

## THE ROLE OF URBAN ENTOMOLOGY TO ENSURE FOOD SAFETY AND SECURITY

VACLAV STEJSKAL(\*)

(\*) *Crop Research Institute, Department of Stored-product pests control, Drnovska 507, 161 06 Prague 6, Czech Republic, stejskal@vurv.cz*  
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### *The role of urban entomology to ensure food safety and security*

The presentation covers the recent advances achieved mainly in the fields of risk evaluation and monitoring of urban insect and mite pests. The paper discusses the following topics in detail: (i) Mites cause serious risk for occupational allergy in grain stores; (ii) Cockroach allergens Bla g 1 and Bla g 2 are stable enough to persist in households for more than one year; (iii) Identification of immature stages is under-studied: comprehensive identification keys for pest egg stages are still not available; (iv) The importance of correct and unified methods for interpretation of filth detection and population sampling and monitoring of stored product pests in Europe. This invited paper was funded by Accademia Nazionale Italiana di Entomologia and co-funded by the project MZe CR, VZ - 0002700604.

KEY WORDS: urban entomology, insect and mite pest, food security, allergy in cereal stores.

### INTRODUCTION

#### *Urban entomology definitions*

Entomology concentrates its main focus on the study of insects. This branch of science is diverse and includes many entomological sub-disciplines. Urban entomology and stored product entomology belong among the most important entomology sub-disciplines due to their beneficial impacts on human society. There are no universally accepted sets of definitions concerning entomological disciplines and sub-disciplines. Surprisingly the most comprehensive book and textbook on urban insects and arachnids (A handbook of urban entomology; ROBINSON, 2005) by prof. W.H. Robinson does not provide any definition of urban entomology as a scientific discipline.

In general textbooks and dictionaries, "Urban entomology" is usually defined as a scientific discipline that deals with insects that come into close contact with humans and affect immediate surroundings of daily life. Some authors even classify "Urban Entomology" as a sub-discipline of forensic entomology. For example, the forensic entomology web pages (e.g. <http://www.forensicentomology.com/definition.htm>) equipped the readers with the following classification and interpretation: "The broad field of forensic entomology is commonly broken down into three general areas: medico legal, urban, and stored product pests. The urban aspect deals with the

insects that affect man and his immediate environment. Urban pests are of great economic importance and the forensic entomologist may become involved in civil proceedings over monetary damages. Stored product insects are commonly found in foodstuffs and the forensic entomologist may serve as an expert witness during both criminal and civil proceedings involving food contamination". The definition variation shows that stored product and urban entomology are quickly evolving disciplines that interact with other fields of science.

### STORED PRODUCT PROTECTION AND URBAN ENTOMOLOGY IN ITALY

There is a long tradition of stored product and urban entomology in Italy. Courses on urban and stored product entomology have been available for students at several universities across the Italy. The Italian stored product and urban entomology is internationally recognized for making significant contribution in many areas, including pest monitoring, mating disruption, pest-proof packaging materials and pest chemical and physical control (FRILLI, 1965 DOMENICHINI, 1980, 1982, PAGANI, 1982). Considering the importance of Italy as a producer and exporter, pests of alimentary paste has been the subject of much research (TREMATERA, & SÜSS 2009). Part of that long-

term tradition represents an excellent organization of various conferences and symposia concerning urban entomology and food protections and safety.

The symposia and workshops have always attracted many scientists and food industry representatives from Italy and abroad. The most famous event has probably become the series of conferences “La Difesa Antiparassitaria Nelle Industrie Alimentari Ela Protezione Degli Alimenti”. These conferences are connected with the names of many internationally recognised Italian urban and stored product entomologists and acarologists; e.g., Prof. Domenichini, Prof. Pagani, Prof. Frilli, Prof. Suss ... ..to name just a few.

In early 90<sup>ties</sup> of the last century, Italian urban and stored product scientists have also become founding members of the international IOBC Stored Product Entomology group. Until today, this small group has gradually increased manifolds. Nowadays IOBC conferences are regularly attended by stored product and urban entomology scientists from more than 50 countries. The IOBC/WPRS Working Group on Integrated Protection of Stored Products (<http://www.iobc-wprs.org/>) meets every two years to discuss new findings regarding the following topics: biology of stored product pests, methods of pest prevention during storage, transportation and handling pheromones, traps and other methods to detect stored product pests, all aspects of biological control, prevention of microflora infection and development of mycotoxins, physical, chemical and other techniques for stored product pest control, futurology: overviews and future trends on all aspects of storage pest control. wood-boring, urban, quarantine and museum pests .

Prof. Pasquale Trematerra was the main local organizer for the Conference of the IOBC/WPRS (OILB/SROP) Working Group on “Integrated Protection of Stored Products” (29 June-2 July 2009) hosted by University of Molise Campobasso, Italy. The objective of the conference was to discuss new research developments in integrated protection of stored products , particularly the non-toxic control methods. Communications were focused on maximising the dissemination of new control technologies able to reduce the use of residual pesticides and on minimising risks to non-target organisms and environment contamination.

This well attended conference and meeting (organized by Accademia Nazionale Italiana di Entomologia in Florence in 2011) is a further proof that the Italian urban and stored product entomology has not only good tradition and historical roots but also strong presence and bright future.

#### URBAN AND STORED PRODUCT ENTOMOLOGY IN THE CZECH REPUBLIC

This paper reviews some of the results that have been achieved by scientists at Crop Research Institute (CRI) Prague. The department of stored-product pests control (CRI) has a long tradition. It was established over 60 years ago and is the only department in the Czech Republic dealing with post harvest protection of agricultural commodities. Its area of competence extends to all places where materials of animal and plant origin are stored, such as warehouses of the Ministry of Agriculture, as well as food processing factories and private households. The current research of department is aimed at integrated pest management and food safety. The study of department responses an interdisciplinary research (entomology, rodentology, food science, medicine, physiology) with the topics as follows: (i) Faunistics, pest as vectors; (ii) pest morphology and physiology; (iii) pest life history; (iv) biological control and anti-feedants (GMO); (v) monitoring; (vi) physical and chemical control; (vii) pests as allergen producer in stored food commodities.

#### INSECTS MITES AND FOOD SECURITY AND FOOD SAFETY

When men began to store food, it was attacked by a vast array of insects, mites and rodents which before had been of no significance in human environment. In spite of the advanced motoring and control systems possessed by a modern society, urban and store product insets a mites are still real problem around a world. In the tremendous food-storage organization of today, insects destroy thousands of tons of food annually. While “food security” is the main issue for developing countries, the developed countries are more concerned by problems associated with “food safety”. “Food safety” has recently transformed into scientific discipline describing handling, preparation, and storage of food in ways that prevent foodborne illness and food contamination. This includes a number of routines that should be followed to avoid potentially severe health hazards. Arthropods have been recognized as potential significant health hazards because of their allergenic (mites, psocids, cockroaches, mice) or mutagenic (e.g. *Tribolium* spp.) effects. As a consequence, stored product and urban pest tolerance is very low and their economic thresholds are approaching zero level (STEJSKAL, 2002).

Stored product pest may be source of indirect

contamination of stored commodities, by pesticide residues (> MRLs) of chemical treatment by protectants. Direct contamination includes physical, microbial and chemical (toxins, carcinogens and allergens) arthropod contaminants. Parts of arthropod bodies, exuviae and feces are physical contaminants whose safe levels are regulated by Defect Action Levels (DALs) in USA. For example, the alarming extent of contamination of Italian flour by fragments of insects and mites has been recently demonstrated by team of prof. Trematerra (TREMATERRA *et al.*, 2011). All stored product inhabiting arthropods (cca 500 species), pest, non-injurious fungivores and beneficials parasites and predators of pests all can become source of physical contamination. The most frequently reported cause of physical contamination are internally feeding insects (*Rhizopertha* sp., *Sitophilus* sp.). Many species host and transfer toxinogenic fungi or microbial human/animal pathogens. Mites produce chemicals responsible for bad smell of grain while *Tribolium* spp. are the only storage pests producing carcinogens. Evidence is growing that exposure of alimentary products to arthropods causes of allergenic sensitization. Some species of Acarina, Blattodea, Coleoptera, Lepidoptera and Psocoptera may cause allergic reactions in humans exposed to remnants of their bodies. No critical levels are available for contamination of food agro-commodities by allergens of arthropods.

Virtually arthropod and vertebrate pests occur at every point along the chain of food production. Since pests represent profound economic and medical risk, their presence must be monitored (e.g. DOMENICHINI & ALDINI 1995; TREMATERRA, 1997) and pest populations systematically controlled; either chemical or non-chemical way (SÜSS & SAVOLDELLI, 2009). However, the currently used pesticides and biocides have been under strong legislative pressure in European Union. Many groups of extremely active chemicals have been deregistered or resistance has evolved (e.g. methyl bromide / SAVIGLIANO *et al.*, 2006/, organophosphate insecticides, first generation of rodenticides). Many of the remaining insecticides and rodenticides will not survive the upcoming decade, leaving a significant gap.

With the restriction of traditional tools, there is an urgent need for new research (SÜSS & LOCATELLI, 1996; SÜSS & TREMATERRA, 2003) concerning integrated pests management (TREMATERRA & SÜSS, 2009), pest risk assessment, identification, detection, monitoring (TREMATERRA & SCIARRETTA, 2004) and control of urban and stored-product pests.

This presentation will provide overview of the current research achievements in the field of identification, monitoring, pest allergenic-risk assessment and control of stored product and food industry pests in the Czech Republic in collaboration with various European and Non-European institutions and universities.

#### RISK EVALUATION, IDENTIFICATION AND MONITORING OF SELECTED URBAN AND STORED PRODUCT PESTS

##### *Mites cause serious risk for occupational allergy in grain stores*

RESULTS - We estimated risk of occupational allergy to stored grain arthropods and false pest-risk perception in Czech grain stores (STEJSKAL & HUBERT, 2008). Arthropods are a documented cause of occupational allergy in cereal stores. Since the current allergenic risk of various arthropods in grain stores is not known, we evaluated its extent using data from the Czech Republic (CZ). We surveyed 514 grain storage units for pest composition and density. Farmers were questioned for pest taxon-related pesticide treatments. Mites constituted the largest group of collected pests (92%) followed by psocids (5%), beetles (3%) and moths (0%). 60% of mites belonged to known allergen producing species; the most abundant were *Acarus siro*, *A. farris*, *Tyrophagus putrescentiae* and *Lepidoglyphus destructor*. Grain samples belonged to the established ARL classes as follows: (i) safe-ARL: 37% (ii) low-ARL: 53%; (iii) high-ARL: 6%; (iv) danger-acute asthma-ARL: 4%. The enquiry among farmers revealed that almost no pesticides were targeted solely to control mites.

CONCLUSION - This study suggests that mites represent, due to their allergenic potential, density and frequency, the most serious source of allergens in stored grain in CZ. However, the medical aspect of pest control – such as allergy avoidance strategy – is overlooked since grain feeding insects were mostly chemically controlled, regardless of their relatively low density and allergen production in comparison with mites.

##### *Cockroach allergens Bla g 1 and Bla g 2 are stable enough to persist in households for more than one year*

RESULTS - Cockroaches occur not only in public housing but occupy most the food industry premises (STEJSKAL & VERNER, 1996), where

potentially endanger food safety. Feces of German cockroaches (*Blattella germanica* L.) are medical and food safety hazards since they contain microbial pathogens and allergenic proteins including Bla g1 and Bla g2. Cockroach allergies were documented as serious problems in apartment houses and hospitals. In this work we explored for how long may allergens remain (i) in flats after cockroach extermination and (ii) in laboratory under simulated temperature conditions (i.e. 15, 20, 25, 30 and 35°C). We found that allergens Bla g1 and Bla g2 were very stable over time both in flats and in laboratory after exposure of various temperatures. In households allergen Bla g2 remained unchanged while the content of allergen Bla g1 decreased by cca 30% in the period of 9 months. Allergenic symptoms may therefore still remain even after successful cockroach extermination from the infested apartment.

**CONCLUSION** The results indicate that, Bla g1 and Bla g2 allergens can persist in feces for several months under usual household humidity and temperature. In sensitive person, allergenic symptoms may therefore still remain even after successful cockroach extermination from the infested apartment. This highlights the importance of regular cockroach monitoring coupled with implementation of preventive control measures. In case of active infestation not only pest control but also deep cleaning and sanitation along with chemical decontamination of allergens should be executed.

*Identification of immature stages is under-studied: comprehensive identification keys for pest egg stages are still not available*

**RESULTS** - Usually identification features are known for adults. External egg morphology of stored-product pests based on optical and scanning electron microscope (SEM) micrographs is studied in our department. We examined eggs of the following storage pests groups: mites (Acarina), psocids (Psocoptera) and storage beetles (Coleoptera: Anobiidae, Bostrichidae, Silvanidae, Laemophaleidae). Diagnostic characteristics were described and identification keys were constructed and published (KUCEROVA & STEJSKAL, 2002, 2008; 2009; 2010).

**CONCLUSION** - Identification of immature stages is strongly under-studied. Although several keys have been published, eggs of many species still remain un-described due to lack of proper funding. As a consequence, comprehensive identification keys for pest egg stages is not available

*The importance of correct and unified methods for interpretation of filth detection and population sampling and monitoring of stored product pests in Europe*

**RESULTS** - We showed that the sampling tools and methods as well as and laboratory extraction methods affect interpretation of grain infestation by storage pests (KUDLIKOVA-KRIZKOVA, *et al.*, 2007, STEJSKAL *et al.*, 2008, LUKAS *et al.*, 2009, HUBERT *et al.*, 2009, TREMATERRA *et al.*, 2011). European Union countries undergo the process of unifying laws. This is also true for protocols designated for monitoring and evaluation of pests and pesticide risks. This study was aimed at exploring whether different methods of sampling and extracting pests would lead to different pest population estimation. We compared two methods of sampling (surface sampling with cup-sampler vs. subsurface sampling with spear-sampler) and two methods of pests' extraction from samples (automated sieving vs. Tullgren apparatus) taken from a highly pest infested flat grain store. Overall eight species of mites, seven species of beetles and two species of psocids were identified. The pest population density ranged between 0-12 individuals per sample (200 g) in psocids, 0-14 in beetles and 2-25060 in mites. Surface sampling with cup-sampler was significantly more effective than sampling using subsurface spear-sampler.

**CONCLUSION** - Various European countries and producers are using different methods for pest sampling and pest extraction from samples. However, this study revealed profound variation in pest population density and spatial distribution when estimated by different sampling methods from the identical place (store). This indicates necessity for creation of common European protocol for sampling and detection of storage pests.

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For those working in international development, food security is a complex problem to solve and one that goes beyond hunger alone. With the global population expected to reach 9 billion by 2050, people are asking how we can best address the nature and scale of the challenges that lie ahead.Â 1. Balance food and nutritional security. Until recently, attention has been focused on investment in research of the traditional staple crops â€” maize, rice and wheat â€” to tackle hunger. But it is now widely accepted that we must go beyond calorie intake and look at the nutritional balance of the crops grown and consumed. A better balance between the research and development of staple crops and horticultural crops â€” fruit, legumes and vegetables â€” is the obvious key to alleviating malnutrition. Broad societal issues, including water quality, food safety, environmental pollution, sustaining biodiversity, pesticide use, and improved crop and forest production systems form the core of a third area of research focus within the Department of Entomology. Protection of our agricultural, urban, horticultural, and forest resources from insect attack and reducing risks from insect-borne diseases require a constant search for safer, more cost-effective, and environmentally responsible means of pest management. Areas of Specialization. The Department of Entomology is nationally recognized for it