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Analysis of free fatty acids in food substrates and in the dust and frass of stored-product pests: Potential for species discrimination?

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ABSTRACT

The larger grain borer, *Prostephanus truncatus*, is a serious beetle pest that tunnels extensively to produce large quantities of dust and frass. The natural enemy *Teretrius nigrescens* is an important biological control beetle which is known to exploit at close-range solvent-extractable chemical cues in the dust and frass. The objective of the current study was to analyse quantitatively and qualitatively, the free fatty acid mixtures in different food-substrate materials both before and after insect attack by a range of stored-product pests in order to ascertain whether differences in these mixtures could explain the *T. nigrescens* selectivity to *P. truncatus* dust/frass over that of other species irrespective of food substrate. By TLC, GC and GC–MS we found triglyceride and five free fatty acids were the most abundant chemicals in dust/frass (palmitic acid (C16:0), stearic acid (C18:0), oleic acid (C18:1), linoleic acid (C18:2) and linolenic acid (C18:3)). In maize flour, *Sitophilus* species did not significantly change free fatty acid concentrations whereas with *P. truncatus*, *Rhyzopertha dominica* and *Dinoderus minutus* there were 4–6-fold increases, and, for *Tribolium* species there were over 20-fold increases. These differences provide interesting insights to tunnelling/feeding habits and are correlated with known feeding preferences within grain. Principal component analysis (PCA) demonstrated that free fatty acid ratios in dust/frass of different species are most linked to the food substrate and confer little discriminatory information that could be used to distinguish between the different species. Although increases in free fatty acid concentrations are good indicators of pest infestation and this may contribute behaviourally in an additive or synergistic way, we conclude that other chemical(s) are present and are key to *T. nigrescens* recognition of *P. truncatus* on different substrates.

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1. Introduction

The larger grain borer, *Prostephanus truncatus* (Horn) (Coleoptera: Bostrichidae), is the most serious pest of stored maize and dried cassava roots in Africa (Hodges et al., 1983; Dick, 1988). It tunnels extensively into these foods to produce large quantities of dust and frass (Fisher, 1950; Hodges, 1986; Rees et al., 1990; Stewart-Jones et al., 2004). *Prostephanus truncatus* is not native to Africa as it was first accidentally imported to the continent in the late 1970s, and in 1991 its Mesoamerican natural enemy *Teretrius nigrescens* (Lewis) (Coleoptera: Histeridae) was intentionally released into Africa for classical biological control (Dunstan and Magazini, 1981; Harnisch and Krall, 1984; Kalivogui and Mück, 1991; Richter et al., 1998).

Although long-range cues for prey-habitat location by *T. nigrescens* are well known (Rees et al., 1990; Böye et al., 1992; Helbig et al., 1992; Key et al., 1994; Scholz et al., 1998), what happens at closer range within the habitat is still being investigated (Stewart-Jones et al., 2004, 2006, 2007). It is now known that at close-range, adult and larval *T. nigrescens* are arrested by chemicals in the dust/frass of *P. truncatus* which are solvent extractable, and that these chemicals trigger intense searching behaviours (Stewart-Jones et al., 2006). Extracts of *P. truncatus* dust/frass collected from different tunnelling substrates are all similarly behaviourally active towards *T. nigrescens*, but extracts of dust/frass from other stored-product species are far less behaviourally active or even repellent (Stewart-Jones et al., 2007). We performed an initial chemical analysis of extracts of maize flour and *P. truncatus* dust/frass on maize by thin layer chromatography (TLC) and this indicated that *P. truncatus* infestation significantly increased the free fatty acid content in the dust (Stewart-Jones, 2002). Open column chromatographic separation of maize flour extract and extract of dust/frass from *P. truncatus* on maize

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