Issue No. 4

FUMIGANTS AND PHEROMONES

Published by Fumigation Service & Supply and Insects Limited, Inc.
10505 N. College Avenue
Indianapolis, Indiana 46280
317/846-5444

Featured Writer... Our featured writer for this issue is Mr. William Schoenherr, formerly Vice President of Lauhoff Grain Company in Danville, IL. Bill is a graduate entomologist from Blackburn College in Illinois. He served in a regulatory capacity with the U.S. Dept. of Agriculture for 8 years, then spent 34 years with Lauhoff, retiring in 1981.

Bill Schoenherr has published many articles relating to the food industry, has received several awards for his contributions to the industry, and has given many overseas seminars on food protection. He definitely was a pioneer in food protection. Here is his look at.....

An Overview of Pest Management

by William Schoenherr

Let us begin by asking questions: Why pest management? What changes have taken place in the past 40 years? Where and why has there been progress and success? Who has been instrumental in the development of workable pest management programs?

Let us reconstruct the conditions that existed in the early 40's and the changes that made it necessary to establish effective pest management programs. At that early date, much of the food consumed in the home and in restaurants was prepared from fresh and locally grown raw materials. As this country reconstructed following the financially difficult period between 1930 and 1940, the food processing industry also changed. Small companies that survived the depression began to expand, while large companies became even larger. The use of locally grown foods became the exception rather than the rule. Both in the home and in food service outlets, we relied upon commercially canned, dried and frozen foods prepared, processed or manufactured at some distant location. Dependence upon the commercially prepared foods that were shipped long distance and stored for long periods of time made it necessary to develop protective measures.

More strict legal requirements were enacted along with stricter enforcement. Equally important, it necessitated a commitment by industry to develop pest management practices in order to comply with the legal requirements and to reduce losses that occurred during processing as well as during poor shipping and storage conditions and from inadequate packaging.

Changes and improvements came quickly. Our schools of higher learning did an outstanding job of preparing students to meet the exacting requirements of food protection. Also credit should be given to the business community for their acceptance of the legal and humane responsibilities.

The responsibility and credit for the spontaneous and rapid development of safe and realistic pest management programs represents the combined efforts of many dedicated individuals. As those early pioneers leave their active roles, it should be reassuring to everyone that the challenges of the 80's will be met by qualified scientists, persons who have been trained to recognize the potential for quality failure and to set in motion the preventive measures to assure safe and nutritious foods. With prevention now the rule, not the exception, and with an ever-increasing number of qualified individuals directing the programs, along with new and vastly improved procedures, we can expect the high quality food that we are privileged to enjoy in this country to remain safe and pure.

Improved methods of construction for processing equipment and buildings and for storage and transportation facilities has reduced the need for time-consuming control procedures and likewise has reduced the need for expensive and often hazardous preservatives and pesticides.

The use of pheromones is another example of progress. The food industry is ready for this advanced technique of monitoring.

The need to "put out fires" is fading into the past, and the science of pest management is coming of age.

Pheromones:

In many insect species, chemical signals, called PHEROMONES, regulate activities such as egg laying, food finding, courtship, mating, aggregation, fear, and mobilization against intruders. Sex attractant pheromones, which are emitted by insects to attract mates, have been identified for many species, especially among the Lepidoptera (moths & butterflies). The majority of these pheromones are produced by female insects to attract males. Aggregation pheromones are substances which attract insects of both sexes. Many Coleopteran (beetles) sex pheromones are aggregation pheromones. Most attractant pheromones are highly specific and attract insects of only one species; however, some are attractive to several species (i.e. Indian meal moth and **Trogoderma**). Attractant pheromones act at very low concentrations. A 1-milligram load of pheromone is a fairly common dosage per lure, but a dose of 10 micrograms is not uncommon.

The major uses of insect attractants include monitoring for the presence or absence of pest species, determination of population densities, and direct management of the pest species by mass trapping or mating disruption through "air permeation." When an appropriate pheromone is dispersed into the atmosphere, it may interfere sufficiently with the mating communication system of an insect species to produce a significant reduction in the larval population of the next generation.

Synthetic versions of attractant pheromones serve as lures in traps for many insect species. Pheromone trapping is widely used for detection of insects, defining the boundaries of an infestation, timing pesticide applications, measuring the effects of control procedures, and monitoring quarantine programs.

A potential application of attractant pheromones in insect control is to lure insects to a location where they can be brought into contact with control agents such as insecticides, chemosterilants, or pathogens, thus killing the insects, sterilizing them to eliminate future generations, or booby-trapping them to spread diseases throughout an insect population.

from Pesticide Handbook Entoma, 1982

Pheromone Spotlight:

David K. Mueller

Red and Confused Flour Beetle Pheromone. This paper was presented by David K. Mueller, R.P.E., at the Entomological Society of America's North Central Branch meeting in St. Louis on the 16th of March, 1983.

Tribolium Aggregation Pheromone: Field Trial Studies

The purpose of this study was to evaluate the attractiveness of the racemic mixture and the four isomers of 4, 8 dimethyldecanal in field trial situations.

Laboratory results are important in this type of study. However, before we implement a new pheromone in the marketplace, practical field trial testing is essential to evaluate a new product. The end user needs practical recommendations on some fairly difficult questions about the use of these insect infestation surveillance tools.

Tribolium castaneum, the red flour beetle, and **Tribolium confusum,** the confused flour beetle, are well-known stored product and cereal pests of cosmopolitan distribution. Richard T. Cotton lists these as undoubtedly the worst insect pests of prepared cereal foods. Metcalf, Flint and Metcalf, note that the red flour beetle and confused flour beetle are two of the most annoying pests in retail grocery stores and warehouses and are extremely serious in flour mills. In a 1980 survey of stored product insects of the United States, Mueller shows that these insects are listed in the top five most important insect pests of processed food and raw grain throughout the United States.

The stored product industry is quite anxious to obtain an insect infestation surveillance tool, like an effective pheromone trap, for these insect pests.

In 1980 and 1981, T. Suziki of Japan showed that 4, 8 dimethyldecanal has been identified and synthesized as the aggregation pheromone of the flour beetles, **T. castaneum** and **T. confusum.** Faustini has published evidence proving that the natural pheromone is produced on the femur of the adult flour beetles:

Photo of enlarged femur. (Courtesy of Dr. Daryl Faustini)

All locations used in this study had observed a natural infestation of **Tribolium** and were willing not to make a pesticide application during these field trial evaluations.

Dr. Kenji Mori of the University of Tokyo supplied the four isomers of 4, 8 dimethyldecanal.

After gridding out a test location, the placement of each trap was determined by a random draw, similar to drawing a number out of a hat. Traps were checked 3 or 4 times the first week and weekly after that.

The field trial tests were conducted in: 1) a retail seed and animal feed building in Michigan, 2) a flour mill in Michigan, 3) a macaroni plant in Illinois, 4) a dog food plant in Indiana (twice). Results:

1) Retail seed and animal food building.
Duration: 28 days.
Pheromone: 5 mg, racemic, 4,8 dimethyldecanal

Attractant	# Traps	Insects Trapped	#/Trap
Pheromone + oils	4	6	1.5
Pheromone	4	1	0.25
Oils	4	0	0.0
Control	4	1	0.25

2) Flour mill
Duration: 14 days
Pheromone: 5 mg, racemic 4,8 dimethyldecanal

Attractant	# Traps	Insects Trapped	#/Trap
Pheromone + oils	3	2	0.66
Pheromone	3	3	1.0
Oils	3	4	1.33
Control	3	0	0.0

3) Macaroni food plant
Duration: 10 days
Pheromone: 4 isomers, 4,8 dimethyldecanal
Traps were rotated each day.

Concentration	Isomer	Insects Trapped
0.1	RR	4
0.1	RS	0
0.1	SR	4
0.1	SS	3
1.0	RR	0
1.0	RS	0
1.0	SR	3
1.0	SS	0
5.0	RR	1
5.0	RS	0
5.0	SR	0
5.0	SS	3

4 controls
RR – 5 RS – 0 SR – 7 SS – 6 Control – 0

4) Dog food plant
Duration: 14 days
Pheromone: 4 isomers, 4,8 dimethyldecanal

Concentration	Isomer	Insects Trapped
0.1	RR	11
0.1	RS	9
0.1	SR	10
0.1	SS	9
1.0	RR	10
1.0	RS	6
1.0	SR	15
1.0	SS	18
5.0	RR	9
5.0	RS	18
5.0	SR	12
5.0	SS	10

6 controls
RR – 30 RS – 33 SR – 37 SS – 37 Control – 17

5) Dog food plant (3 months later)
Duration: 10 days
Pheromone: Racemic 4,8 dimethyldecanal

Concentration	# Traps	Insects Trapped
1.0	4	3
0.5	4	1
0.1	4	1
0.01	4	3
Control	4	2

Conclusion: In field trial conditions where natural infestations of red flour beetles and confused flour beetles were known to occur, 134 traps were placed in 21 different locations of four different types of stored product plants. In my opinion, the aggregation pheromone 4,8 dimethyldecanal has short range attraction (7 to 12 feet) to adult red and confused flour beetles. This aggregation pheromone for these long-lived beetles will bring some of these insects to the general area of the point source. However, when compared to the sex attractants for Lepidopterous insects (moths) and short-lived beetles, it is substantially less attractive. This pheromone, with a good food attractant and an effective trap, will work to monitor red and confused flour beetles for the stored product industry. It should be used to monitor small areas, old code-dated pallets of material, machinery, grocery shelves, and other locations where **Tribolium** are thought to be present. It would not be practical to generally monitor a large food warehouse or storage facility.

New Products:

The new sterilant/toxicant rodenticide for Norway rats, **Epi-Bloc,** is now available from Fumigation Service & Supply, Inc. Epi-Bloc kills male Norway rats that consume enough bait and sterilizes those that eat a smaller amount.

Epi-Bloc is available in 3-gal. drums containing 500 bait sachets and 50 prebait sachets. It is a restricted use pesticide; you must be certified in the proper category to purchase and use it.

Also available from FSS are **No-Pest** Vapona strips. In addition to the normal uses of Vapona strips for controlling stored products insects, No-Pest strips are labeled

for controlling cockroaches in meter and electrical boxes.

For more information, call FSS at 317/846-5444.

COMMENTARY

Can we be overdoing a good thing? The use of 5% Vapona as a space application is becoming a popular insect control measure and preventive tool for the stored product industry. It is very effective, relatively inexpensive, and potentially very harmful to the applicator.

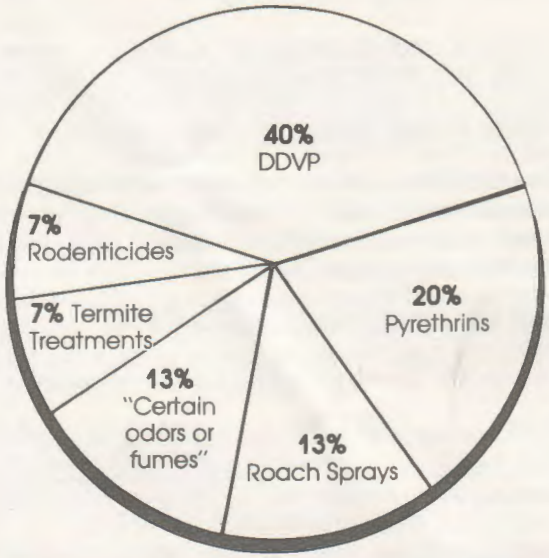
I am concerned when we see how toxic Vapona is to insects. I am concerned when we see the increased routine use of Vapona. I am concerned when we see our own cholinesterase levels drop to an unhealthy level even when extreme caution is taken to protect ourselves. I am extremely concerned about the proposed use of 20% Vapona as a space spray in food handling establishments!

The concern for the applicator is amplified by a recent survey reported in **Pest Control** magazine. Forty percent of the health-related complaints by the PCO's surveyed were attributed to the use of Vapona. I doubt if Vapona represents 10% of the total pesticides used by these people.

Besides the risk to the applicator, what about the Vapona residue that is being left on stored products? Our food is being exposed to multiple applications of Vapona all along the food chain and no one seems to be concerned. We all worry about which product has a label expanded to include "of food processing plants," and we worry about which product contains 1,1,1-trichloroethane. Let's take a step back and start being concerned that some basic questions need to be answered. Are we overdoing a good thing?

David K. Mueller

Chemicals and activities linked by PCOs to suspected exposure symptoms



PEST CONTROL July 1983

Cholinesterase and the Pesticide Applicator

Reproduced in part with permission of William Lamb, Chemical Systems Inc., Chicago, IL (assisted by Dr. John V. Osmun)

What is cholinesterase? Cholinesterase may be best understood by referring to it as a nerve enzyme. An enzyme, of course, is a complex chemical substance within the body that carries out a specific function. Therefore, the nerve enzyme cholinesterase is a body chemical that carries out a specific function in the nervous system.

In the nervous system, cholinesterase is essential in controlling nerve impulses. When it is not present in sufficient quantities, the nerves become overstimulated to the point of nervous breakdown, shock and eventual death.

Another nerve enzyme closely connected to the cholinesterase nerve function is "acetylcholine." It is the function of acetylcholine to activate a nerve impulse, and in turn the cholinesterase function is to terminate that acetylcholine nerve activation. To illustrate, let's suppose that a nerve pattern is a light switch to control one particular light. When the switch is turned on, the light burns. When the switch is turned off, the light goes off, and the electrical circuit is broken. Acetylcholine is the "on" switch. It connects the electrical circuit that makes the light burn. Cholinesterase turns that light off or breaks the electrical circuit that permits the light to burn. Without the "off" function, the light would continue to burn, or with a short in the circuit, the light would flicker on and off uncontrollably. The same is true if the cholinesterase is removed or reduced in the nervous system. We would lose all control of our nerve impulses, and they would throw our body into a total nervous breakdown.

What is the importance of cholinesterase to the pesticide applicator? Certain pesticides such as the carbamate and organophosphate insecticides, herbicides, and fungicides have the ability to destroy or counteract the function of cholinesterase. With repeated exposures to anti-cholinesterase pesticides, the level of cholinesterase in a human body may gradually drop to a dangerous level.

In order to determine if this is happening to a person, it is necessary for a simple blood test to be performed at a medical clinic to determine the normal level of cholinesterase in that person. This is referred to as a "base line." Each person will have his own individual base line number. A safe number for one person may be fatal to another person. There is no substitute for a base line number. This base line number should be established as early as possible in the life of a pesticide applicator and checked no less than once each year.

There are symptoms that may warn an individual of low cholinesterase. Some of these are dilation of the pupils in the eyes, loss of appetite, hypertension, and overall weakness. Frequently, however, people do not have symptoms until they are in real trouble. This is one reason why it is not a very good policy to wait until a symptom occurs before checking the body's level of cholinesterase. If this level nears the point of 75% below the base line, there is definite cause for alarm.

When a low level of cholinesterase is detected in a person, how long will it usually take for that body to regenerate itself to a safe level? This, too is a matter based entirely upon an individual's own body metabolism. Usually, if the level is not disastrously low, recovery may be accomplished in a few days to a couple of weeks. However, this may not be true if the level has gradually reduced over a number of years as the result of continuous small exposures to organophosphates and carbamates. The level could build back up as gradually as it was reduced. This can be determined by more frequent blood tests and the recommendations of a qualified physician.

What are the pesticides that may be used in operations that fall into the categories of carbamates and organophosphates?

Carbamates - carbaryl (Sevin), dimetilan, Ficam W, mexacarbate (Zectran), propoxur (Baygon)

Organophosphates - abate, chlorpyrifos (Dursban), coumaphos (Co-Ral), diazinon, dioxathion (Delnav), **dichlorvos (DDVP or Vapona)*** dimethoate (Cygon), disulfoton (Disyston), fenthion (Baytex, Entex), malathion, methyl parathion, naled (Dibrom), parathion or ethyl parathion, ronnel (Korlan), tetrachlorvinphos (Gardona), trichlorfon (Dipterex)

*Vapona (DDVP or dichlorvos) is the one chemical in both of these groups that is beginning to see more and more use in various types of application. In the stored product industry a 5% Vapona is being used in ULD equipment. In the tobacco industry a 20% Vapona is commonly used in this manner. Therefore, a little more information about Vapona may be justified at this time.

Vapona is easily absorbed through the skin, and if only small amounts are spilled on the clothes or body, these may produce very serious results requiring medical treatment (Hayes, 1963).

The following statement was taken directly from a Vapona label: "Repeated exposure to cholinesterase inhibitors may, without warning, cause prolonged susceptibility to very small doses of any cholinesterase inhibitor. Allow no further exposure until time for cholinesterase regeneration has been allowed as determined by blood test."

Respiratory protection - When Vapona is being applied indoors, those applying the insecticide must wear at least a full-face gas mask with a filter-type canister which gives full protection against organic vapors and acid gases. A small cartridge-type respirator does not give adequate protection when Vapona is being used for industrial purposes.

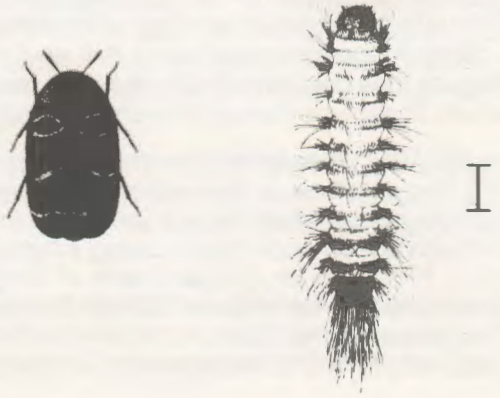
Vapona should be used only when the plant is not in operation, and when no food products are exposed. Food should be removed or covered during treatment. All food processing surfaces should be covered during treatment or thoroughly cleaned before use.

How about some of the fumigants and chlorinated hydrocarbons common to the industry (i.e. phosphine, methyl bromide, carbon tetrachloride, chloroform, ethylene dibromide, ethylene dichloride)—will these too affect the body's cholinesterase? No. Only the carbamates and organophosphates have the ability to act upon cholinesterase levels. Most of the organochlorine materials are nerve poisons, but they react in a way entirely different than cholinesterase inhibitors. The liver will probably suffer the most from the halogenated fumigants listed. It is the responsibility of the liver to detoxify poisons that enter the body. These halogens, however, tend to be so potent that they destroy the function of the liver.

Does the ammonium carbamate in the fumigant Phostoxin® have any effect upon a body's level of cholinesterase? No, none whatsoever. It is essentially inert.

Insect Spotlight

Trogoderma variabile (warehouse beetle)



Khapra beetle, scientifically known as **Trogoderma granarium,** was finally eradicated from the U.S. in 1966, at a cost of over $11 million to county, state and federal governments. The khapra beetle, one of the major pests of stored foods in many parts of the world, has a close relative which is now becoming recognized on its own merit as a serious pest. This insect, **Trogoderma variabile,** formerly called **Trogoderma parabile,** is commonly known as "warehouse beetle". If there is an insect that is truly a voracious feeder, the warehouse beetle falls into that category because of the long list of foods that it attacks. Next to khapra beetle, it is the most serious pest species of the family Dermestidae.

The warehouse beetle is common throughout most of the U.S. It attacks a wide variety of stored foods, plus dead insects and other dead animals. This beetle can tolerate extreme weather conditions, and the larvae can live up to three years without food or water. In an experiment with cold temperature, 100 **Trogoderma variabile** larvae were kept in a freezer at 0°C for 7 days. Sixty percent survived.

Trogoderma variabile is part of the dermestid beetle group. The adult's appearance varies, but it is very similar to **Trogoderma inclusum.** They can be distinguished by the middle row of markings on the wing covers. This row is shaped like a mustache on **T. variabile,** while it extends farther toward the head on **T. inclusum.** The adult is brownish-black and about 1/8 inch long.

Larvae are very difficult to identify, as they are quite similar to the other **Trogoderma** species. They are 1/4 inch long, yellow to medium brown in color. The body tapers slightly at both ends. An identifying characteristic of all **Trogoderma** larvae is the dark, spear-shaped setae (hairs) on the last 3-4 segments of the abdomen.

There are 16 species of **Trogoderma** which are somewhat similar in appearance. Within these 16, there are some adult species that are so extremely identical that their genital organs must be examined to determine identity. The larvae are also difficult to identify, and it takes an expert to make a correct identification.

The larvae are parasitized by Broconid wasps, so the presence of these tiny wasps may indicate an infestation of **T. variabile.**

Adult warehouse beetles live only 3-5 weeks. They begin to fly at temperatures of 20°C. Females do not fly until they mate.

These beetles often feed on nectar and pollen outdoors, then move indoors to lay their eggs on a protein source. They prefer to congregate along the east wall of a building, as they are attracted by the light and warmth of the sun. The larvae burrow into cracks and crevices.

Okumura (1967) mentioned two medical reports concerning two relatives of the warehouse beetle: "The establishment of a case of cantharíasis in an infant in Indiana was based upon the following information: On March 6, 1964, two larval specimens of **Trogoderma** were submitted to me for identification. The specimens were collected in the stool of a four-month-old baby boy who was ill. The larvae were in sufficiently good condition to identify them to genus, but not to species. Live larval specimens were submitted later from packages from the same lot of high-protein baby cereal which had been fed to the child, and I identified them as **T. glabrum**, a species relatively common in the United States."

"This case of intestinal cantharíasis was further substantiated by the consulting physician: 'As far as I know, the symptoms in the Indiana infant with ulcerative colitis were attributed to the beetle larvae of **Trogoderma glabrum.** Since the peak incidence of this disease in the third decade of life, more importance might be attached to the beetle larvae as the etiological agents. It is important to report each case, since more cases would give greater weight to the etiology of the disease. Another important point to establish is whether symptoms in the patients abated with the disappearance of the larvae.' "

"The case in which cantharíasis was presumed to occur took place in California, October 1964. A four-month-old baby boy was fed a high-protein baby cereal in which the larvae of **T. ornatum** were later found. I identified the specimens (one live, one dead, and two cast skins) taken from the original package of baby cereal. According to the mother, the baby became ill two or three days after eating the cereal. The baby did not vomit, but had mild diarrhea. A personal interview with the mother disclosed in detail the reactions of the child after swallowing the larvae. She stated: 'The baby showed signs of varying degrees of digestive distress, culminating in a severe outbreak of screaming and crying and absolute refusal to eat (though at the same time seeming hungry, and trying to eat—each time, however, becoming rigid and red, and arching his body and screaming, evidently in pain). It was on this occasion that I noticed the larval skin, and later, upon looking further, the live specimen in the cereal box. I was alarmed at the discovery and called the doctor. By the time he was able to call me back, the baby had fallen asleep. He whimpered all that night and even more markedly the following night, with varying signs of distress during the day.' The doctor did not administer any medication, and after a couple of days the baby recovered." There is no doubt in my mind that the warehouse beetle can cause similar illness.

An excellent sex attractant pheromone system is available for **T. variabile** and other **Trogoderma** species. Insects Limited, Inc. has been very successful in monitoring warehouse beetle populations with pheromone traps. In some instances, mass trapping with pheromones has been successful.

(This article was taken in part from "Warehouse Beetle, A Major Pest of Stored Food," by George T. Okumura.)

National Pesticide Information Retrieval System:

What products are registered federally and/or in my state to control pest "X"? Is product "B" registered to control pest "C" on site "D"? What products does company "M" have registered in my state?

Have you ever needed answers to these kinds of questions? There is a new service coming in October,

Survey Form:

Please fill out and return this form so we can better serve you.

1. Do you wish to continue receiving Fumigants & Pheromones newsletter?

YES_____ NO_____

2. Are there any changes or corrections we should make in your mailing address?

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3. Is there someone else in your organization who would benefit from this newsletter? If so, give name and address:

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4. Are there any particular subjects you would like to see covered in this newsletter?

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5. Do you wish to receive a new product guide free of charge?

Fumigation Service & Supply, Inc._____

Insects Limited, Inc._____

Return this form to:
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Indianapolis, IN 46280

1983 which will answer these and a myriad of other questions in minutes – even seconds – simply by placing a phone call. It is called NPIRS.

NPIRS (National Pesticide Information Retrieval System) is being developed at Purdue University through a cooperative agreement with USDA. NPIRS is a computer-based data resource that contains information describing key characteristics of all 48,000 pesticide products registered by the U.S. EPA and participating state regulatory agencies.

You do not have to be a computer whiz or data processing expert to use the NPIRS. This "user friendly" system is based on a series of menus which guide the user into making a request for information. Almost any computer terminal on the market today, when equipped with dial-up capabilities, can access the NPIRS.

For more information on the NPIRS, call or write Jim White, User Service Manager, NPIRS, Entomology Hall, Purdue University, West Lafayette, IN 47907 (telephone 317/494-6614).

Special Discount on Pheromone Traps!

Insects Limited, Inc. is offering a limited discount on pheromone traps: $5.00 off on the new Storgard™ Indian meal moth kit, **Tribolium** (flour beetles) kit, **Trogoderma** (warehouse beetle) kit, or Serrico™ (cigarette beetle) kit. This special ends October 15, so call or return the coupon below now.

Name _____

Company Name _____

Address _____

City_____

State _____ Zip_____

Phone _____

No. Kits

_____ Indian meal moth, 3 traps/kit, $20.00 each.

_____ **Tribolium** (flour beetles) & saw-toothed grain beetle, 10 traps & 20 lures/kit, $53.00 each.

_____ **Trogoderma** (warehouse beetle), 10 traps & 20 lures/kit, $53.00 each.

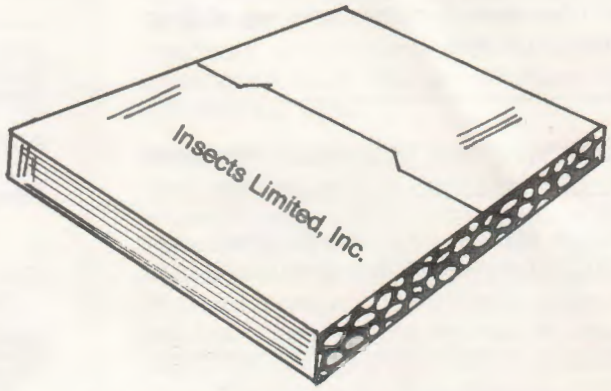
_____ Cigarette beetle, 10 traps & 10 lures/kit, $40.00 each.

New Pheromone Available

A pheromone trap is now available for the red and confused flour beetles. This trap also attracts the saw-toothed grain beetle and various larvae.

Field testing by Insects Limited, Inc. proves that the Storgard™ **Tribolium** traps are effective in isolating hidden flour beetle infestations. We now have a new monitoring tool for an age-old pest.

Red Flour Beetle



Insects Limited, Inc., first in stored product insect pheromones!

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