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Understanding and Controlling the Red Legged Ham Beetle (*Necropia Rufipes*)

Alexandria Hammel

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MS Degree Project

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Goal of the Project and Some Background

The Red Legged Ham Beetle (*Necrobia Rufipes*), RLHB has fascinated me since the moment we met. The beautiful greens and blues that sparkle from its elytra, the sharp and fast red legs that flash just below the body and just last month I was able to see a RLHB in flight for the first time. My squeal of delight was not left un-mocked by my coworkers. This beetle is a detrimental and determined stored product pest. One that, we in the pet food business, don't take lightly. This generated a need for control in warehousing as distribution but also in the most challenging of environments, the pet food store. The RLHB has an extra oily exoskeleton. The beetle will also close up it spherical as a reaction to changes in the environment. As a result, all fumigants must be used at max dosing to have an impact on a population. This is not a feasible solution in a pet food store, particularly one that contains, well…pets.

So how do you control an insect population in a store with live animals? Obviously cleaning and sanitation but if you don't know anything about the insect, where do you focus? How do you make your cleaning efficient? You can't! I needed to learn as much as I could about the RLHB. Not only because it was intriguing and then mesmerizing, but because my job depended on it. To begin Integrated Pest Management (IPM), I needed answers to these questions:

- What attracts the RLHB?
- Where does it harborage?
- How do I educate the pest control industry on the RLHB to prevent future misidentifications, consumer complaints and lost product?
- How do I deter them or kill them when they're already damaging stored products?
    - AND how do I do this safely?
    - Organically?
    - Easily?
    - Without harm to the stores?

Project and Project Outcomes

There are four parts to my project.

First, I will determine what best attracts the RLHB. I will use the information I know about origin and background as well as current industry practices to try and find a monitoring solution. Monitoring is key to an IPM program and without it, I'm setting myself up for failure. I will document a choice study.

Second, I will determine a pet safe way to control a RLHB population. What will kill them? How long will it take to kill them and how much of it do I need to kill them? I will apply a desiccant at varying rates and record the time is takes for desiccation to occur and at what application rates.

Third, I will apply the gathered information and use it in 2 pet food stores in Texas. How do I use what I've learned about monitoring and application to help the pet food stores? Will this actually work in a real life example? I will monitor for the beetles to determine appropriate application area, then apply desiccant for multiple months while recording any and all population changes. Seeing a reduction in over 90% of the population will constitute a successful application and treatment method.

Lastly, I will create educational materials and a repeatable plan to share what I've learned. This information will be used to educate pest control companies, other industry and to repeat this process in the future.

This research began when I started my graduate studies. The research took many many years, many many airplane rides and even more blood, sweat and tears. I will share with you my complete works from the collection and observation of the species to data collected from pet food stores in Texas as well as my current conversations on how to repeat this process in additional stores in Arizona with RLHB infestation and presentations to professionals across the country on how to safely control the beautiful *Necrobia Rufipes*.

Choice Study: What attracts the RLHB?

Choice Behavior of the Red Legged Ham Beetle

(*Necrobia rufipes)*

Alexandria Hammel, BCE

Photo taken during choice study. (larvae and adult)

Introduction

The *Necrobia rufipes*, commonly known as the Red Legged Ham Beetle (RLHB) or sometimes the Copra Beetle is a new and rarely understood stored product pest in the United States. This beetle has been associated with a wide variety of stored products and is very different than your traditional stored product beetle in the way it travels as well as its ability to elude traditional methods of pest control. In the retail environment where I currently study this insect, the method for monitoring activity in any given location includes a glue trap with a slice of the greasiest pepperoni around inside a protective cardboard box. This tactic does work however as I begin to understand the origins of the RLHB, I wonder if there isn't a better attractant out there. Currently there are no synthetic pheromones available and it is known that many pyrethrums or fumigants must be used at maximum quantities to show an impact on controlling the population.

The RLHB originates in South America where it developed the name Copra Beetle because it infested coconut flesh as it dried in fields. As this product was shipped throughout the world, so was the Copra/RLHB. The most attractive diet current known for the RLHB are greasy and drying meats, cheeses, fish as well as coconut. Museums and taxidermy professionals will use this beetle and the close relatives to clean off the dried meats or flesh of an animal carcass before display.

Materials and Methods

I collected 26 Red Legged Ham Beetle specimens from a pet store in North Western Arizona. I collected the specimen from various locations in the store and placed them into a storage container which I have included a picture of below along with a variety of dog food kibble, as this is what they were using for food in that environment. I purchased some pepperoni from the local grocery as well as some shredded and dried coconut and fresh coconut. I transported the specimen to my hotel room where I spent the next 2 hours observing their behaviors as well as offering 10 individuals 5 minutes each to choose

between a fresh peperoni slice and a mixture of shredded and fresh coconut. I transported each specimen individually into the “choice environment” with a cotton swab.

Transportation Container

Supplies

“Choice Environment” Container

Behaviors Observed

During the observation period for each insect, I was watching for the following observed behaviors to draw conclusions from-

1. Eating Coconut
2. Eating Pepperoni
3. Eating neither coconut or pepperoni

I also observed additional behaviors that were presumably unrelated to their food choice; those are detailed in my observations paragraph below.

Observations

When placed in the "choice environment" many specimens spent a significant amount of time trying to escape which the same behavior primarily observed in the transportation container. One interesting observation was over 9/10 specimen spent 100% of their time in the upper right quadrant of the "choice environment." Out of the 10 specimen observed only 1 was able to climb to the ceiling of the "choice environment" while many others tried and failed. Typically when they failed and landed on their backs they spent the next period of time with their front limbs embedded in their mouthparts. 1 specimen spent the entire 5 minute period on his back, unable to turn over after a failed attempt at climbing the sides of the container.

During transportation and other general observation periods outside of the test period, I observed some interesting behaviors. I have included below some of the pictures I captured of the mating occurring in the travel container on the last page. Also noteworthy, I left all specimen in a container overnight with both pepperoni and coconut and when I awoke there were 4 specimen (of the 26) in the coconut, 4 specimen mating, 2 dead specimen and 1 specimen stuck on his back.

Below you will see the behavior observations during the test period.

Figure1. Choices made by individual at specific intervals.

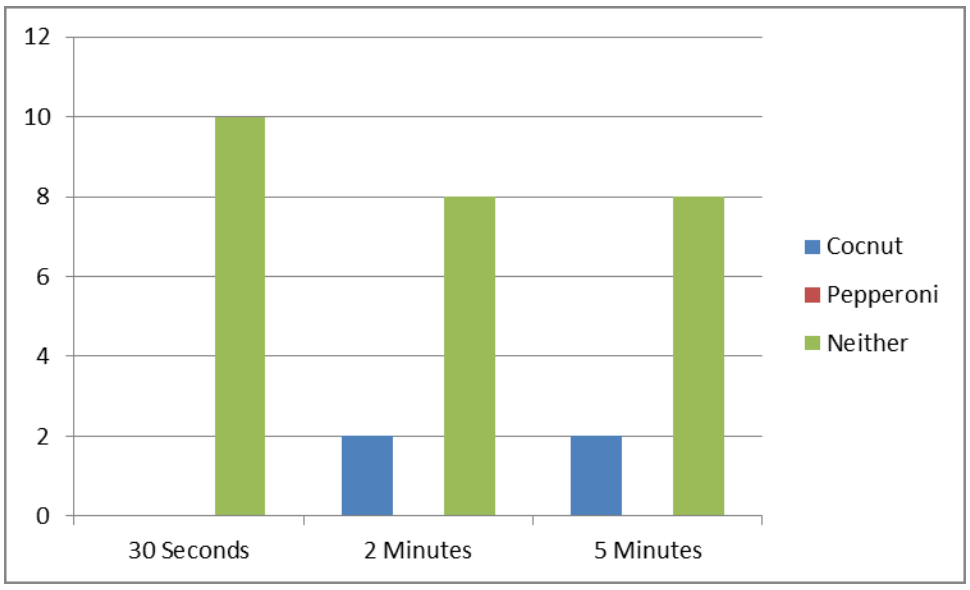


Figure 2. Ethogram of choice behavior over observation period

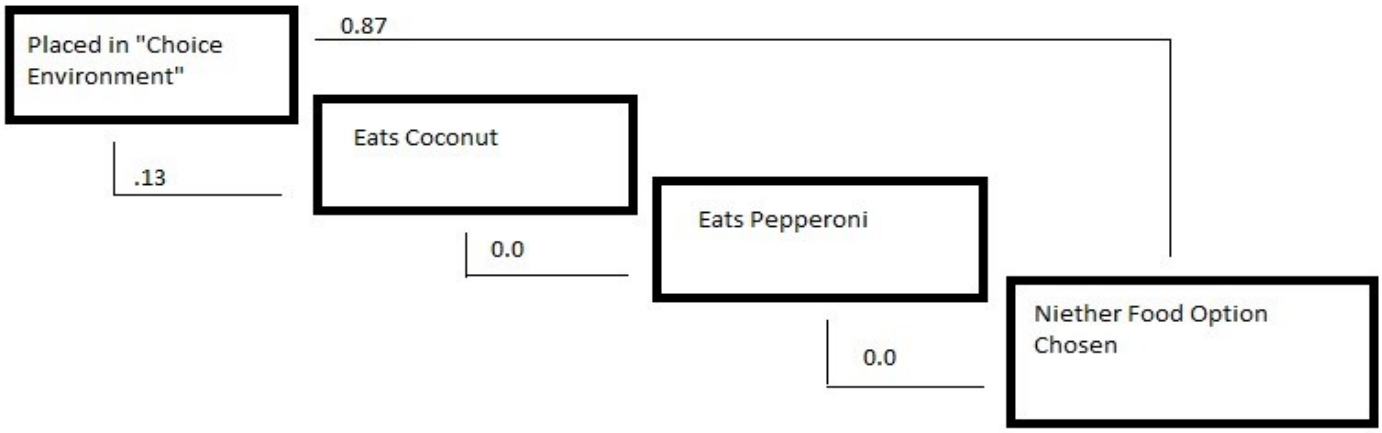


Figure 3. Ethogram at 30 second observation

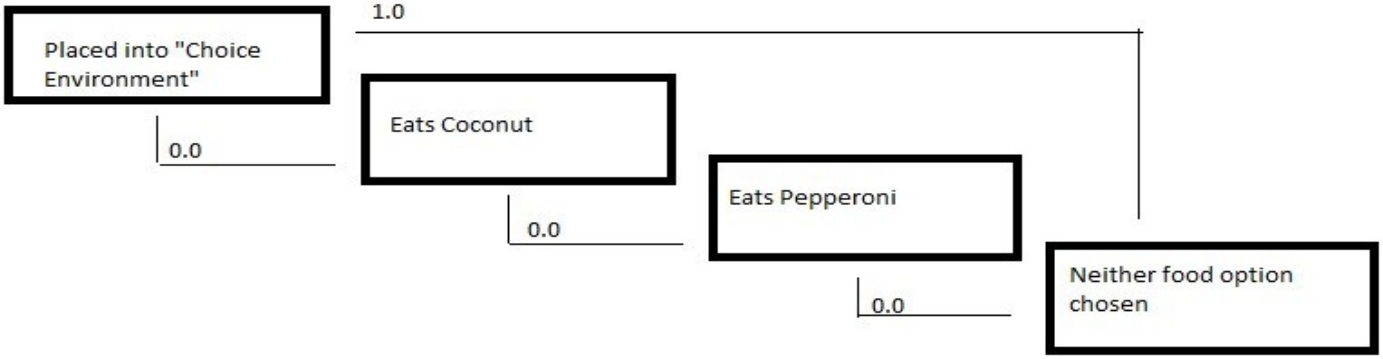


Figure 4. Ethogram at 2 minute observation

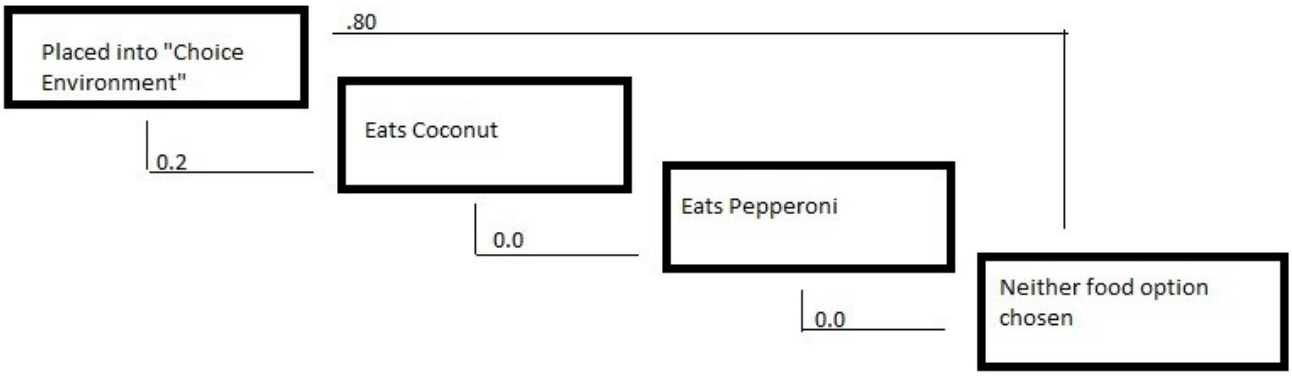
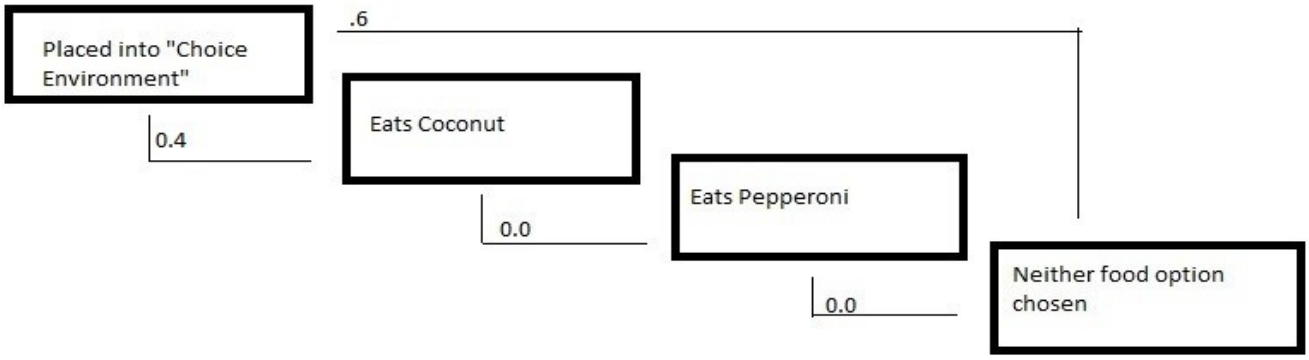


Figure 5. Ethogram at 5 minute observation



Discussion

The conclusion I drew from this observation was that our current monitoring methods can be upgraded. I thought the pepperoni would be the most attractive to the population because that was what I had been told by professional pest control operators; however genetics must play a greater role in food based attracting than I knew. I've also always been told the fresher the product the more attractive it is to a RLHB and I now doubt this information. I will continue my research at work by conducting some in-field choice studies with coconut as well as using coconut as an attractant for baseline data in other research. I am currently attempting to assist locations with active populations to control their RLHB damage with diatomaceous earth. If we can find the best attractant available we should have greater success with exposing a population to DE and therefore eliminating a greater percentage of the population. Some questions I still have are;

- Is it shredded coconut or "fresh" that is attractive?
- If there are multiple insects together, will they "signal" to one or the other?
- Is there a preference for larvae?
- Would coconut oil have the same effects?
- When the population becomes accustomed (if ever) to captivity, will they make more predominant choices?

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Ebeling, Walter. "Chapter 7- Pests of Stored Food Products." *Urban Entomology*. Slightly Rev. [ed.]. ed. Berkeley: Division of Agricultural Sciences, U of California, 1978. Print.

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RLHB Control: Desiccation Study, What kills them?

Desiccant Time-lapse of the Red Legged Ham Beetle

(*Necrobia rufipes)*

Alexandria Hammel, BCE

Photo taken during desiccant study.

Introduction

As described in my previous observation paper, the *Necrobia rufipes* or the Red Legged Ham Beetle (RLHB) has become a stored product pest in the United States and can be found abundantly in pet food stores. As found in my first observation paper there are many areas for improvement regarding monitoring, understanding and controlling the RLHB. Also as previously mentioned, there are currently no synthetic pheromones available to attract or confuse this insect. It is known that many pyrethrums or fumigants must be used at maximum quantities to show an impact on controlling the population. Because of the sensitive nature of the pet food stores, typically housing live animals and fish, almost any insecticide poses a significant risk to the company and the animals they house and sell. This places us without any treatment methods for controlling the RLHB beyond proper sanitation.

The RLHB is capable in both larval and adult stages, to chew through many materials. It is a predatory insect that will cannibalize as well as feed on other insect's eggs, pupa and larva. The RLHB is a very capable crawler (figure 1).

Figure 1

Video, Click Here

The evolutionary advantages that have been granted to this insect leave us with very limited control options. The losses sustained by this insect as well as my undeniable fascination with the RLHB has directed me to looking into low impact control methods.

My thought process for determining diatomaceous earth (DE) might be an option is as follows:

What safe insecticide alternatives do we have for a pet food stores?

Method	Pros	Cons
Pheromone	Safe Easy to apply	NOT AVAILABLE
Diatomaceous Earth	Safe Cheap	Messy Unsure of Success
Insect Growth Regulators	Safe	Not Labeled for RLHB Time consuming
Cleaning and Rotation	Safe Cheap Multiple Benefits	Will not combat quickly spread insects

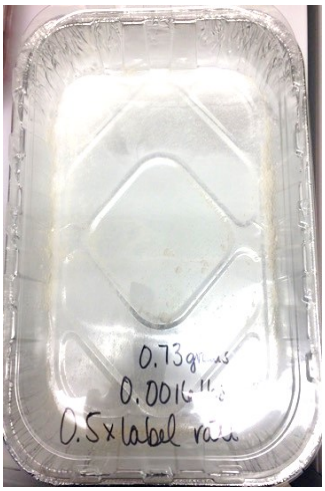
A pet food store is kept in low temperatures relative to the RLHB, typically around 70˚ Fahrenheit all year round. The lower temperatures typically indicate less flying activity for an insect and the means of travel would be crawling. If the RLHB crawls actively thought a pet food store, maybe we can coat areas with DE and desiccate the RLHB without any danger posed to dogs, cats, fish or humans. I have started these field trials in some pet food store locations in Texas. However, I am unaware if the DE can penetrate the specifically oily exoskeleton present on the RLHB. The results so far seem promising however it's too little data to tell. I would like confirmation, in a controlled environment that DE can be used as a desiccant for RLHBs.

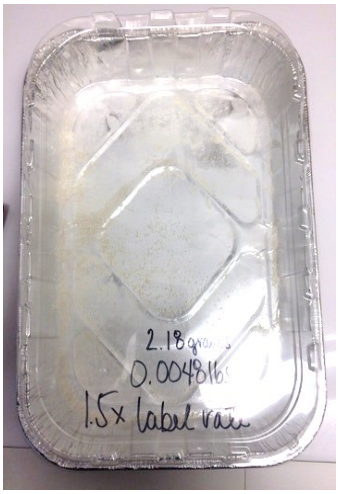
Materials and Methods

I again collected some Red Legged Ham Beetle specimens from a pet store in North Western Arizona. I collected the specimen from various locations in the store and placed them into the same storage container with dog food. I transported the specimen back to my home in Illinois.

I used three foil cake pans with lids as the desiccant environments. The DE I used in my field tests is the same brand and type I used in my desiccant environments. It's a food grade DE with crawling insects on the label.

Transportation Container





"Desiccant" Containers

As you can see from above, the three separate desiccant environments had separate application rates of DE, to determine if dose changed the time of desiccation. I've included the SDS as well as the label in my references section. The label calls for 1 lb. for every 409 square feet. The containers are 1.31 square feet meaning the label rate calls for 0.0032 lbs per container. Because my scale would not accurately measure to 4 decimal points on lbs. I chose to convert to grams. I had the first one with ½ the label rate per square foot or 0.73 grams. The second was the standard label rate at 1.45 grams and the third a 1.5 the label rate or 2.18 grams per container. I also placed kibble in each desiccant environment to somewhat mimic the store also I didn't know how long the RLHBs would survive, if the desiccant doesn't work I didn't want them to die of starvation (figure 3). I then planned on monitoring survival for the next 24 hours. Starting at 15 min increments and then increasing to half hour and then 2 hour increments for the remainder of the 24 hours or until all specimen had died.

Figure 3

Behaviors Observed

During the observation period I was specifically watching for the following;

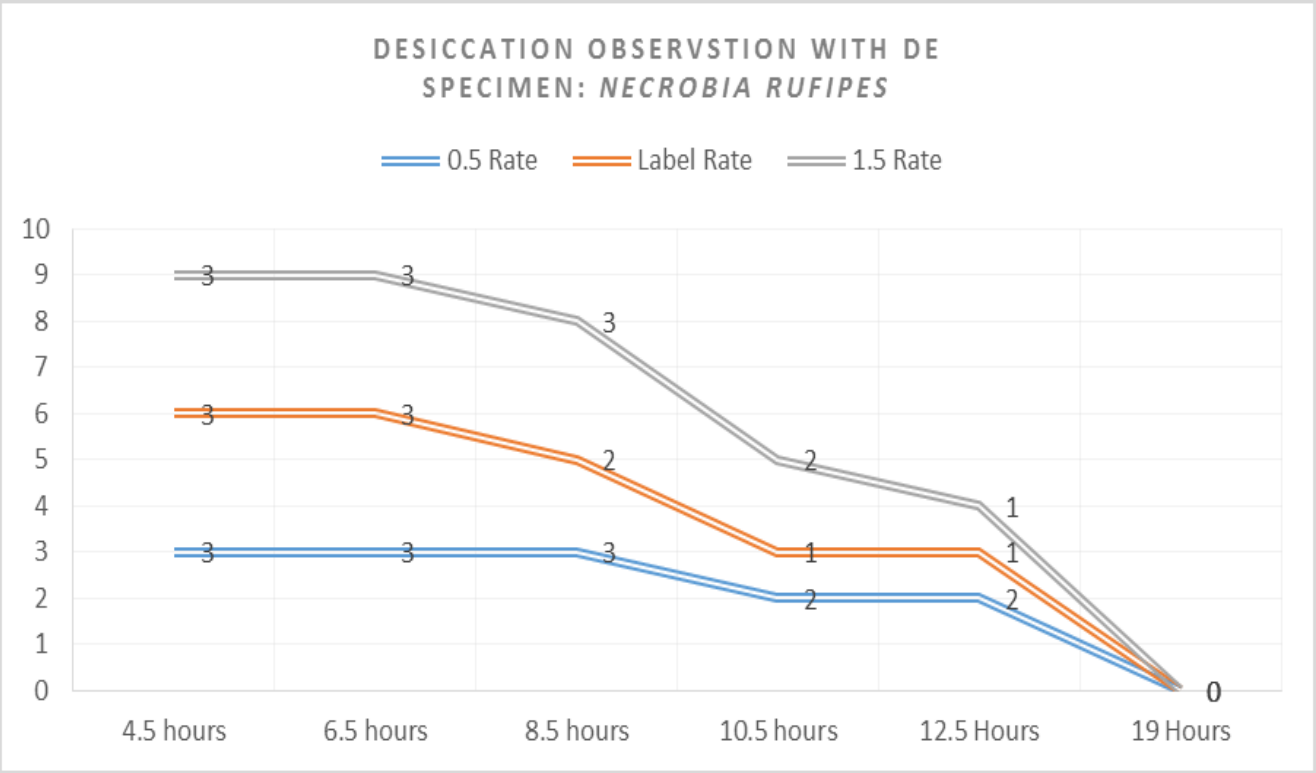
4. Death
5. Slowed Movement
6. Flipped Over

Observations

As I have typically seen with RLHB, they will hide under anything available as well as cluster together when possible. Many of the beetles hid under the kibble when I wasn't checking for signs of life. They were however, coated with DE from traveling within the desiccant environment (figures 4 and 5). At the 30 min mark, the beetles traveled much less in their environment and moved much more slowly.

Figures 4 and 5

The results were not unusual and followed my hypothesis fairly closely. It took 8.5 hours for the first death to occur and the population declined steadily after that time frame. There was a 6.5 hour gap between monitoring from 1 am to 7:30 am where the entire population succumb to desiccation. Please see an illustration of those results below.



Time Lapse	0.5 Rate	Label Rate	1.5 Rate
15 min	3	3	3
30 min	3	3	3
45 min	3	3	3
1 hour	3	3	3
1.5 hours	3	3	3
2 hours	3	3	3
2.5 hours	3	3	3
3 hours	3	3	3
3.5 hours	3	3	3
4 hours	3	3	3
4.5 hours	3	3	3
6.5 hours	3	3	3
8.5 hours	3	2	3
10.5 hours	2	1	2
12.5 Hours	2	1	1
19 Hours	0	0	0

There were 9 specimen total with 3 in each of the varying application rates. The numbers in the column representing the live specimen count. Please see the table to the left for monitoring counts.

Dead RLHB from observation period

Dead RLHB from observation period

Discussion

I'm glad to say that DE exposure will result in the death of the RLHB. It appears the added oil on their exterior does not impact their ability to become dehydrated. I was unable to locate adequate research on desiccation timeframes for other crawling beetles however, these results do not appear to be abnormal. I was quite impressed with a 19 hour 100% kill. Now that I have a better insight on the time frame where death might occur I would like to monitor hours 12-19 more closely, perhaps switch the 15 min interval times to somewhere in those observation hours. As always, I have multiple lingering questions that have presented themselves post observation;

- When the environment is enclosed, like the pan, does that concentrate the exposure because it virtually eliminates any air flow?

- Are there ingredients that I can try that simply plug the spiracles of the insect? As the DE came in contact with either kibble or an insect it became “sticky” and clumped. I wonder if the spiracles became impacted during this observation.
- I’ve concluded the population would be greatly impacted with any application rate from ½ the label rate to 1 ½ the label rate after 19 hours, is there an observation period in there to narrow down that kill time for all applications?
- The label rate application had the observations first death, was that just happenstance or is that repeatable?
- All application rates seemed quite heavy, is this even something that can be done on a retail scale because of the mess?

When I repeat this observation, I will place DE in ½ the container (at the same varying rates) with an attractant in the middle of the DE and leave the other ½ of the container clean. This would help to replicate a retail environment, the clean area being the aisle ways and the DE application occurring under shelving. I am eager to see repeatable results as well as continue the collection of data in the field.

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http://norganics.com/label/insectdust2kg.pdf

http://stgabrielorganics.com/product/insect-dust-diatomaceous-earth

RLHB infestation control: Does this work in the real world?

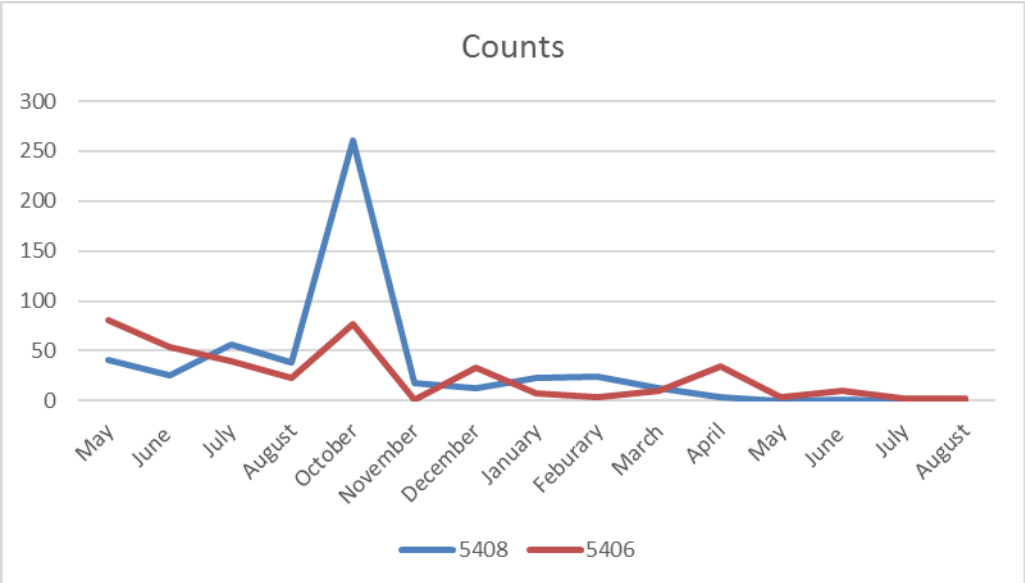
The Collection Period and Data Gathering: Slide Show

Application Results: Excel Format

Month	5408	5406
May	41	81
June	26	54
July	56	40
August	38	23
October	261	77
November	18	1
December	12	33
January	23	8
Feburary	24	3
March	12	10
April	3	34
May	0	3
June	1	10
July	0	2
August	1	2

Fast Facts DE	
Average Pre Application:	77
After 6 month Average:	1
% Reduction	**-97.56%**

Fast Facts Cimexa	
Average Pre Application:	50
After 6 month Average:	10
% Reduction	**-97.53%**



Application began in October of 2015. In April of 2015 location 5408 switched from DE applications to Cimexa applications. DE was a very messy application that results in consumer complaints to the location as well as store personnel complaints of dust and too much labor to clean. The results indicate this is an applicable solution for the control of RLHB in a retail environment.

RLHB Education Materials and Guidance: How do I generate awareness?

Typically when a customer or even an internal contact has questions or concerns around insect activity and the RLHB, we will present some brief educational materials to them. Typically this presentation will be guided by question the audience has asked as well as giving them small details that may help them remember the insect in the future. Here is an example of a slide show I would use:

Educational Slide Show: Click Here

Below is guidance we give our customers around RLHB education.

Red Legged Ham Beetle

Guidelines for retail response

The Red Legged Ham Beetle (RLHB) has a green metallic body with red legs and is primarily a meat eater and will attack any products that have meat as the first ingredient or any products that are only meat products like bones and rawhides. They are driven by odor and will seek out the freshest or best smelling product in the area and exploit it for their reproductive capabilities.

Inspection of the entire retail store including the back stock area is critical to beginning the process of understanding where RLHB populations are currently living. RLHB's will seek out any

small crack, crevice, spilled product, plush toys, bedding materials, ears of bagged product, wooden pallet holes, holes in peg board or corrugated cardboard to pupate.

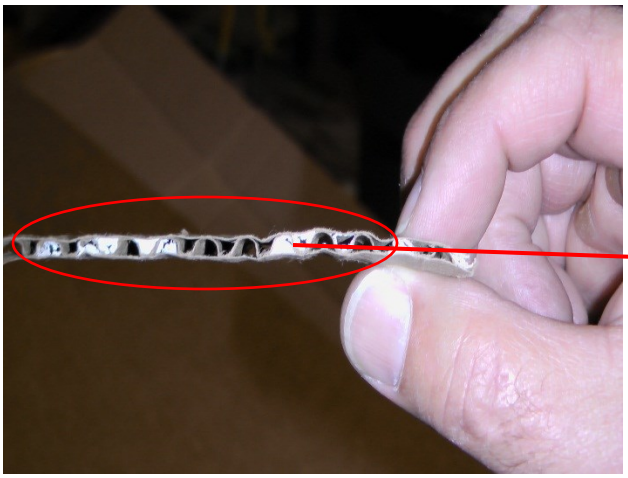
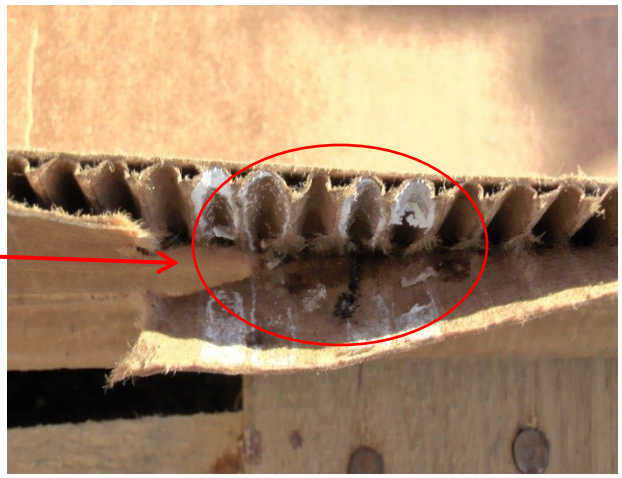
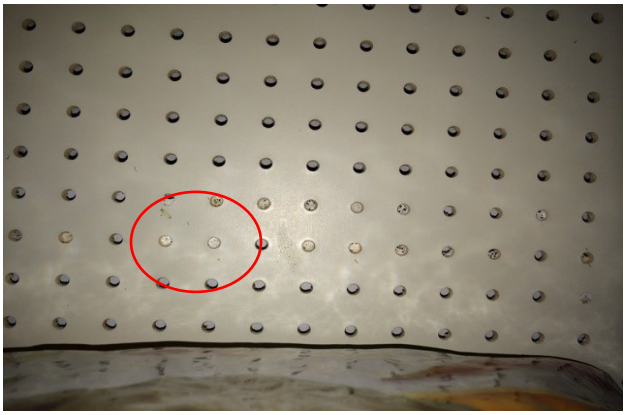
Once the retail location has been evaluated and a list of all locations where RLHB issues exist, a walk through with the store management team, their pest control operator if available and any additional interested parties will be necessary. This should be viewed as an opportunity to train and educate the retail team on your findings and to make recommendations on how to move forward and resolve the current issue.

Provide guidance on how to inspect, where to look, what to do if discovered and how to prevent this from occurring again. We will address these individually.

How to Inspect:

Locations that will require a closer inspection will be dog food with meat as the number one ingredient, any and all pig ears, rawhide's, bones (especially ham), plush toys and bedding, holes in peg board, any spilled kibble behind or under shelving, returned product in back stock room, all cardboard in the entire store including display shippers, product display boxes and slip sheets.

RLHB's will leave behind very distinct white chalky webbing when they are living and laying eggs.


What to do if detected?

If you have discovered RLHB infestations around or throughout the retail store you should document your findings. Record your observations as to the extent of the issue, the products affected, how wide spread this issue appears to be and any conversations you may have had with the retail management team and/or their pest control company. Given that there is not a standard answer as to why they have RLHB issues and that each case you discover may exist

due to different environmental concerns this is not a topic you should attempt to have with the management team in that location without consulting the Retail Food Safety Team and /or offering our services.

RLHB Control: Is this repeatable? Real life example continues.

A customer called us to a location in Arizona. We were able to evaluate this location for a RLHB infestation and confirm this would be an appropriate store to repeat the desiccation test. Below is the repeatable guidance given to the pest control company around setting up monitoring stations as well as preparing the area for application. My goal is to make this desiccation study effective without needing my direct supervision on each and every visit. To make this a truly viable treatment option, it needs to be able to be executed without me.

AZ Desiccation RLHB Project Location #2136
Alexandria Hammel 314.224.9886

RLHB Protocol:

1) Determine effectiveness of Cimexa applications on controlling a present Red Legged Ham Beetle (RLHB) population in a store without significant sanitation opportunities

Supplies Needed:

- Glue Boards
- Pepperoni
- Cimexa
- B&G
- Application License

Start Up Instructions:

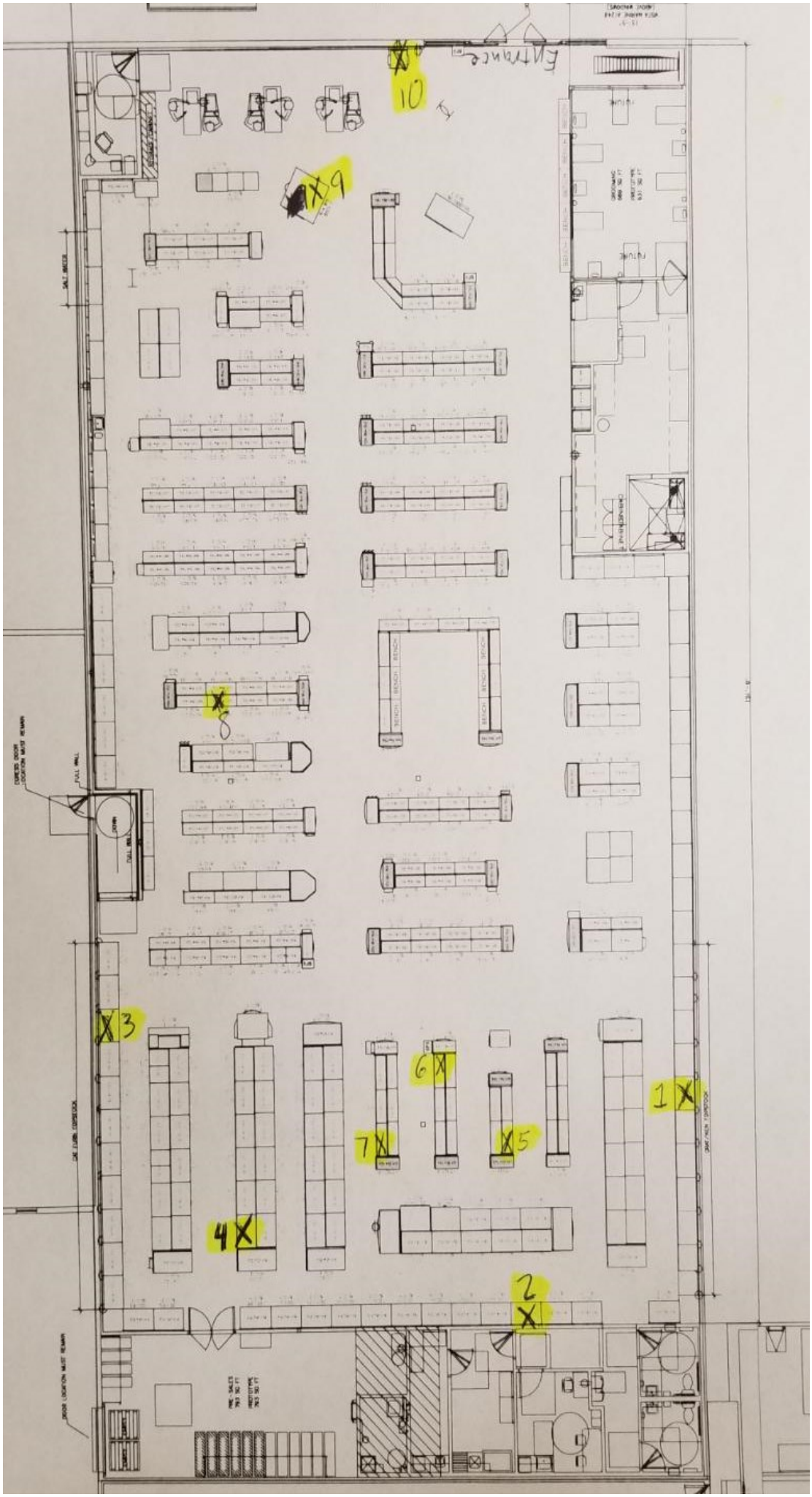
- Set up 10 monitoring locations with pepperoni under shelving in the following aisles:
  1. Dry Dog Food*
  2. Dog Dog Food*
  3. Dry Cat Food
  4. Cat Litter
  5. Bones*
  6. Bones*
  7. Treats
  8. Wild Bird
  9. Treat Bar
  10. Near Front Window

  *these should be separate/different aisles
- Collect data on a monthly basis on monitoring glue for 3 months.
  - Replace Glue Board and Pepperoni every month and place monitors in same locations

Next Step:

- Based on the data collected, I would like to take the aisle of highest activity as well as one to the right and one to the left and apply Cimexa in a wet application to shelving unit and the floor below the gondola.
- Continue monitoring for 6 months with glue boards and pepperoni as a food attractant.
  - The store must thoroughly clean the store every month a few days before application visit.
  - After cleaning, the Cimexa is applied and THEN the monitors are placed.
    1. Clean
    2. Apply Cimexa
    3. Place Monitors
- Alexandria Hammel and T.M. (customer representative) must be present for initial application and at a minimum every 3 months for application.

We are currently into the first month of monitoring. The traps have been set and laid but no numbers have been collected yet. They were placed June 26, 2018. Below is the map.


Entrance
10
9
8
3
6
1
7
5
4
2

Conclusion and Next Steps:

Treatment of the RLHB is an ongoing study. As with all effective pest control, knowing an understanding your pest is the most important piece. Studying, observing and monitoring the insect's leads me to new and great insights continuously. I'm excited to see the results of the study in Arizona, can this be completed by a pest control company and a customer without my monthly supervision? This location is different than the Texas stores, not only geographically but also in layout and product displays.

I've encountered a handful of locations with RLHB activity as I visit with customers in retail but not many that have adequate sanitation practices AND a RLHB infestation. Those are the stores that can benefit from a desiccation treatment plan. If sanitation is the largest opportunity in a retail store, a desiccation treatment will not change that. That has been, by far my largest battle when educating the pest control companies. Integrated Pest Management is reliant on sanitation, without sanitation harborage location are abundant and chemical treatments are rendered ineffective.

I don't feel as if I'll ever stop learning about the RLHB and how it lives and breeds. From my original choice study in 2014, I've kept a population alive in a small habitat that I keep in my laundry room at home. I've shared small numbers with colleagues to help them generate their own populations and I've added others collected from different parts of the US to add to their tiny gene pool (who knows if that makes a difference?). But it's fun and exciting to try new foods and it makes me proud to have been able to keep a population for this many years. I owe these guys a lot, they teach me more than I could have ever learned in a text book. I hope to continue to share all I learn with colleagues and customers to protect resources globally for a more sustainable future.