Fumigants & Pheromones

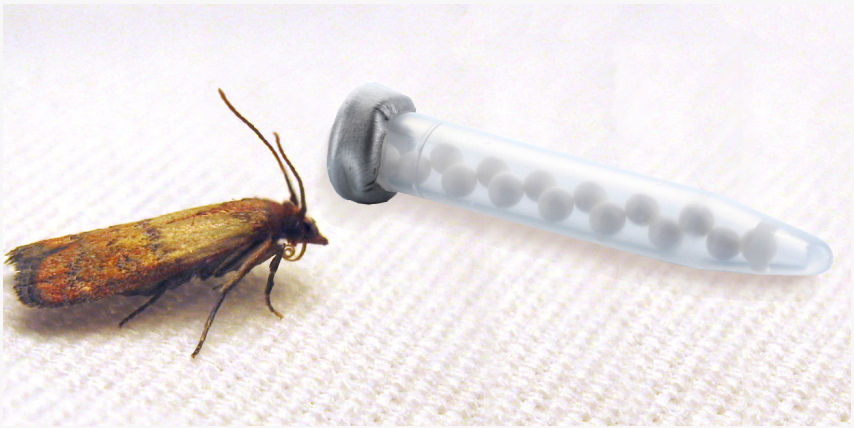
Digital Newsletter Delivered by Insects Limited, Inc. *Issue 158*

Why Don't All Insects Have a Commercial Pheromone Lure?

Pat Kelley, BCE
President of Insects Limited

It can be quite frustrating when you have a pest insect driving you crazy and you want to locate its source. You know that pheromone lures work great to monitor for food moths, clothes moths and other all-around pests like cigarette beetles and warehouse beetles. Why then, isn't there a commercial pheromone lure for insects like silverfish, carpenter ants, termites, etc.?

To answer this question, we need to take a deep look into insect biology and how different species of insects use pheromones to communicate. Let's take a look at some of the variables and how they come into play regarding pheromone lures.



A male Indian meal moth male is attracted to a pheromone Bullet lure that mimics the female sex pheromone

Social Insects vs Solitary Insects

Social insects are described as insect species that have evolved into large, cooperative colonies that utilize caste systems for divisions of labor and reproduction. Ants, bees, hornets, wasps and termites are viewed as social insects. Some ant colonies have reached numbers greater than one million individuals.

Pheromones play an important communication role with social insects when it comes to alarm signals, location of food, whether or not the colony should increase in size and even dominance within the colony. Queen honeybees, *Aphis mellifera* for example have been found to produce five compounds that are used to control many types of worker behavior. If a queen bee happens to die, the lack of her pheromone will cause virgin, winged females to shed their wings and develop ovaries so they can begin laying eggs. Once they do this, they themselves start to produce the queen pheromone to bring order back to the colony.

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A queen honeybee communicates her dominance and other information to worker bees using her pheromones

Swarming bees outside of a hive that is queen-less or is overpopulated can be attracted to pheromones produced by new queens and will swarm in large numbers where those pheromones are found.

If a queen bee dies within a colony or if a hive becomes overpopulated, some of the existing colony will leave the hive and will swarm to areas where a combination of queen-produced pheromones are located. Beekeepers can purchase live honeybee queens and place them in bee boxes to attract swarms.

Another example of social insects using pheromones can be found with ants. Many species of ants use pheromone trails to assist the colony in finding food supplies. As foraging workers locate food, they will drag their abdomen on the ground to leave a trail for the next round of foragers. If the food supply is large, they leave more pheromone along the trail. This signals the colony to send more workers to retrieve the food. While these pheromones strongly affect the colony behavior, they are short-lived and may only last for 10 minutes.

So even while we know that this group of social insects use pheromones on a daily basis to communicate, most of these pheromones are not designed to pull-in insects from long distances. Most of the pheromones that are being used in colonies are short-lived and will only effect behavior in specific situations. For this reason, pheromone monitoring lures for ants, termites, bees and wasps are not effective enough to make them viable in commercial monitoring systems.

Social Insects like these ants use a short-term (10-minute) pheromone trail to direct the colony to food sources

Sex Pheromone vs Aggregation Pheromone

When it comes to non-social insects, some species utilize sex pheromones much more than others. Sex pheromones tend to be the best at attracting adult males to the traps for monitoring purposes. As an example, an Indian meal moth female can put out a few nanograms of pheromone and attract a male from 100 ft (30 m) away. Indian meal moths have a short life as an adult (1 week) and are strong flyers. The adults do not feed and their main purpose is to reproduce. For these reasons, Indian meal moths are an excellent candidate for monitoring with pheromone lures since mating is their sole purpose.

Sex pheromones typically work better to monitor for insects compared to other pheromone types

Adult flour beetles don't use long distance sex pheromones to find each other, they tend to find each other within food sources to mate. Adult flour beetles utilize aggregation pheromones to attract other beetles to a food location. Flour beetles will live as adults for many months and thus do not need to mate is such a small window of time. Since the confused flour beetle cannot fly and the red flour beetle spends most of its life within its food source, they are not considered to be as mobile as other stored product insects. Mobility also plays a big role in how far away a pheromone trap might attract an insect from. An aggregation pheromone signals to wandering beetles that there is an accumulation of other flour beetles in a particular area. An aggregation pheromone for flour beetles is typically only going to be able to pull a flour beetle into a trap from a relatively short distance of 10 feet (3 m) away. If existing flour beetles are already located within a decent food source in that area, they tend not to wander and you may not even be able to pull them in from that distance. Aggregation pheromones tend not to work as well as sex pheromones.

The ease or difficulty to synthesizing an insect pheromone may determine whether or not a lure is available for that species

Difficult Routes of Chemical Synthesis or A Lack of Research

Some insects like the furniture beetle, *Anobium punctatum* have a sex pheromone that works well to attract adult males, but the lab synthesis to make the pheromone is so difficult or the compound is so unstable that there are no commercially available lures.

Another problem may be that pests with lesser economic impacts to society still may not had sufficient research done to identify their pheromones to see if they can be synthesized into commercial lures.

The Odd beetle, *Thylodrias contractus* is an example of a dermestid beetle pest that still has not had their pheromone identified. Pests with little economic impact may not make sense to invest time and resources into for a university looking for grant funding or for a business desiring to make profits.

Some Insect Species May Not Utilize Pheromone

Finally, for some insects, little is understood on how or if they use pheromones to communicate. Neither sex pheromones nor aggregation pheromones are available for these insects even though they may be bigger economic pests. Insects Limited is working on food attractant lures that will help to monitor for some of these pests like the common silverfish. There seems to be promise in successful monitoring if the food attractant lures are placed near a harborage area, but for these insects, there are no working pheromone options.

Insects like the common silverfish, Lepisma saccharina do not have commercially available pheromone lures

Conclusion: Why some Insects have Pheromone Lures and Others Do Not

Whether or not a specific species of insect has a pheromone monitoring lure available comes down to several factors. These factors include; whether or not the species is a social insect, how pheromones play into the insect biology, how mobile the insect is, whether or not there has been research into that species' pheromone to identify it and finally how difficult it may be to synthesize the identified pheromone.

Any and all of these factors come into play when considering if there is a pheromone lure for an insect. Decisions are made on a pest-by-pest basis by universities and pheromone producing companies. If an insect doesn't produce a viable pheromone or if it doesn't make commercial sense to research and produce a pheromone lure for that insect at this given time, there will likely not be one available to purchase. There is always hope that research breakthroughs will open up new avenues to successfully trap the pests that haunt us.

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Trials and Tribulations of Lure and Trap Testing: Field Trials

James Feston, BCE
Director of Research & Development,
Insects Limited

One of the most exciting and frustrating parts of developing a new product in-house or evaluating an existing product for distribution, is testing it out in the real world or as we call this “field trials”. Field trials are typically carried out in third-party production, storage or distribution sites. On paper, the story should be so simple:

- Develop a protocol
- Find a testing site
- Carry out protocol exactly as it is written
- Get your answer

Of course, in real life, the story is much more fraught than a short bullet-pointed list. So, for the purposes of this article, I feel the story is best expressed in brief narrative form.

A field trial of an All Beetle trap at a third party location. Photo by E. Estabrook

It wasn’t easy to get to this point. You heard about this product/ idea years ago, and have been working with it ever since. You’ve invested time and money followed by successive additional investments of time and money. You did all the research, it checks out in the lab, success is just around the corner!

It’s time to get it out there and do a final check, get that rubber to hit the road. With some leveraging of contacts and some kind words (and possibly more money), you find the perfect site to test things out. What fortune! And it’s only been a brief year and a half since you started the search. It’s a shame that by the time it was ready, the temperature dropped early, the test facility isn’t climate controlled, and the bugs have settled in to wait until spring to start flying again. No matter, you file away the materials and the protocol until Spring. Sooner than you know it, the bugs are flying and you get out there and set up the test!

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All is well until you check the traps for the third time. A few are missing from on-site cleaning, another has been vandalized, and another is filled to the brim with an insect you were not even looking for. Also, the facility manager helpfully informs you that they performed a pesticide fogging of the facility 2 weeks ago and forgot to mention it. You press on! The trial comes to an end, you have been looking at the numbers during the trial and you think things will be OK. You take all the data back, crunch the numbers and the results are… mixed. The good scientist in you recognizes the "challenging" data set in front you and draws only the conclusions that are supported. Which is that we need to do this whole thing over again.

Now older and wiser, you conduct the experiment again, minus some kinks, get much cleaner data, and (let's make this a happy ending) it turns out that the test product is great and should be rushed to market with great haste and conviction! Now on to the next!

Fortunately, most field trials don't feature all the pitfalls from the story. But to be sure, there will always be something, and that's the challenge that makes a successful test rewarding. So what are the takeaways?

- **Stay focused.** What question are you really trying to answer? If the purpose of the testing is to determine if the product works or not, write your protocol first and foremost, to answer that question. The more complicated it gets, and the more questions you try to answer in the same test, the harder it gets to pull anything meaningful out if things go south.
- **Stay organized.** When experiments go on for months or weeks, it's easy to get lost. A clear summary at the beginning of your protocol of what you are doing and why is helpful to stay on track. Creating your data table ahead of time and filling it in as you go, is superior to the sticky note, random notebook method of record keeping. Ask me how I know.
- **Plan for issues.** Of course, you can't predict the future, but you can certainly learn from the past when constructing a protocol. Try to remember the things that have gone wrong before, and work to avoid them, or plan around them entirely.
- **Communicate clearly.** Field studies often require cooperation between several people from multiple companies who may have various degrees of capacity, and interest, in helping you. The spectrum runs somewhere between enthusiastic/competent to antagonistic/ineffectual (they don't have time be playing bug scientist when there is work to be done!) The point is, do your best to make sure everyone understands what they are doing, and to some degree, why. Also, don't be too surprised if you find participants making "executive decisions" about the protocol. Just try to be aware and communicative enough to catch these surprise changes before things get too bad.
- **Keep it real.** You have a choice when you are interpreting results. It isn't hard to draw questionable conclusions from a data set, especially messy field data. And that is when you need to be judicious and honest. If not for it's own sake, then at least to avoid the product tanking when it hits the market because it doesn't work. The worst part of selling a product that is intended to help people, is to have them tell you it doesn't work. Do the right thing, and sleep well at night.

One of Insects Limited's core values is to provide the absolute best products available worldwide that help our customers solve their pest issues. It is only through thorough research, study, and testing that we achieve superior products. ***This is what we take pride in and this is why we take the extra steps to make sure that all of our products are thoroughly tested before they are brought to market***.

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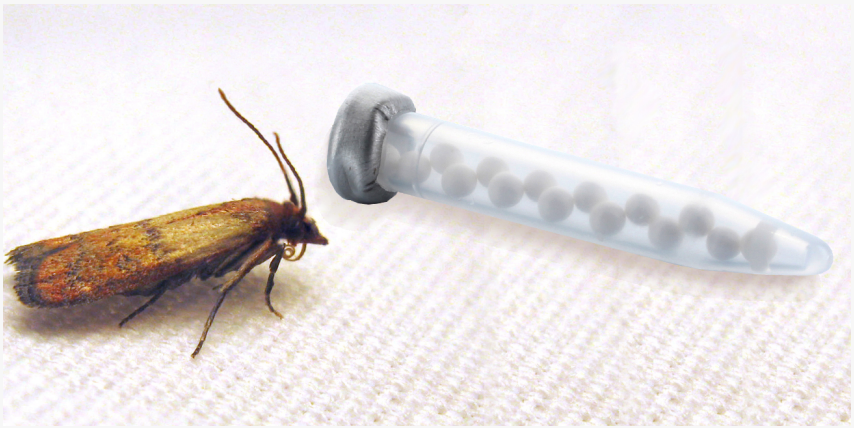

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