From Concept to Product: Commercialization of Insect Pheromones

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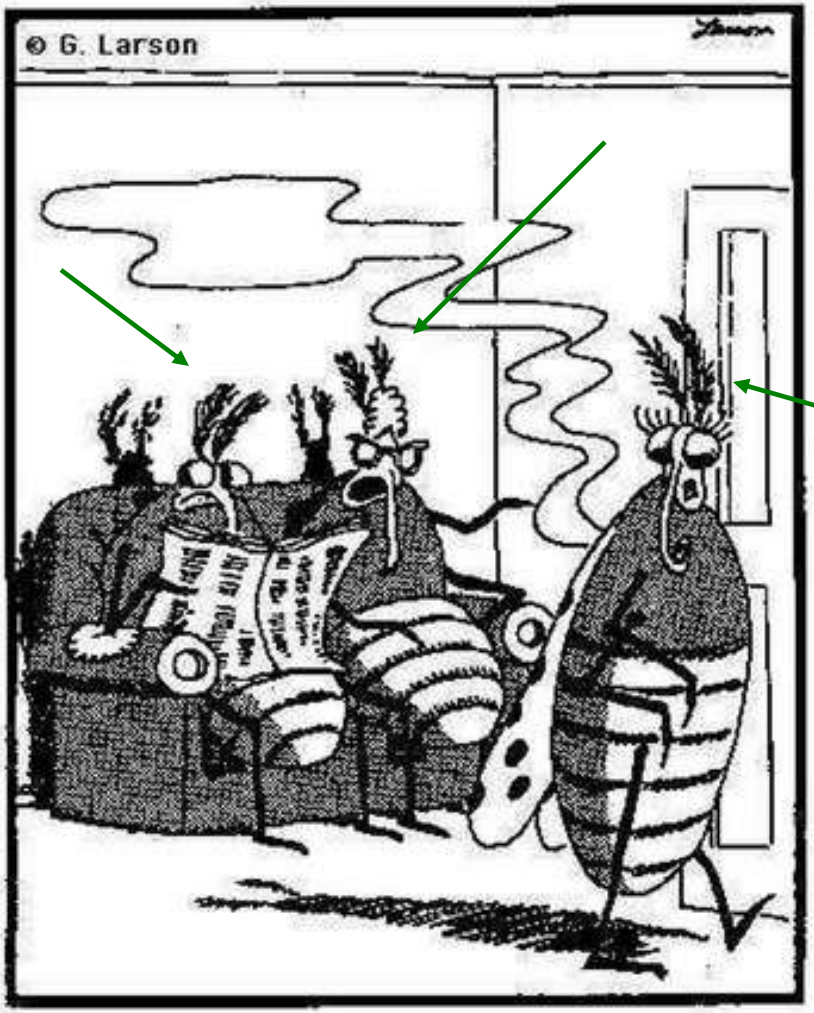
Outline of talk

- What is a pheromone?
- Types of insect pheromones
- Commercialization of pheromones
- How does this relate to the Brown Marmorated Stink Bug story?

What are pheromones?



"Hold it right there, young lady! Before you go out, you take off some of that makeup and wash off that gallon of pheromones!"

A chemical used for intraspecific communication.

How are they detected by insects?

What do insects use them for?

Alarm pheromones:

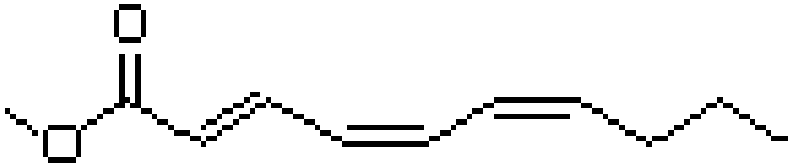
Result in: modified behavior to address danger

Examples: aphids dropping from branch, or simulating movement of wind to decoy predators; ants or bees swarming from the nest to confront predators

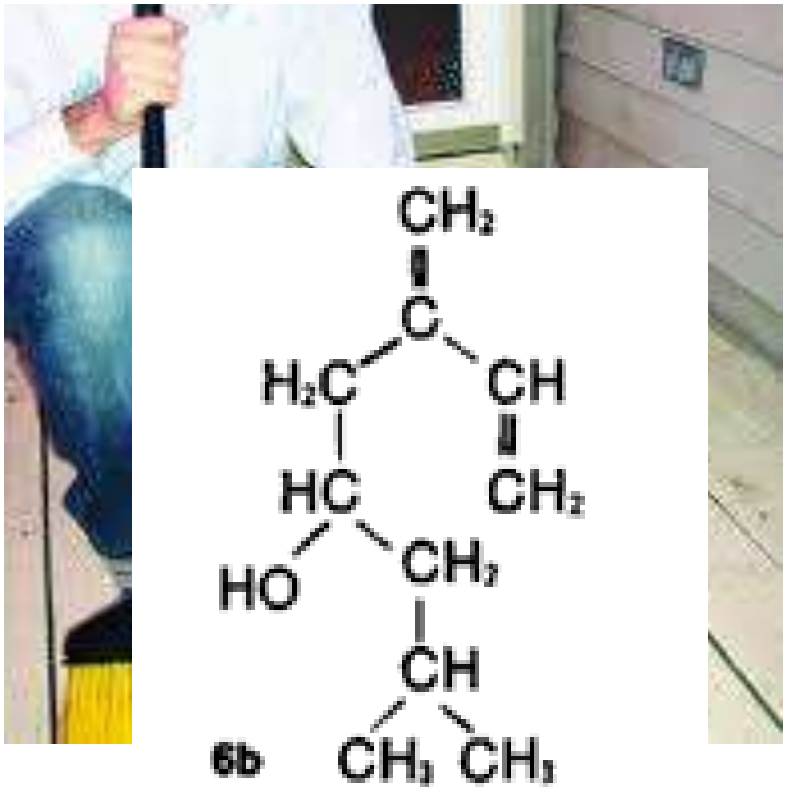
Chemical characteristics: volatile and short-lived either due to size or degradation

Aggregation pheromones:

Results in: insects gathering together



Examples: bark beetles mass-attacking a tree; brown marmorated stink bug aggregation



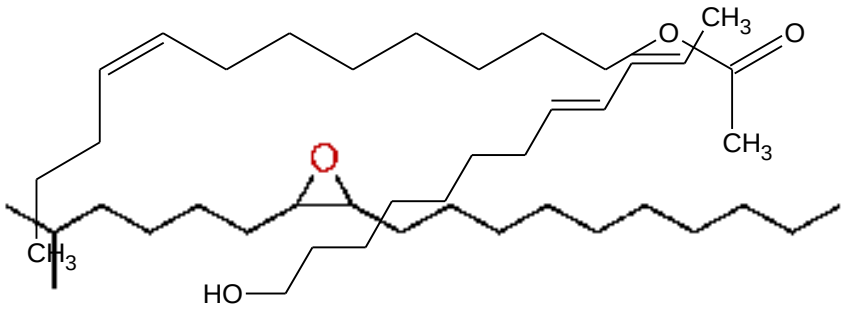
Chemical characteristics: longer-lived; can be cyclic & more complex

Sex-attractant pheromones:

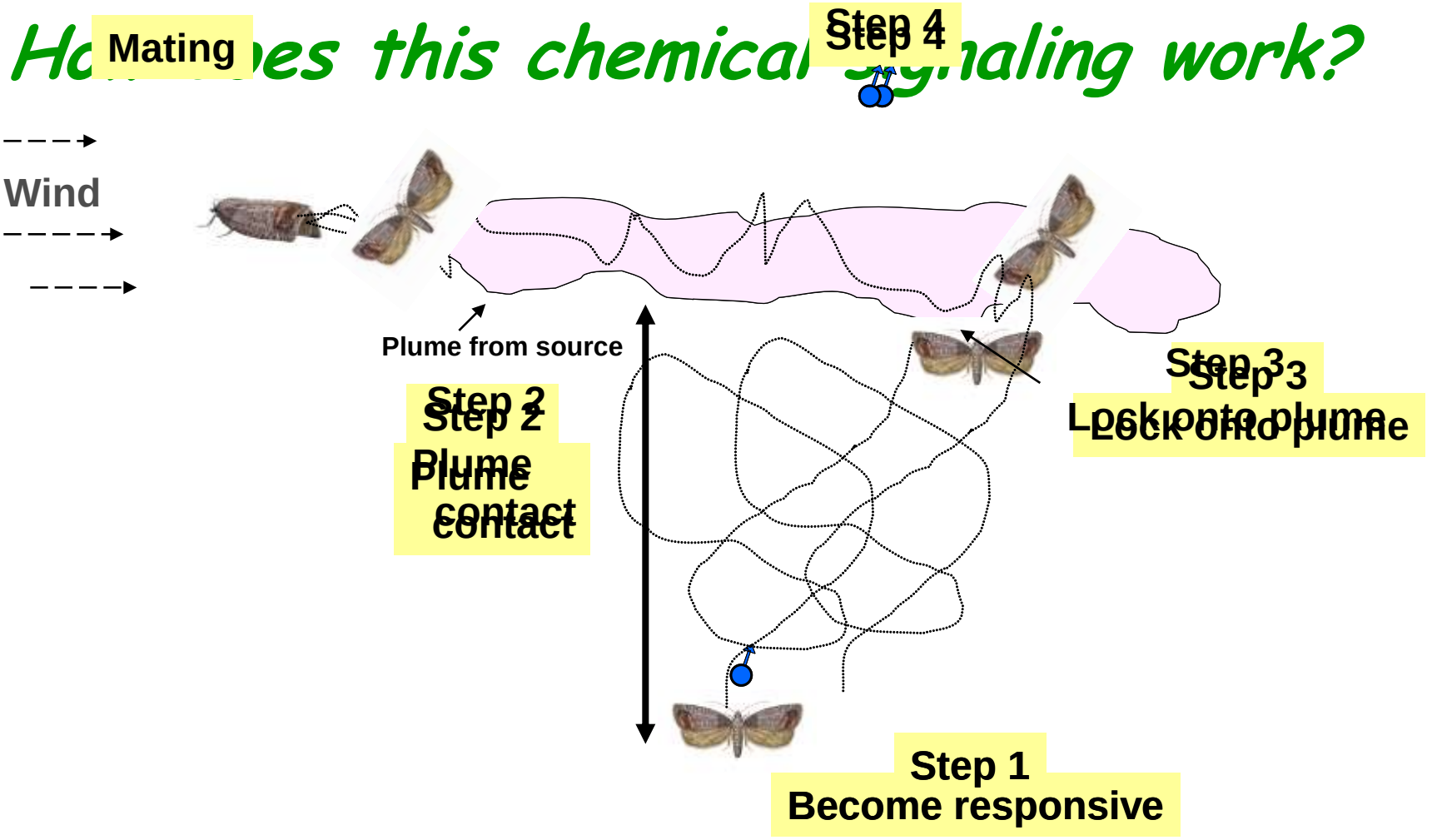
Results in: mating

Examples: gypsy moth; codling moth; oriental fruit moth

Chemical characteristics: longevity dependent on species; generally straight chain 10-18 carbons



How does this chemical signaling work?



Mating disruption occurs in any of steps 1-4

A brief history of pheromones

1870 Jean-Henry Fabré
Documents "Pheromone behavior"
Giant Peacock moth - *Saturnia pyri*

1959
1st insect pheromone ID
Bombyx mori
500,000 female extracted

50yrs

1959
Karlson & Luger suggest term Pheromone
- Greek for "carrier of excitement"

1960
1st suggestion to utilize pheromones to disrupt insect mating
- Morton Beroza (USDA/ARS)

1967
MD 1st shown in field
– Harry Shorey

40yrs

30yrs

1978
1st EPA reg. pheromone- PBW

1880 1900 1920 1940 1960 1980 2000 Year

Timeline

Mating disruption efforts since that first EPA registration…

Efforts have focused on developing the technology

Pheromone identifications and large-scale production

Increasingly varied deployment devices

Commercialization of pheromones

Four step process:

1) Identify

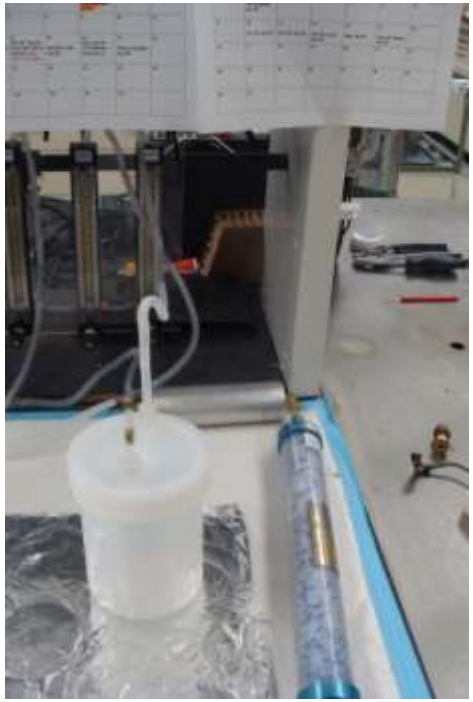
2) Verify

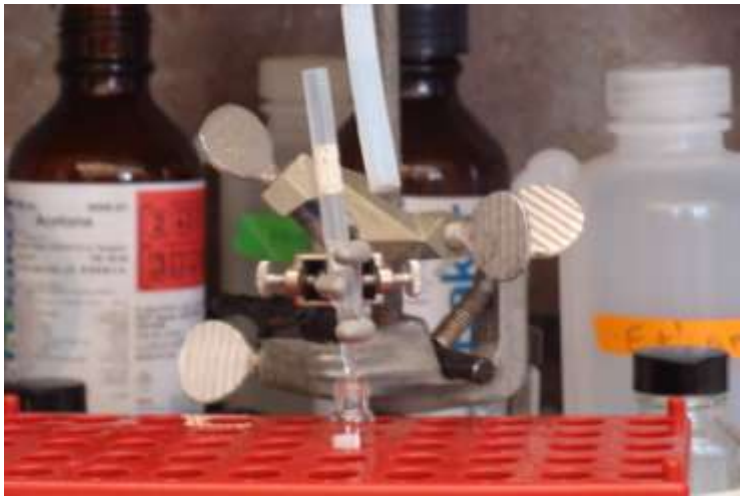
3) Implement

4) Optimize

Identifying pheromones?

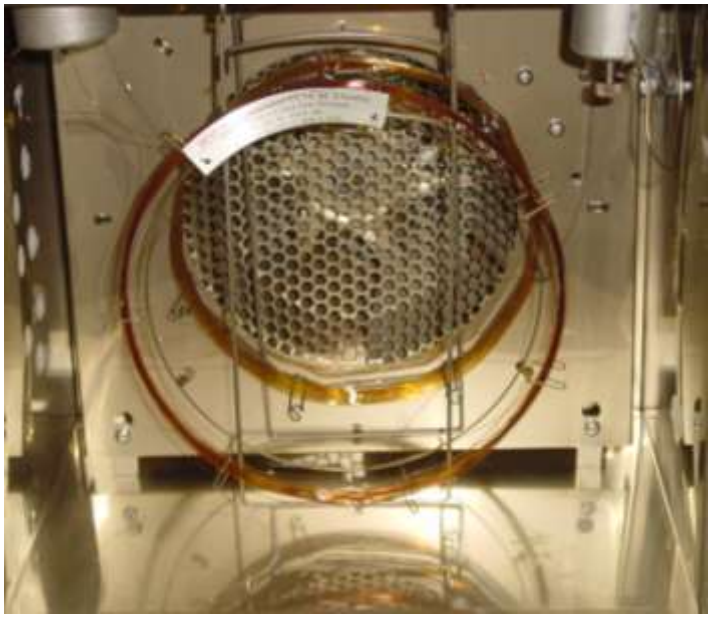
Removal of LOTS of pheromone glands and chemical extraction of chemicals within the glands, *OR…*

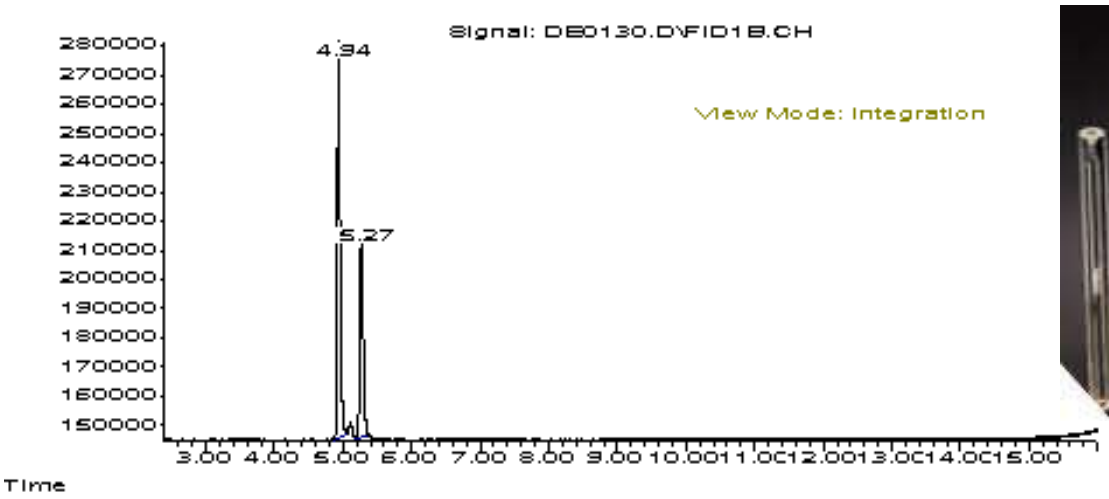




Volatile capture systems

Identification using GC/MS

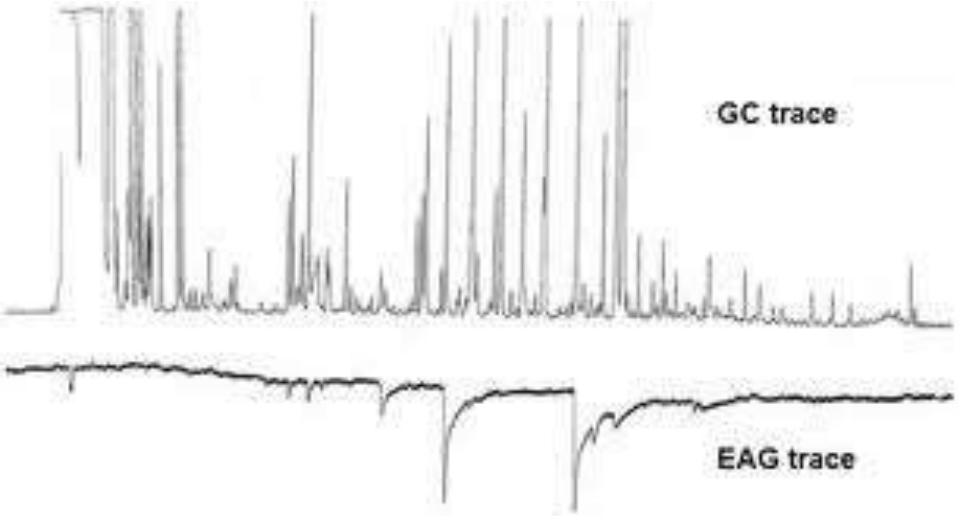




Verification of pheromone activity…

Testing in a wind tunnel (field or lab)

Verification of pheromone activity…



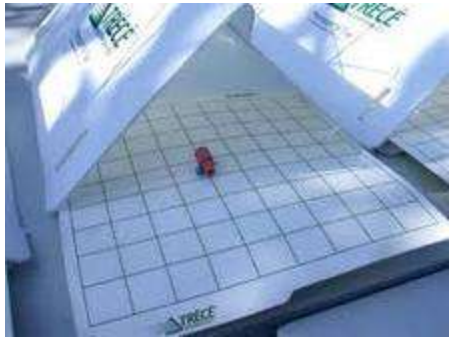
Testing for compound activity using coupled GC/EAG (electro-antennography) technology

Implementation (products)…

Use pheromones for monitoring insect presence/abundance

Use pheromones for mass trapping/removal of insects

For monitoring insect presence/abundance or mass trapping:



Implementation (products)…

Use pheromones for monitoring insect presence/abundance

Use pheromones for mass trapping/removal of insects

Use pheromones to disrupt mating














Implementation (products)…

Use pheromones for monitoring insect presence/abundance

Use pheromones for mass trapping/removal of insects

Use pheromones to disrupt mating

Use pheromones in conjunction with insecticide for “attract and kill” technologies

For “attract and kill”

And other experimental products…

Optimization…

Goal: increase efficacy while decreasing cost and labor…

Standard practice is to change:

- color of the trap
- position of the trap in relation to the crop
- dosage of the released pheromone
- type and release characteristics of device
- deployment of the release device

Mating disruption efforts since that first EPA registration…

Efforts have focused on developing the technology rather than the science

Pheromone identifications and large-scale production

Increasingly varied deployment devices

The mechanisms are not clear.
Understanding the mechanism *SHOULD* drive technological developments.

Optimization…

New data collection and analysis techniques are leading the way to demonstrate the mechanisms involved in mating disruption.

J Chem Ecol (2006) 32: 2089–2114
DOI 10.1007/s10886-006-9134-8

Differentiation of Competitive vs. Non-competitive Mechanisms Mediating Disruption of Moth Sexual Communication by Point Sources of Sex Pheromone (Part I): Theory[1]

J. R. Miller • L. J. Gut • F. M. de Lame • L. L. Stelinski

Received: 1 November 2005 /Revised: 9 March 2006 /
Accepted: 7 May 2006 / Published online: 4 October 2006

Abstract This study establishes a theoretical framework for differentiating among possible behavioral mechanisms whereby sexual communication of moths is disrupted in crops treated with point sources of pheromone. The major mechanisms recognized in the mating disruption literature fall into two main categories: competitive (competitive attraction = false-plume-following) and non-competitive (camouflage, desensitization, and sensory imbalance). Each disruption mechanism has been precisely defined verbally, and then the

Optimization…

New research and graphing practices are leading the way to demonstrate the mechanisms involved for mating disruption.

These techniques can guide companies in the development of pheromone-based technology.

Brown marmorated stink bug

Discovered in Allentown, PA in late 1990s

Originated from East Asia, where it was a minor pest of tree fruit

Initially considered a homeowner's nuisance, it is now recognized as a serious pest

Brown marmorated stink bug

First noticed in orchards in 2003-2004.

Feeds on: tree fruits, stone fruits, vegetables (esp. tomatoes and peppers), sweet and field corn, soybeans and others (est. 300 host plants).

Low presence in wine grapes will spoil the batch of wine. Some concerns about dairy cows ingesting feed-corn infested with BMSB & whether there will be negative impacts on the taste and quality of the milk.

Brown marmorated stink bug

Growers in heavily infested areas of the mid-Atlantic lost 50-100% of their apple crop in 2010.

Estimated 10+% reduction in apple production in PA and MD due to BMSB alone.

BMSB feeds in the orchards for all 5 instars, and due to broad host breadth can rotate among crops.

Insecticides used for IPM have largely been ineffective.

Brown marmorated stink bug

Found in New Hampshire in summer 2010.

Discovered in Allentown, PA in late 1990s

Originated from East Asia, where it was a minor pest of tree fruit

Initially considered a homeowner's nuisance, it is now recognized as a serious pest

Brown marmorated stink bug

Originally considered a homeowners pest because it aggregates and enters homes in large numbers in the fall, looking for a warm(er) and quiet(er) place to settle down for the winter.

It has an aggregation pheromone!

So where are we in the four step process?

1) Identify

2) Verify

3) Implement

4) Optimize

?

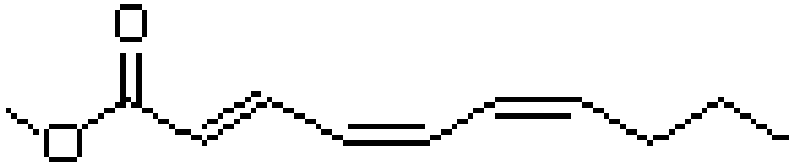
Identify/Verify…

Looking for the true BMSB pheromone

Ongoing research led by USDA scientists Jeff Aldrich (pictured) and Tracy Leske.

Identify/Verify…

BMSB has some responsiveness to the aggregation pheromone of another Asian stinkbug, *Plautia stali*



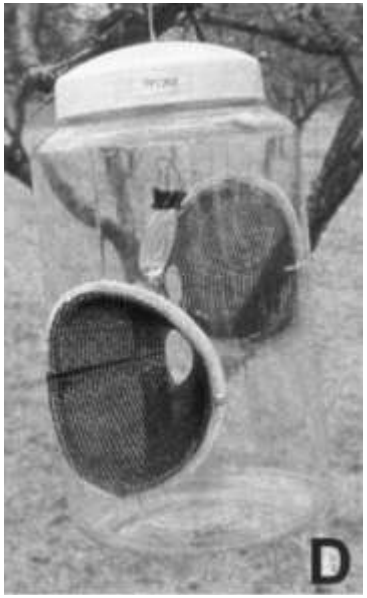
This pheromone is only just becoming available for commercial distribution in the U.S.

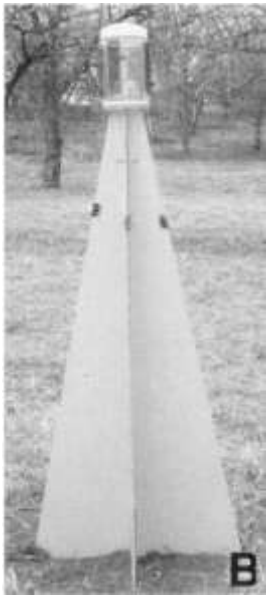
Implementation…

Difficulties with trapping BMSB:

Stink bugs are highly visual and may not enter traps

If stink bugs do enter traps, they may leave again, reducing trap efficacy as a monitoring/detection tool





Optimization…

But, BMSB may be a good candidate for attract and kill technology.

If a trap/pheromone blend were optimized to allow stink bugs to enter a trap, the inside of the trap could be treated with insecticide to provide a lethal dose to the insect without having to spray throughout the orchard, possibly killing beneficial insects.

Push-pull technology: using attractive stimuli (pheromones, a host crop that will not be harvested), pull the BMSB out of the crop to be protected. Treat the crop containing the BMSB.

Be aware, but

It's true…

- BMSB has the potential to be a serious crop pest
- There are few recommendations yet as to control strategies, and strategies rely on broad spectrum insecticides
- It was found in NH last year

However,

- The first NH samples were found in a state survey for insect pests (Forest Health Group); we may have caught the invasion early
- There is a lot of focus on this pest by federal, university, and industry research groups

What can you do?

Have you seen this insect?

This is the Brown Marmorated Stink Bug (BMSB). Recently found in Portsmouth, it has the potential to become a serious crop pest. We are seeking your help in detecting it throughout New Hampshire. If you have seen the BMSB please contact us at (see reverse):

Because of difficulty trapping, BMSB, we are asking the citizens of NH to notify us if they see BMSB, so we can determine if and how wide-spread this pest is in our state.

UNH Cooperative Extension has a web-site dedicated to BMSB in NH. Check there for contact information for sending digital photos or specimens:

http://extension.unh.edu/Agric/AGPMP/Brownmarmoratedstinkbug.htm

Questions?