A TRAPPING METHOD TO EVALUATE EFFICACY OF A STRUCTURAL TREATMENT IN EMPTY SILOS

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Abstract - This paper describes the development of a trapping protocol for monitoring populations of insects in disused, vertical, concrete silos during a practical field trial of a structural treatment. The protocol was developed within the constraints of the structure, and optimised the type and amount of attractant, time in situ and number of traps per silo. It was used to estimate populations of several species of Psocoptera and Coleoptera in a series of silos before and after application of Dryacide® (an activated diatomite) and provided a convincing practical field demonstration of the effectiveness of this material.

INTRODUCTION

The residual population in a well-cleaned, empty grain store is located in the small cracks and crevices where, despite the best efforts, grain residues will still remain. The resource available to insects in such refuges is limited and as this food is depleted the insects must forage more outside the refuges, as demonstrated by Bell and Kerslake (1986) for *Oryzaephilus surinamensis* (L.). Food-baited traps can then catch these foraging insects. They may function by arresting insects that wander through, or by actively attracting them. Traps containing no food are generally referred to as refuge traps whereas those containing a substantial amount of food are termed bait traps. Refuge traps are successful because they provide an attractive environment to the insects, where they can be in close contact with surfaces on all sides. Baited traps offer this feature as well as providing a food source.

The best attractant in a trap will be the one that offers the resource most required by a particular species at a particular time. For an unmated female, it may be a mate; for a mated female, a food source upon which to feed and oviposit. Many of the pheromones produced by stored product pests have been identified, and many are available commercially. Considerable work has been done to determine the best food attractants for different species (De Coursey, 1931; Pinniger *et al.*, 1984). The beans and pods cf the carob tree, *Ceratonia siliqua* (L.), have been found to be particularly attractive to a variety of stored product insects (Pinniger *et al.*, 1984).

The work reported here arose from the desire to assess the effectiveness of Dryacide®, a diatomaceous earth coated with silica aerogels (Desmarchelier and Dines, 1987), in a rigorous field test of its use as a structural treatment.

The objective was to develop a trapping procedure that would give reliable relative estimates of population size for all the insect species of interest. Thus experiments were designed to evaluate different kinds and amounts of attractant, the number of traps necessary per bin and the optimal trapping period.

MATERIALS AND METHODS

The Site

The Sydney Terminal Elevator, Glebe, New South Wales, Australia was built in 1921 and decommissioned in 1988. The study was carried out in the original workhouse composed of 80 round bins (240 tonne) arranged in a block 16 x 5, with 60 interstitial star bins (40 tonne). All experiments were done in the round bins. The bins had been cleaned but not used for several years. Their hoppers had been removed and the bottoms sealed with a steel plate. Therefore, access was limited to manholes in the floor above the bins, but entry was prohibited because the bins had become unsafe.

The Trap

Because entry to the bins was prohibited for safety reasons, traps had to be lowered on strings. Thus there was limited control over the placement of traps, which meant that certain well-known traps were unsuitable. Those that require a specific orientation, such as the Storgard® trap with its oil cup (Barak and Burkholder, 1984/85) were unsuitable because of the sloping floor. Pinniger-type bait bags (Pinniger, 1975) were rejected because the insects might be shaken out as the traps were pulled up from the bin. A modified De Coursey trap (De Coursey, 1931) was chosen because of its simplicity, cheapness and suitability for the situation.

The trap consisted of corrugated cardboard 10 x 15 cm with the tubes formed by the corrugations sealed with tape along one long edge to retain the measured amounts of attractant, and a string tied to the centre of the other long edge. The trap was lowered into the bin on the string and positioned randomly on the sloping floor. It was left in place for the required period then carefully withdrawn, sealed into a plastic bag and returned to the laboratory for extraction of the insects and counting. No insecticide was used so the trap functioned as a harbourage.

RESULTS AND DISCUSSION

The Insects

The most abundant species trapped were psocids (Psocoptera: Liposcelidae), which occurred in most bins. The most important species was *Liposcelis entomophilus* (Enderlein), accounting for about 85% of psocid catches, with minor representation by *L. bostrychophilus* Badonnel and 2 unnamed species related to *L. subfuscus* Broadhead. *Gnatocerus cornutus* (Fabricius) (Coleoptera: Tenebrionidae) and *O. surinamensis* (Coleoptera: Silvanidae) were fairly common, and *Lasioderma serricorne* (Fabricius) (Coleoptera: Anobiidae) and *Rhyzopertha dominica* (Fabricius) (Coleoptera: Bostrichidae) were occasionally trapped.

Attractants

Experiment 1: Six traps were put into every bin, one trap with each of the following attractants: 10 whole wheat grains, 0.2 g whole wheat flour, 0.2 g 1:1 whole wheat flour/carob powder mixture, 0.2 ml wheat germ oil, *Tribolium castaneum* (Herbst) pheromone lure, and no attractant. Nineteen bins were trapped for 10 days in June 1989.

More *G. cornutus* were caught by traps containing whole wheat flour, flour/carob mixture or wheat germ oil than the other traps (Fig. 1). There was little difference in catches between traps for *Liposcelis* spp.

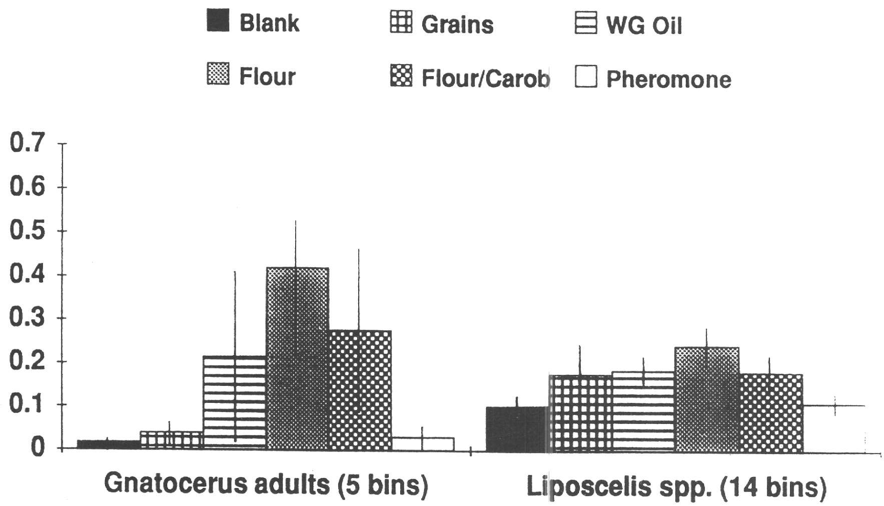

Fig. 1. Numbers of insects caught in traps baited with different attractants. Blank: no attractant, grains: 10 grains of wheat, WG oil: 0.2 ml wheat germ oil, flour: 0.2 g whole wheat flour, flour/carob: 0.2 g 1:1 whole wheat flour:carob powder, pheromone: *T. castaneum* aggregation pheromone lure. The vertical bars represent ± 1 standard error.

Experiment 2: This experiment extended the evaluation of the food attractants used in experiment 1. One trap of each type was set in each of 14 bins known to harbour beetles, for 7 days. The experiment was replicated 3 times in August and September 1989.

Figure 2 shows the proportion of catches in each trap for 3 species. Adults and larvae of *G. cornutus* clearly preferred the flour and flour/carob baits. *Liposcelis* spp. were also more abundant in these traps. Over 52% of the *O. surinamensis* were trapped in flour traps, with the wheat germ oil traps being the next most attractive with 31% of the catch. The wheat germ oil was not attractive however to *G. cornutus* and proved unsuitable for attracting this species.

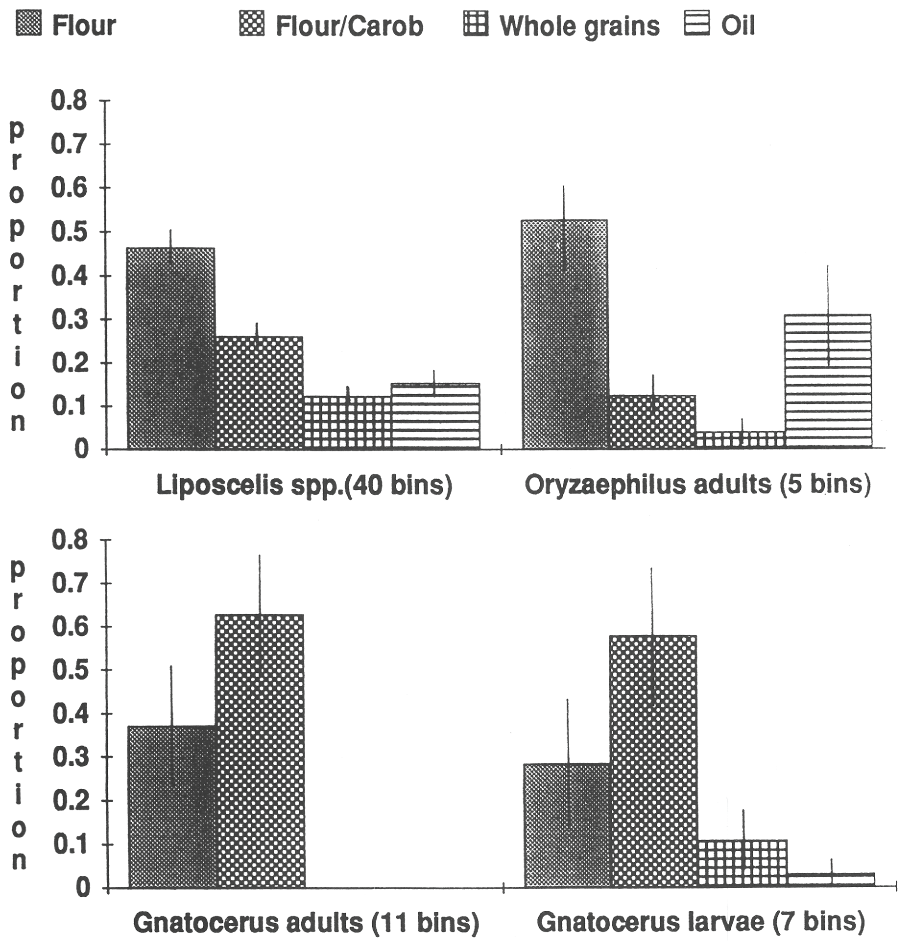

Fig. 2. The proportion of three species of insects in each bin caught in traps with different attractants. The number of bins refers to the number in which insects were trapped in an experiment of 3 x 14 bins. The vertical bars represent ± 1 standard error.

Experiment 3: This was to determine the optimum amount of flour to put in each trap. Four levels were used, 0, 0.2 g, 0.4 g and 0.8 g whole wheat flour. One trap of each was set in 20 bins for 10 days. The experiment was replicated 3 times in September and October 1989.

The data for 3 species are presented in Fig. 3. While unbaited traps caught moderate proportions of *Liposcelis* spp. and *G. cornutus* larvae, they caught very few adults of either beetle species. There was no major effect of quantity of flour for any species.

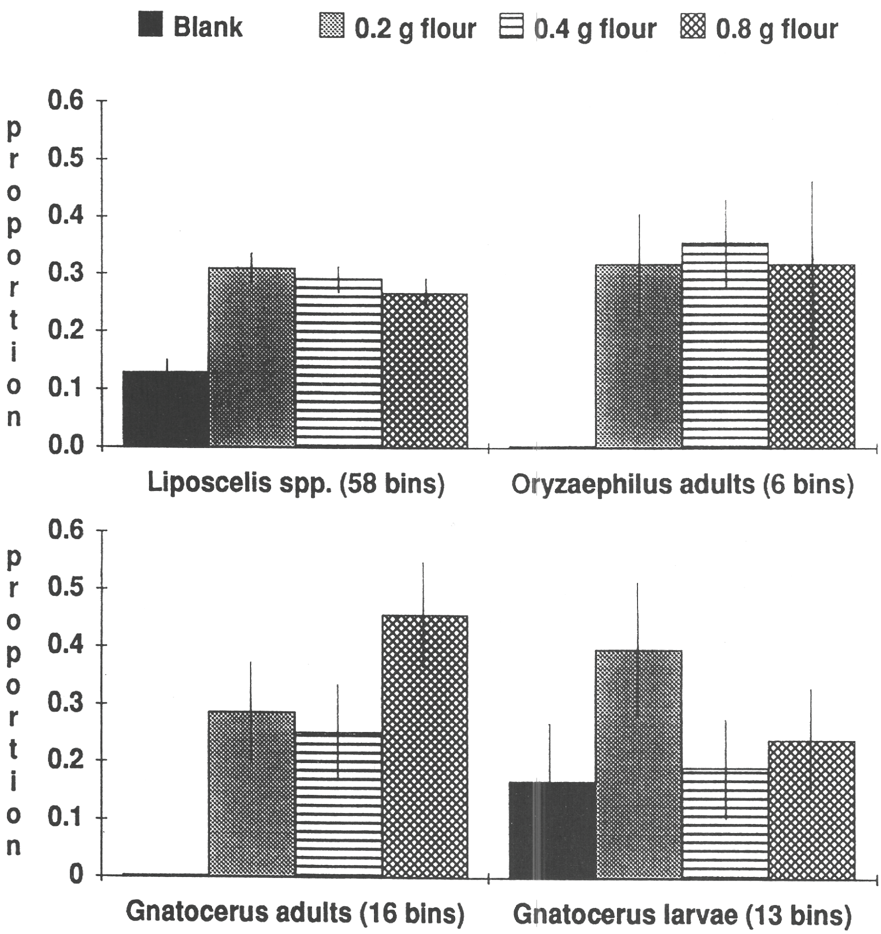

Fig. 3 The proportion of three species of insects caught in traps baited with different amounts of whole wheat flour. The vertical bars represent ± 1 standard error.

Trapping period

Because the trap functioned as a harbourage, it was necessary to determine the minimum time for the population colonising the trap to reach equilibrium with the rest of the population. Nine traps containing 0.2 g flour were placed in each of 7 bins in August 1989. They were removed three at a time, 3, 7, and 14 days after placement.

Data for each bin is presented in figure 4. The 7 day count was larger than the 3 day one in 5/7 cases. The 14 day count exceeded the 3 day count in all cases and the 7 day count in 6/7 cases, although the catches were much larger only in 2 of the bins. Insects were detected in each bin using the 7 and 14 day sampling periods but not in one bin after 3 days trapping. It was concluded that operationally useful trapping studies can be done with periods greater than 3 days but that no conclusions can be drawn from this data on the time period required to attain equilibrium numbers in traps.

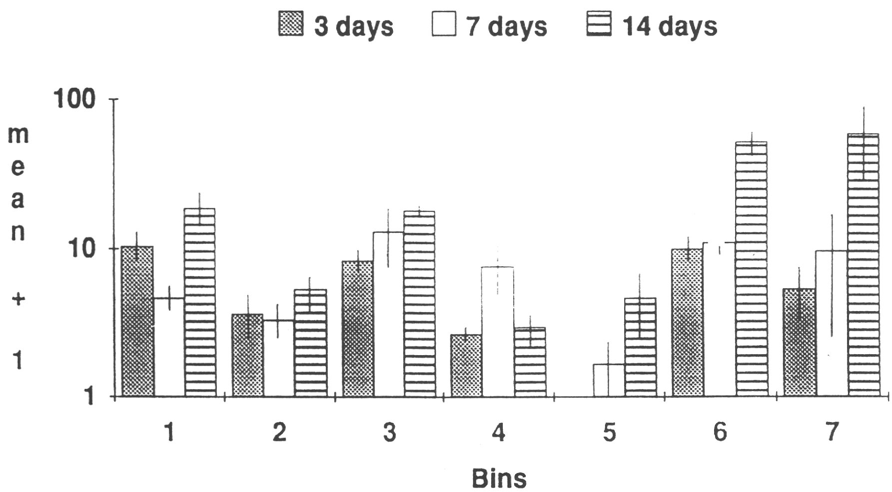

Fig. 4. Mean catches of *Liposcelis* spp. in traps left in place for 3 time periods. The vertical bars represent ± 1 standard error.

The Protocol

Whole wheat flour proved to be a good general purpose attractant for the range of species encountered during this trial. Some flour was necessary to attract the beetle adults but the amount *per se* was not important. The largest amount of flour (0.8 g) created difficulties when counting psocids, while the smallest amount (0.2 g) was easily lost if the trap was not carried upright. Therefore the intermediate amount of 0.4 g was chosen as the standard for the ensuing trial. From an operational point of view, it was adequate to trap for 7-14 days to secure usable numbers in the traps. The total number of insects trapped will increase with the number of traps. Four traps per bin was chosen as the largest number that could be handled easily, and which was one greater than the number that detected insects in all bins in the experiment on trapping period.

Thus the final protocol was determined to be 0.4 g of flour per trap, 4 traps per bin, for a specified period between 7 and 14 days.

Dryacide® Evaluation

Twelve matched pairs of bins with similar populations of *Liposcelis* spp. were selected from previous studies. They were trapped according to the protocol for 10 days preceding Dryacide® application. The results (Fig. 5a) indicated that the bins remained matched, with insect numbers essentially the same in 11/12 pairs of bins, over a wide range of insect numbers.

After Dryacide® application, insects in control and treated bins were trapped again according to the protocol. The number of insects in the control bins remained essentially unchanged whereas those in the treatment bins were dramatically reduced (Fig. 5b). Two conclusions can be drawn. Firstly, the protocol resulted in consistent, reproducible estimates. Secondly, because of this, the diminution in numbers in the treated bins could be attributed to Dryacide®.

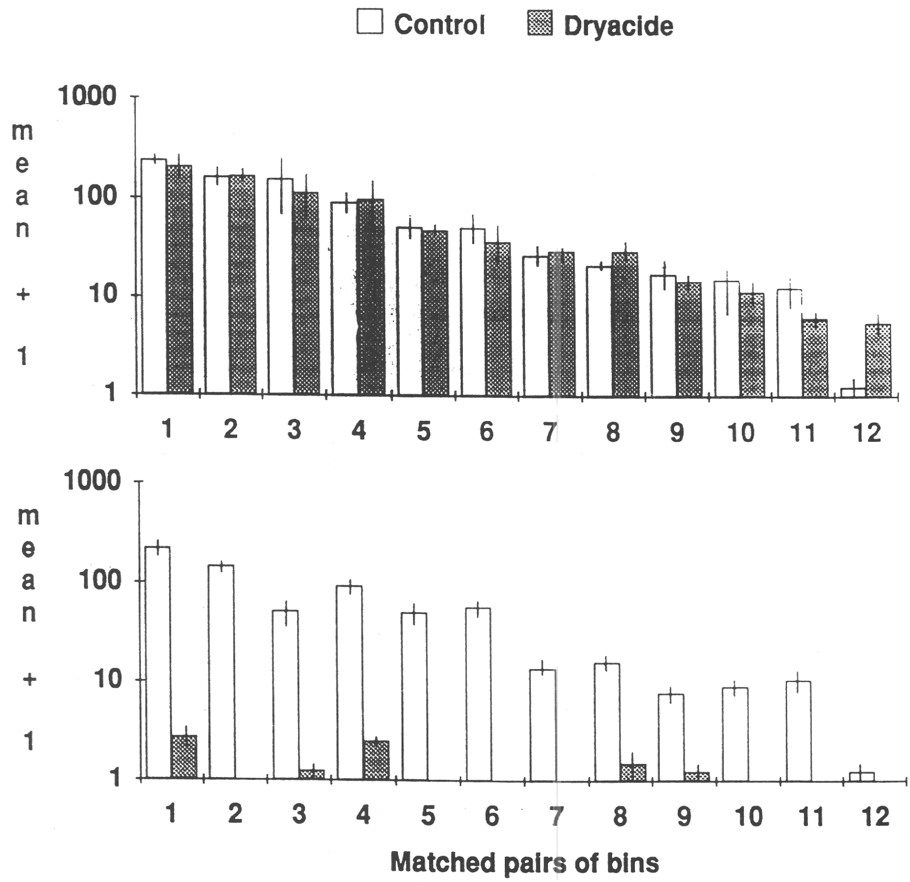

Fig. 5. Numbers of *Liposcelis* spp. caught in flour-baited traps in matched pairs of bins. a. pre-treatment, b. first post-treatment assessment. The vertical bars represent ± 1 standard error.

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UNE METHODE DE PIEGEAGE POUR EVALUER L'EFFICACITE D'UN TRAITEMENT INTERIEUR DES PAROIS DES SILOS VIDES.

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Résumé

Cet exposé décrit le résumé d'un protocole de surveillance des populations d'insectes dans des silos de béton verticaux vides, au cours d'une étude pratique sur le terrain portant sur un traitement des parois appelé Dryacide (de la poudre de diatomées activée). Le plan d'essai a été conçu pour être disposé à l'intérieur des contraintes de la structure, et a visé à optimiser le type et la quantité d'attractif, la durée du séjour in situ ainsi que le nombre de pièges par silo. Il a été employé afin de mesurer les populations de plusieurs espèces de Psocoptères et de Coléoptères présents dans une série de silos avant et après application de Dryacide, et a fournit une démonstration sur le terrain convaincante et pratique de l'efficacité de ce produit.