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& DEVELOPMENT CORPORATION

Study of the small hive beetle in the USA

A report for the Rural Industries Research and Development Corporation

by Doug Somerville

NSW Agriculture

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Foreword

The small hive beetle (***Aethina tumida* Murray**) was formally identified in NSW in October 2002. Up to this date this pest of bee hives was not known to exist in Australia.

After extensive surveillance and inspection by NSW Agriculture and the Queensland Department of Primary Industries (QDPI), the beetle was declared endemic by a combined industry and government committee in late November 2002.

As this pest is only known to occur in a few regions of the world and is not widespread, there is little published information on the potential impact of the beetle on honey bees.

Fortunately (unfortunately for the American beekeeping industry) this beetle was identified in 1998 in Florida and has been extensively studied by the American scientific community. Beekeepers have also had to adapt their management practices to reduce the impact of this pest on their operations. Outside of South Africa (the origin of this pest) and America, the beetle has not been studied and as the beetle does not cause any major concerns in the field to beekeepers in South Africa, the United States of America is a logical country to visit to study the impact of this pest.

To this means, two persons identified by the Australian beekeeping industry were recommended to travel to America and to discuss at length with beekeepers and scientists the modification to management practices that have taken place and the fields of research undertaken.

The resultant information collected by the study group has been clearly laid out in this report and should be carefully considered by the Australian beekeeping industry as to what course of action is required to manage the beetles within Australia and what areas of future research could be considered.

This project was funded from industry revenue which is matched by funds provided by the Federal Government.

This report is an addition to RIRDC's diverse range of over 900 research publications, forms part of our R&D program (honey bees), which aims to improve the productivity and profitability of the Australian beekeeping industry.

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Simon Hearn
Managing Director
Rural Industries Research and Development Corporation

Acknowledgements

Funding for the study was provided by RIRDC for Doug Somerville, NSW Agriculture and Ray Phillips, Chairman of AHBIC. Funding for Bill Winner, Beekeeper Services Manager for Capilano was provided by Capilano Honey. Trevor Monson, commercial beekeeper and pollination agent was self funded.

Initial contacts with key USA scientists were made with the assistance of names and addresses provided by Carolyn Monson, Trevor Weatherhead and primary authors noted on existing published articles on the beetle.

Travel bookings were organised by Juliet Gelling from the Qantas Government Travel Centre. Assistance was also provided from Dianne Smith and John Ryan, the overseas travel section of NSW Agriculture. Administrative assistance was provided by Lea Prosser and Murray Spicer, NSW Agriculture.

The following persons provided favourable information to the group prior to leaving Australia, and assisted extensively in the success of the study once in the USA:

- Laurence Cutts, Department of Agriculture, Florida
- David Westervelt, Department of Agriculture, Florida
- Dr Jeff Pettis, United States Department of Agriculture, Beltsville
- Dr Patti Elzen, United States Department of Agriculture, Weslaco, Texas
- Dr Mike Stranghellini, University of North Carolina
- Dr Mike Hood, Clemson University, South Carolina
- Dr Keith Delaplane, University of Georgia

The following persons generously gave of their time to talk to the study group and impart their experiences in relation to the small hive beetle and other issues impacting on beekeepers within the USA:

- Horace Bell (beekeeper)
- Doug & Pat McGinnis (honey packers)
- Bill Rhodes (beekeeper)
- David & Linda Miksa (queen bee breeders)
- David Hackenberg (beekeeper)
- Cathy DeWeese; Randall Dean; Dr Mike Thomas & Bruce Sutton (Department of Agriculture, Florida)
- Dr Glenn Hall (University of Florida)
- Dr Jim Tumlinson & Dr Baldwyn Torto (USDA, Florida)
- Percy Jacobs (beekeeper)
- Ray Latner (beekeeper & beekeeping supplies)
- Fred Rossman (beekeeper, queen producer, package bees & components manufacturer)
- Micki Hardeman (queen bees & packages)
- Reg Wilbanks (queen bees & packages)
- JM Sykes (beekeeper)
- Don Hopkins (North Carolina State Department Apiarist)
- Nancy Gamber; Norman Randall & Mark Doll (Dutch Gold honey packer)
- Dr Mark Feldlaufer & Dr Anita Collins (USDA, Beltsville)
- Dr Frank Eischen, Dr Raul Rivera & Henry Graham (USDA, Weslaco, Texas)
- Bill Vanderput (beekeeper & pollinator)

Particular mention is made of Laurence Cutts and David Westervelt (Department of Agriculture, Florida), Dr Jeff Pettis (USDA, Beltsville) and Dr Patti Elzen (USDA, Weslaco, Texas). These persons provided some very interesting information, freely gave of their time and experiences and essentially ensured that the Australian study group achieved its aims and objectives. We are particularly grateful to these four persons.

COMMENTS FROM REFEREES:

"The report is quite comprehensive"
Dr Patti Elzen, United States Department of Agriculture, Weslaco, Texas, USA.

"A good report and reflects the impact and our efforts to deal with SHB in America"
Dr Jeff Pettis, United States Department of Agriculture, Belstville, MD, USA.

Contents

Disclaimer

The chemicals and veterinary products mentioned in this report are not registered for use within Australia. It is an offence to use any agriculture or veterinary product contrary to label. For current information on allowable or registered products, please contact your local State Agricultural Department.

Executive Summary

The small hive beetle (***Aethina tumida* Murray**) is a recent introduction to Australia. What its long term impact on the Australian beekeeping industry will be is not known. Doug Somerville (NSW Agriculture), Ray Phillips (AHBIC Chairman), Bill Winner (Capilano Honey) and Trevor Monson (beekeeper and pollination agent) travelled to the USA in March 2003 to study this pest in more depth and to ascertain its impact on the American beekeeping industry and provide possible scenarios for the future of the pest within the Australian context.

To achieve the aims of the group a range of scientists, apicultural extension agents, beekeepers, queen bee and package bee producers and honey packers were contacted.

Essentially the small hive beetle from the American experience can be described as a sub-tropical pest, behaving as a scavenger and opportunist. There is no doubt that the beetle has been transported to most states within the USA, but it is encouraging that few reports of damage have been received from most areas of the country.

Beekeeping management practices have contained the problem in most cases. The adult beetle and the larval stage appear to be very tough and are capable of going into a hibernation phase when climatic conditions do not suit their development or activity.

Warm temperatures in the mid 20°C's and humidity levels about 50% promote beetle activity at all stages. Adults can live in excess of a year and are capable of laying up to 2000 eggs. An egg is the most fragile stage of development but hatches within 24 to 48 hours. The larvae become very active and quickly destroy the surface of combs causing a slimy, sticky mess resulting in unsaleable honey. These larvae will crawl hundreds of metres to seek suitable soils to pupate within. All these stages are temperature and humidity dependent.

Beekeepers experience problems in two fields. Firstly, within the colony the beetle is controlled in most cases and only becomes a problem to colonies weakened for other reasons. In the American context this is frequently due to Varroa mites decimating populations. Small colonies or nucleus colonies used extensively in the queen bee production industry are particularly susceptible to damage from the small hive beetle.

Maintaining strong colonies and fumigating material which originates from dead colonies prior to its reuse are the primary strategies of beekeepers in reducing the problems caused by the beetle in the apiary.

Secondly, within the honey extracting house the problem of the beetle becomes more widespread. Honey combs are normally removed from the colonies and transported to a central location for extraction. In many cases the micro climate of these sheds is ideal for beetle activity. Provided with a food source, the beetle populations can rapidly increase with the larvae causing extensive damage and loss of income through the spoilage of combs prior to extraction. To overcome this, beekeepers have modified their practices and now generally extract honey combs within a day or two of their removal from a colony. The wax cappings are also an attractive food source for beetles and these are processed very quickly after the extraction process. Generally the small hive beetle has meant that many beekeepers have become more "hygienic" when it comes to the extraction process of their beekeeping business, extracting, processing and cleaning up honey plants very quickly and not relegating this job to a less important status.

Provided with a few beekeeping behavioural modifications, this pest of bee hives within the USA context seems to be under control in most circumstances.

It is worth mentioning that other beekeeping issues and management problems were discussed at length. Issues arising from these discussions included Varroa mites, which are clearly the number one problem for American beekeepers and American foulbrood disease would be the second most significant issue.

Medications to control both of these problems are costing the industry dearly due to increasing issues with resistance. Risks associated with the use of chemicals for the contamination of the USA honey crop are also of major concern to the industry.

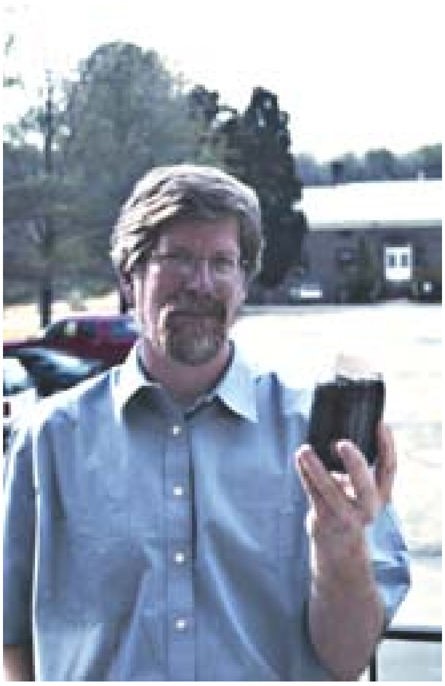
There were some concerns expressed about the possible importation of Australian and New Zealand queen bees due to perceived pressure on the domestic price of queens. Generally, beekeepers liked the idea, although queen breeders were less enthusiastic.

Government support for the American beekeeping industry is presently healthy, although recent events indicate that this will not always be the case. Some states have reduced their inspection networks and a few universities that previously had active researchers and extension personnel have ceased these functions.

In relation to the small hive beetle, research in America has slowed down and resources are being channelled into other areas. Priorities were established for possible research within the Australian context including investigating honey quality after larval activity, reproduction capacity of the beetle in fruit, designing suitable within hive and within apiary trapping devices, triggers for reproduction, and a study of the temperatures which may kill the beetle in stored equipment. The use of a chemical to kill beetles within a hive may also be a possibility if a mechanism is developed that provides complete safety to the bees and eliminates any risks of contamination to honey and bees wax.

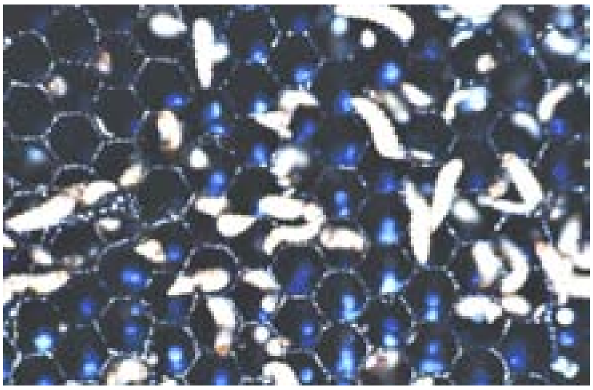
In conclusion, the study covered a range of climatic zones, conversed extensively with persons very experienced with the beetle problem in the USA, and provided the background for the Australian study group to formulate what it believes are priorities for the Australian beekeeping industry to consider.

The remains of 35,000 supers and 3.5 million frames rendered unusable for honey bees due to chemical contamination by the beekeeper. Florida. (Photo: Bill Winner)



Dr Jeff Pettis, a USDA scientist, holds a jar estimated to be 13,000 small hive beetles collected from an apiary of 40 colonies. As the honey boxes were removed the boxes were placed on another box and the beetles ran down into a trapping device. The supers were removed and bumped over a wire screen. The beetles moved from the super through the wire screen which did not permit bee access. The beetles collect in a soapy water bath under the screen. The brood chamber was not shaken so this technique probably only collected 10% to 30% of the beetles present in the apiary.

Small hive beetle larvae “sliming” a comb of honey



Small hive beetle larvae

Eggs of the small hive beetle laid between two glass slides within a very small gap. (Photo: Bill Winner)

A small device made to sit on the bottom board of nucleus colonies contains a piece of the coumaphos strip. Adult beetles can hide in the device and thus come in contact with the pesticide. (Photo: Bill Winner)

A plywood device made to be placed on the bottom board to kill adult beetles. A coumaphos strip is stapled underneath board. Note coin indicating that adult beetles can crawl under board, honey bees cannot.

The underside of the plywood device with a coumaphos strip stapled to the plywood. In this case honey bees cannot gain access to the pest strip.

A pipe entrance designed by JM Sykes to prevent the entry of adult beetles into the hive. Savannah, Georgia. This technique was proven to be unsatisfactory in subsequent research.

The Florida University research apiary. Dr Glen Hall is in the process of testing Varroa mite resistant honey bees developed by Dr John Harbo, USDA. Minimal use of chemicals to test the resistance levels of each strain of bee means that some colonies become very weak and thus are susceptible to small hive beetle infestations.

Three way nucleus hive in 10 frame full depth box with a common shallow super. Four units per stand. Elevation primarily to save on bending over repeatedly. Queen breeders, David and Linda Miksa, Florida.

A coumaphos impregnated plastic strip (CheckMite®) placed on a comb for Varroa mite control.

An apiary only just established for mating queen bees comprised of 700 two way mini nucs. Note package of bees only just placed on top of nucleus box. The bees were to be released from the nucleus that evening and the package cage removed the following day for reuse. Reg Wilbank's apiaries, Georgia.

A two way mini nucleus hive. Note only two small combs and one permanent sugar feeder. The small hive beetle was reported not to be a problem with these units due to the cooler and drier conditions, as distinct from Florida. Reg Wilbank's apiaries, Georgia.

This concrete block building has been built to house a tank to store high fructose corn syrup. The operation utilises between 23-24 thousand lbs of syrup per year. Stored in warm conditions to prevent crystalisation. Reg Wilbank's honey house, Georgia.

An apiary belonging to Bill Rhodes, Florida with bottle feeders for providing corn syrup to colonies.

Africanised honey bees attacking camera in an apiary close to the Mexican border in Texas.

1. Introduction

Objectives of the Study

To review the current research and management practices of scientists and commercial beekeepers within the USA in relation to the beehive pest, the small hive beetle.

Outcomes of the Study

Ascertain the issues and practices that may be relevant to the Australian beekeeping industry regarding the control of the small hive beetle.

Deliverables

Enable the Australian beekeeping industry to prioritise research into the small hive beetle and assist in not unnecessarily repeating research already in progress in the USA.

Background to Study

The small hive beetle is an exotic pest of beehives within Australia. Its presence within beehives in Australia was confirmed in October 2002, after extensive testing by NSW Agriculture and CSIRO entomologists. The initial site identified was Richmond, north west of Sydney. Movement restrictions were placed on beekeepers in the immediate vicinity and extensive surveillance was conducted and coordinated by NSW Agriculture in the Sydney region.

The pest, which originates from South Africa, has the potential to cause the death of a bee colony, damage to stored and unattended combs and spoilage of honey prior to extraction. The impact of the find is the immediate suspension of $4 million plus of live bee exports, a major blow to those who rely on this facet of beekeeping for a significant component of their income.

Once confirmed as the small hive beetle, the Consultative Committee on Emergency Animal Diseases (CCEAD) met and formed a working group comprising of NSW Agriculture staff, QDPI, AFFA, CSIRO and honeybee industry members to determine the extent of infestation in New South Wales and other regions of Australia.

After an extensive inspection and surveillance program coordinated by NSW Agriculture, 103 apiaries in four regions, including the Sydney basin, Stroud, Cowra and Binalong, were confirmed to have the small hive beetle. Included in this number were 13 feral colonies mainly around Sydney. Due to the large number of infected apiaries and its presence in feral colonies, it was decided by the National Management Group that the small hive beetle was not eradicable and thus eventually declared endemic.

At the inaugural meeting of the Small Hive Beetle Steering Committee in Sydney on 18h December 2002, it was decided that an “Australian delegation be funded to undertake a study tour to talk to overseas experts”. This was stated as a high priority with a target date of January 2003.

The primary reason for visiting America rather than South Africa is because the beetle is not considered a serious problem in its native country. It is thought that the small hive beetle will thrive in tropical, semi-tropical and temperate climates, although there is little confirmatory information available. It reached prominence as a pest when it was found in Florida in 1998 and it has now spread to 15 states in the eastern half of the United States where it is sometimes responsible for serious damage to honeybee colonies.

Research Strategies and Methodology

Study Group

Profiles of the four persons participating in the study are as follows:

Doug Somerville has been employed by NSW Agriculture as an Apiculturist for 16 years. He has a broad knowledge of the Australian beekeeping industry and has developed specific interests in honey bee nutrition, floral resource issues and pollination. He is the current editor of the National Crop Pollination Association newsletter and has recently submitted his thesis for examination to obtain his PhD. The thesis title is “Spatial Temporal & Nutritional Variability in the apicultural Floral Resources of New South Wales”. Doug is a regular contributor of articles to the Australian beekeeping journals.

Ray Phillips is the Chairman of the Australian Honey Bee Industry Council which is the peak industry body of the Australian honey bee industry. This includes honey producers, honey packers, queen bee breeders and pollinators. Ray is a second generation commercial beekeeper with 36 years experience producing honey and providing a pollination service. Ray is based in Shepparton, Victoria which is a large horticultural region of that state.

Bill Winner has had a long career in various roles servicing the Australian beekeeping industry. Initially Bill was the assistant editor of “The Australasian Beekeeper” from 1969, becoming editor in 1975 until January 1991. From this point until present Bill has been part of the Capilano Honey team with the current title of Beekeeper Services Manager. Capilano Honey Limited is a cooperative which is owned by contracted honey producers/shareholders. Bill has championed the link between Food Quality Programs and beekeepers, co-writing the widely acclaimed “Reference Manual for Honey Extracting Facilities & Food Safety Program”. Bill is also a current Director of the honey industry based quality assurance program “B-Qual”, which is attracting international interest.

Trevor Monson is a third generation beekeeper based at Gol Gol on the NSW side of the Murray River next to Mildura, Victoria. Trevor has managed up to 2000 hives and currently manages 800 hives. A major component of Trevor’s business activities in recent years has involved providing a professional pollination service. His expertise has been recognised by corporate companies who have sought his audience in relation to advice, setting out future large scale almond orchards to ensure they will be accessible by beekeeper’s trucks and adequately covered by honey bees. Trevor has, in recent years, travelled to California (2002) to study the pollination of almonds in this state and was involved in a beekeeping development project in Laos, Asia.

Travel Route

The study group comprising of Doug Somerville (NSW Agriculture), Ray Phillips (Chairman of the Australian Honey Bee Industry Council), Bill Winner (Beekeeper Services Manager, Capilano) and Trevor Monson (commercial beekeeper and pollination agent), departed on 4th March 2003, flying to LA in the USA, then on to Orlando in Florida. From there the group travelled to various research institutions and beekeeping operations in Florida, Georgia, South Carolina, North Carolina, and Pennsylvania before driving to Washington DC, not far from the Beltsville Bee Research Laboratories. From there the group flew to Texas to visit researchers and beekeepers before returning to LA and Australia by 25th March 2003.

Relevance and Benefits

The entire Australian beekeeping industry has the potential to benefit from the intended project. At this stage the potential impact of the beehive pest, the small hive beetle, is not fully understood and international reports are mixed in relation to their possible economic ramifications. It is also not clear how serious the pest will be to:

- honey quality issues;
- native bees;
- export markets for live bees;
- reproductive capacity in fruit;
- survival in various climatic zones;
- pollen trapping and harvesting activities;
- the movement of bee hives for the provision of pollination services.

2. Summary of the Findings of the Study

2.1 The Small Hive Beetle

In essence this bee hive pest can be described as an opportunist and scavenger, taking advantage of situations that suit its reproduction. It is apparent in the USA that the beetle has had sufficient time to spread across the width and breadth of the country. There is enough evidence to suggest this has indeed occurred, although it appears that the beetle has not established in most of the country. What is very apparent is the sub-tropical nature of the beetle favouring warm to hot humid climates to thrive. Cooler temperate or dry climates do not suit this insect and, as such, the beetle is not likely to cause a major problem in much of Australia.

The primary state affected by the small hive beetle is Florida. Florida experiences a wet and dry season and sandy loam soils are common across the whole state. Both the soil types and the humid warm seasons in Florida are ideal for beetle activity. The beetle has also caused some concern along the Georgia and South and North Carolina coast line. All areas experience regular rainfall, periodic high humidity levels and warm temperatures. There is an annual migration of in excess of 100,000 bee hives from their wintering locations in Florida to the northern states adjacent to the Canadian border. Even so, the beetle does not thrive or cause major concern in these northern regions.

2.1.1 Life Cycle and Behaviour

The life cycle of this insect is very specific in relation to certain climatic parameters. The number of cycles in any 12 months may be as high as six or there may only be one cycle, depending strictly on temperature, humidity and a suitable food source for developing larvae.

Adults: Adult beetles are reported to be strong fliers, capable of covering a few kilometres relatively easily and flights in excess of 10 kilometres are possible. In the hive they can run around the combs with ease, although they have been observed to have poor grip and tumble down between combs at times, particularly when disturbed. Their hard outer casing makes them very difficult for adult bees to chew or sting, although house bees will harass adult beetles and cause them to retreat into secluded areas of the bee hive. There are some reports of bees incarcerating adult beetles by using propolis. In these cases the beetles can somehow mimic young bees and encourage house bees to feed them when incarcerated (refer to references in this report).

The ratio of males to females is almost equal, although males are often the first beetles to infest a new food source. The adult beetle prefers to fly at dusk and overnight. The ratio of male beetles at a new food source is high at dusk, but by morning the male:female ratio is approximately equal. During cool weather, at temperatures below 21°C, the adult beetle will become completely inactive. It is not clear at what temperatures adult beetles begin to die due to the cold. One prediction was that adult beetles will die at just above 0°C, although this needs to be tested. The adult beetles will penetrate the cluster of adult bees to survive. A ball of beetles has been found in the middle of over wintering clustered bees.

Any disturbance of the adult beetles will cause them to scurry for cover away from light. In open screened bottom boards beetles are not often found on the bottom board, whereas with the use of a normal solid bottom board, this is a prime location to find the beetles. The beetle is highly mobile and the population varies significantly through the day and from day to day in each hive as the beetles freely come and go.

Adult beetles are attracted to a number of materials although by far the most attractive substance is brood comb containing brood, pollen and honey with a handful of worker bees attached. Some fruit, particularly rockmelons, have been shown to attract beetles but they need to be overripe. All possible food materials are bypassed in preference to brood combs and stressed bees.

The ideal temperature at which adults will fly was not stated, neither was the ideal humidity. Presumably these insects will be far more active given ideal climatic factors. The number and frequency of adults observed visiting hives varied significantly from week to week indicating that they are influenced by climatic factors in relation to their movements.

Moving or transporting commercial bee hives in a conventional manner (by truck) appears to encourage the beetles to leave the hive. The statement that frequently moved commercial loads of bee hives had less problems with beetles than static apiaries was voiced by a number of people.

Some hives are also far more attractive to beetles than others. Why this is so is not entirely clear. It is well understood that a "stressed" colony is more likely to attract flying beetles but it has been observed where one colony in an apiary attracts a disproportionate number of adult beetles with apparently no difference in colony conditions. Some colonies also demonstrate a low tolerance of the adult beetles, constantly harassing them, whereas other colonies appear to readily tolerate their presence.

When disturbed, adult beetles are induced to mate and lay eggs all within a few minutes. By placing a number of adults in a jar, mating and egg laying activity can be induced by a slight shaking of the jar. Beetles can also be sexed by gently squeezing the carapace. With the female beetle the ovipositor will protrude, with the male no protrusion will occur. This does not appear to adversely affect the beetles. It is not understood whether the female is able to be mated once to be able to lay her full complement of eggs, as she is capable of multiple matings over time. She is capable of laying up to 2,000 eggs during her life and up to 200 eggs per day. Even so, she is also capable of living in excess of 12 months, records indicate up to 16 months in a laboratory situation. Thus we can presume that the adult beetle may survive many situations waiting for the ideal conditions to breed.

One beekeeper claims he estimated that there were 8,000 beetles within a hive with an active honey bee colony with no apparent effect to the bees.

Eggs: The eggs are the most fragile stage of the life cycle of this insect. They are laid in cracks and crevices within the hive and there are reports of eggs laid under the cappings of brood comb. How successful these eggs are at hatching is unknown. Certainly any eggs that are not protected will not be viable, for instance the opportunity for beetle eggs to be transported in queen cages would be extremely unlikely. The egg will hatch within 24 to 48 hours, given ideal humidity and temperatures. At temperatures below 10°C the eggs won't hatch. Ideal humidity levels are 60% plus. Ideal temperatures for hatching eggs were not stated.

Larvae: This stage of the life cycle causes the most concern for beekeepers as it has the potential to cause the most damage to colonies and combs of honey, and problems around the honey house. Larvae normally feed on combs containing honey, pollen and brood. In the process of feeding on the combs a slime is excreted, the honey is uncapped and the mixture attracts atmospheric moisture causing fermentation.

It is possible for 6,000 larvae to infest one comb, thus it is also possible for there to be 60,000 larvae in a hive containing 10 brood combs. There appears to be a degree of self regulation when it comes to the adults laying eggs on suitable food sources. Once larvae are present in numbers the adults cease laying and move on. These larvae can feed for 10 to 16 days before reaching maturity and are in a position to exit the hive to seek a suitable location to pupate.

Once the larvae hatch and moult through their first instar stage, the larvae become very tough and difficult to kill. Once they have reached maturity and are ready to crawl to a suitable location to burrow into soil and pupate, they will cease activity until suitable climatic conditions prevail. If temperatures and humidity levels are not favourable they become inactive. How long larvae can remain in limbo before having to find a suitable site to pupate is unknown. Once these factors are favourable and the larvae are mature they will crawl towards light, seeking suitable soils in which to burrow into. They are easily capable of crawling 200 metres over a concrete floor and probably further seeking soil. They prefer to burrow into sandy loam rather than harder clay based soil and may move well away from the infected hive material in search of a suitable soil type. Stories were relayed during the trip about huge migrations of larvae within the beekeeper's honey sheds and even in people's kitchens where hobbyist beekeepers stacked a few boxes of combs to extract.

Larval survival rates decrease rapidly with falling temperatures. Nearly 100% survive at temperatures around 30°C, whereas at 20°C less than half the larvae survive, at 10°C no larvae survive.

Pupae: The sandy loam soil is the most favourable for the larvae to burrow into. The larvae are capable of crawling considerable distances, thus it is feasible that if a suitable soil type does not present itself next to the infested hive material the larvae will crawl some distance in search of a suitable site.

The soil moisture needs to be between 5% and 25%. If a soil profile is saturated the larvae/pupae will die. As the beetle is so temperature dependent for its life cycle, it can also be assumed that there are ideal temperature ranges for the development of the pupae. Adult beetles have been reported to emerge from the pupal stage anywhere from two weeks and up to 15 weeks after pupation.

2.1.2 The Small Hive Beetle Threat to Stored Combs

A number of situations may occur where material becomes vulnerable to being damaged by larvae.

Deadout colonies: Colonies that have died for whatever reason may leave behind pollen, honey and dead brood. These elements are highly attractive to adult beetles which will readily lay eggs in and around the material. Within a few days the combs will be a sea of larvae feasting on the combs. Quite a few beekeepers warned against the practice of placing deadout boxes onto healthy hives without fumigating the material first with phostoxin®.

The material may contain may hundreds or thousands of eggs or very young larvae that may not be apparent to the casual observer. After placing the contaminated box and frames on a healthy colony, the eggs hatch, larvae grow and increase their activity. Once the larvae have established, adult bees have no mechanism to deal with the problem and thus a perfectly healthy colony will succumb to beetle larvae.

Ideally, fumigating the material with phostoxin® first will kill all adults, eggs and larvae of the beetle and render the material safe for reuse. As the use of cool rooms wasn't common in Florida, the method of cool storage to achieve the same outcome could not be ascertained, although this would prevent beetle and larval activity. It is highly probable that freezing for 24 hours would also achieve the same aim of killing all beetle life stages that may exist in a box.

The classic practice of removing honey and returning the supers to the extracting shed may cause some concern to many beekeepers in Australia, given the American experience. Frequently, combs are stored for a number of days in a warm, moist environment ideal for beetle larvae to thrive. Given an egg may hatch within one to three days it is possible to have a sticky, slimy problem as a result of heavy larvae activity within three to five days.

This problem exists despite outside climatic factors as the micro climate within the hot room or extracting plant now provides the temperature and humidity triggers for beetle activity.

This activity can cause serious economic loss to the beekeeper with combs of honey slimed and fermentation caused by the exposure of the honey resulting from the larvae removing the cappings and the honey absorbing atmospheric moisture.

If the problem is large enough, this may equate to many thousands of dollars worth of unsaleable honey. Most beekeepers have adopted the practice of extracting honey as soon as it is removed from the hives, within a few days at the outside. Traditionally honey combs could be stored for days or weeks before being extracted. A few beekeepers referred to using existing hot rooms and attaching a dehumidifier or air conditioning unit to the room to reduce the humidity below 50% which will prevent eggs from hatching and may limit larval development.

Honey is not attractive to beetles on its own, but cappings are. Reports where cappings and wax pieces left in an extractor or settling tank attract adult beetles and subsequent larval activity were disturbing. Thus it would be prudent for beekeepers to remove all cappings and process these also within a day or so of extracting. The slum gum usually discarded as a result of removing the wax from the cappings may also create another breeding ground for the beetle and should be immediately disposed of.

Once combs were extracted, the damage caused by the beetle larvae was significantly reduced and normal wax moth control measures ensured that beetles did not become a nuisance in the storage area. Combs containing brood, eggs or pollen were more attractive to beetles than white combs. The use of white comb for honey was favoured by a number of beekeepers due to its reduced attraction to beetles. The use of queen excluders is strongly recommended by all beekeepers experiencing management issues with the beetle. As the use of escape boards was not common amongst those interviewed, the impact of their use on promoting beetle activity could not be gauged.

As beetle larvae seek light when ready to burrow into the ground and are capable of crawling considerable distances, a very bright light can be set up in the shed to attract the larvae. A quartz halogen light may be placed in an appropriate location within the shed with the bulb facing towards the ground only six or so centimetres off the ground. The larvae will crawl towards the light and cook as a result of the heat of the light. This method of detecting larvae was reported to be highly successful, although the larvae have already done their damage and it may be costly running such a light each night within the shed.

2.1.3 Threat to Live Colonies

Reports of the small hive beetle killing colonies appear to be greatly exaggerated. Certainly the beetle larvae are responsible for major damage of combs and material and will overwhelm a weak colony, but the fundamental point is that the colonies are already seriously weakened due to another set of problems. Normally colonies are seriously weakened in populations due to Varroa mite infestations and thus this weak and stressed colony becomes very attractive to adult beetles. If the colony was left then it would, in all probability, die as a result of the Varroa mite infestation or some other bee disease or ailment. The beetle, being an opportunist, takes advantage of the stressed and weak colony, quickly turning the remaining combs of brood and honey into a sticky, slimy mass as a result of beetle larval activity. Stressed colonies in the Australian context may result from nutritional disorders, artificially weakened colonies (nucleus colonies) or colonies suffering from adult or brood disease. Strong, healthy colonies will not be affected by the beetle, only weaker colonies or stressed colonies become attractive to adult beetles.

The main area of concern regarding colonies is in queen rearing where small nucleus colonies are managed for large scale queen bee production. Mini nucleus colonies located in favourable climatic zones for beetle activity will be prime targets for beetle infestations. Areas where the climatic factors exhibit cool or dry conditions may sustain mini nucs without a lot of interference from beetles.

Even so, queen bee producers and beekeepers managing nucleus colonies need to be very mindful of the risks associated with beetle activity given ideal climatic factors, combined with the presence of weak colonies. It is the experience of some queen bee producers in the USA that beetle larvae will simply overcome mini nucleus colonies, particularly when the climatic factors are desirable for beetle activity.

2.2 Other Issues Impacting on the USA Beekeeping Industry

2.2.1 Varroa Mites and Other Pests and Diseases

Varroa mites are the most serious pest facing the beekeeping industry in America. Constant monitoring is required and encouraged to ascertain mite populations and target treatments to keep mite levels at an acceptable level. Once mites can be easily seen on worker bees or brood, the colony is said to be heavily infested. The presence of drone brood greatly accelerates the Varroa population. The sugar shake method of removing approximately 200 worker bees from around the brood area and placing them in a jar with powdered sugar is common to determine mite levels. Even so, it was said that very light infestations of mites were not picked up by this method.

Once a swarm or clean colony has been established it would take up to three years before the colony would totally succumb to the mites and die. Feral colonies are now non existent in much of the USA. Historically a normal winter loss before Varroa mites came along was 10%, this rose to 25 to 30% after mites established. In recent years this is now frequently 50% of all colonies.

Varroa mites have been identified as largely responsible for this increased fatality rate over winter. The chemicals used to control mite populations are rapidly losing their efficiency. Resistant mites have become a major concern to the industry and it would appear there is no promise of any significant solution to the problem in circulation at present. Breeding resistant strains of bees is thought to present some promise, although it is thought by many that this approach to solving the Varroa problem is in its early days. Combined with other disease and pest treatments, the cost to beekeepers is now approximately $10 US per hive per year in medications.

American Foul Brood appears to be the next biggest general problem for American beekeepers on a national level. Historically, beekeepers have prolifically medicated colonies to suppress AFB. The medications used are now ineffective due to resistance of the bacteria to the antibiotic. The antibiotic now commonly used across America is not registered for such purposes and as it has already been in common use for three years, reports of resistance to this antibiotic have also been reported. Beekeepers face a major dilemma in seeking further drug solutions to their problem of suppressing AFB as each new drug provides potential risks to contaminating honey in the form of residues and receiving a backlash from the domestic market. An estimate that latent infestations of AFB in colonies may be as high as 50% within most apiaries creates a major quandary in relation to any strategy that might suggest the future non medication of colonies. Gamma irradiation, although available, is not used to any extent to sterilise contaminated equipment.

All other pests and diseases could be described as regional in their importance as management issues to American beekeepers.

Tracheal mites account for significant deaths of colonies over winter in cooler climatic zones. The small hive beetle is a major problem in the sub-tropical climate of Florida.

European Foul Brood was said to be a significant problem when pollinating blueberries in Maine. Chalkbrood didn't get much of a mention, probably due to the widespread practice of corn syrup feeding which appears to assist colonies in keeping this disease under control.

There were some indications that nutritional disorders may also account for the demise of colonies in some areas, but due to the proliferation of various pests and diseases afflicting honey bees these disorders were hard to identify.

2.2.2 Queen Bees

As we were able to interview both honey producers and queen bee producers, we obtained interesting insights into the issues either group felt were important at the time.

The market for early queen bees in the USA from January through to May is quite strong with prices ranging between $9 to $12 US per queen. From June onwards, during the summer, the price dropped down to as low as $6 US.

Queen producers operate much the same systems as in Australia, although cell raising colonies were generally feeding greater numbers of grafted larvae than the Australian situation. There was also a marked lack of drone mother colonies near each mating yard which may impact on the quantity of suitable aged drones available to mate with each batch of virgin queens.

As drone brood favours the rapid expansion of Varroa mite populations, this will cause major management problems for maintaining drone mother colonies and the need to produce healthy drones capable of strong flight. The proliferation of medications to suppress Varroa mites and control AFB was also thought to be affecting the longevity of queens and fertility of drones.

Honey producers were generally in favour of the importation of Australian queen bees to supply early requirements from January onwards, others expressed concern over the importation requirements regarding pests and diseases and the possibility that imported queen bees from Australia may weaken the domestic price of queens in the USA during the same period. There was also concern that allowing Australian queen bees entry may open the way for imports from other countries with lower priced queen bees. Mexico was mentioned, though an unlikely source due to the presence of Africanised bees.

In essence, American queen breeders were hesitant about the importation of queen bees due to a lack of knowledge of the potential of Australia to produce numbers of queens at a price that may impact on domestic queen bee producers.

2.2.3 Government Scientific/Education/Inspection Support

There are three levels of government support for the American beekeeping industry, all very active. Unfortunately this support is slowly eroding and in the previous 12 months this almost became a rapid decline in support. The three levels are from the USDA (United States Department of Agriculture), various state universities and State agricultural departments.

The USDA maintain four significant research laboratories specialising in honey bees located in various areas across America. It was proposed to close three of these and maintain one only research laboratory which would have seen the exodus of many researchers out of honey bee research and many experiments cease.

Fortunately this move by the federal government was circumvented by the beekeeping industry. One of the significant tools used to accomplish this was the emphasis of the role of honey bees as pollinators and their value to the economy via the value of fruit, vegetables, grain crops, etc. One research laboratory had a box of pamphlets on the value of honey bees as pollination agents to US Agriculture published by the American Honey Board. They were freely given to all visitors to ensure honey bees maintain a high level of importance in the political arena.

The various universities scattered across the country are involved in education, extension and research. Each university that had a focus on honey bees often have only one or two scientists on staff specialising in honey bees. Some honey bee scientific positions have been lost in recent years within the American universities.

The State government Departments of Agriculture are very mixed in their support for the beekeeping industry. Certificates are required for the interstate movement of bee hives and package bees, yet some states had next to no personnel that were able to sign such certificates. Two adjoining states visited, North and South Carolina, illustrate the point. South Carolina had one inspector, whereas North Carolina had six. Both states are much the same size and beekeeping activity is similar. It is apparent that state governments are drifting away from any responsibility they may have had in the past to the beekeeping industry.

2.2.4 Honey Market Issues

Wholesale honey prices achieved by beekeepers are similar at the time of writing to what is being achieved in Australia.

The range and position of liquid retail honey packs in supermarkets is pathetic. In sizeable supermarkets, often only a handful of lines, placed on the top shelf, were observed. Clearly there is an opportunity for liquid retail pack sales to increase within the American market. Similar positioning of product and number of product lines were observed in a trip to California in 2002.

As for the beekeeping industry, their major concern should be product contamination from potential residues from any one of the medications in common use across America, mainly to manage Varroa and control AFB. There appeared to be no clear national strategy on how to deal with this problem.

3. Areas for Future Research

The following points are not in any order of priority, they have been identified by the members of the Australian study group as possible areas for future research.

1) Investigate honey quality after small hive beetle larvae have "slimed" a comb of honey.

2) Reproduction success on fruit: At what stage of maturity is fruit attractive to adult beetles? The research conducted with the small hive beetle and fruit was done with a number of adult beetles in each treatment. Could they have cannibalised each other to obtain the necessary protein to breed? If beetles can reproduce on fruit, what is the risk of transporting this pest within the context of the international trade of horticultural produce? This subject needs to be closely considered by the Australian Horticultural Industries. Banning managed bees from horticultural regions would not be productive, as feral colonies will harbour populations of the small hive beetle and the adult beetles are said to fly considerable distances.

3) The necessity for an in hive trap is apparent as adults may live for in excess of 12 months, waiting for the triggers to reproduce. If the adults can be reduced in numbers then the problem will be reduced in apiaries and honey houses when environmental factors favour breeding.

4) Further studies to clarify the triggers for the reproduction of the small hive beetle including egg to death of adults. How long can each stage survive and under what conditions?

5) Investigate the use of light traps within honey extracting and storage facilities to determine presence of the small hive beetle larvae.

6) Investigate the use of coumaphos in an enclosed device where adult honey bees will not be able to come in contact with the chemical, but where the adult small hive beetle will. The longevity of the chemical may provide a long term solution to reducing adult beetle numbers within hives if the use of such chemicals can be rendered safe for honey bees and eliminate any potential risk of contaminating honey or bees wax.

4. Travel Diary

The following notes are points of interest recorded from conversations with a range of beekeepers and scientists within the USA. They are only arranged in order of days on which each conversation took place. The points are not organised into any subject order.

4th March

Travel. All members of the study group on flight from Sydney (QF11) to Los Angeles in California. Met with Robert Eustace, Business Development Manager for Capilano and Dave McArthur, Business Development Manager, North America for Calkins & Burke Limited, BC, Canada.

5th March

Travel. Flight from Los Angeles, California to Orlando, Florida. Hire car to Mt Dora, north of Orlando.

6th March

Met up with Laurence Cutts, Assistant Chief Apiary Section, and David Westervelt of the Bureau of Plant and Apiary Inspection, Division of Plant Industry, State of Florida, Department of Agriculture and Consumer Services.

These two gentlemen acted as our hosts for the day, visiting Horace Bell, arguably America's largest beekeeping operation with over 56,000 bee hives under management, in the afternoon visiting the Tropical Blossom Honey Company Inc., proprietor Douglas McGinnis.

During the day we were also accompanied by Dr Max Watkins, Director of Vita (Europe) Ltd., United Kingdom, whose interest was in miticides.

Discussions with Laurence Cutts

The small hive beetle is a greater nuisance along the coast in sandy soil conditions. Whenever the temperature or humidity falls, the adult beetles make themselves scarce and are difficult to locate in a hive.

Florida is one of America's major beekeeping states with 220,000 to 250,000 colonies. Approximately half of these hives are migrated into the northern states for honey production in the summer. Last year the value of the honey crop in Florida was $30 million US. Floral prospects in Florida in summer are poor, bee hives are either migrated to Maine or New York to pollinate blueberries or North and South Dakota for honey production. Approximately 40,000 bee hives are used for blueberry pollination in Maine. The primary honey plants within Florida include Tupelo (*Nyssa species*), Palmetto (*Sabal palmetto*), Orange blossom (*Citrus aurantium*), Gallberry (*Ilex glabra*).

There is an active inspection service within Florida for AFB. Beekeepers are encouraged to prophylactically treat colonies to "prevent" AFB. Even so, if an inspector finds AFB in the beekeeper's hives then the beekeeper is prevented from using antibiotics. Beekeepers are not encouraged to use Tylosin in the treatment of bee hives as this is not a registered drug. Infected colonies are burnt whole. Material can be irradiated but this is regarded as an expensive alternative. The cost of irradiation varies according to how busy the irradiation plant is. Compensation in some circumstances is available up to the value of $30 US per hive, although the current value of a single story full depth bee hive is at least $100 US. Irradiation costs vary from $5 to $8 per deep super. Many beekeepers who regularly migrate north/south kill off half their colonies in the fall and migrate the remaining colonies to Florida where they are bred up over winter and split to make up the numbers once again ready for the spring migration north.

The Florida Department of Agriculture only suggests honey being fed back to colonies if it has been gamma irradiated. Most beekeepers don't report cases of AFB within their apiaries to the Department of Agriculture, they deal with it themselves.

Laurence believes that a nutritional disorder exists in Florida which is occasionally referred to as disappearing disease. Most beekeepers focus on the parasites and diseases as the main cause of colony population weakness.

Melaleuca quinquenervia, a native of Australia, is a major honey and pollen plant in Florida. It is regarded as a major woody weed in Florida and an active biological control program is in the process of attempting to reduce or suppress its spread. This plant has become very aggressive, crowding out native species occurring in large forests. The species flowers every year through winter for five to six months, although the honey is considered to be low in quality and of a poor flavour. Melaleuca, Brazilian pepper (*schinus terebinthifolius*) and Chinese tallow (popcorn) (*sapium sebiferum)* are considered excellent honey plants within Florida. Brazilian pepper blooms in the fall and is the most dependable honey crop in Florida, although like Melaleuca, this species is also an invasive introduced species and aggressively competes with native floral species.

In a good year it is not unusual to obtain a 200 lb honey crop from popcorn. The flowering period is for three to six weeks over summer, with a distribution across the northern areas of Florida, across into Mississippi, Louisiana and areas of Texas.

Information from Dr Max Watkins

There has been a marked increase in the resistance of Varroa mites to Apistan and coumaphos treatments in the last six years. The UK based company that Dr Watkins represents is in the process of developing a gel containing two pheromones to assist in the control of the mite. At this stage the company continues to have problems with the delivery mechanisms within the hive.

Vita Ltd have developed a field diagnostic test for AFB—"AFB Prototype P5". This was developed with assistance from the Ministry of Agriculture in the United Kingdom. At this stage the test kit is expected to sell for 10 Euros or approximately $10 US. The company is developing a similar test kit for EFB.

Horace Bell Visit

Horace Bell indicated that he manages the largest number of bee hives within the USA, with over 56,000 hives. At the time of our visit he was employing 76 persons, mainly Mexican in origin. Labour costs per hour were $5.50 US for males and $5.25 US for females. He will employ up to 100 persons at the peak of the season.

His beekeeping system is unique within the USA. All colonies are remade approximately four times over the year. An apiary containing all material including honey supers are transported back to the factory, the colonies are completely pulled apart, all honey combs are extracted and the number of adult bees and frames of brood are equalised. A new queen is introduced and he has a goal of placing 6 frames of foundation into the brood nest of 50% of his colonies per year, a staggering 336,000 frames! This newly made up colony is then transported to an out apiary and fed syrup to stimulate breeding. Population increase is carefully managed to ensure colonies are not strong enough to swarm when the new nectar crop begins and the whole process is repeated. This management strategy requires very large storage facilities for the stacks of extracted combs. This creates an ideal environment for wax moth and the small hive beetle.

Excessive use of Phostoxin® was apparent and the liberal use of other chemicals to control the beetles was also alluded to. (This is not encouraged by the Florida Department of Agriculture.) A very large pile of bee boxes and frames in a nearby field comprised of 35,000 supers were the result of the misuse of chemicals and the chemical contamination of that equipment making it unsuitable for honey bee habitation.

Horace regards Varroa and Tracheal mites as his biggest problem—indicating that the small hive beetle is more a nuisance. Its spread through Florida was a lot slower than Varroa. Wax moth is an all year round problem in Florida. Skunks, bears and ants can all cause problems for bee hive management.

Horace has counted up to 8,000 beetles in a hive, with the colony apparently not being affected. Combs with pollen and/or old brood are always a problem with beetles. A dead hive, particularly stacked in a shed, will attract large numbers of beetles. The beetle problem is seriously reduced during cold weather. Phostoxin® kills beetle larvae, eggs and adults. When the larvae are in large numbers they can be readily seen crawling along the floor of the shed towards light. Horace refers to this phenomenon as “mobile rice”. There were a dozen or so guinea fowl around the storage shed that were said to consume many of the small hive beetle larvae. The soil surrounding the storage areas is treated with permethrin in an attempt to control the pupil stages of the small hive beetle.

The colonies, once made up in the shed, are provided with a 5 lb jar containing corn syrup. The syrup is released slowly at first with only one hole in the lid. As the colony population increases, further holes are placed in the lid to increase the volume of syrup available to each colony.

Horace has a requirement for 10,000 packages at the beginning of December each year. He prefers a 3 lb package, but will use 4 lb packages and split them in two. At no time are bees allowed to eat honey. With honey at $1.42 US/lb it is far more economical to provide corn syrup at 14c/lb as a replacement.

Most of the cost of controlling the small hive beetle is in the use of Phostoxin® within the sheds. Horace believes that the Australian beekeeping industry doesn’t need to “panic” about the small hive beetle.

Laurence Cutts & David Westervelt

Beetles will not readily fly during the day, they can be observed more frequently flying in the early morning/early evening. Florida experiences a wet and dry seasonal pattern, the beetle activity is reduced during dry conditions. Larvae can stay in a hive for months until the conditions are “right”, when they will exit the hive and pupate into ideally sandy loam soil.

The small hive beetle responds to tropical climatic conditions. At temperatures below 70°F (21°C) the adult beetle becomes immobile. The small hive beetle is very “tropical”, preferring high temperatures and humid climates. The small hive beetle has not been a problem in the northern states of America due to climate. The beetle larvae won’t pupate during cool conditions or rain events. The bees generally have the small hive beetle under control until the hive is disturbed, which triggers a response by the beetles, which may lead to the demise of the hive from excessive beetle damage from larval activity. Moving a hive will normally encourage the adult beetles to leave the colony.

Beetles seemed to be highly attracted to colonies that have been disturbed. Beetle eggs hatch within 24 hours. Where Varroa seriously weakens the population of a colony, beetle numbers can become a major problem. Tracheal mite infestation or any issue that stresses a colony may trigger a beetle population explosion. Honey combs need to be extracted as soon as they are removed from the hive. Even after three days, beetle larvae may be well established in the combs. Brood in honey combs in the honey house will attract beetle activity, white combs help reduce this problem.

Once adult beetles are disturbed they are stimulated to mate and lay eggs. These eggs hatch very quickly when conditions are right. Dead out hives should not be stacked, they need to be fumigated first with Phostoxin® before reusing the combs on a healthy colony. Once the larvae have infested the combs, placing these combs on a healthy colony will only promote the demise of that colony. The larvae and slime need to be removed first by pressure washing with warm water. The mature larvae will not leave the shelter of a hive during rain. Once the rain event has ceased, the mature larvae will leave the hive in search of a suitable soil to burrow into.

Normally, once the adult beetles lay a batch of eggs they will leave that hive. Adults have been kept alive for a year within a laboratory situation. If a number of adult beetles are placed in a container, taping on the container will stimulate the beetles to mate and lay eggs within 10 minutes.

Douglas McGinnis, Tropical Blossom Honey Co. Inc.

This honey packer focuses on niche markets, with small packs, gift baskets, etc., with some export markets. Approximately 1,500 tonne is packaged annually favouring local honey such as Orange, Tupelo and Palmetto. The company is the largest marketer of comb honey in America, with a big demand for the product from the Hispanic population. Doug is a current member of the National Honey Board.

Honey quality and damage by the small hive beetle was not considered an issue by the company as no problems had been experienced to date. Cut comb is stored at 65°F (18°C) and subject to a dehumidifier which is said to control wax moth and the small hive beetle.

7th March

David Westervelt acted as our host for the day, visiting Bill Rhodes, a commercial beekeeper with 13,000 hives for honey production and, in the afternoon, visiting David and Linda Miksa, queen bee breeders and honey producers. David and Linda’s son Ted is primarily a honey producer, migrating between Wisconsin and Florida.

Bill Rhodes

Based in Florida, Bill manages 13,000 hives primarily for honey production and some pollination. His operation employs 8 people and 1,200 hives are contracted to pollinate squash, cucumbers and melons in Georgia.

Bill states that, “beetles are not a problem compared to Varroa”. Dead hives left to sit in the field for two or three weeks will attract beetles. This material needs to be removed and fumigated. An insecticide is sprayed around the ground where supers are stored.

Bill sees a few beetles around his apiaries but believes "good strong hives never get overtaken by beetles". He places cardboard traps within the hive, the beetle comes in contact with an insecticide strip and dies. All hives are moved regularly, which may assist in controlling the beetle. Quote from Bill: "I don't think you have anything to worry about (in Australia), although around the honey house may be a problem". Bill doesn't use queen excluders in his operation but believes that the use of queen excluders will seriously reduce any beetle problems, as they are attracted to brood.

Once honey is removed from hives and stacked in a storage room attached to the extracting facility, the whole room is fumigated with methyl bromide.

If a colony becomes weak for whatever reason, usually Varroa mite infestations, then beetles will become a problem. A lot of syrup is fed to colonies either in gallon buckets or 8 lb jars. Between 20 and 25 lbs of corn syrup can be fed to each colony. Hives are over-wintered with a shallow super of honey. Corn syrup is cheaper than sugar syrup and a container in winter may take seven to 10 days for the bees to clean up. A 55 blend corn syrup, which is 77% sugar, is preferred due to low carbon levels at 15.1 cents/lb. The corn syrup is cheap compared to fuel for the trucks.

David Westervelt

The period from egg to pupation in the ground can be as little as seven days. This can be slowed down by reduced temperatures or restricted diets. Pupae can stay in the ground for three months. Usually expect high survival levels of 98% when conditions are favourable, whereas if protein is limited, survival may be reduced to 75% although the number of eggs laid may increase. Poorer diets will also result in a smaller beetle than normal. The small hive beetle has been observed feeding on pollen with flowers which may indicate they could breed without access to bee hives. At humidity levels below 50% the small hive beetle eggs do not hatch.

An average winter loss before Varroa was 10%, now 30%, although this appears to be rising to 50% with the increasing use of chemicals in the hive.

David Miksa

David is primarily focussed on queen bee production and uses 3-way, 3-frame nucleus colonies housed in a 10-frame hive body. A Manley super common to all nucleus colonies is placed over a queen excluder. The entire unit is housed on a stand approximately 85 cm off the ground. The soil around the apiaries is sandy loam. Beetles are not considered a problem, probably due to the stronger populations. Sugar boards are placed over each hive and pollen supplement is provided to each nucleus colony for the winter period. This is primarily done to ensure strong nucleus colonies and sufficient drone numbers to begin queen rearing early in the season. Early queens sell for $10 US.

Last year David produced 102,000 queen cells. Between 100 and 180 three-way nucleus colonies are placed in each yard. A total of 1,164 three-way nucleus colonies were managed last year for queen production.

David doesn't actively pursue honey or specifically manage colonies for drone production. He believes that there are plenty of drones due to the large number of commercial beekeepers in the area. Cell building colonies are given 30 grafted cells every three days. Up to 60 colonies are utilised as cell builders. Grafting starts on 1st March and finishes at the end of November. Queens are caught a minimum of 23 days during the busy season after ripe cells have been placed in the nucleus colony. During the off season catching may extend up to 90 days. Between 8 to 10 queens are mated in each nucleus colony each year. The break in brood as a result of removing the queen reduces the number of treatments for suppressing Varroa populations.

David estimates between 8 and 10 queen breeders are based in Florida. He produces approximately 20,000 queens each year. A major part of his business is producing queen cells. An old rule of thumb in relation to the value of queen cells and queen bees is a queen cell should be equal in value to 2 lb of honey and a queen should be worth the equivalent of 10 lb of honey (wholesale value).

David has had the experience of suffering serious beetle infestations in dead colonies with ample stored pollen in the combs. Once an apiary was flooded, with the entrances closed to flight, the resident bees over heated and died and beetle larvae took over the hive. Any burr comb, particularly comb containing brood, returning to the home storage sheds needs to be cleaned up as soon as possible otherwise beetle larvae will infest the comb.

David Westervelt

Comments by David Westervelt on David Miksa's three-way nucleus colonies. A single 3 or 5-frame nucleus colony is more susceptible to small hive beetle attack than a strong three-frame nucleus colony with a common super across the three colonies. With hives placed on the ground it is possible to find beetles at times in the debris found at the entrance of hives.

8th March

Met with Dave Hackenberg, commercial beekeeper with 3,000 hives for honey production and pollination. Dave occupied a full day, touring his apiaries and facilities. Dave is a migratory beekeeper with his main extracting plant in Louisburg, Pennsylvania. He is a past president of the American National Beekeepers Federation, and is currently on the National Honey Board.

David Hackenberg

David used to pack honey, up to two million pounds per year, but in 1994 his factory was a completely gutted by fire. With increasing emphasis on food safety and the general trend in businesses consolidating, David made the decision not to reenter the honey packing business. His business is now honey production and pollination, over wintering in Florida and migrating to the northern states along the Canadian border during summer. Pollination of apples ($35 US to $40 US), blueberries and cranberries is carried out in Maine for $50 US per hive. Blueberry pollination is particularly "hard" on bees as the colonies often run out of pollen. At a stocking rate of two to five hives per acre, they are often broodless at the end of blueberry blossom. It is possible in a normal year for his bees to produce 100 to 150 barrels of blueberry honey.

David uses queen excluders, division board feeders and flat lids in his operation. As for the small hive beetle, he has heard horror stories of the damage the beetle can cause, although he has not experienced this himself. His experience is that south of Interstate 40 the beetle can be a significant problem (Interstate 40 begins in North Carolina and runs east-west through Tennessee and Arkansas, across to California). Moving bee hives on a regular basis seems to reduce the beetle problem. All the honey supers are transported to Lewisburg, Pennsylvania for extracting wherever it is produced in the USA. It is quite common to store several thousand boxes of honey in preparation for extraction. Under these circumstances, beetle larvae can be a problem. A large halogen lamp has been set up in the factory, with the bulb facing the concrete floor and close to the surface. Larvae crawl to the light and cook under the intense heat generated by the bulb.

David uses queen excluders which reduces the amount of brood in honey supers. From experience, combs with brood and/or pollen are highly attractive to the beetle. Bees are moved by semi-trailers with 490 hives in a load. Two years ago bees were stopped on the Arizona/California border due to fire ants. A total of 37 loads of bees were prevented access into California on the pretext of possible fire ant introductions.

Varroa is by far the worst problem for American beekeepers. Apistan was used for eight or nine years with satisfactory results until resistance become a problem. Varroa developed a resistance to Coumaphos within three years. Amitraz has been used on and off for seven to eight years. Generally, queen bees have performed at a lower level than was acceptable. This has been partly blamed on the range of different chemicals used in a colony to control Varroa. Before Varroa, a normal over wintering loss would be 10%, now it's 25%. Splits made in cooler weather are not bothered by beetles.

Another issue pressuring beekeeping interests in Florida is the expansion of urbanisation. Florida is a popular retirement state with 750 people moving into the state per day. Traditional beekeeping country is quickly being overrun by urban development.

Any combs infected with beetle larvae are washed with warm water then placed in a strong populous colony to clean up.

9th March (Sunday)

Travelled to Gainsville. Visited Homosassa Springs Wildlife State Park.

10th March

We met with Laurence Cutts, Florida Department of Agriculture & Consumer Services, including staff Cathy DeWeese (Secretary) and Randall Dean (Inspector); Dr Mike Thomas (Entomologist), and Dr Bruce Sutton (Bioscientist) at Gainsville.

Randall Dean demonstrated techniques for measuring wings to determine degree of Africanisation and the methods used to locate tracheal mites in the thorax of worker bees.

Dr Mike Thomas was responsible for the first positive identification of the small hive beetle in the USA after a number of other institutions had failed to do so. Dr Bruce Sutton provided us with a demonstration of the use of gas chromatograph technology.

We visited Dr Glen Hall (Research Scientist), University of Florida, where we inspected the apiary within which the evaluation of breeding stock for resistance to Varroa mites is being conducted.

Visited USDA labs and met with Dr Jim Tumlinson and Dr Baldwyn Torto who have conducted research into the pheromones and odours attractive to the small hive beetle.

Laurence Cutts

In relation to the incursion of Africanised honey bees, a series of cardboard swarm traps were placed around all ports and along interstate highways in Florida, numbering 500 traps. Cardboard traps are favoured by bees over plastic nucleus boxes, it was thought due to the humidity in the state. Each trap contained a pheromone lure to ensure the attractiveness of the cavity to swarms. Originally the USDA provided all the traps and most of the monitoring was conducted by the State Department of Agriculture. The USDA are no longer responsible for the program and thus it has become a state sponsored exercise. The cardboard trap was originally designed as a disposable flower pot and modified for the purpose of catching swarms. When in the field, the pulp or fibre cardboard modified flower pots lasted between three and four years in Florida. The average rainfall across Florida is approximately 50 inches.

As for the small hive beetle Laurence doesn't know any beekeepers who are having a major problem. Varroa is easily the major pest to beekeepers. Even so, if a colony is stressed for whatever reason, then the beetles can invade a hive and the larvae will finish the colony off. The small hive beetle larvae have the ability to remain in a larval stage for many weeks before entering the ground to pupate. If conditions are too wet they will stay in the hive. After dark the larvae will migrate from the infected combs into suitable soils.

Pupation can be as long as 105 days (quote from Dr Lundie, South African study), although in Florida seven to 10 days seems to be an average pupation duration before emerging as adult beetles. Emergence is usually just after dark or at dusk. For one reason or another, some colonies seem to be highly attractive to adult beetles, they will also come and go from hives for reasons unexplained. Treating the ground around an apiary will assist in keeping beetle numbers down, although this will not eliminate the beetles. The larvae of the beetle life cycle is the stage at which the economic damage is inflicted on beekeepers.

Some beekeepers have placed, in the extracting room, a 4-frame nucleus box with combs of brood and pollen to attract adult beetles. The beetles are then killed off when present.

A halogen light is very attractive to larvae. They will crawl 60 feet across a concrete floor to a halogen light. Some beekeepers sprinkle chlorine over the floor which is very effective in killing larvae.

Laurence predicts that Australian beekeepers will have a beetle problem when honey supers are brought back to a hot room and stored for extraction. A halogen light set up in the corner of the shed will act as a guide to the presence of beetle larvae, prewarning the beekeeper of possible problems.

Once there are a lot of larvae present, the adults will leave the material. One dead hive could conceivably raise 100,000 adult beetles. Once you start removing honey, beetles will be a major concern.

Laurence did hear of one case in Texas, where 500 pallets of honey waiting to be extracted were found to be infested with beetle larvae. This amounted to $US500,000 worth of honey lost due to the small hive beetle in one large operation.

Dead out hives need to be managed to reduce the problem of the small hive beetle. It is important to fumigate the material before it is placed back on a healthy colony. This is best done with Phostoxin. PDB will kill adults but not eggs and probably not larvae. (Cool rooms are not common in Florida, so their effectiveness in controlling or reducing the damage caused by beetles could not be assessed.)

Bees will not attempt to clean up a comb that has been "slimed" by beetle larvae. The slime has to be first washed off the combs before returning the combs to a strong colony. Adults and larvae will drown very quickly in water.

In Florida extracting orange blossom honey during spring does not create a problem with the small hive beetle due to the cool night time temperatures 85°F (30°C) day, down to 60°F (15°C) at night. Beetles become a problem as the weather warms, particularly during summer honey flows in Florida. At temperatures below 50°F (10°C) the small hive beetle eggs won't hatch. The microclimate in a hive will vary from that of the general climatic conditions prevailing. The microclimate within a colony may be attractive for beetle activity. The adult beetle is very tropical in relation to its activities. At temperatures below 68°F (20°C) it will become immobile.

How long an adult beetle takes to die at low temperatures is unknown. Adult beetles can over-winter at low temperatures within the bee cluster in Minnesota at temperatures of –30°F (less than -25°C).

Adults can live for in excess of 12 months, one record of 14 months.

Generally in South Africa, honey is removed from the colony and extracted within 24 hours, thus the South Africans do not have a problem with the small hive beetle as they have learned to live with it.

Laurence was told of one experience where cappings were left in the settling tank on top of the honey and they became infested with beetle larvae. This illustrates the need to process cappings fairly quickly.
The small hive beetle will take advantage of any hive that is stressed for ANY reason.

There is currently no research in progress on the small hive beetle in Florida. All attention has been refocussed on Varroa mites. The beetles have forced a lot of beekeepers to be more sanitary in the honey house.

The small hive beetle has probably now been introduced into all states within America. Beekeepers in Texas and California are "scared to death" of the beetle, but it's not likely they will cause a big problem due to the drier conditions prevailing in these states. By 1st June each year all the migration of honey bees out of Florida is complete.

In 1998 125,000 hives were moved to 16 different states, thus beetles have now been in residence in the north for at least four years, although the experience in the northern states is that beetles pretty much disappear.

The small hive beetle in packages can be a problem. Placing a coumaphos strip in a package does not kill all the beetles. The use of coumaphos can be riskier for the beekeeper.

Beetle eggs are normally laid in clumps in cracks and crevices within the hive. If an egg was to hatch in a queen cage then there would be no protein for the larvae to survive on. The eggs are very fragile and easy to damage, whereas the larvae are very tough.

David Westervelt developed a cardboard trap containing a coumaphos strip. The trap is placed on the bottom board. The hive bottom board must be cleaned of all burr comb so the trap lays flat on the board. Bees will pester beetles and make them run under the cardboard to get away from the bees. Traps are necessary when humidity is high. Dry or drought conditions control beetle numbers. Bee Go is the major chemical repellent used to clear supers of bees, using escape boards may create ideal environments for the beetle to invade if climatic conditions are favourable. Bee Go has been observed to force the adult beetles to leave the hive.

Randall Dean

The Florida Department of Agriculture continues to monitor for Africanised bees. The initial program was funded by the US government, the cost of continuing the program has fallen back onto the various states.

Initially wing measurements are used to determine the degree of Africanisation of the bees. If the wing measurements indicate a strong possibility of Africanised genes, then the sample is sent for DNA analysis. It takes 10 to 15 minutes to prepare the necessary number of wings from worker bees for measurement. DNA analysis costs $500 US per sample, thus this technique is utilised only after wing measurements indicate that Africanised genes could be present.

Out of 200 swarm traps, 75 would catch a swarm each year. These were set some distance away from known managed apiaries. A colony could survive in one of the cone swarm traps for up to three years before eventually succumbing to Varroa mites. Since 1986 there have been 32 positive interceptions of Africanised bees into Florida. In the last five years, three or four swarms have been collected off ships and most of the samples tested have been collected in swarm traps. The swarm traps can also attract squirrels and rats. They are usually checked for bee activity every 21 days.

Laurence Cutts

The small hive beetle is a scavenger. Other similar beetles include the southern pine beetle that infests pine trees that are under stress. If you over super a hive this may create problems in managing the small hive beetle. The small hive beetle is a bigger problem in nucleus colonies in queen rearing yards. Generally, the smaller the colony, the more problem will be encountered with managing the small hive beetle.

With the sugar shake method of determining Varroa presence, place the bees into the container first then sprinkle sugar over the top. Shake the bees and sugar together and leave for a minute. This technique will ensure a better count of Varroa if present.

Dr Mike Thomas

Chief Entomologist for the Florida Department of Agriculture, Mike positively identified the small hive beetle in the USA, only after the beetle had been incorrectly identified by other institutions for a year and a half. A beekeeper originally sent the beetle to the South Carolina University and six to eight months later further samples were submitted to the Georgia University. Both institutions failed to correctly identify the beetle. Georgia and South Carolina beekeepers were experiencing problems with the beetle a year before Florida beekeepers reported any problems. The whole family of beetles are scavengers. The small hive beetle has been found in bumble bee nests. A mercury vapour light (400 watts) can be used to attract larvae in a shed, although the power consumption can be significant.

Dr Glenn Hall

The location of the visit was the Research Apiary within the University of Florida. The primary research in progress is the evaluation of breeding stock developed by John Harbo from the USDA laboratory at Baton Rouge. The stock has been selected for its Varroa resistant properties. In the process, the research is attempting to identify the DNA markers that relate to Varroa resistance. Unfortunately the stock being tested has a very poor brood pattern. Attempts to cross the selected stock to improve the brood pattern are currently being undertaken. Significant problems with supersedure of test queens, as each queen is only inseminated once. Also, the small hive beetle is a problem as colonies become weak. There are some worries that the SMR (suppression of mite reproduction) queens have been released to the beekeeping industry too soon before the stock can be fully evaluated. The program is being sponsored by government grants and the Florida State Beekeepers' Association. John Harbo apparently found that he could find resistance in any population of honey bees by continuing to select resistant strains within the population.

A small hive beetle trap has been developed for the test nucleus colonies, comprised of a piece of plywood 50 mm by 100 mm. A groove has been cut in one side and an insecticide strip has been placed in the groove. A piece of corrugated plastic is fixed over the insecticide strip. The beetles can get excess to the strip but not the bees. Two to four of these traps are placed in each colony. They have found that screened bottom boards with nucleus hives elevated 1.5 metres off the ground, have also assisted in reducing the small hive beetle problem. Once in a while a trap is found clogged with dead beetles, or the gaps are propolised, thus they need to be checked for their ongoing effectiveness. The propolis needs to be removed fairly regularly at times. Most beetles die outside of the trap and fall through the screen or are removed by the house bees. In colonies with screened bottom boards, traps are placed above the brood. Observations within the research apiary indicate that the small hive beetle seems to reproduce more often in colonies under shade rather than colonies placed in direct sunlight. The screen gauge used in the bottom boards is 8-mesh to the inch.

The propolised traps are collected and placed in the freezer to remove the propolis. Glenn believes that temperatures just above freezing will kill beetles.

Dr Jim Tumlinson & Dr Baldwyn Torto

University of Florida, Gainsville—Research Scientists specialising in insect pheromone studies. Extracted honey is not attractive to the small hive beetle. The most attractive odour so far discovered is that emitted by honey bees themselves. Other substances vary in their attractiveness to female and male beetles.

Laurence Cutts

600,000 hives in Texas—3 inspectors.
240,000 hives in Florida—17 inspectors.

Universities in the USA are drifting away from agricultural research. Laurence used to manage 2,200 hives before joining the Florida Department of Agriculture.

The small hive beetle thrives along the coast in South and North Carolina, but not inland. To Laurence's knowledge, there are 22 USDA researchers within four research laboratories. Twelve universities conduct some bee research, including Florida (1), Georgia (1), North Carolina (1), Penn State (2), Cornnell (2), New York (1), Ohio (2), Wisconsin (1), Minnesota (1), Oregon (1), California (2 or 3).

11th March

Travelled with Laurence Cutts north to the Florida Dadant dealer, parted company with Laurence and travelled into Georgia and met up with Fred Rossman a package bee and queen bee producer. Fred also manufactured boxes and various wood products for bee hives.

Percy Jacobs (Beekeeper we met at Dadants Beekeeping Supplies, Northern Florida)

Percy manages 50 to 70 hives. The small hive beetle is a real problem in the honey house. Pulls honey off hives and extracts straight away. Stacks supers in the shed and fumigates with PDB, hardly sees any beetles in the hive, still too cold for them in his area. Places an empty box under each stack of supers and places PDB on top of stack, also spreads a lot of PDB around the floor in the storage area.

Information from Ray Latner (beekeeper and Dadant beekeeping supplier). They used to pull all the honey off the hives and move their bees, then extract honey once all the bee hives are shifted. Now the honey is extracted straight away as a result of small hive beetle problems.

Fred Rossman

Based at Moultrie in Southern Georgia. Fred produces queen bees, package bees, honey, beekeeping supplies and provides a pollination service. A lot of cotton and peanuts grown in the area.

Fred produces 15,000 queens per year, produced 35 drums of honey last year, normally produces between 12,000 and 15,000 packages. Queens are mated in 3,600 nucleus colonies, mainly baby nucs. He prefers a 3 or 4-frame deep nucleus colony, queens are caught at 18 to 20 days sometimes only 13 to 14 days. Some cells are produced and normally sell for $3 US. Queens sell for $9 US for 100 or more. This price drops to $6.50 US in June. Usually queens should be worth the equivalent of 10 lbs of honey as a general historical rule, although with the high honey prices this equates to $15 US a queen which is not obtainable from the market. 8,000 hives are under management for package bee production and pollination.

Varroa is the biggest and most expensive problem. Queen cells can't be raised satisfactorily in colonies with coumaphos strips present.

The small hive beetle is generally not a problem, probably due to the cooler weather. Strong colonies do not suffer a beetle problem, weaker baby nucleus colonies can be overcome by beetles. One yard lost up to eight baby nucs due to the small hive beetle. The apiary with the most problems was comprised of baby nucleus colonies on sandy soil. Stored combs with honey extracted do not present a problem in relation to the small hive beetle. Phostoxin is usually used to control wax moth and will also control beetles. Problems exist in the extracting room as beetles seem to be very attracted to combs full of honey. If left for a few days before extracting, a major problem with beetle larvae can develop.

A small sugar ant can cause problems at times, completely covering hives and stressing colonies. Old combs are burnt due to the low bees wax prices as the labour required to retrieve the wax and repair the frames does not warrant the expense.

Between 900 and 1,000 nucleus colonies are placed in one yard, usually four rounds of queens are obtained in spring before the price is reduced. Each cell raising colony is given 120 cells. Approximately 85% of these will be raised. When these mature cells are placed in a nucleus colony, about 85% will mate successfully.

Billy Engle (Beekeeper contacted by phone from the Rock in North Georgia)

The small hive beetle hasn't given him a lot of trouble. Worst month is September. Places coumaphos traps in hives which helps keep beetle numbers down. Has seen beetles overwinter within the cluster of bees, will cause problems in a queenless colony and is also more of a problem in a nucleus colony than full sized colonies. For some reason the beetle is not attractive to some bee hives, some bees behave very aggressively against the beetle, whereas others tolerate the beetle.

12th March

Visited Harderman Apiaries (Micki Harderman) family operation producing queen bees and packages in Georgia. Visited Reg Wilbanks, Claxton, Georgia, who also produces queen bees and packages.

Micki Hardeman

Hardeman Apiaries, Mt Vernon, Georgia. Specialises in package bees, queen bees and pollination services.

Between 30,000 and 40,000 packages produced each year; 50,000 to 65,000 queens. Each yard has 1,200 double nucleus colonies with a total of 6,000 double nucleus colonies managed. Each mating yard has 55 to 60 hives for drone production. Only 400 to 500 queens are expected to be on mating flights at any given date. Queens are caught at 10 days of age onward. Each year all apiaries are inspected by a government inspector to allow the interstate movement of package bees and queens.

Varroa and Tracheal mites are a real major problem. Tracheal mites particularly a problem in the cooler areas. Sunflower and peanut oil mixed with sugar seems to work well for Tracheal mites. Beetles aren't a significant problem in the area, it does affect very weak colonies. A piece of towel soaked in vegetable oil seems to kill the beetles. Each year close to $10 US is spent per hive on medications to control pests and diseases. The region within which the Hardman's operate, winter nights can be as cool as 10 to 12°F (-12°C) and frosts can stay until 10.00–11.00am. A lot of days only reach 40°F (4°C). Bears and raccoons can be a problem. Bears can completely "bust up a yard".

Each colony has a frame feeder. Corn syrup is fed to stimulate the colony as much as possible. A pollen substitute is provided to each colony at the time of syrup feeding. Blend 55 corn syrup won't crystallise, whereas blend 45 will crystallise fairly quickly. The enterprise is a large family concern, with father, three middle-aged sons, grandsons, etc. A total of 14 people work in the business.

For prices of packages and queen bees from Hardeman Apiaries, refer to Appendix.

Reg Wilbanks

Past President of the American Beekeepers Federation and currently on the National Honey Board, Reg is a fourth generation beekeeper with an engineering degree.

Reg operates 6,000 hives. He places 700 two-way baby nucleus colonies per site. Each baby nucleus colony has two combs and a feeder. All yards are permanent with larger full sized boxes raised off the ground due to termite problems. Colonies are being stimulated all the time with 55 high fructose corn syrup. Doesn't regard it as economically feasible to feed pollen substitutes. The entire business goes through 23 to 24 thousand pounds of high fructose corn syrup each year. As for the mites, beetles, etc., Reg's quote sums it up, "these pests have taken the joy out of beekeeping, those beekeepers who are left are better beekeepers".

Varroa mites are controlled with the regular use of Fluvalinate, Armitras and coumaphos applied at different times during the year. It takes about two weeks to treat every colony. Mite populations are constantly being checked throughout the year. As for the beetle, the biggest problems are encountered in summer, otherwise it "can be handled just like wax moth—clean operation and honey house sanitation". All hives have a small hive beetle trap on the bottom board.

It is also getting harder each year to find suitable sites to place apiaries.

The main package sold is a 3 lb unit, although some 2 lb and 4 lb packages are also produced. The packages once made are stored in a cool room and held at 60 to 65°F (15 to 18°C) with oxygen pumped into the room until shipped.

13th March

Met with JM Sykes, semi-commercial beekeeper at Richmond Hill, near Savannah, Georgia. Discussed beetles, beekeeping, etc. Mr Sykes' primary source of income was catching crabs. Travelled to North Carolina beekeepers meeting.

JM Sykes (Richmond Hill)

This operation is located on coastal Georgia near Savannah. Mr Sykes is primarily a commercial fisherman and operates bee hives as a sideline. The small hive beetle becomes a major problem for him from June to August during the summer months. To overcome the beetle he developed a concept using a PVC pipe entrance in the middle of the hive at the front, blocking off all other access points for bees and beetles. The pipe is approximately 25 mm in diameter, jutting out 150 mm from the hive. Mr Sykes claims that the beetle has difficulty entering the hive, thus reducing the impact of this pest. His extracting area and honey house is air conditioned and, as such, beetles are not a problem. He runs 900 hives and doesn't requeen.

14th March

The 2003 Joint North Carolina/South Carolina Beekeepers' Association Spring Convention. A workshop was conducted for our benefit on the small hive beetle, which included selected scientists and advisory staff from a range of institutions. Those present included: Dr Jeff Pettis, USDA, Beltsville; Dr Mike Stanghellini, NC University; Dr Mike Hood, SC Clemson University; Don Hopkins, NC State Apiarist; Dr Wyatt Mangum, SC Clemson University; Jose Ruz, Spanish Apiculturalist; Bill Sheppard, NC Bee Inspector; Australian study group members.

For conference agenda and local government resolutions, refer to Appendix.

David Westervelt

The checkmite strip (coumaphos) is impregnated with an organophosphate and can be active for three years against beetles and mites as long as bees don't propolise the surface of the strip. To kill beetles the strip should be placed on the bottom of the hive in summer and on the top in winter.

A beetle trap used in the apiary comprised of a five litre bucket with lid with four large holes drilled in the sides. A small piece of brood comb and approximately 50 bees is placed in each trap. Brood comb and bees are 10 times more attractive than brood comb on its own. Fresh fruit is not attractive, it needs to be rotting. David has bred four generations of beetles on fruit. Each generation becomes smaller, the first time it reduces its size by a third, then a quarter of that size. The number and size of beetles increased dramatically once they have access to brood and pollen.

Beetles can move with swarms. David has found 400 beetles in a swarm. A weak nucleus colony placed at the extracting plant is useful in attracting adult beetles.

Workshop at Conference on the Small Hive Beetle

Dr Mike Hood

The beetles were first collected in South Carolina in 1996, although it wasn't properly identified until 1998. By then it had spread along the coast of South Carolina and Florida. It is thought that a possible point of entry could have been Charleston or Savannah—both major shipping ports. There is also a possibility that the small hive beetle was introduced on fruit or vegetables.

There continues to be major problems with the beetle along the coast. Varroa mites are a severe problem. In the mountains the small hive beetle is not as bad, the problem occurs following periods of warm wet weather, dry periods slow beetle activity. Only adults overwinter in the hive, this creates an opportunity to control the beetle. There are a number of reports that the coumaphos traps are working well, although they are unlikely to work during very cold weather. Beekeepers cannot legally use coumaphos in the spring due to the possibility of contaminating honey. Beekeepers claim that Guard Star (Permethrin) treatment of soil around hives in early summer controls beetle numbers.

Beetles are opportunist. If the right conditions occur, the small hive beetle takes advantage. The pupal stage can survive dry conditions, resuming development once moisture is available. Stickies in storage with pollen are attractive to the beetles. Mike is in the process of developing a beetle trap that can be placed inside the hive. He has found that adult beetles are attracted to cider vinegar (article published in the American Bee Journal, May 2003–page 405). Beetles are also attracted to bees. The problem is that the attractants are competing with the bee hive itself which is highly attractive. Mike conducted an impromptu survey of all those present at the workshop, asking each person to write down in order of importance the most to least serious pests and diseases of honey bees. The results were interesting, with Varroa holding the number one place, followed by AFB. After this there was a wide range of opinions in regard to what pest or disease held what position.

Varroa and Tracheal mites spread throughout the USA in a matter of a few years, whereas the small hive beetle has been taken by bee truck to all parts of the USA but has not established or caused major problems in most of the country. The small hive beetle can be a big problem around honey houses.

Donald Hopkins (State Apiarist, North Carolina Department of Agriculture & Consumer Services)

The beetle can pass through the gauze on the package bee cages. At different times of the year the beetle can be smaller and can easily pass through the mesh. The best time to kill Varroa is during the winter when bees are clustered. A chemical strip is placed in the middle of the cluster.

Don also provided evidence of high beetle populations occurring along the north-south interstate highway running through North Carolina, a popular route for beekeeping trucks. This suggested that the adult beetles readily flew from bee hives being transported across the USA.

Dr Mike Stranghelli

The main problems occur with small hive beetle when you have stressed colonies. Larvae are tough, they can survive in a petri dish for six weeks with no food or water. Sticky mats don't work, the beetle walks straight across them.

David Westervelt

The small hive beetle has been found on flowering plants. The major problem areas for both Varroa and the small hive beetle are along the coast. Once adult beetles have come in contact with Coumaphos strips, they die within three to six hours. Many beekeepers soak the soil around honey houses with insecticide to kill beetle larvae and pupae. A honey house may be bee proof, but it's not beetle proof.

Maintain healthy strong colonies. Do not allow beetles to reproduce by treating each hive to control the adult beetle. Beetles love to hide, so traps, etc., need to use this principal. When extracting, the settling tank needs to be skimmed of wax cappings at least every three days and the wax bits and pieces that build up in a radial extractor need to be removed daily and processed.

Dr Jeff Pettis

The female beetle can store sperm and is capable of laying up to 2,000 eggs in her life—up to 200 per day. The adult beetle can live for 16 months.

General comments from participants:

- Perceptions and fear of the unknown is breeding emotionally driven responses to the beetle issue.
- At 65°F (18.3°C) adult beetles become immobile.
- Cappings need to be processed as soon as possible after extracting, so as not to provide an ideal breeding material for beetle larvae.
- Beetles have made beekeepers more hygienic around their extracting plants.
- Two ways to deal with adult beetles: place a number 6 mesh screen over a box of combs with bottom attached or over a bath of soapy water. When manipulating boxes from a hive, place them on the box, beetles will move through the screen and either drown in the soapy water or hide in the box of combs. The box of combs can then be taken back home and placed in a freezer to kill all the adult beetles.
- Mini nucleus colonies used to rear queen bees will be a problem in relation to managing the small hive beetle.

15th March

Convention: Speakers included:

- Dr Wyatt Mangum—The giant bees of India
- Don Hopkins—State inspector's reports
- Dr Jeff Pettis—The small hive beetle
- Dr Mike Hood—IPM and Varroa mites

Various afternoon sessions attended included:

- Dr Mike Hood—Small hive beetle control alternatives
- Various NC State apiculture staff:
  - Varroa mites, bee pests and predators
  - Tracheal mites and bee diseases

North Carolina's State Apiary Inspector Report

Losses of up to 60% reported in over wintered colonies. The average is 30% presumably due to Varroa, starvation and Tracheal mites. The state operates a fumigation chamber for the sterilisation of hive components for AFB control using Ethylene Oxide. Not 100% effective, need to remove all combs with scale and all honey.

A report from South Carolina regarding state apiary inspections: The program has been seriously reduced and, as such, regulations are not enforced.

Dr Jeff Pettis (USDA)

Presentation to conference:

There are three areas of research:
1) Basic biology
2) Honey house problems
3) Survival in queen cages

Two separate haplotypes suggest multiple introductions of the beetle. The question still remains—how did they get here? The spread of the small hive beetle through the US equates to the migratory pattern of beekeepers. Adults live and overwinter within the honey bee colonies. Eggs are laid and larvae develop within five to 15 days on pollen and bee brood. Rain can trigger the dispersal of larvae into the soil to pupate. Soil type and moisture can be a limiting factor. Once the soil has warmed to 30°C, the pupae will hatch in 13 days. Various experiments investigated the soil question. Factors limiting reproduction success included soil type, soil moisture and temperature.

Twenty larvae were placed in separate containers of soil and subjected to different temperatures. Below 10°C nothing emerged; at 20°C the emergence of adult beetles was described as fairly successful, whereas at 30°C the emergence was described as good.

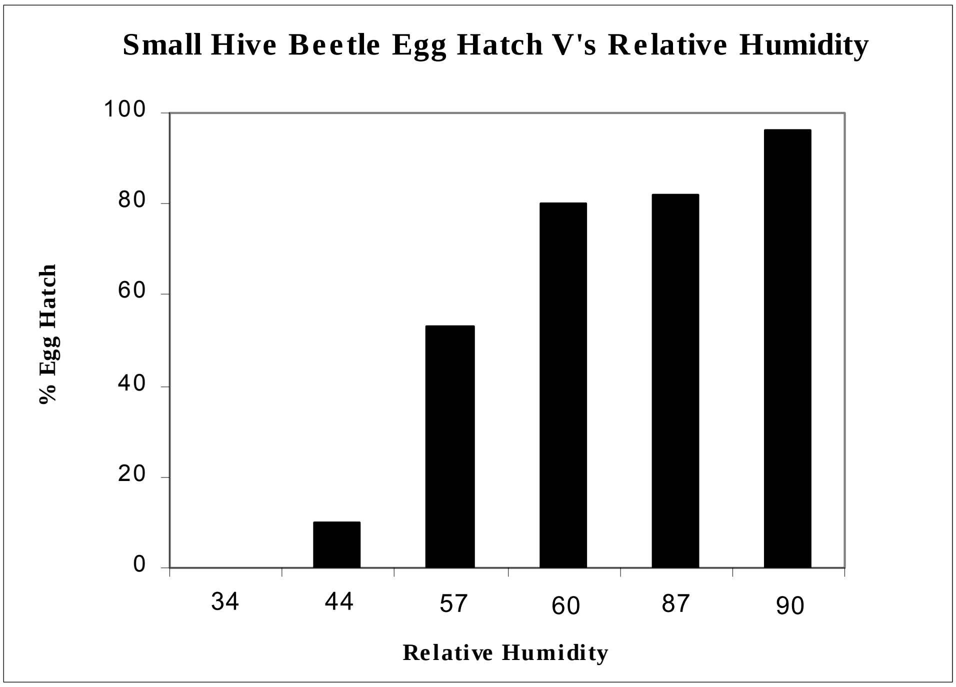
Soil types had an impact, ranging from best results for sandy soil through loam to poor success with hatching in clay soil. In harder soils pupae have been found to a depth of 50 mm.
There was also a very low survival rate with soil moisture levels below 5% or greater than 25%. There is a very poor survival in saturated soils.

Reproduction rate of the small hive beetle is potentially large. It is possible for 6,000 larvae to feed on one frame of brood; 30,000 larvae on five frames of brood or 60,000 larvae on 10 frames of brood.

Honey house problems:

- Remove honey combs with no brood or pollen for extraction.
- Process honey combs within five days.
- Lower the relative humidity below 50% in the comb storage and extraction area.

The relative humidity versus eggs hatching. The following graph illustrates six different relative humidities and the percentage increase in hatching beetle eggs at 30°C.



Air movement over frames reduces the egg hatching rate, air movement also reduces the relative humidity.

The answer to the question of whether the small hive beetle eggs can survive in queen cages, is no. The eggs are very fragile, they hatch very quickly in 1 to 1½ days and larvae will dehydrate.

Various diets were fed to the young small hive beetle larvae including queen candy, dead bees, and both candy and dead bees. Ten instars were placed in each cage and held for 14 days n = 30/trt without water. No larvae survived. Once water was added to the diet the survival rate was 77% on dead bees, 18% on candy and 83% on dead bees and candy. It is possible for adult beetles to live for greater than 12 months with access to water and honey only. Adult beetles fed on nothing or only queen candy will not survive beyond four days at temperatures above 30°C, with water only the adults will live for 20 days.

Thus, the small hive beetle will always be a more significant problem on warmer locations, around apiaries with sandy soil types and during periods of high moisture. Key points:

- Keep a clean and dry honey house, extract combs as soon as possible, keep brood and pollen out of honey combs.

- The small hive beetle is not going to put you out of business. They are very good scavengers with a high reproductive rate.

Further Discussion

The effectiveness of screen bottom boards is unknown and not proven as a control mechanism for the small hive beetle. The adult beetle can fly many miles and is capable of foraging on nectar and pollen within flowers. In sandy soil the beetle larvae can burrow 100 to 150 mm into the soil, larvae will crawl a long distance (hundreds of metres) to find a suitable soil structure to burrow into. One mated female can lay fertile eggs for two weeks.

Mike Hood (Professor of Entomology Apiculture, Clemson University, South Carolina)

Session: Small Hive Beetle Control Alternatives

Integrated Pest Management (IPM) is being pushed harder by researchers and industry leaders as a means of managing Varroa mites. Normally only 35% of the Varroa mites in a colony are to be found on the adult bees, the rest of the mite population is to be found in the brood cells. Further information on Varroa can be found on http;//entweb.clemson.edu. Some degree of success has been suggested in controlling mites using screened bottom boards.

There was a strong roll up for Mike's workshop on the small hive beetle (50), as compared to a following workshop on Varroa mites, pests and diseases (17), indicating the degree of concern this new pest has amongst beekeepers. Mike tested Mr JM Sykes' method of controlling beetle access into a hive and found it ineffectual. Placing a pipe in the middle of the front of the hive and preventing access via the normal entrance reduced brood area and reduced the volume of honey stored in the hive.

In some areas of South Carolina the beetle numbers haven't increased, probably due to climatic effects.

Devices placed around the apiary to trap adult small hive beetles have not been entirely successful. A lure superior to the hive and bees themselves has not been found. Cider vinegar kills more beetles than any other substance so far tested at Clemson University, accounting for a 20% reduction in adult beetles. Mineral oil kills 100% of the adult beetles, but is not attractive to the small hive beetle. Mineral oil and cider vinegar will not mix.

Donald Hopkins (State Apiarist, North Carolina)

Session: Varroa mites, Bee Pests and Predators

Varroa mites were first found in the USA in 1987. They were found in North Carolina in 1991. The mite population increases rapidly in the presence of drone brood. One fertile female mite can be produced on a worker pupae when it hatches at 21 days, whereas three fertile female mites can be produced on a drone pupae when it hatches at 24 days. If you can observe mites feeding on worker pupae then the population of mites in a colony can be considered to be very large.

Originally 200 adult bees were placed in a jar with a screen cover and the bees are sprayed with automotive quick start. The bees and mites are killed but the mites release and can be shaken through the screen. The screen is an 8-mesh hardware cloth. The same jar and screen can be used with the sugar shake method. Place bees in jar and sprinkle the fine sugar dust over the bees. Lightly shake the contents and leave to stand for a minute or two. The container is then shaken over a bucket of water so the mites will dislodge, fall through the screen and can be easily seen floating on the water. The bees can then be released. A plastic jar is preferred, as glass jars break when dropped. A jar made for such purposes should be standard equipment for all beekeepers.

Both methods described will find similar numbers of mites if they are present. The bees used in the shake method should be young and obtained from around the brood combs as they are more likely to have mites just after emerging from a cell.

Tracheal mites are best dealt with using a menthol treatment. This only kills adults and not eggs, thus the process needs to be repeated after two weeks. An absorbent pad is soaked with a combination of menthol and canola oil. A thick paper towel works well. The pads can be stored in a sealed container in the fridge until required.

Material in North Carolina infected with AFB is either burnt or fumigated with ethylene oxide. The treatment doesn't kill all the bacteria within the scales, thus it is recommended that all combs are melted before they are delivered to the fumigation chamber.

16th March

Travelled from North Carolina to Lancaster in Pennsylvania.

17th March

Visited Dutch Gold Honey Inc., one of the larger honey packing companies within the USA. Hosted by Nancy Gamber, daughter of the founder of the company, also the President and CEO of the company. Norman Randall, Vice President of operations, provided us with a guided tour of the factory facilities. Discussions with Mark Doll about quality issues and honey. Travelled to Beltsville, Maryland.

Dutch Gold Honey Inc. (Lancaster, Pennsylvania)

We met with:
- Nancy Gamber (President and CEO)
- Norman Randall (Vice President of Operations)
- Mark Doll (Quality Assurance Supervisor)
- Jill Clarke (Vice President, Sales)

All honey drums are washed and cleaned before reselling them to the beekeeper. The price quoted per pound usually includes the freight costs from the beekeepers shed which may be 5 to 6c/lb. The return freight of empty drums is also paid for by Dutch Gold. Prices are moving towards 1.45c/lb (approximately $5 AUS). A premium of 20c/lb is paid for extra light amber. A price discount of 30c/lb exists for reducer honey. Any excess or faulty drums are crushed on site.

The biggest problem facing the honey industry internationally is residues in honey.

Dutch Gold Honey Company provides an award to researchers who make a significant contribution to the national beekeeping industry. The award is also accompanied by a cash donation of several thousand dollars as a contribution to research.

Procedures for touring the plant and map or plant, refer to Appendix.

18th March

Met with Jeff Pettis and the entire research staff at the USDA Beltsville bee research laboratory in Maryland, including Research Leader Dr Mark Feldlaufer.

The Australian study group had rolling discussions with most research staff about a range of subjects including the small hive beetle, Varroa and Trachael mites and queen bee research.

Beltsville Bee Research Laboratory

Met with staff including scientists Mark Feldlaufer (Research Leader), Jeff Pettis, Anita Collins, Judy Chen, Jay Evans, Jan Kochansky, Barry Thompson and Gunter Weirich.

Research into the small hive beetle has been completed and is in the process of being submitted for publication.

- The reproduction of the beetle on fruit research was all conducted within the laboratory. No field work was attempted, thus the risk of the small hive beetle infesting fruit in the field is unknown. Rockmelons were very attractive to the beetle in the laboratory.

- Convinced rain triggers the larvae to migrate, they crawl easily 50 metres over a concrete surface. There is a tendency for the larvae to move en masse.

- The adult beetles lay eggs in cracks in the hive body. We don't know a lot about the actual triggers that cause this egg laying. We do know they need protein to successfully reproduce, normally pollen and/or brood.

- A useful project would be to investigate what are the triggers for oviposition within a hive. Are they constantly trying to lay just a few eggs or are they waiting for the right set of conditions?

- More improvements to an in-hive trapping mechanism needs to be developed.

- Honey from combs that have been slimed by the small hive beetle larvae have an increased bacteria, mould and fungi count associated with fermentation.

19th March

Flight from Washington DC to McAllan, Texas via Dallas.

20th March

Visited USDA Weslaco honey bee research facilities. Round table discussions with Dr Frank Eischen, Research Scientist; Dr Raul Rivera, Chemist; and Henry Graham, Beekeeper Technician.

Taken to an apiary containing Africanised honey bees and experienced the intensity and furiosity of the defence mechanisms and behaviour of this strain of bee **(AUTHOR'S NOTE: We do not want these bees in Australia under any circumstances**).

USDA Weslaco Bee Research Laboratory (Texas)

Met with Dr Frank Eischen, Raul Rivera and Henry Graham.

Thus far the small hive beetle hasn't made it to Weslaco which is located in Texas near the coast and Mexican border. The small hive beetle is not seen as a major national problem and, as such, the research direction more recently has returned to pollination orientated projects.

The biggest problem with the small hive beetle will be around the honey extracting shed. Slum gum dumped will create a great environment for the beetle to breed, this material needs to be burnt as soon as possible.

Stressed bee hives in the warmer and more humid environments will be affected by the beetle.

Question asked by Frank indicating a possible research topic: What are the cues to initiate massive mating and population explosions of the small hive beetle?

Buckets hung around an apiary containing honey, brood and pollen trap hundreds of adult beetles particularly at dusk.

In relation to the small hive beetle breeding on fruit, a paper with more detail than that published in the American Bee Journal is currently in press in Apidology—title: Fecundity of the small hive beetle grown on various fruits. (Accepted)

Another question asked by Frank that deserved attention: What will be the beetle population in areas with old fruit left in paddocks, particularly rockmelons where breeding may occur?

Bees and combs are always more attractive than fruit.

Lots of beetles have been found in feral colonies. Beetles were found in the middle of a cluster during winter when the colony is broodless. The beetles were almost in a cluster themselves.

Yet again another question asked by Frank: What is the overwintering capacity of the adult beetle and the pupae?

21st March

Meeting with Dr Patti Elzen, Research Scientist. Discussions on research into the small hive beetle, past, present and future.

Visited local commercial beekeeper, Bill Vanderput, who manages between 3,000 and 5,000 hives primarily for pollination and some honey production. Bill also deals in beekeeping goods for other beekeepers in the area. There are no small hive beetles in this region of Texas so Bill was unable to discuss the pest on an experience level.

Dr Patti Elzen (Research Entomologist—Weslaco USDA Bee Research Laboratory, Texas)

Once larvae start migrating out of a hive the colony is "shot". It is best to treat the soil around these hives to keep beetle populations under control. Most beekeepers manage the beetle problem, it can't be eradicated. The honey house will be the major area for concern, particularly in the cooler regions of the country.

The small hive beetle is a problem in honey houses in its home range in Capetown in South Africa. The honey is removed from the hive and extracted immediately. A cheap labour source allows this to happen. The mechanism causing sliming of the combs is not understood, even so a bottom board covered in honey and mucus from beetle larvae looks disgusting.

Areas of Florida may benefit from beetle traps to keep their numbers down, although in cooler areas this will probably not be warranted. It is impossible to predict beetle biology in relation to traps at this stage. One week traps will be empty, the next full. Also you can't always attract beetles to the same substances—attractive one day, not the next. Adult beetles don't hold on tightly, they dislodge and fall very easily. We recommend to beekeepers that they should manage bee hives with queen excluders in place. Generally queen excluders are common through Florida whereas in Texas beekeepers tend not to use them.

Unfortunately, pollen patties seem to increase beetle numbers. The beetle problem is worse with stationary beekeepers as compared to migratory beekeepers. Manage for a strong colony. Varroa weakened hives are prone to small hive beetle invasion. The adult small hive beetle dies rapidly once they have come in contact with pest strips containing organophosphate—you tend to notice a lot of dead beetles under the trap in the pest strip vicinity. Incorrect use of any organophosphates within a hive has huge contamination risks.

"Not having Varroa is a real nice idea"—quote from Patti regarding Australian freedom of the mite, it should be much easier to manage the small hive beetle. Traps placed around apiaries aren't reliable to measure beetle populations in the field.

22nd March

Visit to local nature reserve.

23rd March

Flights from McAllen, Texas to Dallas to Los Angeles in California. Connecting flights to Sydney and Melbourne. Group arriving in Australia on Tuesday 25th.

5. Published Scientific Notes on the Small Hive Beetle Provided to the Australian Study Group

WM Michael Hood; Gilbert A Miller (2003)

Trapping Small Hive Beetles (*Coleoptera: Nitidulidae*) Inside colonies of Honey Bees (*Hymenoptera: Apidae*)

405–409 American Bee Journal 143(5)

Abstract

The small hive beetle, *Aethina tumida* Murray, is the newest honey bee pest found in North America. The beetles infest not only honey bee colonies, but they also can damage honey supers stacked in honey houses and cause the honey to ferment. A trapping program is needed to safely and economically control this pest. Various materials, alcohol, beer, ethylene glycol, mineral oil, honey and cider vinegar were examined for their attractancy and lethality to small hive beetles. A series of field and laboratory experiments over a 2 year period tested these materials as control agents when placed in an inside-hive trap. Cider vinegar showed the highest counts of dead small hive beetles in the field, but showed low lethality to beetles in lab tests. Mineral oil showed high small hive beetle lethality in lab tests, but resulted in lower beetle trap kill in the field when compared to cider vinegar. These investigations suggest that small hive beetles can be attracted to an inside hive trap, but further work will be required to develop this technique into a successful control program.

Jay D Evans; Jeff S Pettis; W Michael Hood; Hachiro Shimanuki (2003)

Tracking an Invasive Honey Bee Pest: Mitochondrial DNA Variation in North American Small Hive Beetles

1–7 Apidologie 34

Abstract

We describe the current and past distributions of North American small hive beetles (*Aethina tumida)* having two distinct mitochondrial DNA haplotypes. A collection of 539 hive beetles showed irregular distributions of these haplotypes across the southeastern US. Beetles from the first collections made in coastal South Carolina showed haplotype NA1, exclusively. This haplotype is less common in Georgia and was not observed in North Carolina. Later collections from this and other parts of South Carolina appear more similar to those found in other states. The body size of beetles was not correlated with their haplotype, suggesting that differences in haplotype frequency do not reflect selection pressures on covarying differences in the genomes of these beetles. We discuss the implications for interring the number of separate hive beetle introductions to the US, and for estimating the migration dynamics by hive beetles as they expand their ranges in the New World.

James D Ellis, JR; Keith S Delaplane; Randall Hepburn; Patti J Elzen (2002)

Controlling Small Hive Beetles (*Aethina tumida* Murray) in Honey Bee (*Apis mellifera*) Colonies Using a Modified Hive Entrance

288–290 American Bee Journal

Abstract

This study was designed to test whether colony invasion by adult small hive beetles can be reduced by replacing the regular entrance of a hive with a ¾ inch (2 cm) PVC pipe located 3–4 inches (7.6–10.2 cm) above the bottom board. Colonies with pipe entrances had significantly fewer adult beetles (46.9 beetles/colony) than open colonies (107.7 beetles/colony). Pipe entrances did not significantly affect the amount of sealed brood in a colony nor the temperature inside colonies. However, brood significantly affected temperature inside colonies and there was a tendency for reduced brood in colonies with pipes; temperature increased as the amount of brood in a colony increased. Brood did not affect the number of adult beetles present in colonies. This experiment shows that modifying a colony's entrance may help control small hive beetles, but more work is needed to offset unwanted effects of reduced colony entrances.

PJ Elzen; D Westervelt; D Causey; J Ellis; HR Hepburn; P Neumann (2002)
Method of Application of Tylosin, an Antibiotic for American Foulbrood Control, with Effects on Small Hive Beetle (Coleoptera: Nitidulidae) Populations
1119–1122 Journal of Economic Entomology 95(6)
Abstract
The method of application of the antibiotic tylosin (Tylan) for control of oxytetracycline-resistant American foulbrood (*Paenibacillus larvae* White) was tested in honeybee (*Apic mellifera* L.) colonies. A powdered sugar mixture with tylosin, applied as a dust, was efficacious in eliminating American foulbrood symptoms at a rate of 200 mg Tylan per 20 g of powdered sugar, applied at weekly intervals for 3 weeks. A second method of treatment consisting of Tylan mixed with granulated sugar and vegetable shortening and applied once as a patty, at an equivalent total dose as the dust method, to diseased colonies also effectively eliminated symptoms of disease. In all colonies treated with patties, however, small hive beetle (*Aethina tumida* Murray) populations significantly increased, compared with the powder sugar method or untreated controls. Bee populations in patty-treated colonies also were significantly reduced, most likely the result of the invasion and proliferation of adult and larval small hive beetles. Such reduction in colony strength was not seen in dust-treated colonies. Because of the obvious damaging populations of small hive beetles, concerns about development of disease resistance, unknown risks of residues, and lack of support by regulatory agencies for the use of the patty method, the use of the dust method of tylosin is greatly favored over the patty method.

JD Ellis; CWW Pirk; HR Hepburn; G Kastberger; PJ Elzen (2002)
Small Hive Beetles Survive in Honeybee Prisons by Behavioural Mimicry
326–328 Naturwissenschaften 89
Abstract
We report the results of a simple experiment to determine whether honeybees feed their small hive beetle nest parasites. Honeybees incarcerate the beetles in cells constructed of plant resins and continually guard them. The longevity of incarcerated beetles greatly exceeds their metabolic reserves. We show that survival of small hive beetles derives from behavioural mimicry by which the beetles induce the bees to feed them trophallactically. Electronic supplementary material to this paper can be obtained by using the Springer LINK server located at htpp://dx.doi.org/10.1007/s00114-002-0326-y.

D James; JR Ellis; Keith S Delaplane; W Michael Hood (2002)
Small Hive Beetle (*Aethina tumida* Murray) Weight, Gross Biometry, and Sex Proportion at Three Locations in the Southeastern United States
520–522 American Bee Journal 142(7)
Abstract
This study was designed to appraise differences in sex proportion and mean body width, length and weight between sexes of small hive beetles (SHB) from Clemson, SC; Wadmalaw Island, SC; and Richmond Hills, GA. Adult female beetles were significantly longer than males within each location. Overall means did not differ for width between sexes. Due to small variation in width between sexes, width may be an important factor when designing exclusion or trapping devices for SHB. Overall, female beetles weighed significantly more than males. There tended to be more females than males at each location.

Alexis L Park; Jeffery S Pettis; Dewey M Caron (2002)

Use of Household Products in the Control of Small Hive Beetle Larvae and Salvage of Treated Combs

439–442 Apicultural Research

Abstract

We tested the effects of several common household products on small hive beetle larval mortality and then observed honey bee acceptance of combs treated with these products. Bleach was most effective and fast-acting, killing 100% of tested larvae within 4 hours of treatment. Detergent was also effective and killed around 85% of treated larvae after 24 hours. Oil, oil and water, and vinegar were less effective. Combs treated with water and vinegar were acceptable to bees after 1 hour, while bleach and detergent-treated combs remained repellent for at least 24 hours. We propose that bleach is a fast acting and safe product suitable for controlling small hive beetle larvae in honey houses and for use in the salvage of combs infested with larvae.

Jeff Pettis (2002)

Airing Out Small Hive Beetle Problems in the Honey House

Published in the "Speedy Bee" Newspaper

Summary

It has become quite clear that honey awaiting extraction can be subject to small hive beetle attack and beetle problems can develop rapidly in the honey house. If honey is held for more than five days, larval development and damage to the honey is likely. During our studies we observed that beetle eggs did not hatch when the relative humidity was below 50%. It is possible to reduce or eliminate beetle damage in stored honey by simply circulating air through the supers. This air movement reduces the relative humidity within stored honey and in turn, leads to egg desiccation (drying out). Movement of air down through stored honey *resulted in complete or nearly complete protection* from small hive beetle damage. The use of circulating air across stored honey prior to extraction provides the beekeeper with an inexpensive and chemical-free method to protect honey from small hive beetle damage. Moving air over stored honey, even with brood and adult beetles present, provided protection from the beetles. One of the commercial beekeepers we worked with was so impressed with our results that he had mounted window fans in his storage area and simply places pallets of honey beneath the fans if he can't extract the honey immediately. He has also modified his pallets to raise the supers two inches off the base of the pallet to facilitate airflow. Beekeepers will invariably find their own way of modifying and adapting these findings to their operations.

James D Ellis Jr; Peter Neumann; Randall Hepburn; Patti J Elzen (2002)

Longevity and Reproductive Success of *Aethina tumida* (Coleoptera: Nitidulidae) Fed Different Natural Diets

902–907 Journal of Economic Entomology 95(5)

Abstract

The longevity and reproductive success of newly emerged, unfed adult *Aethina tumida* Murray assigned different diets (control = unfed; honey-pollen; honey; pollen; empty brood comb; bee brood; fresh Kei apples; and rotten Kei apples) were determined. Longevity in honey-fed small hive beetle adults (average maximum: 167 d) was significantly higher than on other diets. Small hive beetles fed empty brood comb lived significantly longer (average maximum: 49.8 d) than unfed beetles (average maximum: 9.6 d). Small hive beetle offspring were produced on honey-pollen, pollen, bee brood, fresh Kei apples, and rotten Kei apples but not on honey alone, empty brood comb, or in control treatments. The highest reproductive success occurred in pollen fed adults (1773.8 ± 294.4 larvae per three mating pairs of adults). The data also show that *A. tumida* can reproduce on fruits alone, indicating that they are facultative parasites. The pupation success and sex ratio of small hive beetle offspring were also analyzed. Larvae fed pollen, honey-pollen, or brood had significantly higher pupation success rates of 0.64, 0.73, and 0.65 respectively than on the other diets. Sex ratios of emerging adults fed diets of pollen or brood as larvae were significantly skewed toward females. Because small hive beetle longevity and overall reproductive success was highest on foodstuffs located in honey bee colonies, *A. tumida* are efficient at causing large-scale damage to colonies of honey bees resulting in economic injury for the beekeeper. Practical considerations for the control of *A. tumida* are briefly discussed.

JR Baxter; PJ Elzen; Wt Wilson; JD Kellerby (2001)
Gardstar 40% EC (Permethrin) Efficacy Trials as a Ground Drench for the Control of the Small Hive Beetle Around Honey Bee Colonies, 2000
Arthropod Management Tests. Vol 26. http://www.entsox.org/Protected/AMT/AMT26/L3.asp
Small hive beetle: *Aethina tumida* (Murray)
Small hive beetles were reared by placing mated females in 500 ml glass jars with sealed bee brood. The jars contained sufficient soil to allow prepupae (wandering stage) to burrow and pupate. The prepupae and pupae were collected and used in efficacy trials. Loose, moist soil was placed in plastic containers measuring approximately 26 by 36 cm, to a depth of approximately 16 cm. Each treatment group was replicated three times with 20 individual prepupae or pupae per container. Treatments: (A) Prepupae were added to containers in which the soil surface had previously been treated with GardStar applied at the label rate (5 ml/gal). This was to stimulate a ground drench application. (B) Prepupae were added to containers and allowed 24 h to burrow into the soil. The soil surface was then treated with GardStar applied at the label rate (5 ml/gal). (C) Prepupae were added to containers and allowed to burrow into the soil overnight. The soil surface was not treated and served as a check. (D) Pupae were buried 7–8 cm under the soil. The soil surface was then treated with GardStar applied at the label rate (5 ml/gal). (E) Pupae were buried 7–8 cm under the soil. The soil surface was not treated and served as a check. All treatment containers were covered with a fine mesh screen to prevent the escape of emerging adult beetles. The soil surface of all treatments was lightly misted with water weekly to ensure optimum moisture levels for continued beetle development. After 6 wk, beetle mortality, emergency and survival were recorded. The data were subjected to ANOVA and treatment means were compared using LSD ($P = 0.05$).

GardStar provided excellent control of prepupae both before and after they entered the soil with a mortaility rate of 97%. It also proved adequate for control of pupae buried in the soil with a mortality rate of 88%. Untreated prepupae and pupae had a mortality rate of 7 and 25%, respectively.
P Neumann; CWW Pirk; HR Hepburn; AJ Solbrig; FLW Ratneiks; PJ Elzen; JR Baxter (2001)
Social Encapsulation of Beetle Parasites by Cape Honeybee Colonies (*Apis mellifera capensis* Esch.)
214–216 Naturwissenschaften 88
Abstract
Worker honeybees (*Apis mellifera capensis*) encapsulate the small hive beetle (*Aethina rumida*), a nest parasite, in propolis (tree resin collected by the bees). The encapsulation process lasts 1–4 days and the bees have a sophisticated guarding strategy for limiting the escape of beetles during encapsulation. Some encapsulated beetles died (4.9%) and a few escaped (1.6%). Encapsulation has probably evolved because the small hive beetle cannot easily be killed by the bees due to its hard exoskeleton and defensive behaviour.

PJ Elzen; JR Baxter; P Neumann; A Solbrig; C Pirk; HR Hepburn; D Westervelt; C Randall (2001)
Behaviour of African and European Subspecies of *Apis Mellifera* Toward the Small Hive Beetle, *Aethina Tumida*
40–41. Journal of Apicultural Research 40(1)
Abstract
Adult and larval beetles feed on pollen and brood, but mostly cause damage by feeding on honey, rendering it foul and unusable. A common observation of South African beekeepers is that African honey bees defend against adult and larval SHB by continuously harassing adults and removing larvae from the hive. In contrast, beekeepers in the USA with European honey bees rarely see such defence. We quantified the defensive behaviour toward the SHB by *a. m. capensis* and North American European *A. mellifera*. We previously demonstrated that adult SHB will feed on European honey bee eggs in a laboratory setting, even in the presence of excess honey and pollen. Jars were established with five adult beetles, a known number of Cape honey bee eggs in uncapped comb, and excess honey and pollen. Results showed overall, within 24 h the SHB ate 94% of the Cape honey bee eggs. Our results confirm field observations both in the south eastern USA and in South Africa: in the USA, the European honey bee exhibits only slight behavioural defensiveness against the SHB, whereas in South Africa, the Cape honey bee quite vigorously defends its colonies against this beetle. However, given the opportunity, the SHB ate eggs of the Cape honey bee as readily as they ate European honey bee eggs in Florida.

Peter Neumann; Christian WW Pirk; Randall Hepburn; Patti J Elzen; James R Baxter (2001)
Laboratory Rearing of Small Hive Beetles *Aethina Tumida* (Coleoptera, Nitidulidae)
111–112. Journal of Apicultural Research 40(3–4)
Abstract
The bottom of the container was filled with two pieces of comb (approx. 30 x 15 cm) taken from honey bee colonies containing either honey and pollen or brood. The container was kept in a dark storeroom at room temperature (ranging from 17°–24°C) without normal daylight. The adults moved rapidly over the combs and immediately started feeding on the honey, pollen and brood provided. SHB larvae were observed to more on and in all combs from day 4 onwards supporting an egg stage of about two days. As soon as the first larvae showed the 'wandering phase' from day 18 onwards they accumulated in the corner of the box facing the door of the storeroom, thus showing positive phototaxis as previously reported. On day 21 larvae were transferred into a new pupation container with autoclaved soil instead of frames. The larvae rapidly moved into the soil. From day 24 onwards the pupation container was checked on a weekly basis when the soil was moistened with water by filling the holes of the piece of wood. From day 57 onwards, adult beetles emerged. All emerging beetles were removed from the containers and sexed. 42.6% of the introduced wandering larvae emerged as adult beetles. Our results clearly show that SHB can be reared easily in large numbers in the laboratory without sophisticated equipment. Breeding of SHB is also successful on a diet of honey and pollen alone. However, in our study larvae readily accepted bee brood as food. Thus, we recommend including bee brood in the diet whenever possible. The high mortality rate in our study may be due to the fact that many larvae tried to pupate in a relatively small container. We therefore recommend using several containers to reduce larval/pupal density in the soil. The observed female biased sex ratio of offspring SHB supports other observations that beetles would be found in a ratio of two females to one male. The female biased sex ratio may be related to the parasitic life history of *A. tumida*, especially to observations that multiple mating by males is common in SHB and that males tend to infest colonies before females. Our data clearly show the enormous reproductive potential of SHB probably necessary for an obligate parasite.

Patti J Elzen; James R Baxter; David Westervelt; Charlotte Randall; William T Wilson (2000)
A Scientific Note on Observations of the Small Hive Beetle, *Aethina Tumida* Murray (Coleoptera, Nitidulidae), in Florida, USA
593–594. Apidologie 31
Abstract
Flight activity was monitored as described in Elzen et al. [1]: plastic bucket traps baited with 10 g honey, 5 g pollen, and 50 ml live adult honey bees (*Apis mellifera* L.) were hung 2 m above the ground in an infested bee yard. Four holes cut in the sides of the traps were covered with 8 mesh (ca. 4 mm screen openings) hardware cloth to allow adult beetles to enter the traps. The numbers of beetles found in the ten baited traps and five control (unbaited) traps were checked every 4 h from 08.00 until 20.00 h and repeated the following day. Approximate temperature during flight time was 30°C. Observations showed significant flight activity from 16.00–20.00 h on the first check day, well before sundown (complete sundown was after 21.00 in June). Our results indicate that perhaps flying adult beetles respond to other cues in addition to photoperiod. It is interesting to note that on the day when so many beetles were caught between 16.00–20.00 h, there was a slight rain shower immediately preceding this time period. The sex ratio of these captured beetles was significantly skewes toward males. The following morning at 08.00 h, the ratio of males to females was not significantly different from 1:1. Our data indicate that males are earlier fliers than females. Food preference by adult and larval beetles was determined in a laboratory test, giving the larvae and adults a choice between honey, pollen, and bee brood. Even in the presence of honey and pollen, small hive beetle adults and larvae preferred to feed on honey bee pupae.

J Baxter; PJ Elzen; WT Wilson (1999)
Control of the Small Hive Beetle (*Aethina Tumida*)
308 American Bee Journal 139(4)

Abstract

With the recent discovery of the small hive beetle in Florida, and now in the coastal regions of Georgia, South Carolina and North Carolina, it is necessary to develop control measures for use both inside and outside of a colony. This new pest has the potential to be a serious threat to US beekeeping. One problem is controlling the small hive beetle inside a colony is finding a treatment that is effective but causes no damage to bees. A preliminary test was set up to screen 8 different insecticides in a plastic strip matrix (provided by Y-Tex Corp., Cody, WY and Bayer Corp., Shawnee Mission, KS). These strips were cut into 2 cm x 5 cm pieces and placed inside 20-ml scintillation vials. Either 3 adult beetles or 3 pre-puae were placed in each vial. Each treatment was replicated 10 times for a total of 30 adults or larvae exposed to each insecticide. Untreated vials served as controls. Vials were held about 27° C for 24 hrs and then checked for mortality.

Zeta-cypermethrin, bifenthrin and chlorpyrifos have the potential to harm been (Baxter, unpublished data, 1997) and therefore require caution. Ethion, amitraz and ivermectin provided inadequate control. Coumaphos was chosen for the in-hive treatment because it is safe for bees and has been used to control *V. jacobsoni* in Europe. It is now being developed for mite control in the US. Permethrin without PBO was selected as a ground drench. Permethrin can harm bees if it is applied directly on them.

Adult beetles hide under cardboard attached to the bottom board (D. Westervelt, Pers. Comm., 1998). Coumaphos strips attached to 15 cm x 15 cm pieces of cardboard with one side removed to expose the corrugations were stapled to the bottom board. This proved to be highly effective in controlling the beetles with 99.9% mortality after 72 hours. As an added bonus, larvae were also attracted to the cardboard and many of them were killed.

Permethrin (40%) was mixed at the fire ant rate of 5-ml per 4 litres of water and applied using a hand-held pump sprayer. Four litres were adequate to drench the soil in front of approximately 6 hives. This treatment caused high mortality (>90%) in both emerging adults and pre-pupae.

Although these are preliminary results, coumaphos as an in-hive treatment and permethrin as a ground drench show great promise against this newly discovered pest.

Table. Mortality of *A. Tumida* exposed to eight insecticides.

Treatment	Mean Percent Mortality	
	Adults	**Larvae**
Zeta-cypermethrin	100a	100a
Permethrin	100a	100a
Bifenthrin	100a	100a
Chlorpyrifos + PBO	100a	100a
Coumaphos	100a	100a
Ethion	13.3b	26.7c
Ivermectin + PBO	70.0c	20.0bc
Amitraz	13.3b	3.3bd
Control	4.9b	7.0d

Means within a column followed by different letters are significantly different (p<0.05,LSD)

FA Eischen; D Westervelt; C Randall (1999)
Does the Small Hive Beetle Have Alternate Food Sources?
309 American Bee Journal 139(4)
Abstract
Aethina tumida, the small hive beetle, has recently become a serious pest of honey bee colonies in South eastern United States. We have initiated a study of this sap beetle's diet breadth and preferences. Free flying beetles that were naturally infesting two apiaries in South Florida were presented with a range of fruit in 8-litre plastic pails. The St. Lucie apiary consisted of four living colonies, but had a few weeks previous held 90+ colonies, most of which had been killed or greatly weakened by small hive beetles. The soil in the vicinity of these hive sites contained many beetle larvae, pupae and emerging adults. The Volusia County apiary was a staging area for beekeeping operations, and involved hundreds of colonies, many of which were infested. Our hypothesis was that a portion of the adult beetles emerging from the soil in the St. Lucie apiary would find suboptimal feeding conditions. These beetles if offered a choice might select foods other than those found in a bee hive. On the other hand, adult beetles emerging in the Volusia Country apiary would find a great many available honey bee colonies and would choose them over alternate foods.

Weekly observations starting 25 November 1998 showed that adult beetles in the St. Lucie apiary were highly attracted (100+/fruit) to a number of fruit, including cantaloupe and pineapple; moderately attracted (20+/fruit) to grapes, mango, and honeydew melons; and weakly attracted (2+/fruit) to avocado, banana, and starfruit (carambola). Beetles were not attracted to tomatoes. In the Volusia County apiary, beetles were weakly attracted to bananas only. Beetles were positively identified by MC Thomas, USDA, Gainsville, FL.

Feeding trials under captive conditions showed that mating, egg laying, larval development, and adult eclosion occur normally on a diet of cantaloupe. Additional tests are planned. We tentatively draw the following three conclusions: 1) *Aethina tumida* prefer honey bee colonies; 2) when the preferred diet is not readily available, these beetles will choose to eat and oviposit on selected fruit; and 3) beetle reproduction can occur on some of these fruit.

P Elzen; J Baxter; F Eischen; WT Wilson (1999)
Biology of the Small Hive Beetle
310 American Bee Journal 139(4)
Abstract
The small hive beetle, *Aethina tumida* Murray, was first officially reported in North America in November 1996. Since that time it has been officially verified in Georgia and South Carolina. In US areas where it occurs, this beetle has been found to be devastating to honey bee operations, resulting in loss of previously healthy hives.

Adult beetles are attracted to a combination of odors of hive products plus bees. It is also presumed that additional beetles are attracted to an aggregation pheromone released by adult beetles. Lundi (1940, S. Africa Forestry Sci. Bull. 220) has reported on the life cycle of the small hive beetle in South Africa: Once in the hive, eggs are laid in groups; the egg stage lasts 2-3 days. Small white larvae then hatch which feed on hive products for ca. 10-14 days. Thousands of larvae can be seen within the hive, all of apparently similar age. Larvae then enter a wandering stage, during which they cease feeding and migrate to soil outside the hive to pupate. The pupal stage lasts ca. one month, after which adults emerge and fly to hives. Adults can live up to six months. Five complete generations were completed in one year in South Africa.

Lundie reports that beetles primarily attack previously weakened hives; our observations in Florida, however, have shown that beetles attack and overtake previously healthy hives under good management. Lundie also reports that adults and larvae damage hives by feeding on honey and pollen only, but we have experimental data showing adults feeding on eggs and observations showing adults and larvae feeding on bee larvae and pupae, as well as honey and possibly pollen.

Honey seeps from the frames, becoming fermented and fouled, resulting in a definite “rotten orange” smell. Honey is thus rendered unusable.

Because of its status as a new pest in the US, much is not known of its biology in this new geographic location. Key to such knowledge is why the small hive beetle is so devastating in the US, whereas it is considered a minor pest in South Africa. Such a difference implies that there are natural controls in South Africa which are not present in the US. Additionally, all infestations in the US have been of European bees, which do not show hygienic behaviour toward beetle infestations; perhaps African honey bees are more defensive against beetle infestations.

Much is left to learn about this new species attacking honey bees in the US. There is currently a combined effort of USDA laboratories, universities, and state agencies involved in studying the biology and potential control of the small hive beetle in the US.

J Pettis; H Shimanuki (1999)
Distribution of The Small Hive Beetle (*Aethina tumida*) in Soil Surrounding Honey Bee Colonies
314 American Bee Journal 139(4)
Abstract
The small hive beetle, *Aethina tumida* Murray, was recently identified in the United States and was previously known only from sub-saharan Africa. The distribution and severity of this pest in bee hives in North America is largely unknown at this time. To begin to understand the biology of the beetle we examined the distribution of beetle life stages in the soil and determined the longevity of beetles held without food. Larvae, pupae and newly eclosed adult beetles were found from 1-20 cm deep in sandy soil in south central Florida, nearly 80 percent in the first 10 cm of soil. Eighty three percent of all beetle life stages were collected within 30 cm of the entrance of hives, 17% at 90 cm and no beetles were found at 180 cm. Some adult beetles survived for five days without food or water and thus can survive long enough without food to be easily transported to new areas. Our data on beetle distributions in the soil indicate that, in sandy soil, larvae do not crawl far from the hive to pupate. However, the distance and depth of beetles reported here will surely change with changing soil type. These observations provide a start for future studies on the biology and control measures for the small hive beetle in North America.

JR Baxter; PJ Elzen; D Westervelt; D Causey; C Randall; FA Eischen; WT Wilson (1999)
Control of the Small Hive Beetle, *Aethina tumida* in Package Bees
792–793 American Bee Journal 139(10)
Abstract
Since its confirmed discovery in Florida in June 1998, the small hive beetle (*Aethina tumida* Murray) has spread to honey bee colonies (*Apis mellifera*) throughout the eastern US and has been reported from several midwestern states. While it is most likely that the nature of beekeeping to migrate around the US is mainly responsible for this spread, questions have arisen in the bee industry as to the control of the small hive beetle in the shipment of package bees from infested areas. In order to answer these questions, we undertook two large studies in the southeastern US designed to test beetle control strategies in packages.

From both of these trials we concluded that adults of the small hive beetle prefer to leave packages once they are shaken into them. We did nothing to prevent escape of beetles from the packages because we wanted to test the treatments using the same mesh hardware cloth that is used in commercially constructed packages. It appeared that the smaller adult beetles are able to escape through the wire screen of the packages, but that the larger beetles remain inside. In the final analysis, however, we feel that the best method to ensure beetle-free packages is to control the beetles in the hives from which bees are shaken.

JS Pettis; H Shimanuki (1999)
Observations on the Small Hive Beetle, *Aethina tumida* Murray, in the United States
152–155 American Bee Journal
Abstract
The small hive beetle, *Aethina tumida* Murray, was recently identified in the United States and was previously known only from sub-Saharan Africa where it is considered a minor pest. The distribution and severity of this pest in bee hives in North America is unknown. To begin to understand the biology of the prevalence of different lifestages during winter and the longevity of adult beetles held without food and water. Beetle larvae, pupae and newly enclosed adults were found from 1 – 20 cm deep in sandy soil in south central Florida with nearly 80% in the first 10cm of soil surface. Eighty-three percent of all beetle life stages were collected within 30cm of the hive entrance, 17% at 90cm and no beetles were found at 180cm. In contrast, in Florida larvae, pupae and adults were found in February. The adult beetle is proposed as the overwintering stage. Some adult beetles survived for five days without food or water and thus can survive long enough to be easily transported to new areas. These observations provide a starting point for future studies on the biology and control of small hive beetles in North America.

Patti J Elzen; James R Baxter; David Westervelt; Charlotte Randall; Keith S Delaplane; Laurence Cutts; William T Wilson (1999)
Field Control and Biology Studies of a New Pest Species, *Aethina tumida* Murray (Coleoptera, Nitidulidae), Attacking European Honey Bees in the Western Hemisphere
361–366 Apidologie 30
Abstract
The small hive beetle, *Aethina tumida* Murray, is a nitidulid species newly recorded attacking honey bees in the Western Hemisphere. We initiated field and laboratory tests on the control and biology of this new pest. Very high mortality of adult and larval *A.tumida* in Florida and Georgia hives resulted from field tests using 10% coumaphos in plastic strips in trapping devices on the hive bottom: as high as 90.2% beetle mortality occurred in hives in Florida. Adult beetles were found in the laboratory to feed on honey bee eggs, completely consuming all eggs, even in the presence of honey and pollen. Odors from hive products plus adult bees were found to be significantly attractive to flying adult beetles, as evidenced in baited trap studies. Hive products alone or bees alone were not attractive to adult *A.tumida*.

PAPERS TO BE PUBLISHED

JS Pettis (not submitted as at 18/3/03)
Effects of Temperature, Moisture and Soil Type on the Survival of the Small Hive Beetle, *Aethina Tumida* Murray
For: Journal of Economic Entomology
Abstract
The small hive beetle, *Aethina tumida* Murray, was recently identified in the United States and was previously known only from sub-saharan Africa where it is considered a minor pest. The distribution and severity of this pest in bee hives in North America is unknown. To understand the biology of the beetle potential limiting factors to its spread and survival we examined temperature, soil moisture and soil type for their effects on the ability of larval beetles to pupate and emerge as adults. Beetles complete their life cycle by leaving the hive in the larval stage, burrowing into the ground to pupate and emerge as adults. Larval survival was decreased at lower temperatures with survival rates of 96%, 46% and 0% for larvae held at 30, 20 and 10 C respectively.

SOIL MOISTURE AND SOIL TYPE DATA TO BE ADDED

As of February 2001 the small hive beetle had been reported in Florida, Georgia, North and South Carolina, New Jersey, Pennsylvania, Ohio, Wisconsin, Minnesota, Iowa, Massachusetts, Maine, Louisiana, North Dakota, Indiana, Michigan, New York.

Jeff Pettis (not submitted as at 18/3/03)
The Effect of Diet on Oviposition and Longevity of the Small Hive Beetle (*A. tumida*)

JS Pettis (Draft not submitted as at 18/3/03)
Survival of the Small Hive Beetles, *Aethina tumida* Murray, on Queen Cages Under Laboratory Conditions
For: American Bee Journal, apicultural Research Section
Abstract not available

James D Ellis Jr; Alexandra J Holland; Randall Hepburn; Peter Neumann; Patti J Elzen
Cape (*Apis mellifera capensis*) and European (*Apis mellifera*) Honey Bee Guard Age and Duration of Small Hive Beetle (*Aethina tumida* Murray, Coleoptera: Nitidulidae) Prison Guarding
Journal of Apicultural Research (In Press)
Summary
The guard age and duration of European (*Apis mellifera*) and Cape (*A.m. capensis*) honey bees guarding small hive beetle (*Aethina tumida* Murray) prisons was determined using 3-frame observation hives, noting the commencement and termination of prison guarding by individually labeled honey bees. European honey bees in the United States began guarding small hive beetle prisons significantly earlier [beginning age (days) 18.55 ± 0.52; mean ± standard error], guarded prisons significantly longer [duration (days) 2.36 ± 0.31], and stopped guarding prisons significantly sooner [ending age (days) 19.91 ± 0.57] than Cape honey bees in South Africa [beginning age (days) 20.61 ± 0.38; duration (days) 1.43 ± 0.12; and ending age (days 21.04 ± 0.37]. Even though the timing of prison guarding behaviour between the two subspecies is significantly different, why small hive beetles infest and destroy European honey bee colonies and not Cape honey bee colonies remains elusive.

James D Ellis, Jr; Randall Hepburn; Keith S Delaplane; Patti J Elzen
A Scientific Note on Small Hive Beetle (*Aethina tumida* Murray) Oviposition and Behaviour During European (*Apis mellifera*) Honey Bee Winter Clusters and Absconding Events
Journal of Apicultural Research (In Press)
Abstract
Experiments were conducted in Georgia, USA during August-September 2002. Six nucleus colonies (nucs) were created. One hundred small hive beetle adults were introduced into each of the nucleus colonies every day at dusk for 14 consecutive days. Two colonies absconded on day 8. During absconding, 5-10 small hive beetles were seen leaving the colony with the bees. Upon examining the 4 non-absconding nucs, most of the beetles were found inside the bee cluster. Data were also collected on beetle oviposition. There were no pollen reserves in any of the non-absconding nucs. We observed many puncture marks in the brood cell cappings. When the cappings to these cells were pulled back or removed, we observed small hive beetle eggs. The fact that bees aborted much of their brood suggests that bees can detect the presence of beetle eggs in brood cells and remove the infested brood. This implies at least partial hygienic behaviour on part of the bees and raises the prospect of honey bee genetics as another tool in our arsenal against small hive beetles. Our data suggest that in their native range small hive beetles do oviposit in brood combs but only in the absence of adult honey bees, which contrasts with the results we found for European honey bees in the United States.

In summary, our observations suggest a number of avenues for new research. Small hive beetles may be able to move to new locations with swarming or absconding bees, thus facilitating the spread of small hive beetles. Secondly, treating for beetles during winter may be advantageous because adult beetles are relatively sedentary, consolidated in the wintering bee cluster, and therefore exposed to in-hive pesticide applications such as the CheckMite™ strip (coumaphos), where beetles will move throughout the cluster and contact the strip. Finally, the apparent hygienic tendency displayed by European bees in this study implicates bee breeding as another tool in the control of small hive beetles. Studies will be taking place to investigate these possibilities.

James D Ellis, Jr; Keith S Delaplane; Randall Hepburn; Patti J Elzen

Efficacy of Modified Hive Entrances and a Bottom Screen Device for Controlling *Aethina tumida* (Coleoptera: Nitidulidae) Infestations in *Apis mellifera* Colonies

Journal of Economic Entomology Apiculture and Social Insects (In Press)

Abstract

The present study was designed to test if poly vinyl chloride (PVC) pipe entrances would render efficacious *Aethina tumida* Murray control in *Apis mellifera* colonies and if screen-mesh bottom boards would alleviate side effects associated with restricting colony entrances. Twenty four colonies in both of 2 locations received 1 of 6 different treatments (conventional solid bottom board and open entrance; ventilated bottom board with 3 mm wide mesh plastic screen and open entrance; conventional bottom and 1.9 cm ID pipe entrance; conventional bottom and 3.8 cm pipe entrance; screen bottom and 1.9 pipe entrance; screen bottom and 3.8 cm pipe entrance). Colonies with 3.8 cm pipe entrances had significantly lower *A. tumida* populations than control colonies in apiary 1 and colonies with 1.9 cm pipe entrances in apiary 2. Pipe entrances significantly lowered colony production and brood production in both apiaries, but these net losses were partially mitigated with the addition of screened bottom boards. Adult *A. mellifera* were heavier in colonies with screened bottom boards than in colonies with conventional ones. Pipe entrances had no measurable liability concerning colony thermoregulation. The percentage of *A. tumida* female was not affected by entrance or bottom board type. Frames of adult *A. mellifera* were affected by screen and entrance, with more *A. mellifera* in colonies with screens and progressively and significantly fewer *A. mellifera* in colonies with 3.8 cm or 1.9 cm pipe entrances compared to open entrances. There were significantly more frames of pollen in colonies with open or 3.8 cm pipe entrances than 1.9 cm entrances, but this cost was offset in 3.8 cm pipe colonies by using a screened bottom board. We conclude that reduced hive entrances (with 3.8 cm pipe) can play a role in the integrated control of *A. tumida* if used in conjunction with screened bottom boards.

JD Ellis, Jr; HR Hepburn; AM Ellis; PJ Elzen

Prison Contruction and Guarding Behaviour by European Honeybees is Dependent on Inmate Beetle Density

Naturwissenschaften (Submitted)

Abstract

Increasing small hive beetle (*Aethina tumida* Murray) densities dynamically change prison construction and guarding behaviour in European honeybees (*Apis mellifera* L.). These changes include more guard bees per imprisoned beetle and the construction of more beetle prisons at higher beetle densities. Despite this, the number of beetles per prison (inmate density) did not change. Further, beetles solicited food more actively at higher densities and at night. In response, guard bees increased aggressive behaviour towards beetle prisoners but did not feed beetles more at higher densities. Only 5% of all beetles were found among the combs at low densities but this increased 5-fold at the higher one, indicating a breakdown of prison guarding by European bees at higher beetle densities.

James D Ellis, Jr; Randall Hepburn; Keith S Delaplane; Peter Neumann; Patti J Elzen

The Effects of Adult Small Hive Beetles, *Aethina tumida* (Coleoptera: Nitidulidae), on Nests and Foraging Activity of Cape and European Honey Bees (*Apis mellifera*)

Apidologie (Submitted)

Abstract

This study identifies differences in the effects of small hive beetles on foraging activity and nests of European-derived honey bees (*Apis mellifera*) in the United States and Cape honey bees (*apis mellifera capensis*) in South Africa. Treatments consisted of beetle-free colonies (controls) and experimental colonies receiving beetles (treatment). Absconding day did not differ significantly between treatment or bee race but absconding was greater between the two treatments in European colonies than in Cape ones. Cape bees used significantly more propolis than European bees. Honey stores were significantly greater in Cape honey bee colonies than in European ones. Bee weight did not differ significantly between treatments or bee race. Treatment did not significantly affect bee populations, brood area, or average foraging behaviour in Cape colonies but it did significantly lower all of these in European colonies. The effects of treatment in European colonies are symptomatic of absconding preparation. Treatment significantly lowered the amount of pollen stores in Cape colonies, but this effect not found in European colonies. The number of beetles in control colonies was significantly higher in European colonies than Cape ones while the percentage of beetles remaining in non-absconding treated colonies was higher in Cape colonies than European ones. These data indicate that adult small hive beetles are sufficient to cause significant harmful effects on colonies of European, but not Cape, honey bees.

James D Ellis, Jr; Randall Hepburn; Amanda M Ellis; Patti J Elzen

Social Encapsulation of Small Hive Beetles (*Aethina tumida* Murray) by European Honeybees (*Apis mellifera* L.)

Animal Behaviour (Submitted)

Abstract

European and African honeybees (*Apis mellifera* L.) utilize social encapsulation to control *Aethina tumida* Murray (small hive beetle), a honeybee colony scavenger of growing international importance. Although social encapsulation of *A. tumida* by African honeybees is well documented, social encapsulation by European honeybees is less understood. In this study, we quantify *A. tumida* and European honeybee behaviours that are associated with social encapsulation of *A. tumida*, describe colony and time (day and night) differences in these behaviours, and detail intra-colonial, encapsulated *A. tumida* distributions. The number of *A. tumida* prisons and *A. tumida* per prison differed significantly between colonies. The number of guard bees per encapsulated *A. tumida* and per prison increased at night. The proportion of encapsulated *A. tumida* making antennal contact with guard bees and mating did not differ between colony or time. *Aethina tumida* activity and feeding from guard bees increased significantly at night (although the proportion of guard bees feeding *A. tumida* did not increase). Colonies differed in the proportion of guard bees biting at encapsulated *A. tumida*. There were no colony or time differences for the proportion of guard bees making antennal contact with encapsulated *A. tumida*. Lower proportions of guard bees were biting the area around *A. tumida* prisons at night. Only 7% of *A. tumida* were found among the combs during both times; all other encapsulated *A. tumida* were distributed around the nest periphery. These findings highlight complex interactions between encapsulated *A. tumida* and guard bees, allowing comparisons to be made between European and African honeybee social encapsulation systems.

James D Ellis, Jr; Randall Hepburn; Keith Delaplane; Peter Neumann; Patti J Elzen

The Effects of Adult *Aethina tumida* (Coleoptera: Nitidulidae) on Nests and Foraging Activity of European-derived Subspecies of *Apis mellifera* and Cape Honey Bee (*A.m. capensis*) Colonies

Apidologie (Submitted)

Abstract

This study identifies differences in small hive beetle effects on foraging activity and nests of European-derived honey bees (*Apis mellifera*) in the United States and Cape honey bees (*Apis mellifera capensis*) in South Africa. Treatments consisted of colonies not receiving beetles (controls) and colonies receiving beetles. Absconding day did not differ statistically between treatment or location although a greater difference was found in absconding frequencies between the two treatments in the United States than in South Africa. Cape bees used significantly more propolis than European bees. Honey stores were greater in South Africa than in the United States. Bee weight did not differ significantly between treatments or locations. The presence of beetles in Cape bee colonies did not significantly affect ending adult bee populations, brood area, morning foraging behaviour, or average foraging behaviour although beetle presence significantly lowered all of these variables in European colonies. The beetle effects in European colonies are noted symptoms of absconding preparation. The presence of adult beetles in Cape honey bee colonies resulted in the significant loss of pollen stores, an effect not found in European colonies. The number of beetles in control colonies and the percentage of beetles remaining in non-absconding beetle colonies was higher in the United States than in South Africa, with the latter suggesting the existence of a carrying capacity for small hive beetles in European honey bee colonies.

6. Appendices

2003 Joint North Carolina – South Carolina Beekeepers Association

Spring Convention

Rockingham, NC **March 14-15, 2003**

Hosted by: NC State Beekeepers Association
Local Host: Richmond County Beekeepers

FRIDAY, MARCH 14, 2003

12 noon – 6.00 pm Meeting Registration: Cole Auditorium, Richmond County Community College

1.30 pm – 5.00 pm Introductory- and Intermediate-Level Beekeeping Short Course

1.30 pm *Welcome & Introduction to the Short Course*, Sally Ellis, NC Master Beekeeper
1.40 pm *Pesticides in the Hive: What You Need to Know*, Taylor Williams, NCSU-NCCES
2.25 pm *Bee Diseases, Pests & Control*, Will Hicks & Glenn Hackney, NCDA&CS
3.00 pm Break, hosted by Mann Lake Beekeeping Equipment Suppliers
3.25 pm *Species and Races of the Honey Bee*, Sally Ellis, North Carolina Master Beekeeper
3.50 pm *Wax Moth Biology and Control*, Dr Wyatt Mangum, Mary Washington College
4.25 pm *Honey Plants of North Carolina*, Bill Sheppard, NCDA&CS

Evening Session

6.30 pm Banquet: All you can eat
7.05 pm Welcome and Door Prizes – Don Moore, NCSBA President
7.20 pm NC Master Beekeeper Awards Ceremony – Dr Mike Stanghellini, NCSU
7.30 pm Entertainment: Drowning Creek Bluegrass Band

SATURDAY, MARCH 15, 2003
Morning Session (Cole Auditorium)

8.00 am Registration for Late Arrivals

8.05 am *Door Prizes and Welcome* – Kenneth Robinette, Chairperson, Richmond County Board of Commissioners, and Don Moore, NCSBA President

8.20 am *The Giant Bees of India and Other Exotic Beekeeping Adventures* – Dr Wyatt Mangum

9.00 am *Reports from Around the State* – Don Hopkins and the NCDA&CS Bee Inspectors

9.40 am BREAK

10.00 am *What's New with the Small Hive Beetle* – Dr Jeff Pettis, USDA Beltsville Lab

10.40 am *Varroa Mite Integrated Pest Management* – Dr Mike Hood, Clemson University

11.30 am LUNCH (on your own)

1.00 pm *Coumaphos and Queen Cups* – Dr Jeff Pettis, USDA Beltsville Lab

SATURDAY, MARCH 15, 2003

Afternoon Session

1.40 – 2.40 pm

ROOM	SUBJECT	LEADER
Burlington	Rolled Candle Making	Richmond County Beekeepers
Rockingham	Understanding Queen Introduction	DFr Wyatt Mangum
Hamlet	Small Hive Beetle Control Alternatives	Dr Mike Hood
Dressing Room A	NC Master Beekeeper Program Exams*	NC Master Beekeepers

2.50 – 3.30 pm

ROOM	SUBJECT	LEADER
Burlington	Making Candles Using Molds	Charles and Nancy Fleckenstein
Rockingham County	Pollination Contracts, Pesticides, and Your Farmer: Protecting Your Hives	Taylor Williams, Richmond Extension Agent
Hamlet	Varroa Mites, Bee Pests and predators	NCDA&CSD Inspectors
Dressing Room B	Tracheal Mites and Bee Diseases	NCDA&CS Inspectors
Dressing Room A	NC Master Beekeeper program Exams*	NC Master Craftsman Beekeepers

4.00 – 5.00 pm

ROOM	SUBJECT	LEADER
Burlington	Making Candles Using Molds	Charles and Nancy Fleckenstein
Rockingham	Assembling Bee Equipment	Richmond County Beekeepers
Dressing Room B	Tracheal Mites and Bee Diseases	NCDA&CS Bee Inspectors
Dressing Room A	NC Master Beekeeper Program Exams*	NC Master Beekeepers

*Certified Practical Exam will be held outside. Please bring your own veil and smoler.

5.00 pm ADJORN UNTIL 2003 SUMMER CONVENTION

RICHMOND COUNTY BOARD OF COMMISSIONERS

125 SOUTH HANCOCK STREET • P. O. BOX 504
ROCKINGHAM, NORTH CAROLINA 28380
TELEPHONE: (910) 997-8211
FAX: (910) 997-8208

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RESOLUTION

WHEREAS, honey bees are indispensable to our food supply as pollinators of melons, fruits, vegetables, and hay crops; and

WHEREAS, the value of crops pollinated by honey bees in North Carolina exceeds $97 million annually; and

WHEREAS, the value-added to U.S. crops by honey bee pollination totals $14.6 billion annually; and

WHEREAS, there are some 10,000 beekeepers in North Carolina who tend 110,000 colonies; and

WHEREAS, the North Carolina State Beekeepers Association, having been in existence since 1917, is the largest active association of its kind in the United States with more than 1200 members; and

WHEREAS, North Carolina sales of honey, beeswax, and other hive products exceed $10 million annually; and

WHEREAS, the 2003 North Carolina-South Carolina Beekeepers Association Spring Convention will be a two-day event on March 14 and 15, 2003 held at the Cole Auditorium in Richmond County.

NOW, THEREFORE, BE IT RESOLVED, that the Richmond County Board of Commissioners is proud to have this opportunity to join with the 20 active members of the Richmond County Beekeepers Association in welcoming the 300 anticipated attendees of the North Carolina-South Carolina Beekeepers Convention to Richmond County.

NOW, THEREFORE, BE IT FURTHER RESOLVED, that the Richmond County Board of Commisissioners hereby expresses its support of this valuable craft and promotes cooperation among beekeeping advocates by designating Saturday, March 15, 2003 as **"NORTH CAROLINA-SOUTH CAROLINA BEEKEEPERS DAY IN RICHMOND COUNTY."**

Adopted this 10th day of March, 2003.

SEAL RICHMOND COUNTY NORTH CAROLINA

Kenneth R. Robinette, Chairman
Richmond County Board of Commissioners

ATTEST:

Marian S. Savage, CMC
Clerk to the Board

2003 Spring Prices

HARDEMAN APIARIES

906 SOUTH RAILROAD EXT.
P.O. BOX 214
MT. VERNON, GA. 30445
912-583-2710 PHONE
912-583-4920 FAX

ITALIAN QUEENS AND PACKAGES

QUEENS		PKGS.	1-9	10-24	25-99	100-UP
1-9	11.50	1/2 lb.	33.00	31.00	29.00	27.00
10-24	10.00	32 lb.	38.00	36.00	34.00	32.00
25-UP	9.75	3 lb.	43.00	41.00	39.00	37.00
		4 lb.	50.00	48.00	46.00	44.00
		NUCS	58.00	57.00	56.00	55.00

RUSSIAN HYBRID QUEENS AND PACKAGES

QUEENS		PKGS.	1-9	10-24	25-99	100-UP
1-9	14.00	1/2 lb.	34.00	32.00	30.00	28.00
10-24	12.25	2 lb.	41.00	39.00	37.00	35.00
25-UP	12.00	3 lb.	46.00	44.00	42.00	40.00
		4 lb.	53.00	51.00	49.00	47.00
		NUCS	61.00	60.00	59.00	58.00

CLIP	1.00
MARK	1.00

Pick-ups are welcome, call for truck load prices.
Yearly inspected by the Department of Agriculture.
Package prices do not include postage.
All shipments must be paid before shipping date.
We accept Visa, American Express, and Master Card.

AMOUNT ____________________________ DESCRIPTION________________
____
____

PRICE @ ____________________________ TOTAL ______________________
____
____

NAME ___________________________
___________________________ DESIRED SHIPPING DATE

ADDRESS ___________________________ __________________________
____

PHONE ___________________________

2002 ITALIAN QUEEN PRICES				
QUANTITY	1 – 8	9 – 25	26 – 99	100 +
PRICE EA.	$12.00	$11.00	$10.00	$8.75
After June 1, 2002				
PRICE EA.	$10.00	$9.00	$8.00	$6.00
Add For: Marking Queen—$1.25 Clipping Queen—$1.25				

2002 PACKAGE BEE PRICES			
QUANTITY	**2LB W/QN**	**3LB W/QN**	**4LB W/QN**
1 – 8	$38.00	$44.00	$51.00
9 – 25	$35.00	$41.00	$48.00
26 – 99	$33.00	$39.00	$46.00
100 +	$31.00	$37.00	$44.00

Add For: Marking Queen—$1.25 Clipping Queen—$1.25
1 lb. Package For Observation Hive $25.00 plus shipping
Queenless Packages deduct $6.00 from regular price

Dutch Gold Honey Packer – visitors' safety procedures

Dutch Gold Facility

At Dutch Gold Honey every person's safety is vitally important. In that regard, we ask that all who enter our doors follow these general safety rules:

1. *Sign in and out of the visitor log.*
2. *Yield the right of way to all powered industrial vehicles (fork lifts, power cords, etc.).*
3. *Maintain a safe distance from all moving equipment.*
4. *Stop, look, and listen at all intersections.*
5. *Never walk on any conveyor line.*
6. *Stay alert of slip and trip hazards such as the many skids in building.*
7. *Stay clear of all restricted areas.*
8. *Stay near to your host or guide at all times in the plant.*
9. *In the event of a plant emergency, your host or guide will lead you to the evacuation point you are closest to. If you become separated, view the map on the reverse of this form and exit thru the nearest exit ("E" squares on the map).*
10. *Always wear appropriate Personal Protective Equipment.*

Emergency Equipment Locations:

Any fire extinguisher symbol designates a fire extinguisher.

First aid kits are located in the lab or supply closet.

Plant Emergency Procedures

Our employees have been trained to react to several different types of emergencies. In each case, our Safety Committee will inform employees, vendors, and visitors of the situation. In the event of a fire, plant evacuation, or chemical spill evacuation, please go to the nearest exit and leave the building. Once clear of the building, proceed to the main parking lot. In a weather emergency, please allow your host to guide you to an internal Safe Room until an all clear has been issued.

In the event of a power outage, please remain in your current position. Even with emergency lighting, the plant will be extremely dark and has many trip hazards. Please remain in one area until a team member with a flashlight locates you and escorts you to a secure location.

CheckMite+®

BEE HIVE PEST CONTROL STRIP

For use only as authorized in NORTH CAROLINA by the U.S. Environmental Protection Agency (EPA) under section 18 of F.I.F.R.A. This labelling must be in the possession of the user at the time of application. **This labelling expires February 1, 2004.**

STATE RESTRICTED USE PRODUCT

FOR USE ONLY BY LICENSED OR CERTIFIED APPLICATORS IN NORTH CAROLINA. LICENSES AND/OR CERTIFICATIONS CAN BE OBTAINED THROUGH NORTH CAROLINA DEPARTMENT OF AGRICULTURE AND CONSUMER SERVICES.

	Percent By Weight
Active Ingredient:	
0,0-Diethyl 0-(3-chloro-4-methyl-2-oxo-2H-1-benzopyran-7-yl) phosphorothioate (coumaphos) ……………………………………………….	10%
Inert Ingredients: …………………………………………………………………	90%
Total …………………………………………………………………………..	100%

KEEP OUT OF REACH OF CHILDREN

WARNING

SEE LABELLING FOR STATEMENTS OF PRACTICAL TREATMENT
AND OTHER PRECAUTIONARY STATEMENTS

NET CONTENT: (10 Strips)

Bayer Corporation
Agriculture Division
Animal Health
PO Box 390
Shawnee Mission, Kansas 66201 U.S.A.

EPA Est. No. 4691-KS-1

CheckMite+®

BEE HIVE PEST CONTROL STRIP

PRECAUTIONARY STATEMENTS
HAZARDS TO HUMANS AND DOMESTIC ANIMALS

WARNING

Do not chew or swallow. Causes moderate eye irritation. Avoid contact with skin, clothing or eyes. Wash thoroughly with soap and warm water after handling. Wash contaminated clothing with soap and hot water before use.

STATEMENTS OF PRACTICAL TREATMENT

If chewed or swallowed: Call a physician or Poison Control Centre immediately. If possible, vomiting should be induced under medical supervision. Drink one or two glasses of water and induce vomiting by touching the back of throat with finger. Do not induce vomiting or give anything by mouth to an unconscious person.

If on skin: Remove contaminated clothing and wash affected areas with soap and water. Get medical attention if irritation appears.

If in eyes: Flush eyes with plenty of water. Call a physician immediately.

To Physician: Atropine sulfate by injection is antidotal. Repeat as necessary to the point of tolerance. 2-PAM is also antidotal and may be administered in conjunction with atropine.

ENVIRONMENTAL HAZARDS

This pesticide is toxic to birds, fish and aquatic invertebrates. Do not apply directly to any body of water. Do not contaminate water when disposing of used strips.

Directions for Use

It is a violation of Federal law to use this product in a manner inconsistent with its label.

Treatments must be applied at a time when bees are not producing a surplus honey crop. Chemical resistant gloves (such as waterproof material) must be worn when handling the strips. Just before application, remove the required number of CheckMite+ Strips from the pouch. Unused strips should remain in original package.

Do not treat more than twice a year for varroa mites nor more that four times a year for the small hive beetle.

For Varroa Treatment – To control varroa mite, remove honey supers before application of CheckMite+ Strips **and do not replace until 14 days after the strips are removed.** Use one strip for each five combs of bees in each brood chamber (Langstroth deep frames or equivalent in other sizes). Hang the strips in separate spaces between the combs as near the center of the bee/brood cluster as possible. If two deep brood chambers are used for the brood nest, hang the CheckMite+ Strips in both the top and bottom brood chambers. Treat all infested colonies within the yard. The treatment is most effective when brood rearing is lowest. Effective control may be achieved by treating hives in the spring before the first honey flow and in the fall after the last honey flow. For maximum efficacy leave the strips in the hive for at least 42 days (six weeks).
Do not leave the strips in hive for more than 45 days. Do not treat more than twice a year for varroa mites. Honey supers may be replaced 14 days after the strips are removed.

For Small Hive Beetle Treatment: To control the small hive beetle, remove honey supers before the application of CheckMite+ Strips and **do not replace until 14 days after the strips are removed.** Prepare a piece of corrugated cardboard approximately 4x4 inches by removing one side. Remove one CheckMite+ Strip. Cut strip in half crossways and staple the two pieces to the corrugated side of the cardboard. Tape over the smooth side of the cardboard (the side opposite the strips) with duct tape, shipping tape or similare tape to prevent the bees from chewing and removing the cardboard. Or use one sided plastic corrugated sheets. Place cardboard as near the center of the bottom board as possible with the strips down. Make sure the bottom board is clean and the strips lay flat on the bottom board. For maximum efficacy leave the strips in the hive for at least 42 days (six weeks). **Do not leave the strips in hive for more than 45 days. Do not treat more than four times per year for the small hive beetle. Honey supers may be replaced 14 days after the strips are removed.**

Storage & Disposal: Do not contaminate water, food or feed by storage or disposal. Keep the strips in original, unopened package until ready to use. Do not store in direct sunlight. Do not store unused strips in anything but original package. Do not store unused strips near pesticides or other chemical substances that could contaminate the strips and result in bee toxicity. Do not reuse the strips. Securely wrap the strips and/or container packaging in several layers of newspapers and dispose in a sanitary land fill.

LIMITED WARRANTY AND LIMITATION OF DAMAGES

Bayer Corporation, Agriculture Division, Animal Health warrants that this material conforms to the chemical description on the label. BAYER CORPORATION MAKES NO OTHER EXPRESS OR IMPLIED WARRANTY, INCLUDING ANY OTHER EXPRESS OR IMPLIED WARRANTY OF FITNESS OR MERCHANTABILITY, and no agent of Bayer Corporation is authorized to do so except in writing with a specific reference to this warranty. Any damages arising from a breach of this warranty shall be limited to direct damages and shall not include consequential commercial damages such as loss of profits or values, etc.