ATHANASSIOU, C.G., KAVALLIERATOS, N.G., PALYVOS, N.E., SCIARRETA, A. AND P. TREMATERRA, 2005: Spatio-temporal distribution of insects and mites in horizontally stored wheat. Journal of Economic Entomology **98**: 1058-1069.

BELDA,C., RIBES-DASI, M. AND J. RIUDAVETS , 2011: Improving pest management in pet food mills using accurate monitoring and spatial analysis. Journal of Stored Products Research **47**: 385-392.

BLOM, P.E., FLEISCHER, S.J. AND Z. SMILOWITZ, 2002: Spatial and temporal dynamics of Colorado potato beetle (Coleoptera: Chrysomelidae) in fields with perimeter and spatially targeted insecticides. Environmental Entomology **31**: 149-159.

BRENNER, R.J., FOCKS, D.A., ARBOGAST, R.T., WEAVER, D.K. AND D. SHUMAN, 1998: Practical use of spatial analysis in precision targeting for integrated pest management. American Entomologist **44**: 79-101.

BUCHELOS, C., T. AND D. G. ATHANASSIOU, 1999: Unbaited probe traps and grain trier: a comparison of the two methods for sampling Coleoptera in stored barley. Journal of Stored Products Research **35**: 397-404.

CAMPBELL, J. F. AND D. W. HAGSTRUM, D.W., 2002: Patch exploitation by *Tribolium castaneum*: movement patterns, distribution and oviposition. Journal of Stored Products Research **38**: 55-68.

CAMPBELL, J.F., CHING'OMA, G.P., TOEWS, M.D. AND S. B. RAMASWAMY, 2006: Spatial distribution and movement patterns of stored-product insects. In: LORINI,I., BACALTCHUK, B., BECKEL, H., DECKERS, D., SUNDFELD, E., DOS SANTOS, J.P., BIAGI, J.D., CELARO, J.C., FARONI, L.R. D.'A, BORTOLINI, L., DE, O.F., SARTORI, M.R., ELIAS, M.C., GUEDES, R.N.C., DA FONSECA, R.G. AND V. M. SCUSSEL (Eds.), Proceedings of the 9th International Working Conference on Stored Product Protection, 15-18 October 2006, Campinas, Sao Paulo, Brazil. Brazilian Post-harvest Association-ABRAPOS, Brazil, pp. 361-370.

FARGO, W. S., CUPERUS, G. W., BONJOUR, E. L., BURKHOLDER, W. E., CLARY, B. L. AND M. E. PAYTON, M. E. 1994: Influence of probe trap type and attractants on the capture of four stored-grain Coleoptera. Journal of Stored Products Research **30**: 237-241.

FLINN, P. W., OPIT, G. P. AND J. E. THRONE, 2009: Predicting Stored Grain Insect Population Densities Using an Electronic Probe Trap. Journal of economic entomology **102**:1696-1704.

LIEBHOLD, A.M., ROSSI, R.E. AND W.P. KEMP, 1993: Geostatistics and geographic information systems in applied insect ecology. Annual Review of Entomology **38**: 303-327.

LIPPERT, G.E. AND D. W. HAGSTRUM, 1987: Detection or estimation of insect populations in bulk-stored wheat with probe traps. Journal of Economic Entomology **80**: 601-604.

SCHOTZKO, D.J. AND L. E. O'KEEFFE, 1989: Geostatistical description of the spatial distribution of *Lygus hesperus* (Heteroptera: Miridae) in lentils. Journal of Economic Entomology **82**: 1277-1288.

SUBRAMANYAM, BH, HAGSTRUM, D.W. AND T. C. SCHENK, 1993: Sampling adult beetles (Coleoptera) associated with stored grain: comparing detection and mean trap catch efficiency of two types of probe traps. Environmental Entomology **22**: 33-42.

SUBRAMANYAM, BH. D. W. HAGSTRUM, 1995: Sampling. In: Subramanyam, Bh, Hagstrum, D.W. (Eds.), Integrated Management of Insects in Stored Products. Marcel Dekker, New York, pp. 142-188.

TREMATERRA, P. AND A. SCIARRETA, 2004: Spatial distribution of some beetles infesting a feed mill with spatio-temporal analysis of *Oryzaephilus surinamensis*, *Tribolium castaneum* and *Tribolium confusum*. Journal of Stored Products Research **40**: 363-377.

Can the DI-SPME gas chromatography mass spectrometer be a tool for identification of stored grain insects - fatty acids and sterols profiling

Xin Du[a], Yujie Lu[b], Giles Hardy[a], Robert N. Emery[c], Wenjuan Zhang[a], Yonglin Ren[a]*

[a.] School of Veterinary and Life Science, Murdoch University, South Street, Murdoch, WA, 6150 Australia
[b.] College of Oil and Food Engineering, Henan University of Technology, Zhengzhou, 450052, P.R. China
[c.] Department of Agriculture and Food, 3 Baron-Hay Court, South Perth, 6151, WA, Australia
*Corresponding author: Y.Ren@murdoch.edu.au
DOI 10.5073/jka.2018.463.058

Abstract

Identifying insect pests is essential for management, but these insects can only be reliably identified by a limited number of highly skilled taxonomists. Expert morphological determination can require dissection and slide mounting of specimens in order to examine distinguishing diagnostic features. Suspected insect pest specimens found in grain products usually consist of only the larvae or larval skins which are very difficult to identify to species, and sometimes impossible to diagnose morphologically. Adult specimens are usually scarce and more often damaged. Misidentification of species could lead to misled pest management practice.

Fatty acids (FAs) have long been recognised as biochemical markers for organism classification. The direct immersion solid phase microextraction gas chromatography-mass spectrometry (DI-SPME-GCMS) technology has been developed and validated for selectivity and accuracy by isolating fatty acids from natural fatty acid methyl esters. Seven different species of stored grain insect pests were analysed by using DI-SPME-GCMS method profiled fatty acids and sterols from insect extractions. Palmitic acid (C16:0), Stearic acid (C18:0) and Oleic acid (C18:1) were absorbed. The ratio of FAMEs/FAs (ME) were calculated and validated as a new biomarker for insect classification. Mid-

chain waxes, low boiling point semi-VOCs, and other lipid components can also be identified by the same method, which can be adopted to be an automated high-throughput method for insect classification, surveillance and quarantine purposes.

Keywords: direct immersion solid phase microextraction (DI-SPME), fatty acids & sterol lipids, biomarker, stored grain insect, insect morphology and identification.

Webbing Clothes Moth, Tineola bisselliella (Hummel) Sex Pheromone Transfer from Monitoring Lures to Textiles

Patrick Kelley*, Laura Mina, James Feston, David Mueller, Alain Van Ryckeghem

16950 Westfield Park Road, Westfield, IN 46087 USA
*Corresponding author: p.kelley@insectslimited.com
DOI 10.5073/jka.2018.463.059

Abstract

The use of synthesized sex pheromone lures for the purpose of monitoring populations of webbing clothes moth, *Tineola bisselliella* (Hummel) in museum storage environments is typical in many museums. Questions about whether the pheromone incorporated in the dispensing lures could possibly transfer over to textiles that are in close proximity to the lures have been posed by museum conservators. Although some textiles may be naturally attractive to clothes moths, the concerns are that the textiles themselves may become even more attractive to insects due to exposure to the pheromone and that this could ultimately cause further damage to the collections. The focus of this study was to determine the degree to which textiles that have been exposed to pheromone lures absorb the pheromone and become attractive themselves. Based on the results of this study, the textiles observed here have little to no additional attraction to insect pests after focused exposure to synthetic pheromone lures over a two-week period.

Keywords: Webbing clothes moth, Tineola, sex pheromone, textile, monitoring.

1. Introduction

The webbing clothes moth, *Tineola bisselliella*, is a cosmopolitan pest that carries economic importance due to damage caused by their larvae feeding on objects that incorporate wool, feather, hair and hide (Krüger-Carstensen and Plarre 2011). Textiles that incorporate cotton, silk, linen, paper and synthetic fibers can also be damaged by *T. bisselliella* if these items have been soiled with urine, sweat, beer, milk, soft drinks, tomato juice or other substances that contain nutritional needs for the moths (Sloderbeck 2004).

Being one of the most common pests in museums in many parts of the world, this species of moth has caused severe damage to cultural heritage objects (Querner 2014). The use of synthetically produced sex pheromone monitoring lures specifically for *T. bisselliella* for the purpose of early detection and locating sources of infestation has become commonplace in some museum institutions to prevent this damage. The use of a pheromone lure within a sticky trap increases the rate of capture twenty-fold over a sticky trap with no lure (Cox et al. 1996) and is a key factor in determining increases in population density and economic thresholds (Plarre 2013).

Concern over the practice of pheromone monitoring was raised by a prominent museum conservation scientist and author who believed that the pheromone incorporated in the dispensing lures would transfer over to museum objects (Florian 1997). Following up on this, this same author made a statement in an online museum conservation listserv that suggested that the volatile fat-soluble pheromone can be adsorbed by materials of artifacts and thus make the artifacts themselves attractive to insect pests (Florian 2011). This posting suggests that even after monitoring lures are removed, the museum collections would continue to attract and draw-in damaging museum pests. The question that this study aims to answer is if pheromone transfer between the sex pheromone lures and a variety of textiles found in museum storage environments is occurring and if these pheromones are making the textiles themselves attractive to pests.