The 12th Fumigants & Pheromones Conference was held March 6-9, 2016 in the festival city of Adelaide, South Australia. From 26 countries 180 people attended this biennial conference on stored product protection. Dave Mueller, president of Insects Limited and conference organizer stated: “This was the best yet. The world class speakers, new Adelaide Conference Center, very special dinner at the Adelaide Oval, record number of sponsors, local host organizers, ‘The Legend’ speaker, and the warm weather made this conference the best since 1993 when the first conference was held in Lübeck, Germany.”

This was the first time this conference was held in Australia. Simon and Sue Ball of Australian Fumigation in Adelaide were the local organizers. Barbara Bass, Peggy Rutkowski, and Lisa Orbaugh of Insects Limited organized many elements of this conference from their offices in Westfield. Speakers included Nayak, Mueller, Corrigan, Baributsa, Ryan, Lombardi, Ball, Emery, Fields, Daglisch, Self, Schlipalius, Waggoner, Thoms, and Simmons. In addition, research posters, “What's New” sessions from manufacturers, and industry displays were part of the program.

Australia is an island continent located about 30 hours from Europe and 20 hours from North America by airplane. Many past participants in the Fumigants & Pheromones conferences found it difficult to travel this long distance to attend. But the Australians, who live far away from European and North American conferences, were excited to have this conference in their country. Adelaide 2016 was attended by 105 Australians. They came from Brisbane, Melbourne, Perth, Sydney, Adelaide and places in between; and there is a lot of “in between” in Australia. Australian conference attendees represented the federal government agencies, the grain traders, pheromone distributors, fumigation companies, food companies, universities, fumigant scrubber companies, federal stored product research organizations, bin sealing companies, and export grain terminals.

Grain is a major export for Australia. They continue to pride themselves on producing and shipping quality grain throughout the world. The government of Australia is so focused on exporting quality grain products that they...

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Rooftop Insect Collectors Find Climate Change Already Affecting Species

by Christine Lepisto

In 1992, Ole Karsholt and Jan Pedersen started collecting bugs in light traps on the roof of the Natural History Museum of Denmark in Copenhagen. A quarter-million bugs later, their data on 1543 species of moths and beetles provides astounding evidence that we don’t need to wait for 2°C (3.6°F) of warming before seeing significant effects of temperature change on the insect community.

As might be predicted, the insect species—bugs that eat only a single species of plant—experience temperature changes more dramatically than generalists. “Earlier studies have confirmed that specialist species also respond rapidly to destruction of their habitats, so we are dealing with a very sensitive group of animals” according to postdoc Philip Francis Thomsen from the Center for GeoGenetics, one of the authors of the study published in the Journal of Animal Ecology.

The nut weevil, Curculio nucum, a connoisseur of the hazel nut, visited the museum roof in the early years of the study but disappeared in later years. Its place was taken by the acorn weevil, Curculio glandium, suggesting that both species are moving northwards to find cooler domains. The data on other specialist species supported the hypothesis, showing increases in populations of hot-dwelling species and decreases in those that prefer cooler climates.

Insects that feed only during the non-mobile larval stage were seen to range quite widely from the habitats of their infancy, at least 10 km distant from the museum roof. The team succeeded to register seven moth species and two beetles which had not previously been on record as inhabiting Denmark, including the Asian lady beetle (Harmonia axyridis) (pictured) which has now spread throughout the country and is considered an invasive species.

The conversion of the data gained from the long-term voluntary monitoring project proves how invaluable such records can be. It seems like citizen scientists could lend a hand in the effort with a little political guidance, benefiting both the people involved and the state of scientific knowledge of our environment.

Graduation Time

Pat Kelley, BCE, Vice President of Insects Limited has received his Master’s Degree in Entomology from the University of Nebraska. Pat has always been a scholar during his 30 years of work with entomology oriented company Insects Limited. His desire to further his education and to pursue a graduate degree is something that he started about four years ago after he turned fifty. The University of Nebraska is one of the only distance learning graduate programs in the country.

Dave Mueller stated: “I have noticed that Pat has really improved his skills in pest problem solving and writing since working on this graduate degree. Pat worked on an odd pest that is rarely studied, the odd beetle (Thylodrias contractus) receiving its name from two very different looking adult genders. Pat has recently taught museum pest management topics at Yale University, New York City, and Buffalo State University. He sits on the Museum Pest Management Working Group. Pat is truly an international expert in museum pest management.”

Edgar Garcia is the son of Luciano and Gabrielle Garcia of Noblesville, Indiana. Luciano, a licensed fumigator with Fumigation Service & Supply, handles the Export Fumigation Division. Edgar will graduate from Purdue University, 3.3 GPA in four years, in Aviation on May 15, 2016. Edgar has worked for FSS during the summers and on school breaks for the past four years. Purdue offers one of the few four year aviation programs in the United States. Edgar is the first University scholarship recipient from FSS/IL. Other scholarship recipients include Sara Lilleodden, U of M Duluth; Ben Lilleodden, Northern Iowa; Adam Gough, DePaul, and Quinn Kelley, Purdue.
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 ‘40s 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 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 food being commercially canned, dried and frozen, 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 improvement came quickly. Our schools of higher learning did an outstanding job of preparing students to meet the exacting requirements for food protection. Also credit should be given to the business community for acceptance of their 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 ‘80s will be met by qualified scientists, persons who have been trained to recognize the potential for quality failure and to set in motion the preventative 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.

Bill Schoenherr is one of the pioneers that built the foundation for food safety and education for our industry. I feel privileged to have known him.
have enacted a grain standard law that doesn’t tolerate insects in their export grain. Considering that Australia is a warm country with the ideal conditions for pest insect growth and development, ‘Nil Tolerance’ is a challenge. Canada has such high standards for their export grain; however, the cold winters make this easier to achieve. The Australians often fumigate their grain with phosphine every 120 days while in storage. This would be similar to the Oklahoma area in the United States that fumigates wheat, on average, three times a year.

Because of the heavy dependence on phosphine fumigants for protecting grain while in storage, the Australian researchers lead the world in understanding and detecting the presence and absence of genetically linked phosphine fumigant resistance. Dr. Manoj Nayak of DAFF in Queensland led off the conference with an explanation of how his lab in Brisbane searches for phosphine resistance and ways to manage this serious challenge.

Rodents received attention from favorites Dr. Bobby Corrigan and Dr. John Simmons. Dr. Corrigan presented some of his training from his New York City Rodent Academy and Dr. Simmons directed his comments toward rodent management in food facilities in Europe.

In all, there were 21 presenters in the first two days. The evaluation sheets gave the speakers high ratings. One evaluation sheet stated: “What we enjoyed most about this conference was the range of speakers and attendees available to talk to. This has been an excellent opportunity to meet people from this industry and share so much knowledge from their expertise.” One person mentioned: “I liked the interaction with others and understanding how things are done in different countries.”

The Gala Dinner sponsored by Douglas Products was very enjoyable and entertaining. The food was delicious, the atmosphere and view over the famous Adelaide Cricket Stadium was impressive, and famous former Test Cricketer for Australia, Wayne Phillips, “The Legend,” told hilarious stories. However, the best part of the evening was the traditional singing contest from the various countries. The massive Australian contingent sang “Waltzing Matilde” while their American counterparts sang: “Home, Home on the Range.” But the winner of the coveted mini-cricket bat (signed by ‘The Legend’) went to Zimbabwe. Zane Accutt, Delport Tobacco of Harare, brought down the house with his tribal hymn from his native country.

Most of the presentations were practical in nature. Mueller, Kelley, Van Ryckegehm, and Daglisch offered pheromone topics: The Practical Use of Pheromones, The Practical Use of Beetle Traps, and Mating Disruption for Indian meal moth (Plodia interpunctella) in food warehouses and The Practical Use of Pheromones in Australia.

At the end of the conference, Dave
Pheromones “Down Under”

by Pat Kelley, BCE
Vice President

Dr. Greg Daglisch calls himself an “Applied Entomologist”. Working as the Principle Research Scientist with the Queensland Department of Agriculture, Fisheries and Forestry (DAFF) in Australia, Daglisch has become an expert in postharvest grain biosecurity and has worked extensively with stored product beetles in the “Land Down Under”.

As an invited guest speaker at this year’s 12th Fumigants & Pheromones Conference in Adelaide, Australia, Daglisch told the international crowd that he is always looking for ways to exploit pest insects in the Australian grain industry. He has done this in part through the trapping studies of three prominent pest beetles: the lesser grain borer, *Rhyzopertha dominica*, red flour beetle, *Tribolium castaneum* and rusty grain beetle, *Cryptolestes ferrugineus*.

Daglisch’s group studied both the seasonal and spatial patterns of these beetles. They did this by counting beetle numbers captured in traps containing the aggregation pheromones of the different beetles. The traps were placed at grain storage sites and non-storage (natural) sites. The seasonal studies showed that even in this very warm country, neither the lesser grain borers nor the red flour beetles take flight in the cooler winter months. When temperatures rose above 25° C (77° F), the flight activity began and the beetles could potentially fly up to a distance of one kilometer (.62 miles). In Australia, the ability of these beetles to fly and disperse during 9+ months of the year, allows the spread of phosphine resistant strains over a considerable portion of the country.

As a means of science helping industry, a big part of Daglisch’s job is spreading the word to farmers that these beetle species (both resistant and non-resistant strains) can fly relatively far distances. They can fly into grain silos from neighboring silos or they can even fly in from non-storage sites like forests and fields. A key part of preventing grain loss in Australia comes through the education of people involved in the grain industry. Farmers must know that when flight activity begins, there is an immediate increase in infestation pressure. They must also know that flight activity can begin long before the harvest and they should prepare for that. It becomes a matter of not “if” but “when” the beetles will arrive.

If you are interested in more information about the 12th Fumigants & Pheromones Conference in Adelaide, go to www.insectslimited.com and click on the conference logo. Here you will find photos from the conference.
PHOSPHINE RESISTANCE UPDATE

by Ethan Estabrook

Phosphine Resistance: Genetics and Strength of Resistance

After 70 years of inadequate fumigation practices involving poorly sealed structures, repeated fumigations and low gas concentrations, phosphine resistant insects are showing up more frequently all across the world. At the 12th International Fumigants & Pheromones Conference, Dr. Manoj Nayak and Dr. David Schlipalius, from the Queensland Department of Agriculture, Forestry and Fisheries in Australia, presented how genetics affect the strength of resistance and why phosphine resistant insects are so difficult to control.

Resistance to phosphine is caused by small changes in specific genes which allow insects to survive phosphine concentrations that would normally kill wild type insects (insects with no resistance to phosphine). Genes resistant to phosphine are called rph1 and rph2. These genes get their name from the “r” in resistant and the “ph” in phosphine. If an insect possess either rph1 or rph2 it will have weak resistance. Weak resistant insects can be 4-25 times more resistant to phosphine than wild type insects. If an insect possess both rph1 and rph2 it will have strong resistance. Strong resistant insects can be > 250-400 times more resistant to phosphine than wild type insects. Different species of stored product pests have different strengths of resistance. Recently, strong resistant rusty grain beetles (Cryptolestes sp.) showed the highest strength of resistance and were found to be 1,300 times more resistant to phosphine. These strong resistant insects threaten the use of phosphine fumigants and need to be managed properly to ensure the future use of phosphine products.

In their 2010 journal “Developing strategies to manage highly phosphine resistant populations of flat grain beetles in large bulk storages in Australia,” Dr. Manoj Nayak and others determined it would take a fumigation at 68°F (20°C) of 360 ppm for 30 days to control all strong resistant rusty grain beetles. That is a full month under fumigation! Their graph indicates the time to population extinction at 68°F (20°C) at two different phosphine concentrations for strong resistant Psocids (book lice) (SR-PSO), strong resistant lesser grain borers (SR-LGB), and strong resistant flat grain beetles (SR-FGB).

Phosphine Resistance: A World View

Phosphine resistance has been detected all across the world. A global survey in 1976 found 33/82 countries had phosphine resistant insects. In India every storage site tested had 76-94% of insects carrying phosphine resistance. Worldwide, there are currently 12 species of stored product pests that have shown resistance to phosphine fumigants. At the 12th International Fumigants & Pheromones Conference, Dr. Manoj Nayak and Dr. David Schlipalius, from the Queensland Department of Agriculture, Forestry and Fisheries in Australia, presented an update on worldwide trends and what Australia has done to help control phosphine resistant insects.

Thirty years ago Australia developed a nationwide monitoring program to determine the trends of resistance frequency in insect populations and now lead the world in phosphine resistance research. As a result, they have longer time and higher temperature requirements for using phosphine. They require a 7-day fumigation if the grain temperature is above 77°F (25°C), 10 day fumigation if the grain is 59-77°F (15-25°C), and suggest not fumigating if temperatures are below 59°F (15°C). Australia also requires pressure testing on silos prior to fumigation to determine if the silo is structurally tight enough to fumigate. Pressure testing is a federal requirement when fumigating grain silos and is called the Australian Standard (AS2628).
The mechanism in which phosphine fumigants kill insects has largely been unknown. Dr. David Schlipalius, from the Queensland Department of Agriculture, Forestry and Fisheries in Australia, presented a new understanding of the phosphine mode of action at the 12th International Fumigants & Pheromones Conference in Adelaide, Australia. This information gives us new insight on how phosphine fumigants interact with the insect biology and may allow us to produce more effective fumigants.

Phosphine is an indirect toxin which means the amount of toxin within an insect increases the longer the insects are exposed to phosphine concentrations. This is in contrary to direct toxins which stay constant over time, such as the case with cyanide. Phosphine produces more and more toxic byproducts with time. These toxic byproducts build up and kill insects by disrupting the fat metabolism process that damages the nervous system. Nerves are dependent on fat metabolism produced by mitochondria. Mitochondria are organelles in cells where the respiration process happens. During a phosphine fumigation, phosphine and oxygen are absorbed into the mitochondria and produce toxic oxygen radicals. These toxic oxygen radicals then interfere with the fat oxidation process which then amplifies and produces additional toxins within the pest.

The genes resistant to phosphine affect the pathway in which phosphine kills insects. The rph1 gene is expressed in fat oxidation and the rph2 gene in oxygen radical. These two genes are genetic mutations. Insects have evolved to endure more toxic byproducts which allow them to survive higher phosphine concentrations. The effectiveness of phosphine fumigants are dependent on the insect’s ability to metabolize fat. Fat metabolism takes time, but this process can be increased with warmer temperatures. This is why phosphine becomes more toxic and effective over longer periods of time and higher temperatures.
Two New Product Guides Available

Fumigation Service & Supply has their new product guide available as a 24-page, full color, and easy-to-read booklet. The electronic edition can be found online at [www.fumigationzone.com](http://www.fumigationzone.com). Jeff Waggoner, general manager for FSS said, “We have highlighted categories in Fumigation, Fogging, Monitoring, Insecticides, Pest Control and Safety.”

Insects Limited has completed its newest product guide also. This 16-page full color and fully illustrated booklet comes both hard copy and online at [www.insectslimited.com](http://www.insectslimited.com). It contains stored product pheromone kits and lures. Tom Mueller from Insects Limited said, “This new product guide includes several new pheromones and the new All Beetle Trap.”

Contact us at 1.800.992.1991 or 1.317.896.9300 for your new catalog, or click on the websites.

VISIT US AT: [www.insectslimited.com](http://www.insectslimited.com)