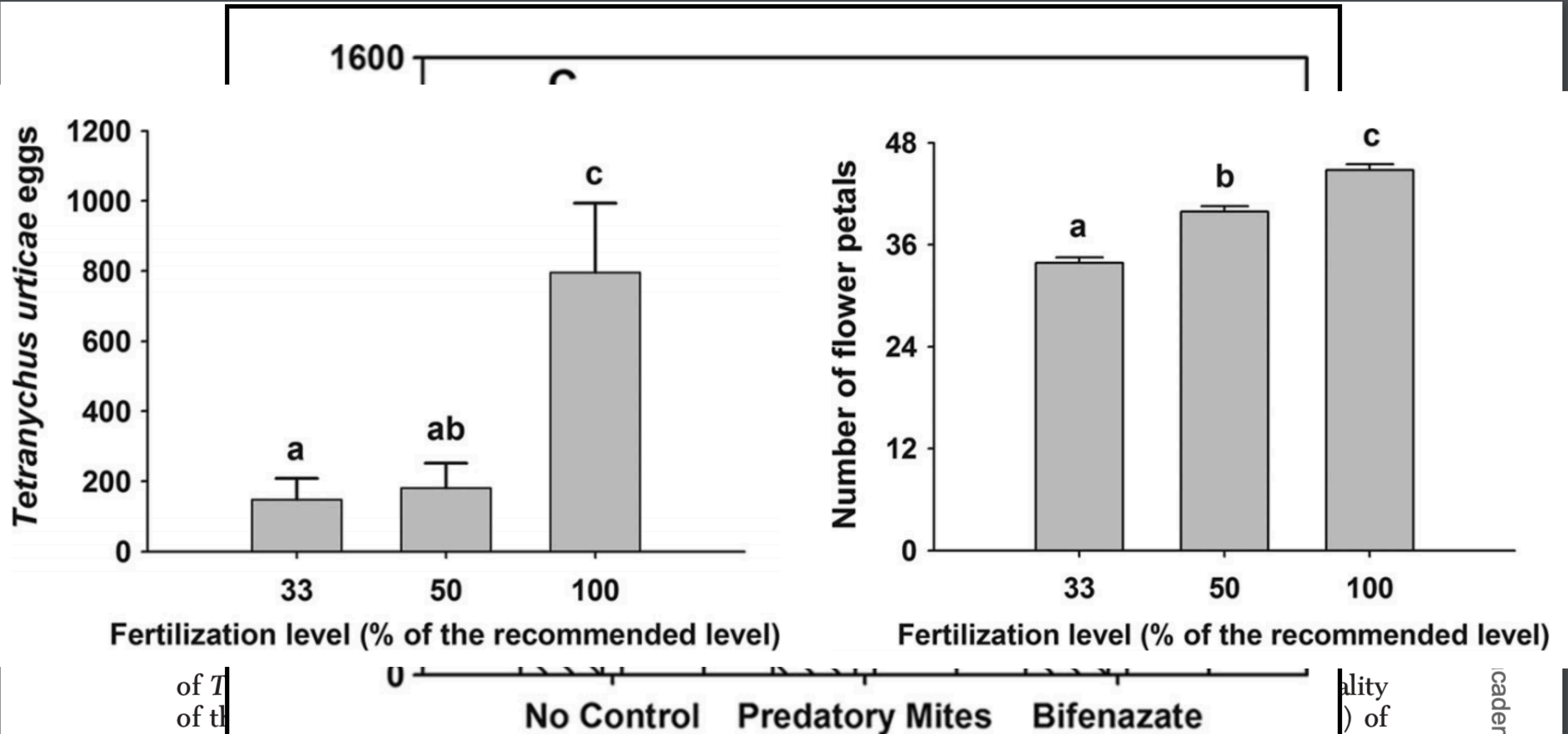
ANDREW CHOW,^{1,2} AMANDA CHAU,^{1,3} AND KEVIN M. HEINZ¹

J. Econ. Entomol. 102(5): 1896–1907 (2009)

ABSTRACT Fertilization reduction could be a useful pest management tactic for floriculture crops if it reduced pest populations with little loss in crop yield and quality. We evaluated the response of the twospotted spider mite, *Tetranychus urticae* Koch (Acari: Tetranychidae), to different fertilization levels for cut roses, *Rosa hybrida* L. ‘Tropicana’ and quantified fertilization effects on 1) management of *T. urticae* on roses, 2) abundance and distribution of *T. urticae* on roses, and 3) yield and quality of the cut rose crop. We tested two fertilization levels, 10% (15 ppm N) and 100% (150 ppm N) of the recommended level for commercial production, and three control methods: no control measure:



Twospotted spider mites | Fertilizer



Caterpillars



Caterpillars



Caterpillars



Caterpillars



Photo Cred: Allen Knutson & Mike Merchant

Caterpillars



Caterpillars



Caterpillars

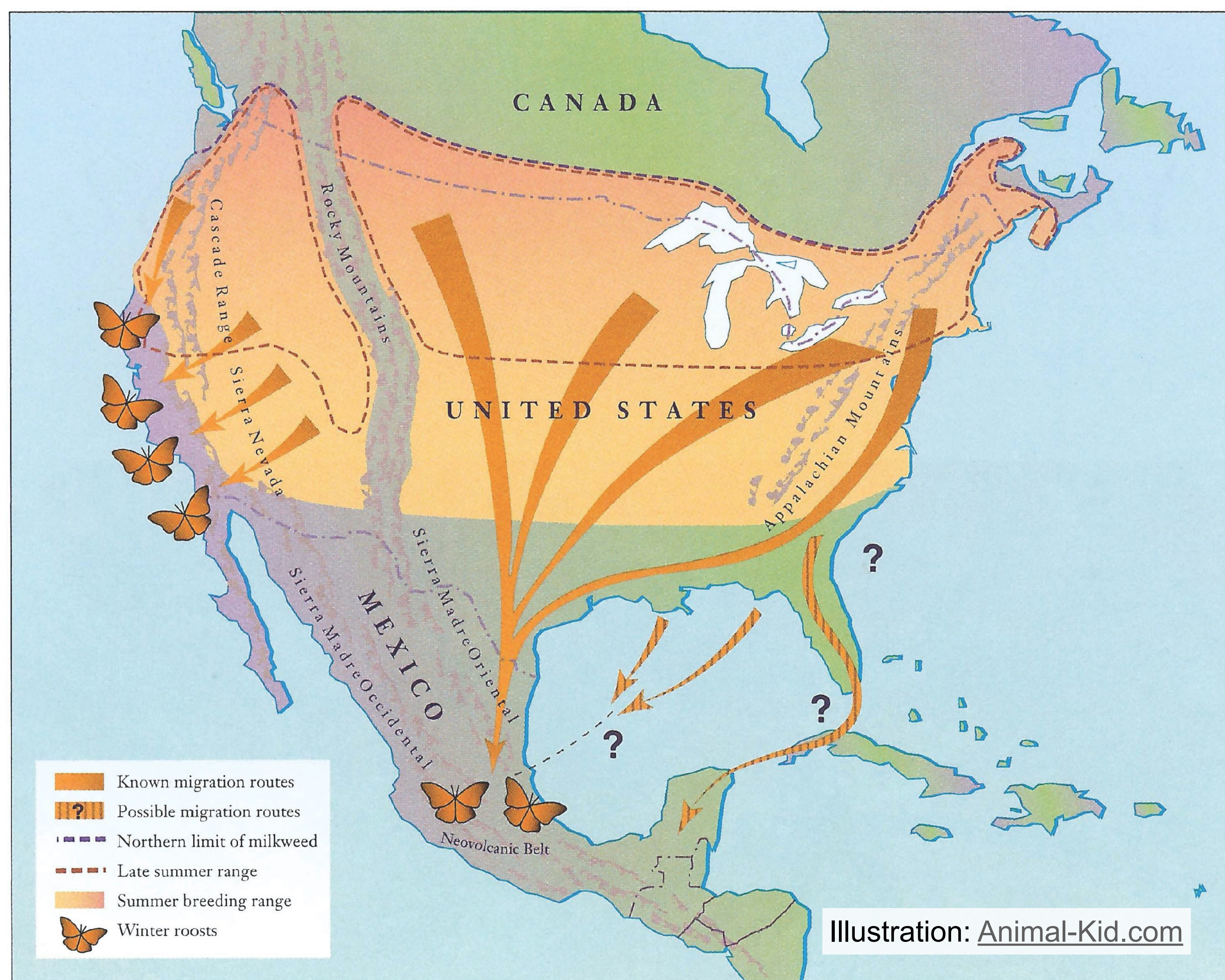
Photo Cred: [Daily Mail](#)







Vafaie 2015





Whiteflies & Aphids



Honeydew



Sooty mold





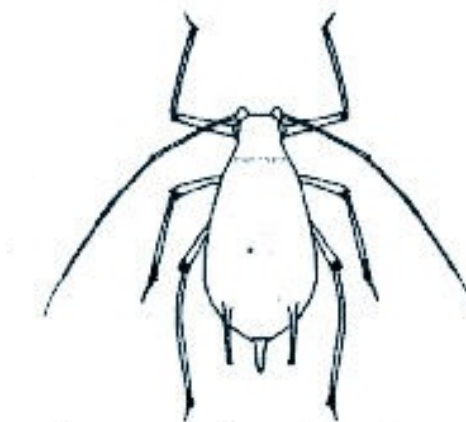
Whiteflies & Aphids



Whiteflies & Aphids

Overwinter

Short daylength
Cooler temperature
Degrading habitat



Asexual wingless
female





[Katja Schulz](#), Flickr, [Some rights reserved](#)



Green Lacewing Adult

Judy Gallagher, Flickr, Some rights reserved



Lacewing larva



Leaffooted bugs

Leaffooted bugs



UC Statewide IPM Project
© 2014 Regents, University of California
Photo by David R Haviland

Adult *Leptoglossus zonatus*



UC Statewide IPM Project
© 2009 Regents, University of California
Photo by Larry L. Strand

Adult *Leptoglossus occidentalis*



UC Statewide IPM Project
© 2000 Regents, University of California
Photo by Jack Kelly Clark

Adult *Leptoglossus clypealis*



Leaffooted bugs

Not to be confused with...

Assassin bugs



[John Flannery, flickr.com](#), [Some rights reserved](#)

A close-up photograph of a wheel bug (Spizella) resting on a large, green, oval-shaped leaf. The insect is positioned in the center-right of the frame, facing left. It has a greyish-brown body with a prominent, spiky, shield-like structure on its back. Its long, thin legs are spread out, and its antennae are visible. The background is filled with other green leaves and some blurred purple flowers, creating a natural, outdoor setting.

Wheel bug



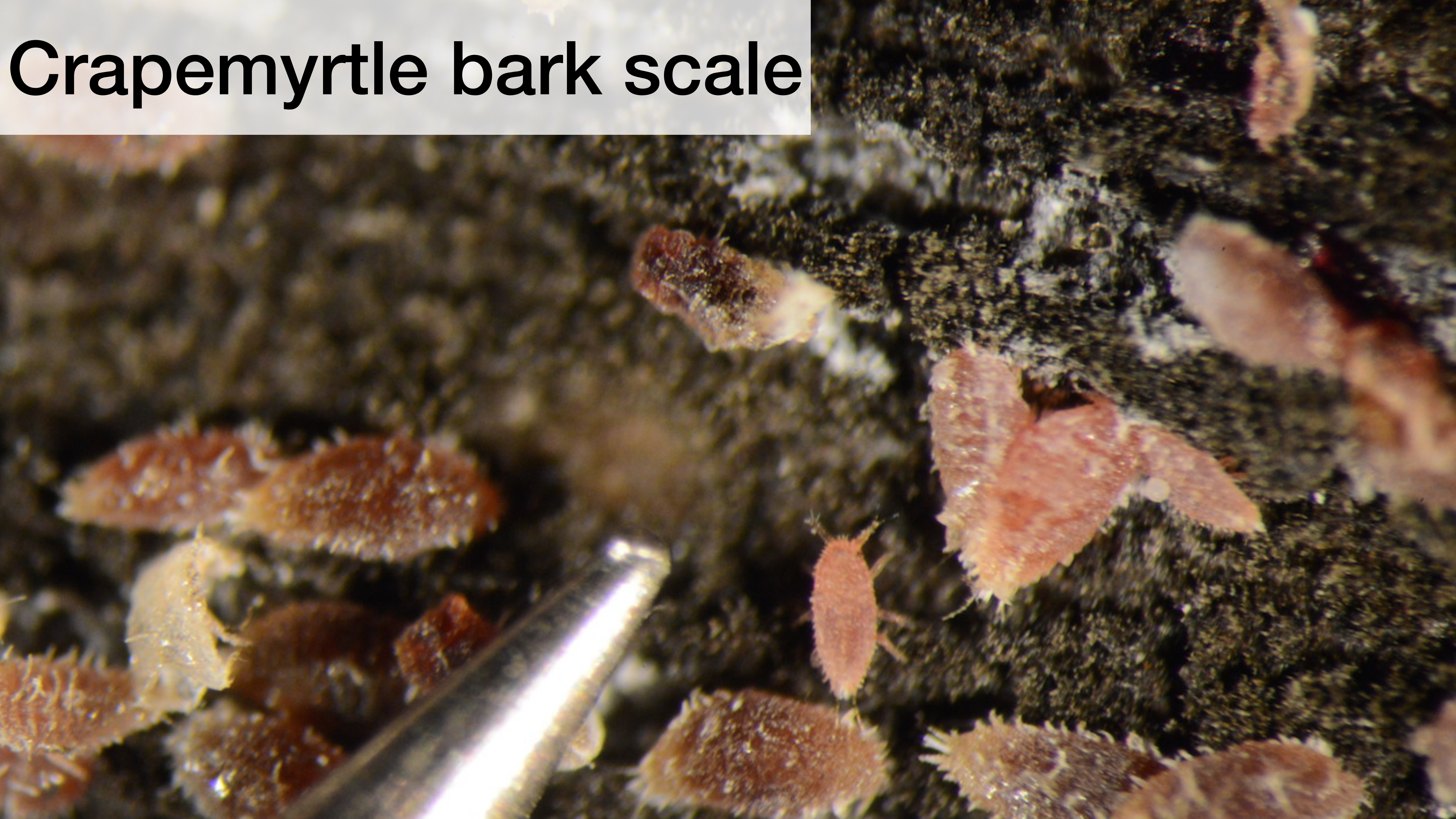
Crapemyrtle bark scale

North Amer. First sighting:
2004, Northern Texas

Now found in:
TX, OK, LA, AR, NM, TN, GA,
AL, MS, NC, SC, VA, and WA

Originally from:
Asia
[*Acanthococcus*
lagerstroemiae
(Hemiptera: Eriococcidae)]

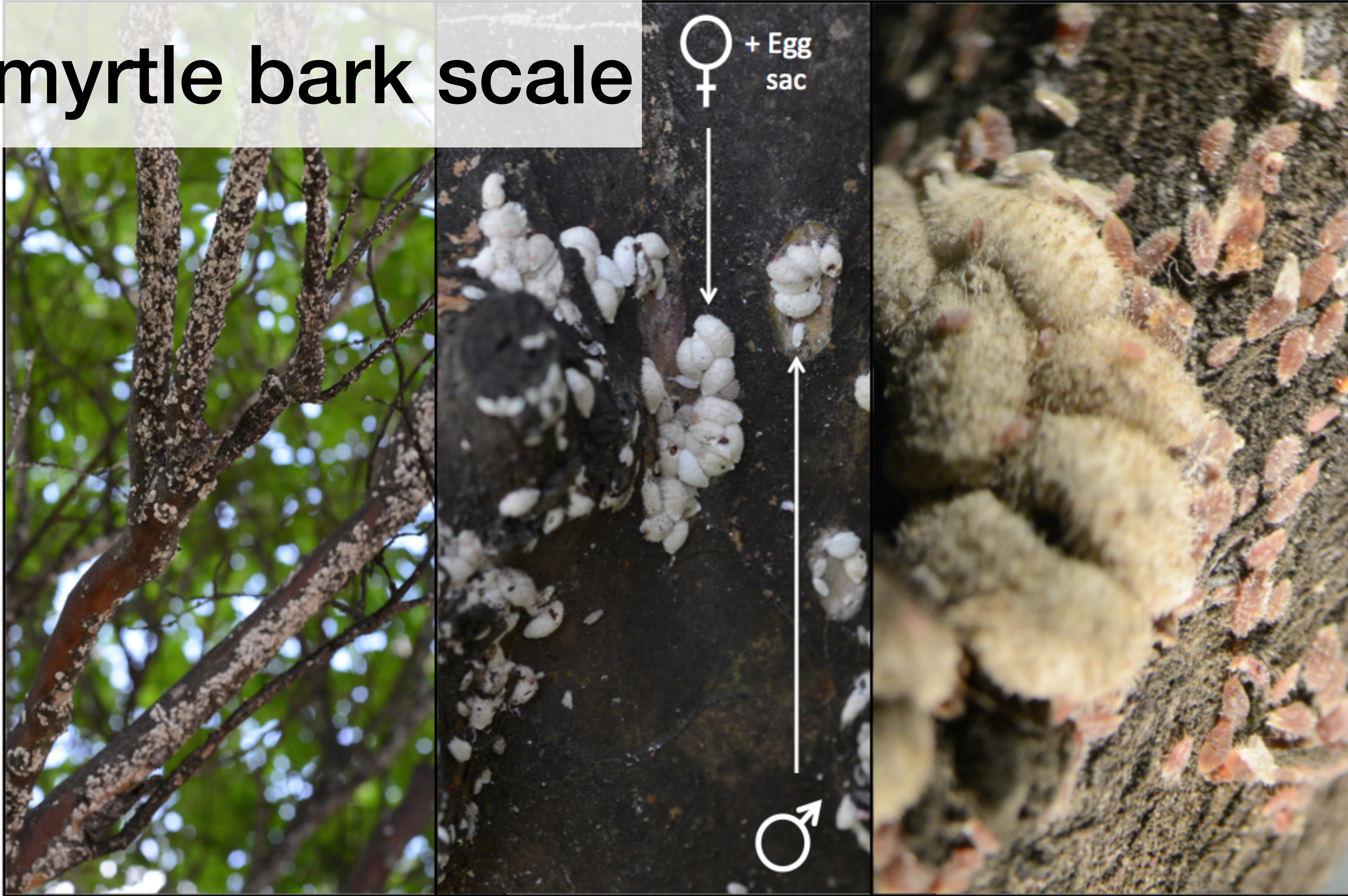
Crapemyrtle bark scale



Crapemyrtle bark scale



Crapemyrtle bark scale



Crapemyrtle bark scale | Nymph (2nd instar)



0.5 mm

Photo courtesy of Zinan Wang et al., LSU

Crapemyrtle bark scale



Crapemyrtle bark scale



60 – 250 eggs/female (n=20)

Crapemyrtle bark scale | Male adult

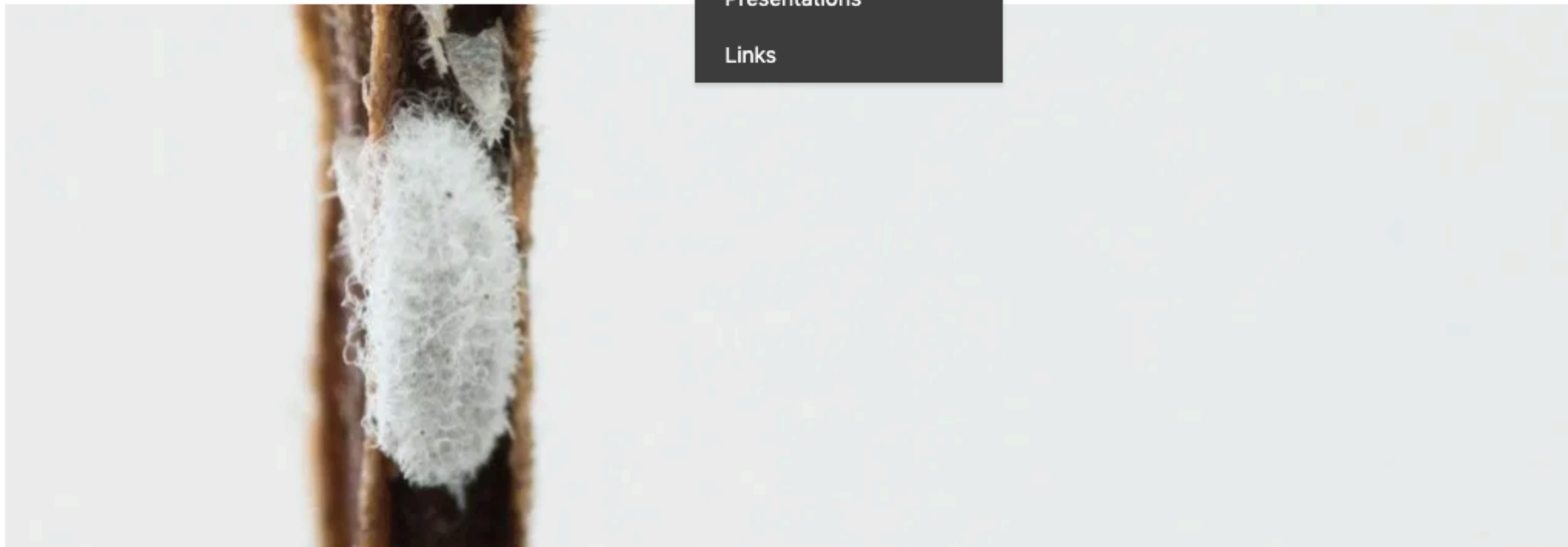


Photo courtesy of Zinan Wang et al., LSU

STOPCMBS.COM

Crapemyrtle Bark Scale

Resource Website

[Home](#)[Crapemyrtle Bark Scale](#) ▾[Report](#)[Updates](#)[Resources](#) ▾[About](#) ▾[Videos](#)[Presentations](#)[Links](#)

Welcome to the crapemyrtle bark scale resources page. See below for additional information about crapemyrtle bark scale biology,

STOPCMBS.COM

[Home](#)[Crapemyrtle Bark Scale](#) ▾[Report](#)[Updates](#)[Resources](#) ▾[About](#) ▾

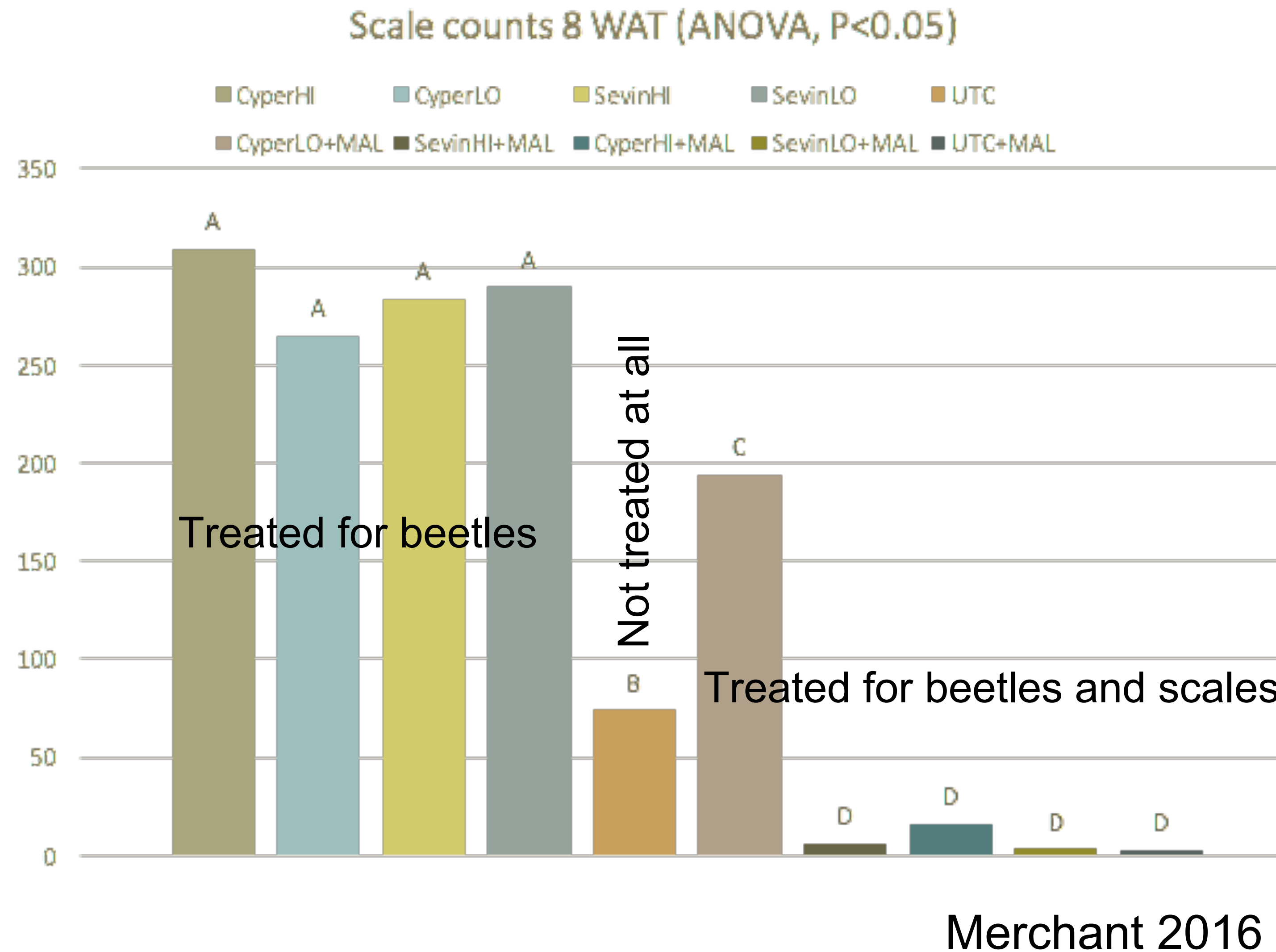
Videos

2018. How to treat for crapemyrtle bark scale. Dr. Michael Merchant.

Length: 9 minutes and 24 seconds.



Crapemyrtle bark scale



CMBS NATURAL ENEMIES

2cm = ~1mm

Coccine IIids



H. bigeminata



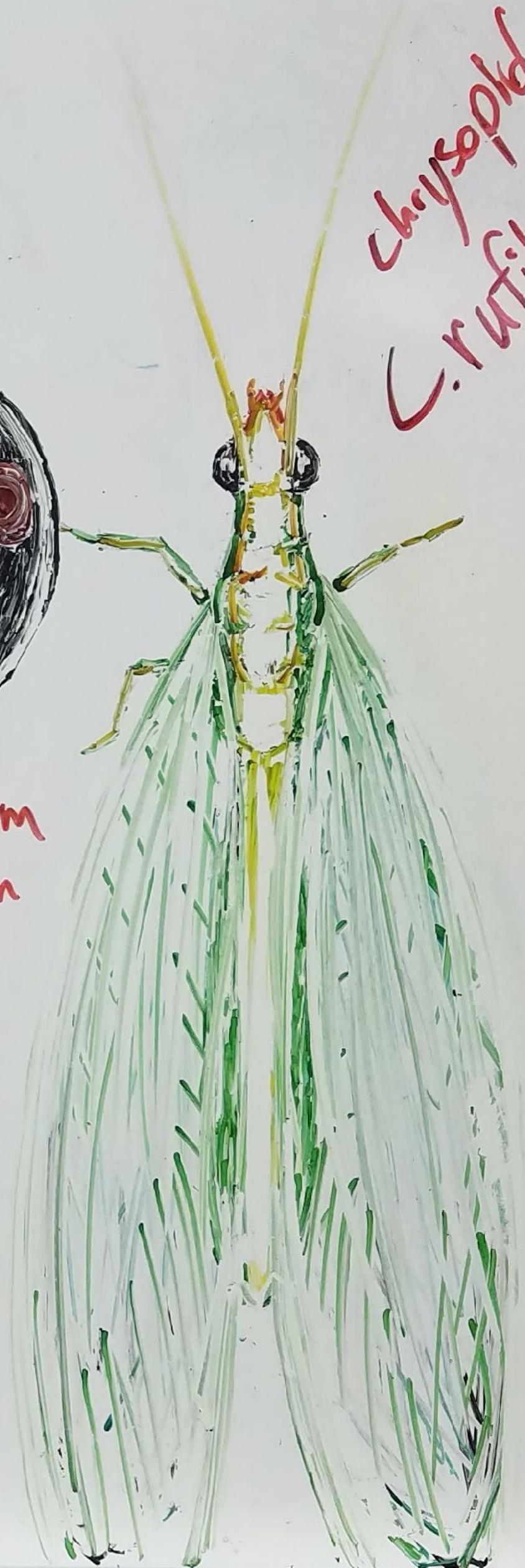
H. lateralis



C. Cacti



A. plagiatum
var. *texanum*



Chrysopa
rufilabris

Kyle Gilder, Texas A&M

is lateralis

Crapemyrtle bark scale?



Monitoring/Scouting

Invasives | Lantern fly



Lawrence Barringer, Pennsylvania Department of Agriculture, Bugwood.org

Monitoring/Scouting

Invasives | Lantern fly

- *Lycorma delicatula*
- First detected in Pennsylvania in 2014.
- (2018) also found in Delaware, New Jersey, New York, Pennsylvania and Virginia
- Introduced from Asia
- Preferred Plant Host: Tree of Heaven (*Ailanthus altissima*)

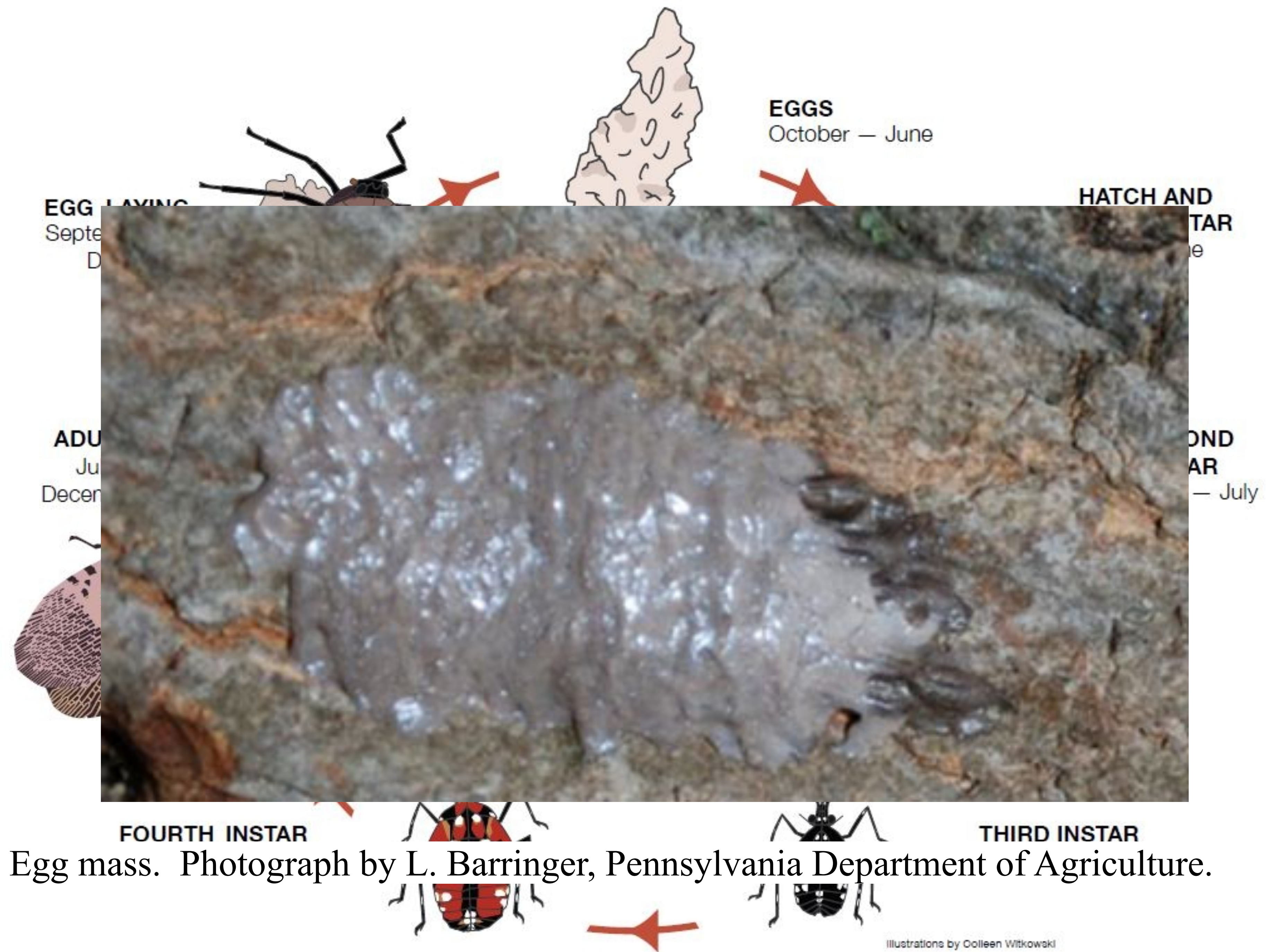


Monitoring/Scouting

Invasives | Lantern fly

- Sucking pest
 - Produced honeydew and subsequent sooty mold
- Feeds on over 70 host plants, including grapes, hops, apples, cherry, stone fruits and walnuts





Egg mass. Photograph by L. Barringer, Pennsylvania Department of Agriculture.

Monitoring/Scouting

Invasives | Lantern fly



https://www.youtube.com/watch?time_continue=26&v=vE1QJ4ADV7c

Photograph by Lyle J. Buss, University of Florida.

Emerald Ash Borer



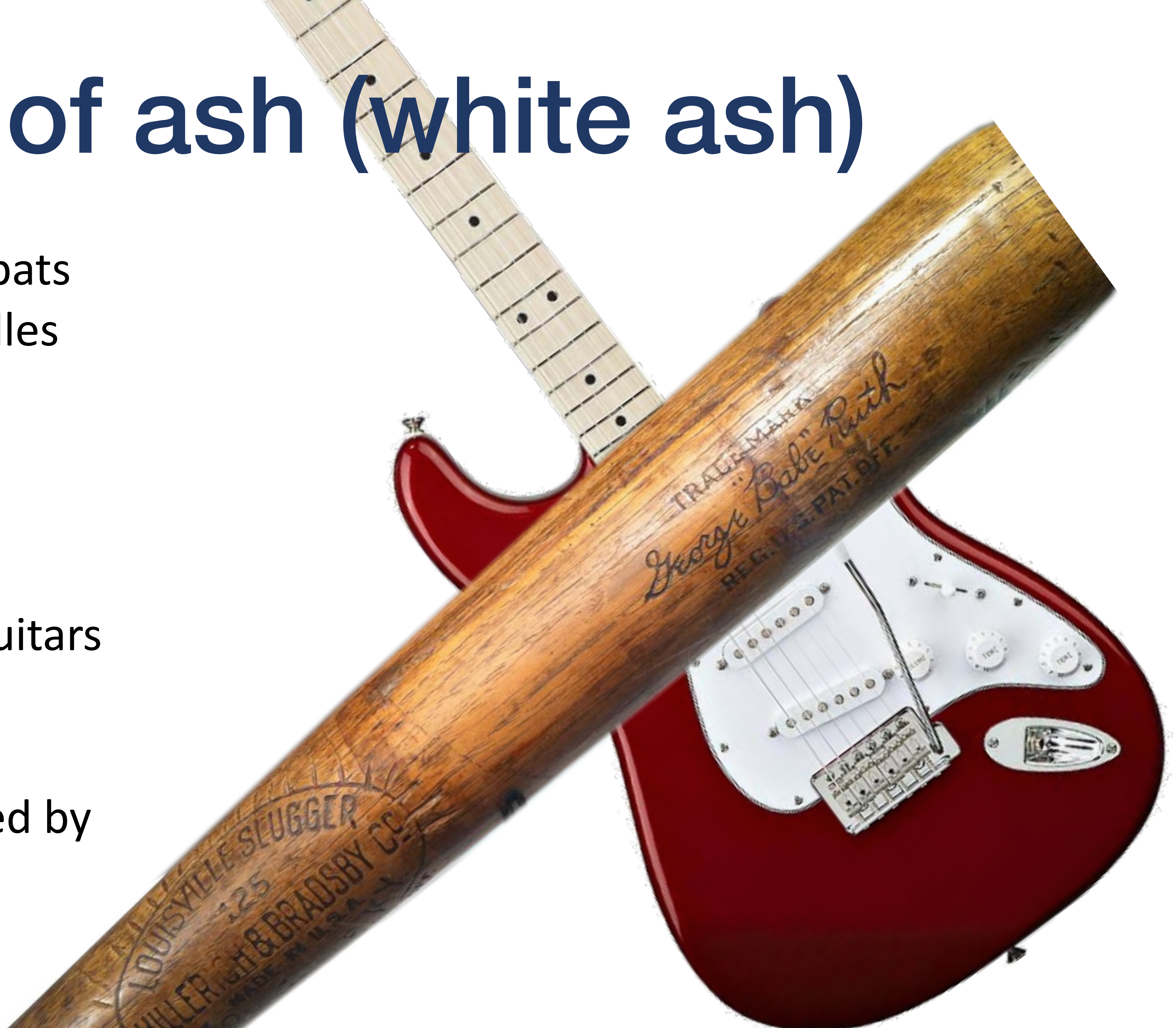
Ash in the United States

- *Fraxinus*: genus of flowering trees in family, Oleaceae
- 21 species of trees in North America north of Mexico
- Opposite leaves, usually pinnately compound



Uses of ash (white ash)

- Baseball bats
- Tool handles
- Oars
- Pallets
- RR ties
- Bows
- Electric guitars
- Firewood
- Furniture
- Seeds used by birds

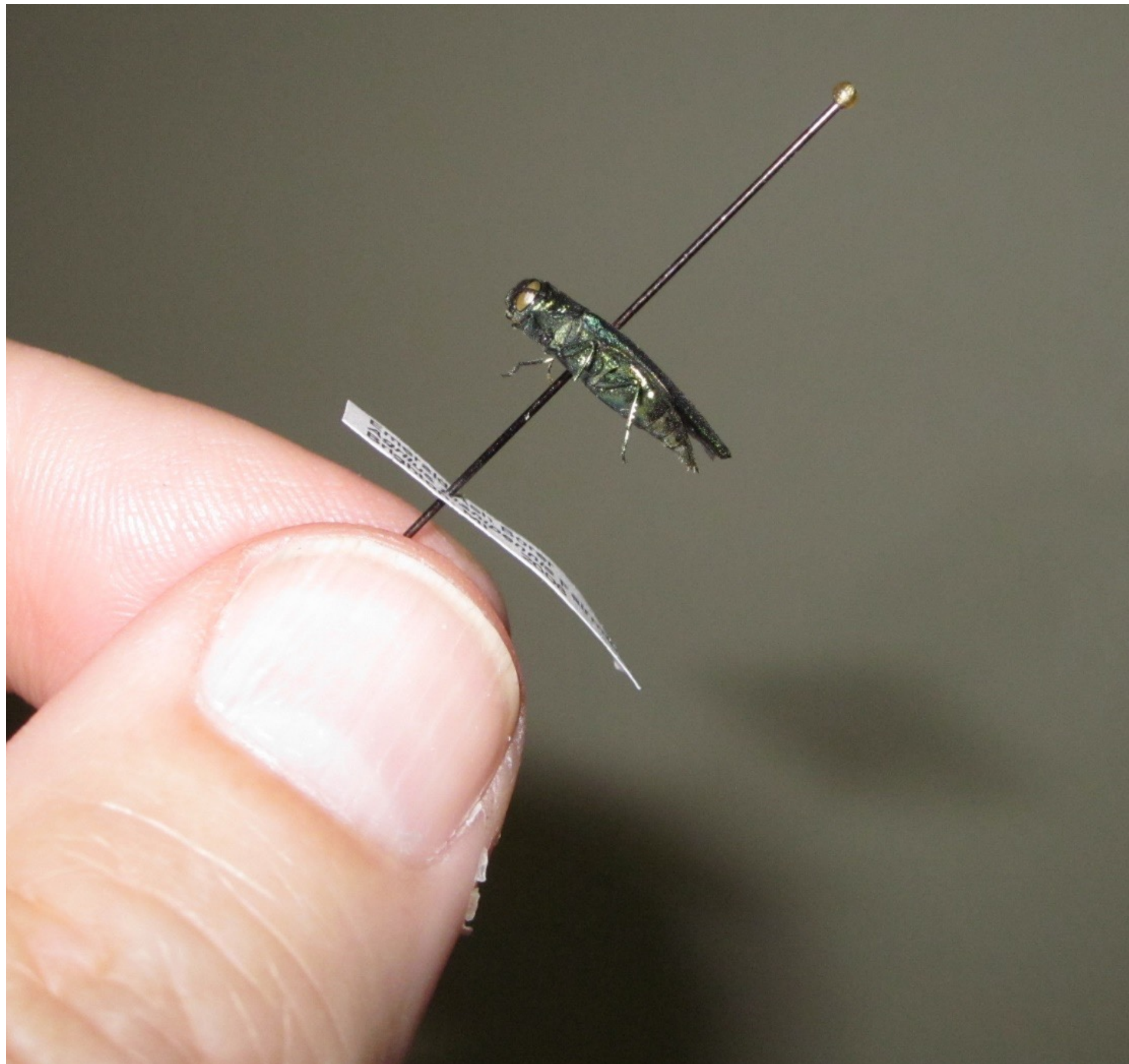


Emerald ash borer

- *Agrilus planipennis* (Coleoptera: Buprestidae)
- Native of Asia, first detected in Detroit MI in 2002 (prob. had been in MI since early 1990s)
- By 2008, 1 million dead or dying ash trees in SE Michigan



History of EAB in U.S.



- Initially very little known about this insect
- Range from China, Korea, E. Russia
- Two pages in a Chinese textbook and a few taxonomic descriptions in journals

History of ash borer in U.S.

- Attacks all species of ash
- In U.S. attacks not only weakened trees, but healthy trees
- Attacks trees in forests and urban sites
- In MI, more than 99% of forest ash with stems >2.5 cm killed



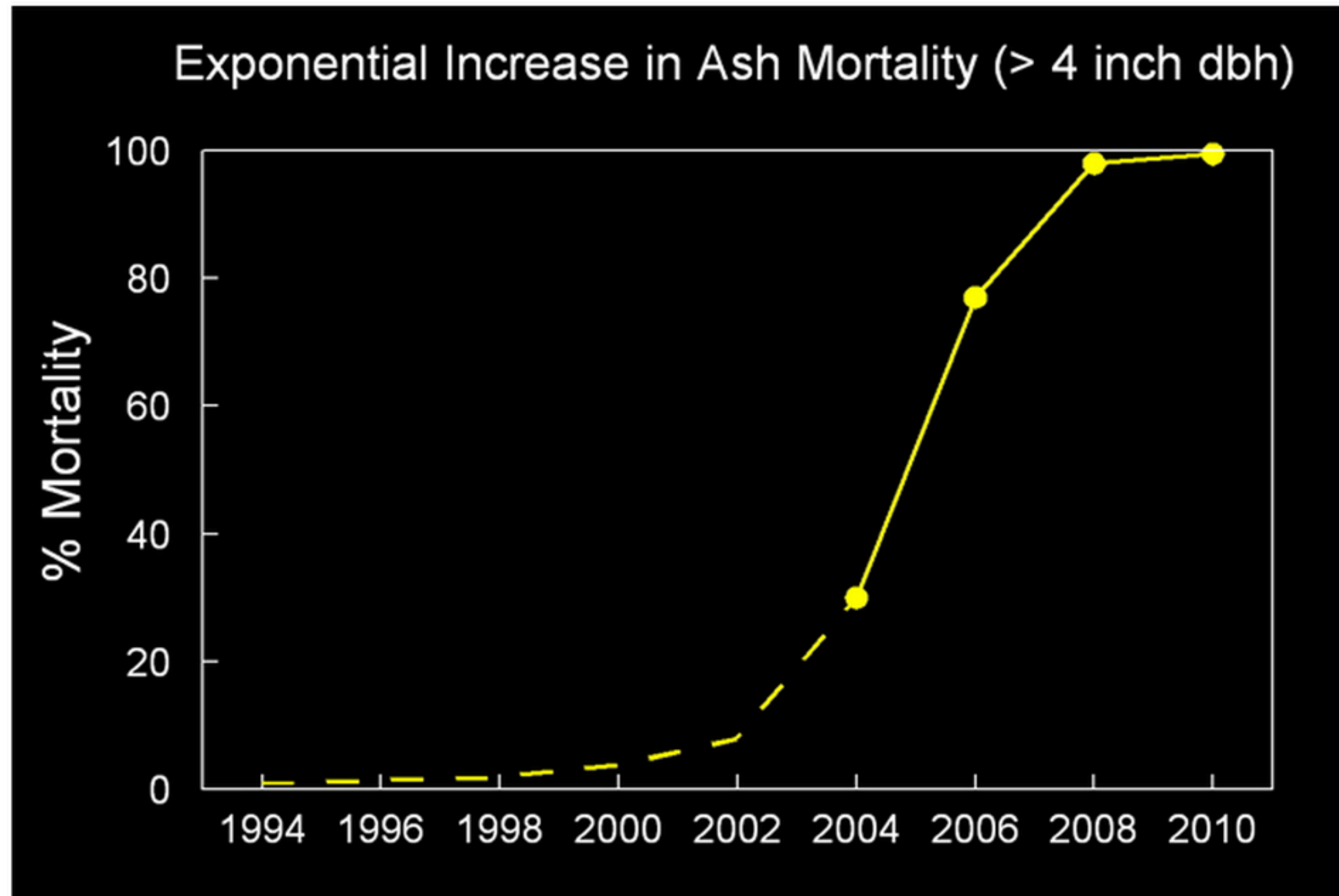
Impact

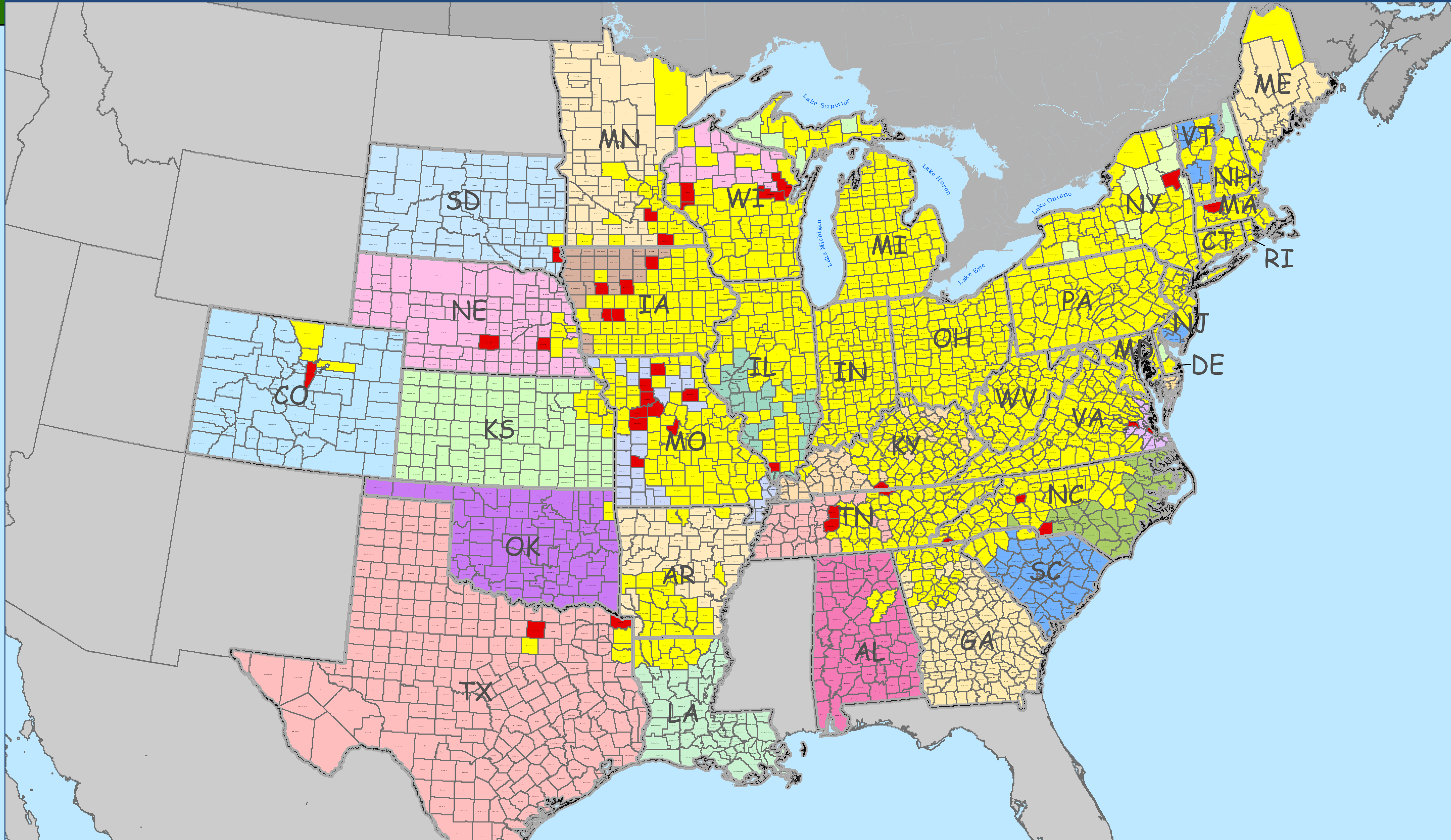
- Larvae feed under bark, disrupt transport of water, nutrients
- Healthy trees killed within 1-3 years of first symptoms
- All sized trees attacked



Courtesy Dan Hermes, Ohio State University
Efficacy of insecticide treatments for EAB: they do work! July 2012

EAB-Induced Ash Mortality in the Upper Huron River Watershed, SE Michigan





Adult emergence begins in mid-to late May, peaks in early to mid-June and continues into late June.



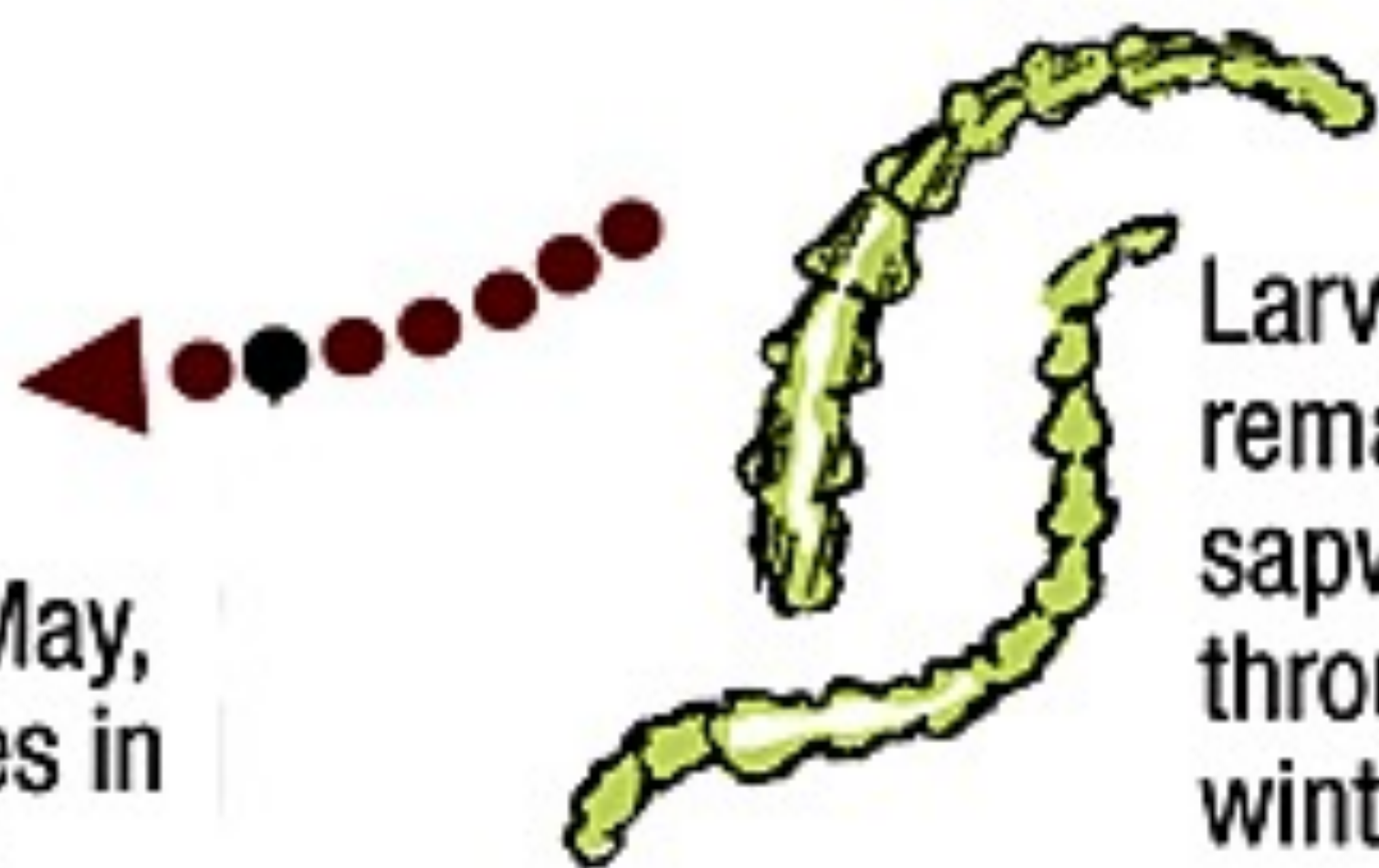
Life cycle of the ash borer

An adult can live for two to three weeks.



Females lay 65-90 eggs during their lifetime.

pupation begins in late April or May, leaving behind a network of holes in the tree which eventually kills it.



Larvae remain in sapwood through winter.

Recognizing damage

Emerald Ash Borer Larva



Courtesy Phil Nixon, University of Illinois

EAB larvae



UGA5016056



Emergence Hole

Courtesy Phil Nixon, University of Illinois



Serpentine tunnels



Cornelia Schaible E+ Getty Images

EAB-encouraged Woodpecker Damage “flecking”



EAB thinning canopy & epicormic branching



Courtesy Phil Nixon, University of Illinois



Courtesy Phil Nixon, University of Illinois

Pesticides

What are pesticides?

Pesticide Use

- Low residual
- High specificity
- “Natural” not always better
- Bee Advisory Box
- Good IPM Practices

THE NEW EPA BEE ADVISORY BOX
On EPA's new and strengthened pesticide label to protect pollinators

The diagram illustrates the 'PROTECTION OF POLLINATORS' section of a pesticide label. It features a bee icon in a diamond shape, which is highlighted by a callout box stating: 'The new bee icon helps signal the pesticide's potential hazard to bees.' The label text includes: 'APPLICATION RESTRICTIONS EXIST FOR THIS PRODUCT BECAUSE OF RISK TO BEES AND OTHER INSECT POLLINATORS. FOLLOW APPLICATION RESTRICTIONS FOUND IN THE DIRECTIONS FOR USE TO PROTECT POLLINATORS.' A callout points to this text, stating: 'Alerts users to separate restrictions on the label. These prohibit certain pesticide use when bees are present.' Below this, it says: 'Look for the bee hazard icon in the Directions for Use for each application site for specific use restrictions and instructions to protect bees and other insect pollinators.' A callout points to the bee icon here, stating: 'Makes clear that pesticide products can kill bees and pollinators.' The label then states: 'This product can kill bees and other insect pollinators. Bees and other insect pollinators will forage on plants when they flower, shed pollen, or produce nectar.' A callout points to this text, stating: 'Bees are often present and foraging when plants and trees flower. EPA's new label makes it clear that pesticides cannot be applied until all petals have fallen.' Below this, it lists exposure routes: 'Bees and other insect pollinators can be exposed to this pesticide from: Direct contact during foliar applications, or contact with residues on plant surfaces after foliar applications; Ingestion of residues in nectar and pollen when the pesticide is applied as a seed treatment, soil, tree injection, as well as foliar applications.' A callout points to this list, stating: 'Warns users that direct contact and ingestion could harm pollinators. EPA is working with beekeepers, growers, pesticide companies, and others to advance pesticide management practices.' The label then says: 'When Using This Product Take Steps To: Minimize exposure of this product to bees and other insect pollinators when they are foraging on pollinator attractive plants around the application site; Minimize drift of this product on to beehives or to off-site pollinator attractive habitat. Drift of this product onto beehives can result in bee kills.' A callout points to the word 'Drift', stating: 'Highlights the importance of avoiding drift. Sometimes, wind can cause pesticides to drift to new areas and can cause bee kills.' At the bottom, it provides information on protecting bees and other insect pollinators, including a link to the Environmental Stewardship website: <http://pesticidestewardship.org/pollinatorprotection/Pages/default.aspx>. A callout points to this link, stating: 'The science says that there are many causes for a decline in pollinator health, including pesticide exposure. EPA's new label will help protect pollinators.'

EPA

Read EPA's new and strengthened label requirements: <http://go.usa.gov/jHH4>

Pesticide Use

150 lbs person = 68 kg

~0.0033 oz / cup of coffee
0.46 oz = ~140 cups of coffee

1 apple seed ~ 0.24 mg of cyanide
0.01 oz = 1,181.2 apple seeds

13.4 oz →

7.2 oz →

0.46 oz →

0.24 oz →

0.01 oz →

Acute toxicity Life-threatening one-time doses

SUBSTANCE	FOUND IN	Lethal dose (LD50 mg/kg)	CATEGORY
Water	... Water	90000	Practically non-toxic
Sucrose	Table sugar	30000	
Monosodium glutamate	Flavor enhancer, soy, cheese	16000	
Ethanol	Alcoholic beverages	7000	
Glyphosate	Herbicide (RoundUp)	5600	
Aluminum hydroxide	Antacid, vaccine adjuvant	>5000	Slightly toxic
Fructose	Fruits, component of sucrose	4000	
Spinosad	Organic insecticide	3700	
Sodium chloride	Table salt	3000	
Eugenol	Clove oil, organic pesticide	2700	
Paracetamol (acetaminophen)	Tylenol, Panadol	2400	Moderately toxic
Vanillin	Vanilla bean, vanilla sugar	1600	
Hydrogen peroxide 70%	Bleach, disinfectant	1000	
Theobromine	Chocolate, tea, guarana	950	
Copper sulfate	Organic fungicide	300	
Chlorpyrifos	Organophosphate insecticide	230	Highly toxic
Caffeine	Natural pesticide, coffee plant	190	
Lead	Batteries, cables, paints	155*	
DDT	Restricted insecticide	100	
Rotenone	Restricted organic pesticide	60	
Vitamin D3	Supplements, fish, mushrooms	37	Highly toxic
Nicotine	Natural pesticide, tobacco	10	
Mycotoxin T2	Plant pathogen, moldy grain	5	
Aflatoxin	Soil fungus, moldy foods	5	
Hydrogen cyanide	Fruit pits, bitter cassava	4	
Botulinum toxin	Botox, Clostridium botulinum	0.001	

LD50: Generally rat oral. Botulinum: mouse and human, nicotine: human, cyanide: mouse.

*Lead: no LD50, lowest human lethal dose included. Colours: EPA toxicity categories.



Thoughtscapism

Measures of Toxicity
thoughtscapism.com

Sources: EFSA, WHO,
EPA, NIH, NHS

Mommy
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Pesticide Use



How to Manage Pests

Pesticide Active Ingredient	Potential Hazard ¹ to					Notes
	Water quality ² (aquatic wildlife)	Natural enemies (beneficials)	Honey bees ³	People and Other Mammals		
				Acute ⁴	Long Term ⁵	
Azadirachtin	<div><div></div>M</div>	<div><div></div>LM</div>	<div><div></div>M</div>	<div><div></div>VL</div>	Not listed	
Dinotefuran	<div><div></div>L</div>	<div><div></div>LH</div>	<div><div></div>VH</div>	<div><div></div>L</div>	Not listed	
Horticultural oil	<div><div></div>NKR</div>	<div><div></div>L</div>	<div><div></div>M</div>	<div><div></div>VL</div>	Not listed	
Neem oil	<div><div></div>NKR</div>	<div><div></div>L</div>	<div><div></div>M</div>	<div><div></div>VL</div>	Not listed	
Pyrethrin	<div><div></div>H</div>	<div><div></div>M</div>	<div><div></div>M</div>	<div><div></div>L</div>	Not listed	
Soap	<div><div></div>NKR</div>	<div><div></div>L</div>	<div><div></div>L</div>	<div><div></div>VL</div>	Not listed	
Spinosad	<div><div></div>L</div>	<div><div></div>LM</div>	<div><div></div>M</div>	<div><div></div>L</div>	Not listed	

- On US EPA list: Not listed;
- On CA Proposition 65 list: Not listed

Water Quality Rating²

Insecticide resistance



Arthropod Pesticide Resistance Database

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Order: **Family:** **Genus:** **Active Ingredient:**

MOA Abbr:

Resistance Year: **Publication Year:** **Country:**

Parameters: **Selecting multiple parameters from same category is treated as OR**

Genus: [**bemisia X**]

Genus Species	Taxonomy (family - order)	Common Name(s)	# Cases	Group
bemisia argentifolii	aleyrodidae homoptera	silverleaf whitefly	22	AG
bemisia tabaci	aleyrodidae homoptera	sweetpotato whitefly	593	AG

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Insecticide resistance



Arthropod Pesticide Resistance Database

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Order: Family: Genus: Active Ingredient: MOA Abbr:

Resistance Year: Publication Year: Country: Type of Resistance:

Parameters: **Selecting multiple parameters from same catagory is treated as OR**

Order: [**thysanoptera X**]

Genus Species	Taxonomy (family - order)	Common Name(s)	# Cases	Group
chaetanaphothrips orchidii	thripidae thysanoptera	orchid thrips	2	AG
diarthrothrips coffeae	thripidae thysanoptera	coffee thrips	1	AG
frankliniella occidentalis	thripidae thysanoptera	western flower thrips	175	AG
frankliniella tritici	thripidae thysanoptera	flower thrips	2	AG
scirtothrips citri	thripidae thysanoptera	citrus thrips	22	AG
scirtothrips dorsalis	thripidae thysanoptera	Cilli thrips / Yellow tea thrips	2	AG
taeniothrips simplex	thripidae thysanoptera		1	AG
Thrips hawaiiensis	thripidae thysanoptera		1	AG
thrips palmi	thripidae thysanoptera	melon thrips	5	AG
thrips tabaci	thripidae thysanoptera	onion thrips	114	AG

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Citation of the Arthropod Pesticide Resistance Database:

Mota-Sanchez, D. and J.C. Wise. 2020. The Arthropod Pesticide Resistance Database.

Michigan State University. On-line at: <http://www.pesticideresistance.org>



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Insecticide Resistance Action Committee | irac-online.org

www.irac-online.org/modes-of-action/

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MODES OF ACTION

The IRAC Mode Of Action (MoA) Classification is the definitive global authority on the target site of insecticides. It is the basis of MoA labelling of insecticides worldwide and is an essential tool for the development of insecticide resistance management (IRM) strategies. For more information please visit the [MoA Team](#) page, and should you wish you are welcome to [submit an active](#) for classification by the IRAC MoA Team.


The colour scheme below associates mode-of action into broad categories based on the physiological functions affected, as an aid to understanding symptomology, speed of action and other properties of the insecticides, and not for any resistance management purpose. Rotations for resistance management should be based only on the numbered mode of action groups.

■ Nerve & Muscle ■ Growth ■ Respiration ■ Midgut ■ Unknown or Non-Specific

Q FILTER BY MODE OF ACTION, CHEMICAL CLASS OR ACTIVE...


1 ACETYLCHOLINESTERASE (ACHE) INHIBITORS	2 GABA-GATED CHLORIDE CHANNEL BLOCKERS	3 SODIUM CHANNEL MODULATORS
A CARBAMATES	A CYCLOPROPENE ORGANOCHLORINES	A PYRETHROIDS, PYRETHRINS
B ORGANOPHOSPHATES	B PHENYLPYRAZOLES (FIPROLES)	B DDT, METHOXYCHLOR
4 NICOTINIC ACETYLCHOLINE RECEPTOR (NACHR) COMPETITIVE MODULATORS	5 NICOTINIC ACETYLCHOLINE RECEPTOR (NACHR) ALLOSTERIC MODULATORS	6 GLUTAMATE-GATED CHLORIDE CHANNEL (GLUC) ALLOSTERIC MODULATORS
A NEONICOTINOIDS	SPIROSYNS	AVERMECTINS, MILBEMYCINS
B NICOTINE		
C SULFOXAFLOR	8 MISCELLANEOUS NON-SPECIFIC (MULTI-SITE) INHIBITORS	9 MODULATORS OF CHORDONAL ORGANS
	A ALKYL HALIDES	B PYMETROZINE

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IR-4 Project Mission

The IR-4 Project aids growers by facilitating registrations of pesticides and biopesticides on specialty food crops (fruits, vegetables, nuts, herbs, spices) and environmental horticulture crops (trees, shrubs, flowers).

About IR-4

What We Do
Our Mission
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At IR-4, we are still diligently working to ensure growers have tools to successfully manage pest problems. Our collaborating network of institutions has individually mandated or strongly encouraged non-essential employees to work from home. Many others have been classified as essential and allowed to complete research as long as adequate social distancing is maintained. While some field locations are temporarily shuttered, administrative activities are continuing. We anticipate that some 2020 research experiments may be delayed or even compromised. Though we want to complete as much as possible, the personal safety of IR-4 team members is paramount.


IR-4 is actively tracking the status of our 2020 field research in the Food Program (residue trials, performance research and integrated solutions) and the Environmental Horticulture Program. Please view our [Food Crop Tracking Spreadsheet](#) to view current status in the food program. For the Environmental Horticulture Program, please visit [Search the Database](#). If you have any questions or need additional information, please reach out to the IR-4 Regional Offices and IR-4 Headquarters.

Regional Contacts

NorthEast Region [Marylee Ross](#)
NorthCentral Region [Anthony VanWoerkom](#)
Southern Region [Janine Spies](#)
Western Region [Michael Horak](#), [Stephen Flanagan](#) or [Mika Tolson](#)

HQ Contacts

General [Jerry Baron](#) or [Dan Kunkel](#)
Food Program Residue Studies [Debbie Carp](#)
Food Program Product Performance Project [Kun](#)
Food Program Integrated Solutions [Kun](#)



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IR4 Database for Insecticide Efficacy (Part I)

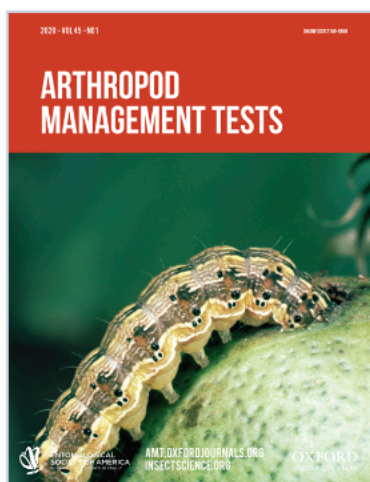
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1 January 2020

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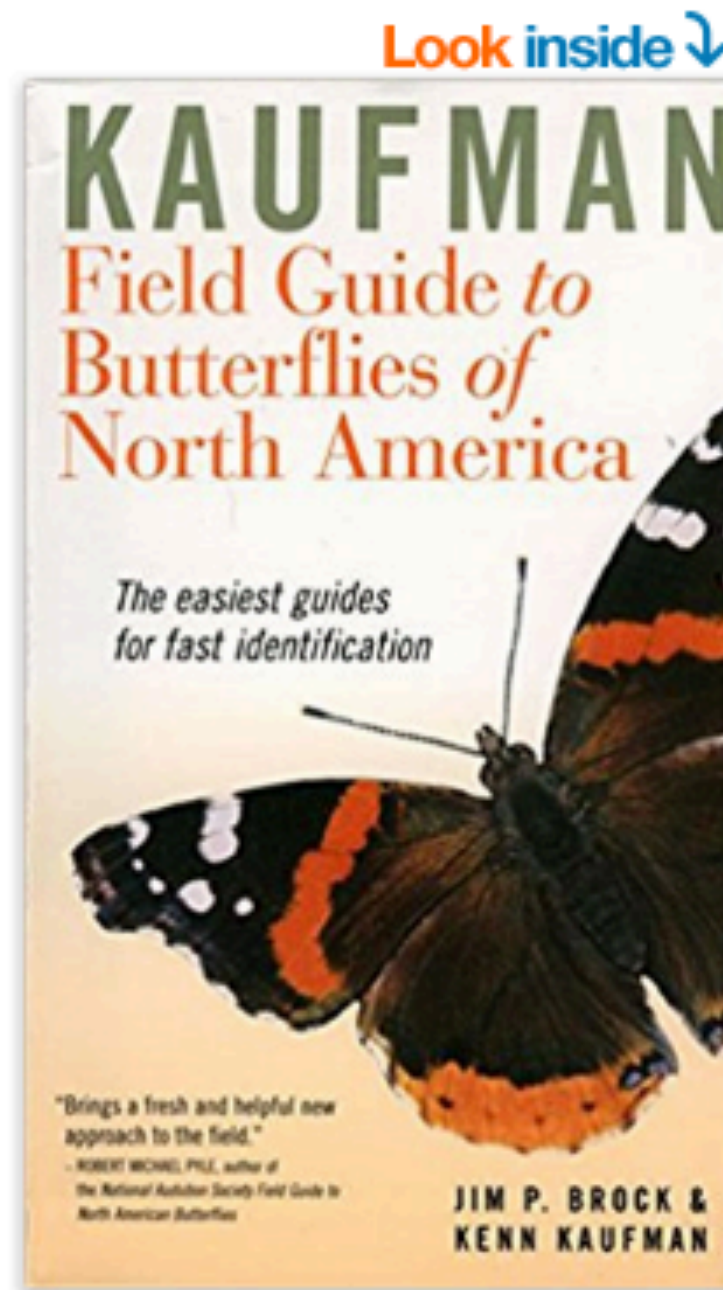
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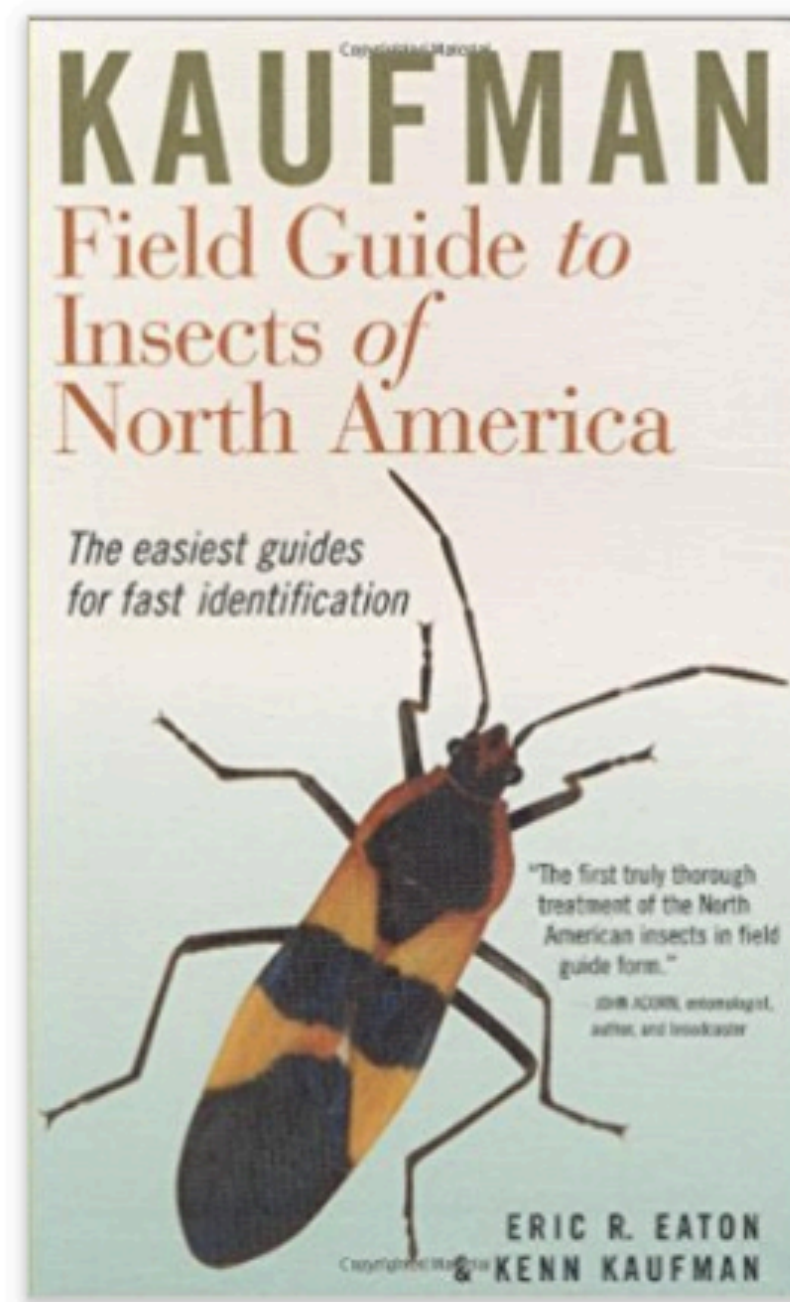
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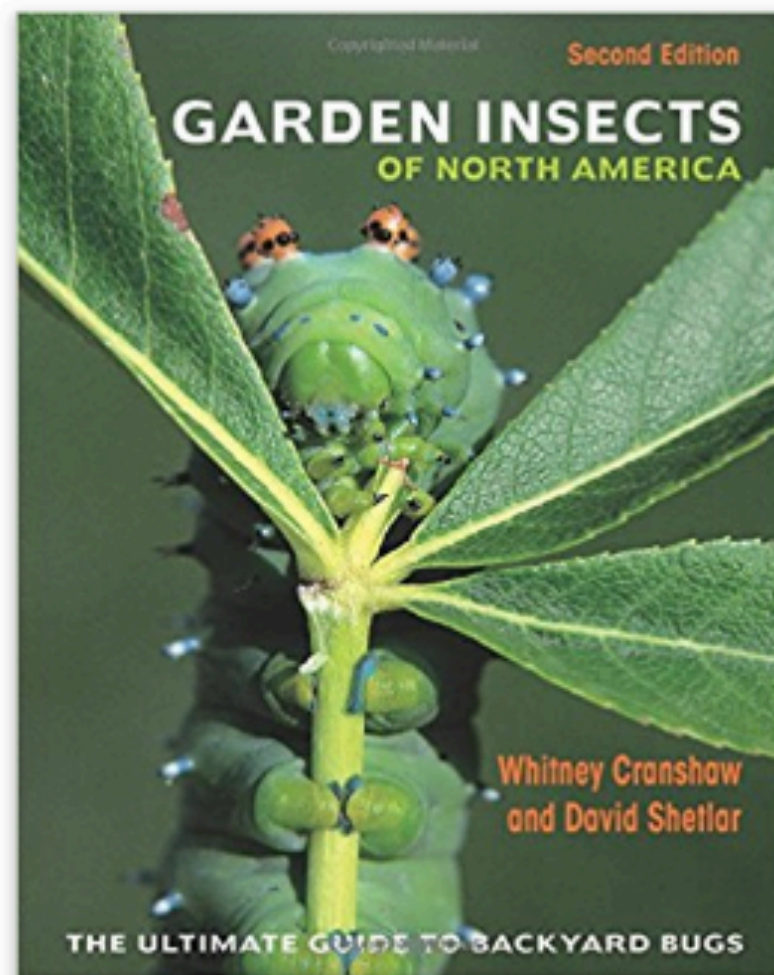
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Pollinators are responsible for **1 out of 3 bites** of food we take each day, and yet pollinators are at critical point in their own survival. Many reasons contribute to their recent decline. We know for certain, however, that more nectar and pollen sources provided by more flowering plants and trees will help improve their health and numbers. Increasing the number of pollinator-friendly gardens and

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Insects and Pollinators

Pollinators by Numbers

Three-fourths of the world's flowering plants and about 35 percent of the world's food crops depend on animal pollinators to reproduce. More than 3,500 species of native bees help increase crop yields. Some scientists estimate that one out of every three bites of food we eat exists because of animal pollinators like bees, butterflies and moths, birds and bats, and beetles and other insects.

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Bugs in Our Gardens

Thank you!

Erfan Vafaie
Extension Program Specialist IPM-II

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