Increase in Acoustic Detectability of *Plodia interpunctella* Larvae after Electrical Stimulation

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Summary

Modern computer and electronic technology has enabled the development of practical acoustic methods for detection of hidden infestations of insects in stored products, plant structures, wood, and soil (see references in Mankin et al. 1999, 2000, 2001 and at http://cmave.usda.ufl.edu/~rmankin). However, like any other detection tool, acoustic monitoring has conditions under which its operation is optimal and conditions under which it would not be appropriate to use. The insects being monitored must be active to be detected, and experience has shown that insects can become quiescent if the temperature falls below optimal, or if they are disturbed (Mankin et al. 1999). Even under optimal conditions, stored product insects are quiet in 10-30% of 5-minute monitoring periods. The duration of quiet periods can extend over 8-10 h during molting (Pittendrigh et al. 1997). Periods of quiescence can lead to false predictions that insects are absent unless the insects can be stimulated into activity reliably by artificial stimuli applied just before monitoring.

Electrical stimulation is used frequently to stimulate large animals and has occasionally been used with insects (e.g., Vander Meer et al.1999). We conducted tests with 4th-instar *Plodia interpunctella* (Hübner) larvae (10-16 mg in weight) to determine if electrical stimulation increased their activity levels. *P. interpunctella* is the major pest of packaged goods in the U. S. The acoustic signal collection and analysis procedures (Figs. 1A-C) were essentially as described in Mankin et al. (2001) and references therein.

The use of a Hot-Shot Sabre Six large animal stimulator on pieces of dry dog food containing individual larvae increased the level of activity ~2-fold. The mechanical agitation caused by incidental handling of the dog food had no significant effect on overall activity. Electrical stimulation shows promise as a method of improving the acoustic detectability of stored product insects in packaged goods.

Methods

Fig. 1A. Apparatus for acoustic monitoring of *P. interpunctella* larval activity in anechoic chamber (see Mankin et al. 1999, Mankin et al. 2001).
a. Piezoelectric sensor
b. Dog food pellet with larva
c. Electrical Stimulator (Sabre-Six, Hot Shot Inc., Savage, MN)

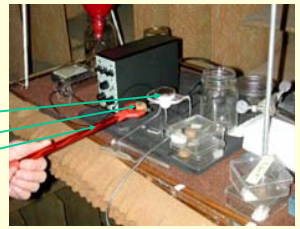


Fig. 1B. Signal amplification and analysis system.
a. Bruel and Kjaer model 2610 amplifier
b. Computer data acquisition and signal processing system with custom-written software (Mankin 1994, Mankin et al. 2001)

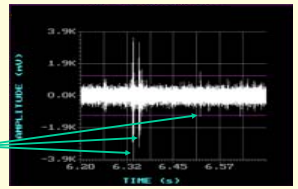


Fig. 1C. Oscilloscope trace of *P. interpunctella* larval sounds. Purple line indicates threshold amplitude of countable sound pulse. (3 pulses appear in this recorded segment).

Results

In tests of activity levels during 3-minute monitoring periods before, immediately after, and 10 minutes after electrical stimulation, there were significant differences in mean activity rates ($F = 5.78$, $df = 179$). Simple mechanical agitation, i. e., equivalent treatment without turning on the stimulator, produced no significant differences ($F = 0.37$ $df = 171$). Note: in Tables 2A and 2B below, mean activity rates followed by the same letter are not significantly different using the Waller-Duncan K-Ratio test (SAS Institute 1988).

2A. Effect of Electrical Stimulation

Measurement Period	Activity Rate (sound pulses/s)
Before elec. stim.	2.0 a
Immediately after	4.1 b
10 minutes after	1.7 a

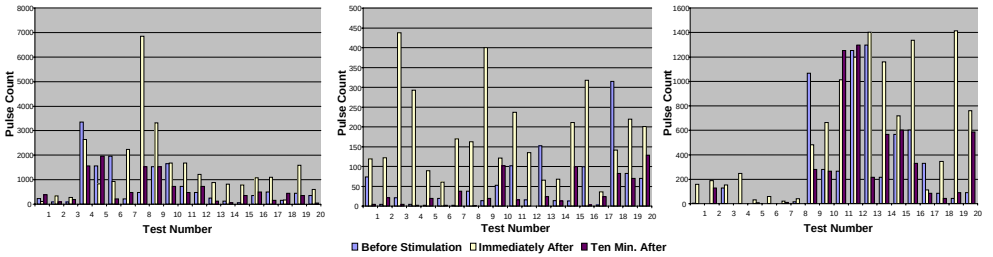
2B. Effect of Mechanical Agitation

Measurement Period	Activity Rate (sound pulses/s)
Before agitation	2.4 a
Immediately after	2.2 a
10 minutes after	2.7 a

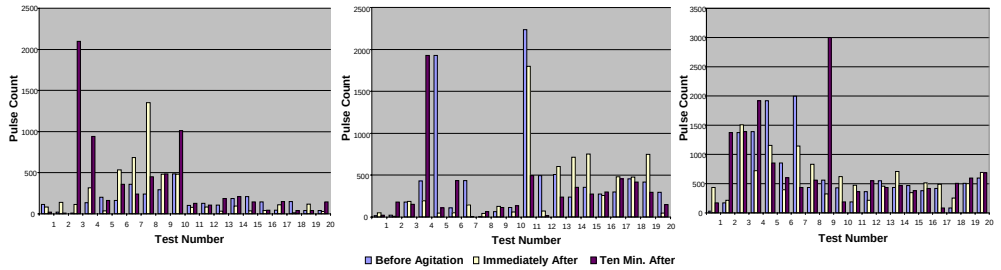
The results from individual tests are shown in the bar graphs below (2C). The vertical axis indicates the numbers of sound pulses produced during the 3-minute monitoring periods.

2C.

Effect of Electrical Stimulation (3 Tests)



Effect of Agitation (3 Tests)



As a result of this study, electrical stimulation techniques are being pursued further for their potential to enhance the sensitivity and reliability of insect acoustic detection systems. In particular, the quantities of materials exposed and tested will be scaled up to consumer package sizes to satisfy the need for nondestructive testing of packaged goods.

References

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