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Evaluation of Anti-Varroa Bottom Boards to Control Small Hive Beetle (*Aethina tumida*)

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***Abstract*—**Australia does not have varroa mite. However, we investigated the efficacy of modified hive bottom boards used for varroa mite management in honeybee colonies to control small hive beetle, *Aethina tumida*. We assessed infestation levels between hives fitted with tube, mesh and conventional (solid) bottom boards in Richmond, NSW eastern Australian. Colonies housed in hives with tube bottom boards were significantly superior to those in hives with conventional and mesh bottom boards. Even though in-hive beetle populations were generally low during the trial period, hives fitted with tube bottom boards however, had fewer small hive beetles than other hives. Although the trial was conducted over only one season, it suggests that there may be benefit in Australian beekeepers changing from using conventional bottom boards even with the absence of varroa mite, when small hive beetle is present.

Keywords*—Aethina tumida*, *Apis mellifera*, mesh bottom boards, tube bottom boards.

I. Introduction

THE small hive beetle (SHB) is a parasite and scavenger of honeybee, *Apis mellifera*, colonies [1]-[3]. It was first recorded in Australia in 2002 [4]. Currently, SHB has managed to establish populations in many parts of the central and north eastern Australian coast and has become a serious honeybee pest [4]-[6]. Different strategies have been suggested to control SHB including biological, cultural, physical and chemical methods [7]. Major methods are the prevention of SHB through sanitation in apiaries and honey houses [8], trapping of larvae using fluorescent lights and adult beetles using nucleus hives [9], [10], chemical control in the hive [10], insecticide treatment of soil [5], [11], [12] and use of Paradichlorobenzene as a fumigant in stored comb [13].

Some chemical products which are commonly used to control the cosmopolitan parasitic mite *Varroa destructor* Anderson & Trueman have been examined for SHB control. Elzen et al. [10] reported a successful use of CheckMite+TM strips. However, this product cannot be used when bees are making surplus of honey. Also, as in the case of varroa mites, resistant strains may develop [14]. On the other hand, Buchholz et al. [15] concluded that organic acids and thymol were ineffective for control of SHB. Thus, the development of sustainable, not chemical, control methods seems desirable to avoid resistance to chemical treatments and prevent contamination of bee products.

One strategy employed in varroa mite management has been the use of modified hive bottom boards [16], [17]. Most of these modified bottom boards utilize metal mesh which aims to cause the varroa mites to fall out of the hive structure depending on the hygienic behavior of bees. This technique might also be used for beetles, which is an innovative approach to controlling a two pest complex by directly reducing in-hive populations [18]-[20].

Tubed bottom board, an alternative to mesh for bottom boards, was invented in 1993 by a French beekeeper. It replicates conditions in some feral hives, which were able to survive varroa mite attack (Mercader, personal comm.). This board has been evaluated in two recent trials in France [21], [22] which compared the tube board with mesh boards for their effects on the number of mites falling from hives via bottom boards, and on varroa mite populations on bees. Unfortunately, neither report presented statistical analyses of the data, so no definitive conclusions could be drawn from their results. However, tube bottom boards have not been assessed against small hive beetle.

Our Objective was to assess the efficacy of modified bottom boards primarily designed to control varroa mite for management of small hive beetle. We also comparing mesh and tube bottom boards against conventional wooden boards for their ability to achieve the above desired outcome.

II. Methodology

A. Experimental Colonies and Design of Bottom Boards

The study was conducted in University of the Western Sydney (UWS), Richmond, NSW [33°35S, 151°10E]. Colonies were requeened by mated sister queens of *Apis mellifera ligustica* L., and equalized prior the commencement of the investigation. Colonies were housed in 10-frame standard Langstroth hives with two-story boxes. Twenty-four colonies were arranged in a randomized complete block design, and hives were equally assigned to one of three treatments, namely: Conventional solid bottom board (control), Mesh-screened bottom board, or Tube bottom board.

The mesh-screened bottom board was composed of stainless steel mesh (3mm), and was modified from conventional bottom boards. Thus, their dimensions corresponded to the inner surface of the ten-frame hive body. The tube bottom boards (supplied by Australia-World Enterprises Pty Ltd, Sutton Grange, Vic) comprised a wooden frame with similar dimensions to the inner surface of the hive body. Plastic tubes of 34mm diameter and 450mm length were set 3.5mm apart

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by three plastic spacer struts, and with an open space between the tubes. Both the mesh and tube bottom boards also had four legs 21 cm long, which maintained the treatment hives that distance above the ground surface.

B. Assessment of Small Hive Beetles In-Hive

We visually screened colonies using the method described in Spiewock et al. [5]. Before a hive was opened it was removed from its original position and replaced by an empty box. If the hive had a super it was removed and stored on a reversed lid, so that no bees or SHB could escape while we were working on the lower box. Each frame was removed separately and carefully examined for larvae and adult SHB, which were collected with an aspirator, and the comb returned. After combs were inspected, the inner sides of the box and the relevant bottom boards were also screened. All adult beetles were returned to their respective hives after the assessment. Data was recorded on monthly during the spring season.

C. Statistical Analyses

Data were analyzed using Analysis of Variance –General Linear Model (SPSS version 15); where multiple samplings over time were conducted, data were analyzed using the repeated measures general linear model to check for interactions between factors and the time of sampling. If there were no significant interactions between factors and the time of sampling, data were averaged over the sampling time and a single analysis was performed. If significant differences between treatments were detected, their means were separated using Ryan's Q-test if the assumption of equality of variance was met, or Dunnett's T3-test if the assumption of equality of variance was not met.

III. Results and Discussion

During the pre-treatment inspection, the mean number of SHB recorded were 14.6, 7.8 and 4.6 beetles per colony for hives fitted with conventional, mesh bottom board and tube bottom boards, respectively, showing no significant difference ($F_{2,14}$ = 1.883, p = 0.189) in number of beetles in hives assigned to the different treatments. SHB populations in all treatments remained low throughout the investigation period, with means of 17.86±2.51, 15.07±3.93 and 6.13±1.15 in conventional, mesh and tube bottom board hives, respectively. Numbers of SHB noticeably increased only in the last observation time (19 February). There was no interaction between time and treatment ($F_{2,28}$ = 1.314, p = 0.289), therefore data from the different observation times were pooled. There was a significant difference between treatments ($F_{2,14}$ = 4.856, p = 0.025), with hives fitted with tube bottom boards having significantly less beetles than the other two treatments, which were not significantly different from each other (Fig 1), even though mesh boards had slightly lower mean SHB numbers that conventional boards.

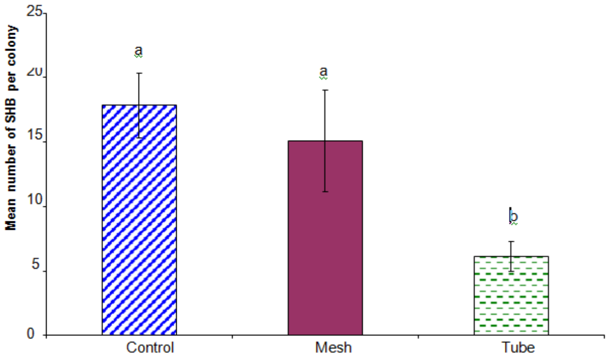

Fig. 1 Mean number of Small hive beetles / colony over the trial period for hives fitted with modified bottom boards, at the UWS site.
*Control was a traditional wooden bottom board.
**Bars represent standard errors of means

Larvae of SHB can be found in infested hives underneath sealed honey combs [23] when adult beetles are able to reproduce; however, in this trial no SHB larvae were detected at any of the treatments for the entire investigation period and the counts only represent adult beetles.

It has been reported that SHB prefer to be located on hive bottom boards (with up to 40% of the hive SHB population located on bottom boards [23]). We recorded no SHB on the two modified bottom boards, although they were present elsewhere in these hives and on the conventional bottom boards. We also observed that there was no hive debris built up on either the mesh or tube botto33oards. This may be the reason why they are superior to the conventional bottom boards, in that they may provide the scavenging SHBs with food in the debris (e.g. dead adult bees [24], and hiding places since adult SHB tends to avoid sunlight and hide in corners or underneath material.

In the hive, SHBs are regularly found everywhere, where they can hide from bees or in areas of the hive with low bee densities; adult SHBs typically hide in small cracks [1], [25]. Indeed plastic hives, used in this trial, would have provided less cracks compared with a wooden hive. Also, SHBs tend to hide under the bottom board of hives [3]. It seems that hives fitted with modified bottom boards on legs (i.e. 21cm high) would limit hiding places for SHB would have assisted in debris removal and hive ventilation. Also, we there was no evidence of deposition of propolis by colonies on the mesh.

Since adult SHBs show cryptic behavior, they are notoriously difficult to spot in hives. Moreover, the beetles are highly migratory [26], and may have left the hive prior to inspection. We therefore recommend that assessment SHB larvae numbers as more valid indicator of colony infestation level rather than SHB Adults, given the fact, that they are the destructive stage.

Mesh bottom boards have also been evaluated for their ability to reduce SHB, entry into hives. It was thought that the use of mesh bottom boards would also increase in-hive ventilation, particularly when used in conjunction with reduced hive entrances to restrict *A. tumida* entry. However, Ellis and Delaplane [27] showed that bottom screens failed to repel beetles, although their use did not lead to greater beetle populations in test colonies. In addition, screen bottom boards only partially mitigated against side effects associated with restricted entrances [28].

Interestingly, in contrast to the USA, strong honeybee colonies in Australia rarely collapse with beetle infestations (D. Anderson [CSIRO], M. Duncan, unpublished data).

In conclusion, there bottom board type influenced the number of in-hive small hive beetles. Tube bottom boards had significantly fewer SHB than the other two treatments, although none of the populations were high, and would not constitute a level likely to impact adversely on hive health (see Spiewock et al. [6]). However, the trial had to be terminated in February 2009, at which time SHB populations were noticeably increasing. Increases in SHB populations have been previously observed at UWS at this time of year (M. Duncan, pers. comm.; N. Annand pers. comm.).

We also observed colony strength and honey and brood production in all hives during the trial period. There were no differences in these parameters resulting from any of the treatments [28]. Given that there were no other conclusive benefits from using either mesh or tube bottom boards except, for SHB in the case of tube bottom boards) there appears to be little reason for Australian beekeepers to commit to the expense of changing from their current use of solid bottom boards, in the absence of varroa mite, particularly if they are in areas where SHB is not a major problem. However, in the event that varroa mite does become established in Australia, mesh and/or tube bottom boards may play a useful role in its integrated management. In such circumstances, it appears that there will be no detrimental effect to hive development and production if modified bottom boards are used [28].

It is recommended that, at this stage, further trials with modified bottom boards need to be conducted to assess their benefits in the absence of varroa mite. It is also recommended that Australian beekeepers are made more familiar with mesh and tube bottom boards and their use in varroa mite management.

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