Australian Government
Rural Industries Research and Development Corporation

Honeybee Research Report 2005

Research completed and in progress for the Honeybee R & D Program

May 2005

RIRDC Publication No 05/053

© 2005 Rural Industries Research and Development Corporation.
All rights reserved.

ISBN 1 74151 151 8
ISSN 1440-6845

Honeybee Research Report 2005
Publication no. 05/053

The information contained in this publication is intended for general use to assist public knowledge and discussion and to help improve the development of sustainable industries. The information should not be relied upon for the purpose of a particular matter. Specialist and/or appropriate legal advice should be obtained before any action or decision is taken on the basis of any material in this document. The Commonwealth of Australia, Rural Industries Research and Development Corporation, the authors or contributors do not assume liability of any kind whatsoever resulting from any person's use or reliance upon the content of this document.

This publication is copyright. However, RIRDC encourages wide dissemination of its research, providing the Corporation is clearly acknowledged. For any other enquiries concerning reproduction, contact the Publications Manager on phone 02 6272 3186.

RIRDC contact details:

Rural Industries Research and Development Corporation
Level 1, AMA House
42 Macquarie Street
BARTON ACT 2600
PO Box 4776
KINGSTON ACT 2604

Phone: 02 6272 4819
Fax: 02 6272 5877
E-mail: rirdc@rirdc.gov.au
Website: http://www.rirdc.gov.au

Published in May 2005
Printed on environmentally friendly paper by Canprint

Foreword

On 1 July 1995, the former Honeybee Research and Development Council became a committee of the Rural Industries Research and Development Corporation.

This publication, Honeybee Research Report 2005, provides details of honeybee research from July 2004 until June 2005 and lists projects commencing in the 2005/2006 financial year. It follows the Honeybee Research and Development Council Research Report 1980-1995 and the RIRDC Reports 1995-1997, 1998-2004, which were a collection of final report and progress summaries of levy funded honeybee research until June 2004. All of these research summaries plus many of the full research reports have been included on the soon-to-be-released version 3 of the Honeybee R&D CD.

This report provides information to help apiarists and others access research recommendations and research in progress, together with researcher contact details, in a simple, easy to read format.

This report, a new addition to RIRDC's diverse range of over 1200 research publications, forms part of our Honeybee R&D program, which aims to improve the productivity and profitability of the Australian beekeeping industry

Most of our publications are available for viewing, downloading or purchasing online through our website:

- downloads at www.rirdc.gov.au/fullreports/Index.htm
- purchases at www.rirdc.gov.au/eshop

Alternatively, there is a RIRDC order form included on the last page of this publication.

Peter O'Brien
Managing Director
Rural Industries Research and Development Corporation

Contents

OFF-FARM ISSUES

Continuing projects

PRODUCTION - Bee Husbandry & Management

Project Title	Drone honey bees- semen production
RIRDC Project No.:	DAN-205A
Start Date:	07/01/2002
Finish Date:	31/07/2007
Researcher:	Mr John Rhodes
Organisation:	NSW Agriculture RMB 944 TAMWORTH NSW 2340
Phone:	(02) 6763 1206
Fax:	(02) 6763 1222
Email:	john.rhodes@dpi.nsw.gov.au
Objectives	• To provide data on the effects of drone age, season (time of year), and differences between unrelated drone breeding lines on the production and quality of drone semen. • To determine if semen quantity and sperm numbers produced are selectable traits.
Current Progress	Data were collected over the 2003-4 season. Breeding line effects – significant differences between the 4 lines examined were shown for all characteristics measured, semen volume/drone, sperm number/drone, sperm viability/drone and sperm motility/drone. The greatest differences between lines were for semen volume and sperm numbers. These results suggest that genetic inheritance may be involved in semen volume and sperm production. A High Line and a Low Line for semen volume and sperm numbers were identified from the 4 breeding lines examined. The two lines were confirmed by a second examination of data collected from drones from queens from the High and Low Lines in January 2005. Experiments to determine the importance of genetic inheritance on semen production are to commence in spring 2005. The presence of disease in drones supplying data for the project has been examined. Further experiments are to include monitoring the health of hives supplying drones, and individual drones supplying semen volume and sperm number data.

PRODUCTION - Diseases & Pests

Project Title	**A study of Gluconobacter – gluconic acid producing bacteria, symbionts of bees: development of biological control for chalkbrood**
RIRDC Project No.:	ANU-58A
Start Date:	01/01/2002
Finish Date:	30/05/2007
Researcher:	Dr Murali Nayudu
Organisation:	Australian National University School of Botany and Zoology Faculty of Science CANBERRA ACT 0200
Phone:	(02) 6125 3643
Fax:	(02) 6125 9758
Email:	Murali.Nayudu@anu.edu.au
Objectives	• To isolate and characterise bacteria from varied Australian bee hives that produce antifungal agents effective against the chalk brood disease. The results of this strategic basic research will provide specific information to carry out applied research in the future to develop a biological control of chalk brood disease.
Current Progress	An understanding of the symbiotic relationship between non-pathogenic gut bacteria and the host honey bee is essential to develop an effective control strategy for chalkbrood. Antagonistic bacterial strains against chalkbrood naturally inhabit Australian bee guts. Bacterial diversity in honey bees was measured in terms of viable count on TSA (Tryptic Soy Agar) and the ability of bacterial isolates to inhibit chalkbrood by a anti-fungal bioassay. Overall, high counts of both Gram positive as well as Gram negative bacteria were found in bees from healthy hives. In contrast, significantly low numbers of Gram positive bacteria, and only very rare Gram negative strains were isolated in bees from chalkbrood infected hives. These results suggest that there is a correlation that bees from diseased chalkbrood hives have a significantly lower viable count and lower bacterial diversity in their gut compared with honey bees from healthy hives. *Pseudomonas* strain AN5 inhibits chalkbrood. Preliminary results from field trials suggest that feeding sugar solution leads to a decrease in chalkbrood infection in bee hives. There is also a trend that there is a significant reduction in the level of chalkbrood disease when the hives were fed with sugar solution with an antifungal agent added.

PRODUCTION - Diseases & Pests

Project Title	**Transmission of American foulbrood (AFB) disease of honeybees through replacement of queen bees**
RIRDC Project No.:	DAQ-293A
Start Date:	01/11/2002
Finish Date:	30/03/2006
Researcher:	Ms Patricia Greer
Organisation:	Department of Primary Industries (Qld) Animal Research Institute LMB 4 MOOROOKA QLD 4105
Phone:	(07) 3362 9684
Fax:	(07) 3362 9440
Email:	patricia.greer@dpi.qld.gov.au
Objectives	• To assess the risk of transmitting American foulbrood (AFB) disease to apiaries through use of contaminated queen bees.
Current Progress	Queens were introduced into hives at Yeerongpilly in early November. Preliminary sampling and testing of these hives revealed no trace of AFB. These are the hives that will be infected with AFB. Two samplings, 1 month apart, on hives in Esk Forestry was also conducted. These hives will receive the queens from Yeerongpilly. Three weeks after the last queens were introduced; the Yeerongpilly hives were inoculated with a suspension containing AFB. Hives were observed at weekly intervals. As infection didn't occur as expected, a further inoculation was carried out in January. This resulted in 100% infection. The disease was allowed to develop until late March, when a decision was made to transfer queens before conditions deteriorated with the onset of Autumn. Due to severe conditions, all hives from Esk were returned to Yeerongpilly for the transfer of queens. This was reasonably successful, with a loss of 16 queens, with 8 of these rearing their own queens. These have been left in the trial at this stage. Queens were allowed to settle in for 3 weeks then the hives were sampled and returned to Esk. Hives will be examined and tested for the presence of AFB on a monthly basis. The full project is expected to be completed by March 2006.

PRODUCTION - Diseases & Pests

Project Title:	**Clarification of aspects of Varroa reproduction - first stage of a possible new control method**
RIRDC Project No.:	CSE-87A
Researcher:	Dr Denis Anderson
Organisation:	CSIRO Entomology GPO Box 1700 CANBERRA ACT 2601
Phone:	(02) 6246 4148
Fax:	(02) 6246 4000
Email:	Denis.Anderson@csiro.au
Objectives	• To determine the hormone profiles in the blood of pre and post-pupal stages of *Apis mellifera* and *Apis cerana* drone brood in Java, Indonesia, and in the blood of Varroa mites infesting those stages. This information will form a basis for developing a possible new method for controlling Varroa destructor on *Apis mellifera*.
Background **Research** **Outcomes** **Implications**	FINAL REPORT DUE SOON

PRODUCTION - Diseases & Pests

Project Title:	**Using temperature manipulation to control Small Hive Beetle**
RIRDC Project No.:	DAN-215A
Researcher:	Dr Garry Levot
Organisation:	NSW Agriculture Elizabeth Macarthur Agricultural Institute PMB 8 CAMDEN NSW 2570
Phone:	(02) 4640 6333
Fax:	(02) 4640 6300
Email:	garry.levot@agric.nsw.gov.au
Objectives	• To develop hive disinfestation procedures involving chilling/freezing of hives/supers to control Small Hive Beetles (Small Hive Beetle).
Background	Small Hive Beetle is a recent introduction to Australia. It has the potential to cause significant economic losses. Small Hive Beetle is now established in eastern Australia. Eradication is not feasible but control aimed at eradication from individual hives should be attainable. Insect development is temperature dependent with warm temperatures favouring growth and cold temperatures inhibiting development. The lower thermal developmental threshold for Small Hive Beetle is unknown. Most insects cannot survive freezing for more than a short time and exposure to 4^{o}C for longer periods is often lethal as well. The use of hive chilling/freezing may offer a practical alternative to insecticide use for killing adult and immature beetles and poses no residue risk for produce.
Research	A laboratory colony of Small Hive Beetle was established at EMAI. All life-stages were transferred to refrigerated cool rooms (max. 4^{o}C) or freezers (max. < 0^{o}C) and stored for varying periods of time to determine a temperature/time combination lethal to Small Hive Beetle. Similar experiments were conducted with infested boxes of stored comb.
Outcomes	Small Hive Beetle is amenable to laboratory culture. Large numbers can be reared at low cost. At 29^{o}C the life-cycle (egg to adult beetle) occupies as little as 28 d but may extend to almost 60 d. All life-stages of the Small Hive Beetle are susceptible to cold temperature. Exposure to freezing temperatures for 1 h is lethal to all life-stages. Up to 8 d exposure to cool room temperature (0-4^{o}C) was required to kill all life-stages.
Implications	Storage of stored comb at cold or freezing temperatures can be effective in disinfesting bee boxes and other material of Small Hive Beetles. However, lack of access to freezers and the protracted time needed to kill larvae in cool rooms may make temperature manipulation an impractical option for Small Hive Beetle control.

PRODUCTION - Diseases & Pests

Project Title:	**Insecticidal control of Small Hive Beetle**
RIRDC Project No.:	DAN-216A
Researcher:	Dr Garry Levot
Organisation:	NSW Agriculture Elizabeth Macarthur Agricultural Institute PMB 8 CAMDEN NSW 2570
Phone:	(02) 4640 6333
Fax:	(02) 4640 6300
Email:	garry.levot@agric.nsw.gov.au
Objectives	• To develop the most appropriate insecticides and insecticide application methods to control Small Hive Beetle inside and outside of bee hives.
Background	Eradication of Small Hive Beetle is not feasible but control aimed at eradication from individual hives should be attainable. An integrated control strategy that includes insecticide intervention, hive management and effective disinfestation of stored comb is considered most likely to prevent Small Hive Beetles causing financial losses to commercial bee keepers. This project aimed to develop a safe, effective in-hive insecticide treatment for Small Hive Beetle control and to investigate the effectiveness of phosphine fumigation of stored comb and the susceptibility of Small Hive Beetle larvae to insecticidal soil drenches.
Research	Laboratory bioassays were conducted against Small Hive Beetle larvae and adults for seven insecticides. The most effective insecticide in laboratory tests was chosen for further investigation. A novel artificial insecticide treated cardboard harbourage for use in bee hives was developed. Preliminary trials were conducted to measure the efficacy of these harbourages under laboratory conditions and to measure the insecticide residues in honey that can be expected after use of the harbourages in bee hives. Trials were conducted to determine the effectiveness of phosphine fumigation in disinfesting stored comb.
Outcomes	The insecticide treated artificial harbourages were effective in controlling Small Hive Beetles in laboratory trials. Results of limited field trials conducted under APVMA Trial Permit 8167 suggested that this control strategy is likely to provide acceptable Small Hive Beetle control. However, in one case bees were able to access the insecticide which resulted in bee deaths and low level residues in honey. This indicated that further development of the harbourage is required to avoid these problems. Beekeepers are warned not to use any in-hive insecticide treatments until further developments are made as they risk hive losses and residues in honey. The insecticide is not currently registered for use in honey production. ***IMPORTANT: PESTICIDES AND ALLIED CHEMICALS ACT 1978*** ***Note that you must use only a registered pesticide and that it must not be used for any purpose or in any way contrary to the directions on the label unless a permit has been obtained under the Act.*** Permethrin soil drenches were effective against larvae. Imidacloprid was equally effective and could be an alternative if needed. Phosphine fumigation that mimicked the current use pattern for wax moth disinfestation killed all life-stages of the Small Hive Beetle.
Implications	An effective in-hive treatment for Small Hive Beetle was developed. However, until a fully effective harbourage is developed and further trials conducted it is uncertain whether the APVMA will allow widespread use of the insecticide treated harbourages

in commercial apiaries.

Permethrin soil drenches provide adequate control of Small Hive Beetle larvae. The allowable label claims for aluminium phosphide tablets will be extended to include the treatment of Small Hive Beetle infested stored (dry) comb.

Publications

Haque, N.M.M. and Levot, G.W. (in press). Laboratory rearing of the Small Hive Beetle *Aethina tumida* Murray (Coleoptera: Nitidulidae). *General and Applied Entomology* **34**:

PRODUCTION - Diseases & Pests

Project Title:	**Literature review and survey of *Nosema apis* of honey bees in Australia**
RIRDC Project No.:	DAN-228A
Researcher:	Dr Michael Hornitzky
Organisation:	NSW Department of Primary Industries Elizabeth Macarthur Agricultural Institute PMB 8 CAMDEN NSW 2570
Phone:	(02) 4640 6311
Fax:	(02) 4640 6400
Email:	michael.hornitzky@agric.nsw.gov.au
Objectives	• To prepare a literature review of *Nosema apis* • Conduct a survey of hives for *N. apis*
Background	*Nosema apis* is an important parasite of adult honey bees. It has been reported to cause significant production losses as a result of a range of effects it has on adult bee longevity, queen bees, brood rearing, bee biochemistry, pollen collection and other bee behaviour. Despite these effects there are no classic signs of infection and hence most infections are unrecognised. There is a need to increase the awareness of beekeepers to this important infection and better determine the prevalence and significance of *N. apis* in Australian honey bees.
Research	Literature searches were carried out to facilitate the collection of data for the *N. apis* literature review. A survey of 800 honey bee colonies for *N. apis* was carried out.
Outcomes	A literature review was produced that provides information on the effects of the disease, current control methods and the laboratory diagnosis of the infection. It provides beekeepers with the information to monitor infection levels in their hives. The *N. apis* survey provided data on the prevalence of *Nosema* spores in Australia. There was a broad range of infection levels ranging from 10,000 to 12,236,000 spores per bee. This range suggested that some beekeepers were better able to control nosema disease than others, although they were probably not aware what impact specific management practices were having on *N. apis* levels. Analysis of the completed questionnaires that were filled in by the beekeepers who took part in the survey indicated the following management control strategies; (i) packing of hives down tight for the winter, (ii) no manipulation of hives during the winter (including no supplementary feeding of individual hives), (iii) no shifting of bees during the winter and (iv) hives with low *Nosema* levels were mostly ¾ to full of honey. It would be useful to carry out a subsequent survey of the same hives at the same time of year to determine whether these factors continue to remain important in minimising the effects of *N. apis*. This work has demonstrated that nosema disease is common in Australian honey bee colonies and that further work should be carried out to determine what impact this disease has on the beekeeping industry in Australia.
Implications	The literature review provides beekeepers with information about the ecology, control and diagnosis of nosema disease. The survey has demonstrated that *N. apis* is a common infection in Australian honey bee colonies and that specific management practices could be used to minimise the effects of the disease.

PRODUCTION - Nutrition

Project Title	Predicting the productivity of honeybees from the nutritional value of pollen
RIRDC Project No.:	ANU–57A
Start Date:	01/12/2001
Finish Date:	31/07/2006
Researcher:	Dr Ian Wallis
Organisation:	Australian National University Division of Botany & Zoology CANBERRA ACT 0200
Phone:	(02) 6249 2533
Fax:	(02) 6249 5573
Email:	ian.wallis@anu.edu.au
Objectives	• To devise a rapid method for explaining the nutritional status and productivity of a colony of bees from the nutritional value of pollen they eat.
Current Progress	We recently completed our small cage pollen feeding experiments, for which we tested 46 different pollens. Our preliminary results show a significant increase ($p < 0.0001$) in dry body weight, wet head weight, and the number of sealed brood cells as the protein content of pollen increases. As dissecting the hypopharyngeal glands is extremely time consuming we used wet head weight as a growth factor instead, and showed that it is an accurate measure of HPG size ($r^2 = 0.79$, $n = 540$, $p < 0.0001$). We have developed an NIRS model to predict the crude protein content of pupae from 123 samples, which were collected from several apiaries over a twelve month period ($r^2 = 0.99$, standard error of cross-validation (SECV) = 0.1100). We have extended our NIRS model to predict the crude protein in pollen to include 160 pollen samples ($r^2 = 0.99$, SECV 0.1127). Our NIRS model for predicting the crude protein of bees, which we are still working on, contains 50 samples ($r^2 = 0.99$, SECV = 0.1498). Thus we have found NIRS to be an accurate tool for predicting crude protein. We are still working on our NIRS models to predict amino acids.

PRODUCTION - Nutrition

Project Title:	**Production of a publication on honeybee nutrition in Australia - 'Fat bees/skinny bees'**
RIRDC Project No.:	DAN-186A
Start Date:	01/01/2000
Finish Date:	30/04/2005
Researcher:	Dr Doug Somerville
Organisation:	NSW Department of Primary Industries PO Box 389 GOULBURN NSW 2580
Phone:	(02) 4828 6619
Fax:	(02) 4822 3261
Email:	doug.somerville@agric.nsw.gov.au
Objectives	• To produce an extension publication on honey bee nutrition, incorporating research findings from past RIRDC projects, literature searches and anecdotal examples of applications in the Australian context in a format that will be readily understood and adopted by beekeepers.
Current Progress	The publication, fat bees/skinny bees, is a manual on honey bee nutrition for beekeepers. Over 120 pages covering information on the essential chemical requirements of honey bees including the components of nectar and pollen. The protein levels of pollens around 25% plus have been recognised as excellent quality pollens, those less than 20% have been described as of a poor quality. Australia has had more pollens analysed than any other country, and for the first time all of the profiles of the analysis are presented, representing 177 species. There is some evidence that pollens from the same genus, i.e., closely related plants, exhibit similar nutritional values in regards to pollen chemical composition. Lack of nectar or stored honey presents the beekeeper with various sets of problems. The various scenarios are discussed with the most appropriate course of action. Likewise, lack of pollen or poor quality pollen creates its own set of problems, often exacerbated by the stimulus of a nectar flow. How to recognise the need to provide pollen supplement and the circumstances which may lead a beekeeper to invest in this practise are discussed. Pollination and queen rearing present their own set of problems and solutions in relation to supplementary feeding and managing nutritional stress. These are discussed and best practise is suggested. Means of preparing and feeding sugar and pollen supplement are presented in different chapters. Our knowledge on pollen supplements is limited, but this area has received a great deal of attention. On the other hand, sugar syrup feeding is a commonly practised management tool in many countries including Tasmania, yet not on the Australian mainland. The information provided in the manual should provide most beekeepers with enough information to seriously consider providing sugar syrup to bees in the future. Forty case studies of beekeepers from every state in Australia and two from New Zealand are provided as examples on what is being practised by commercial beekeepers. They are not necessarily getting it right, but by trial and error, are improving the way they manage bees and ultimately improving the profitability of their beekeeping enterprise.

PRODUCTION - Nutrition

Project Title	Nutrition field trial to maximise colony population
RIRDC Project No.:	DAN-214A
Start Date:	01/04/2003
Finish Date:	30/10/2005
Researcher:	Dr Doug Somerville
Organisation:	NSW Department of Agriculture PO Box 389 GOULBURN NSW 2580
Phone:	(02) 4828 6619
Fax:	(02) 4822 3261
Email:	doug.somerville@agric.nsw.gov.au
Objectives	• To provide evidence of the effectiveness of supplementary feeding honeybee colonies to achieve population increase.
Current Progress	After the 2003 winter supplementary feeding trial, sugar syrup was dropped as an option due to the implications with this treatment promoting Nosema disease. Essentially three treatments were provided to two apiaries in 2005 on a Mugga ironbark honey flow. They were straight pollen, straight soy flour, and a mixture of soy flour, pollen and yeast. The differences in the uptake of the supplement were dramatic, with nearly all pollen supplement consumed, about half the pollen/soy flour/yeast mix, and approximately 20% of the soy flour on its own. The feed was supplied in trays under the lids of each hive every two or four weeks. The total weight gain for one apiary for the winter period was 12.5 kg for the pollen fed hives, 10.4 kg for the mixture, 7.3 kg for the soy flour fed hives, and 6 kg for the control hives. All hives had reasonable pollen stores before being moved onto the Ironbark in autumn. Through June two other soy flours were compared to the one used in the trial and found to be, in at least one case, significantly more attractive to bees. The Nosema tests revealed infection levels at reasonably low levels for the end of August after being on Mugga ironbark for all treatments. The results, although not analysed at this stage, do demonstrate the need to provide supplements that are first attractive to bees. The nutritional values of the food stuffs are secondary if the bees are not prepared to consume the food stuffs provided.

PRODUCTION - Nutrition

Project Title	An Australian survey of pollens for their fatty acid composition
RIRDC Project No.:	DAW-100A
Start Date:	01/05/2001
Finish Date:	31/07/2005
Researcher:	Mr Rob Manning
Organisation:	Western Australian Department of Agriculture 3 Baron Hay Court SOUTH PERTH WA 6151
Phone:	(08) 9368 3567
Fax:	(08) 9474 1295
Email:	rmanning@agric.wa.gov.au
Objectives	• To analyse the fatty acid composition of pollen from at least 120 of Australia's major honey and pollen producing species by 2004 (20 species from each State).
Current Progress	The progress of this project is largely unchanged since the previous report. However, pollen samples received are being put through an acetolysis process and mounted on slides to classify the pollen samples to at least Genus level.

PRODUCTION - Nutrition

Project Title	The effect of high and low fat pollens on honey bee longevity
RIRDC Project No.:	DAW-105A
Start Date:	01/07/2003
Finish Date:	30/11/2005
Researcher:	Mr Rob Manning
Organisation:	Western Australian Department of Agriculture 3 Baron Hay Court SOUTH PERTH WA 6151
Phone:	(08) 9368 3567
Fax:	(08) 9474 1295
Email:	rmanning@agric.wa.gov.au
Objectives	• To ascertain the effect of oleic and linoleic acids on honey bee longevity and their effect on body fat composition.
Current Progress	Three 42 day replicates of testing oleic and linoleic acids have been completed. Results so far generally indicate that honey bees will tolerate pollen with higher concentrations of linoleic acid than oleic acid. Honey bees did raise brood in cages with an additional 6% linoleic acid added to redgum *(Corymbia calophylla)* pollen and oleic acid was limited to only 2%. Statistical analyses not yet completed. Only the protein, fatty acid, lipid and mineral analyses have been completed for replicate 1. Results for replicates 2 & 3 have yet to be completed. One replicate was repeated because of the effect of sugar contaminated with a fungal species. Three 42 day replicates of testing high and low fat soyflour flour mixed with pollen were also tested and completed. Lupin flour was also included. Analyses have not been completed.

PRODUCTION - Nutrition

Project Title:	**Review of honeybee nutrition research and practices**
RIRDC Project No.:	JLB-2A
Researcher:	John Black
Organisation:	John L Black Consulting Locked Bag 21 WARRIMOO NSW 2774
Phone:	(02) 4753 6231
Fax:	(02) 4753 6295
Email:	jblack@pnc.com.au
Objectives	• Develop a review of all nutrition research, which has been undertaken for bees and if possible relate this to practical use by beekeepers. • Develop an integrated framework for bee nutrition research in Australia. • Provide a written report of the review in a form suitable for publication in a scientific journal. Provide after the 2005 R&D meeting a final report including the revised review and recommendations for future RIRDC funded research in priority order.
Background	The review was commissioned by RIRDC to identify the current status of knowledge on the nutrition of honeybees and how this knowledge could be applied to improve the focus of research and the practice of honey production in Australia. Suboptimal nutrition is frequently associated with the use of eucalyptus species which often have high nectar flows, but small quantities of pollen. Colonies working these species for several weeks show reduced vitality, a decline in egg laying capacity of the queen, reduced bee numbers, small bees at emergence, reduced lifespan and increased susceptibility to diseases.
Research	A thorough review of the literature published on honeybee nutrition over the last century was conducted along with a review of past and current RIRDC funded bee nutrition projects. The major aspects of honeybee productivity affected by nutrition were identified and an integrated research program for RIRDC funding suggested. The recommended research program was revised following a 2-day meeting with apiarists and scientists.
Outcomes	Sources of nutrients obtained by honeybees, factors affecting the attractiveness of pollens and variation in the digestibility of nutrients within pollens were assessed. The effects of nutritional status of honeybees on growth and body composition, hypopharyngeal gland development, reproduction, sex ratio of eggs and resistance to disease were quantified. Requirements for growth and reproduction of honeybees within a colony were determined for energy in the form of glucose, protein, essential amino acids, essential fatty acids, minerals and vitamins. Specifications for a pollen substitute were suggested including substances to be avoided because of their toxicity to honeybees. The most important factors affecting the profitability of the bee industry were identified and an integrated research program recommended in order of priority. 1. Develop an effective, economically viable pollen substitute, 2. Refine recommendations for effective feeding of sugar supplements including estimates of the amount of sugar needed to change bee numbers over specified time periods, feeding methods, concentrations and preservation procedures, 3. Investigate the feasibility of using existing technologies such as historical climate records and satellite photography for forecasting future floral resources, 4. Continue development of NIR technology for identifying the nutritional value of pollens 5. Develop effective methods for identifying the early onset of the 'skinny bee' syndrome under laboratory and field conditions.

Implications	A prioritised integrated research program with milestones and resource needs has been provided to the RIRDC Honeybee Advisory Committee for funding considerations.

PRODUCTION - Genetic Improvement

Project Title	**Development of two genetic markers for hygienic behaviour of honeybees**
RIRDC Project No.:	US-123A
Start Date:	01/06/2003
Finish Date:	31/03/2007
Researcher:	Dr Ben Oldroyd
Organisation:	University of Sydney School of Biological Sciences A12 UNIVERSITY OF SYDNEY NSW 2006
Phone:	(02) 9351 7501
Fax:	(02) 9351 4771
Email:	boldroyd@bio.usyd.edu.au
Objectives	• To identify two genes related to hygienic behaviour at the level of their sequence • To produce a diagnostic test so that individuals carrying the allele that confers hygienic behaviour can be identified without field testing • To develop general procedures for the identification of economically important behavioural genes of the honeybee and protocols for their exploitation by industry
Current Progress	Microsatellite markers have been identified for fine mapping within the identified linkage groups. Fine mapping will reduce the current number of potential candidate genes, which will allow sequence analysis to be performed. From this we hope to identify a gene mutation related to hygienic behaviour and understand how this behaviour is regulated in individual bees We have identified two genetic markers, which are strongly linked to hygienic behaviour, using colonies classified as hygienic and non-hygienic from field studies. By sequencing the surrounding regions of one of the markers, we have developed a single-nucleotide polymorphic (SNP) marker, which would allow for the diagnosis of potential hygienic stock without the need of field testing. While initial results showed low potential in identifying hygienic stock, the discovery of a third allele has enabled the redevelopment of the test, which is currently undergoing re-evaluation.

RESOURCES

Project Title	Floral resource database for Tasmania
RIRDC Project No.:	DAT-42A
Start Date:	25/03/2004
Finish Date:	01/08/2005
Researcher:	Dr Simon Pigot
Organisation:	Department of Primary Industries, Water and Environment (Tas) GIS & Information Management Unit Resource Management & Conservation GPO Box 44A HOBART TAS 7001
Phone:	(03) 6233 2419
Fax:	(03) 6233 2744
Email:	simon.pigot@dpiwe.tas.gov.au
Objectives	• Survey and document the floral resources on which the Tasmanian Beekeeping Industry depends. Relate the value of sites and floral resources (in beekeeping terms) to tenure, vegetation type and bioregions in order to help estimate the social, environmental and economic value of the Tasmanian Beekeeping Industry.
Current Progress	The project has been delayed because of illness. The following have been completed: • Census forms designed and distributed. Census returns and visits now cover nearly all Tasmanian operators with greater than 200 hives. Follow-ups will shortly be sent out to complete the survey • Access database has been designed and data entry of returned surveys is approx 75% complete: there are approx 70 species listed from sites with a total number of hives in excess of 10,000. • GIS work and modelling for Leatherwood distribution have been completed to the prototype stage – some fieldwork and refinement is required before the results can be taken to the planned expert workshops. • Field work and site investigation of some hive sites has been done over 04-05 season. A photographic gallery database is being used. The next stages will involve: • Complete data entry and spatial analysis of hive site feeding catchments (to be presented at TBA Conference in June 2005). • Run models based on survey info and available biological data. • Plan and conduct any remaining fieldwork to investigate and refine initial species models as necessary as well as to check any anomalous species names. • Run workshops on important species models (Aug-Sept 2005). • Analysis of entered site data for outcomes listed in project briefing. • Write and submit final report.

RESOURCES

Project Title	The effect of logging on nectar production in NSW forests
RIRDC Project No.:	SFN-2A
Start Date:	30/08/2002
Finish Date:	30/04/2006
Researcher:	Dr Brad Law
Organisation:	Forest Science Centre, Science and Research, DPI PO Box 100 BEECROFT NSW 2119
Phone:	(02) 9872 0162
Fax:	(02) 9871 6941
Email:	bradl@sf.nsw.gov.au
Objectives	• To quantify the impact of logging on nectar production in two eucalypt species (Spotted Gum and Grey Ironbark) by measuring nectar production in different tree sizes in forest under different stages of regeneration from logging. • A better understanding of nectar production in logged forests, when widely communicated, will allow an integration of apiculture with forest management and thus promote sustainability and accessibility.
Current Progress	Progress in the last year has been limited by a lack of flowering in the target tree species. Grey Ironbark did not flower in sufficient numbers on the south coast of NSW to warrant expensive nectar measurements with a cherry-picker. Spotted Gum has been well budded since the end of 2003 and likely research sites have been monitored since that time to ensure the major flowering expected for winter 2005 will not be missed. Spotted Gum trees have already begun flowering as of April 2005, thus significant field work has been scheduled for nectar measurements in this species throughout May, June and July this year.

RESOURCES

Project Title	Securing long-term floral resources for the honeybee industry
RIRDC Project No.:	UA-66A
Start Date:	01/07/04
Finish Date:	31/07/07
Researcher:	Dr David Paton
Organisation:	The University of Adelaide School of Earth & Environmental Sciences Benham Building DP 312 ADELAIDE SA 5005
Phone:	(08) 8303 4742
Fax:	(08) 8303 4364
Email:	david.paton@adelaide.edu.au
Objectives	• The broad aims of this project are to better document the use and importance of native plants (particularly woodland eucalypts) in different landscapes (natural bushland, paddock and revegetation) to commercial beekeepers, identifying deficiencies in the resource base where they exist. This information will then be used to assist in maintaining the health and productivity of current trees from a beekeeper perspective while growing the floral resource base through appropriate revegetation and restoration programs.
Current Progress	Four locations in the Mt Lofty Ranges (SA) have been selected and nectar produced per flower, floral abundances, and extent of use of floral resources by honeybees and native fauna documented. Sites include native vegetation, scattered paddock trees and areas that have been revegetated and provide some stark contrasts. For example, *Eucalyptus leucoxylon* produced similar quantities of nectar in different settings (9-12mg sugar per flower per day) but the extent of use varied 10 fold. At the site with scattered trees nectar-feeding birds made 3 visits/flower/day (vfd) and honeybees 9 vfd on average. In remnant vegetation with a shrubby understorey birds made 33 vfd and honeybees 20 vfd. *Hypochoeris glabra*, a weed, was a key pollen source for bees exploiting *E. leucoxylon* in rural areas. Honeybees visited *H.glabra* flowers around 8 times per day, collecting pollen (5fvd) and nectar (2.9fvd). Flowers of some eucalypts in revegetation areas were visited even more frequently (e.g. *E. torquata* had 185 vfd by honeybees for nectar and 31.5 vfd for pollen, cf birds making 5.8 vfd). A simple scheme for scoring tree health and flowering intensities has been designed and is being implemented to better track regional patterns in flowering of key plants (eucalypts).

RESOURCES

Project Title:	**Eucalypt regrowth thinning trails to optimise leatherwood honey production**
RIRDC Project No.:	FTA-1A
Researcher:	Ms Frieda Heese
Organisation:	Forestry Tasmania 15 Beach Street BELLERIVE TAS 7018
Phone:	(03) 6233 7403
Fax:	--
Email:	frieda.heese@education.tas.gov.au
Objectives	• To demonstrate that non-commercial thinning of eucalypt regrowth will enhance leatherwood regrowth at no extra cost. • To establish a set of prescriptions for the timing and intensity of eucalypt regrowth thinning. • To communicate main findings to the beekeeping and forestry industries.
Background **Research** **Outcomes** **Implications**	REPORT NOT RECEIVED AT TIME OF PRINTING

OFF-FARM ISSUES

Project Title	High power ultrasound for candied liquid honey liquefaction and controlled creamed honey crystallisation
RIRDC Project No.:	UQ-101A
Start Date:	01/10/2002
Finish Date:	30/11/2005
Researcher:	Dr Bruce R D'Arcy
Organisation:	The University of Queensland School of Land and Food Sciences BRISBANE QLD 4072
Phone:	(07) 3346 9190
Fax:	(07) 3365 1177
Email:	B.DArcy@uq.edu.au
Objectives	• To reduce the amount of expensive heating and loss in quality during liquefaction of candied honey by developing an alternate, cost-effective ultrasound based method for the partial or complete liquefaction of candied honey by 2005, with a view to ultrasound having direct application for beekeeper control of honey crystallisation, or for liquefying candied honey prior to decanting in a honey packing plant. • To better control the texture of creamed honey spread by developing an ultrasound based method that enhances the nucleation rate and produces uniform crystal growth in a creamed honey system by 2005, with a view to it being used by beekeepers and honey processors for producing consistent and high quality creamed honey.
Current Progress	Studies are well underway into examining the glucose monohydrate crystals formed from honey samples, in order to determine their size and shape, and the rate of crystallisation. The original honey samples were heat-treated to liquefy, and centrifuged to ensure complete removal of crystallisation nuclei. Crystallisation during storage at 13 ºC was followed with time using an image analyser consisting of a light microscope and a digital camera. The structure of the glucose crystals varied from one floral type of honey to another, including: large plates, small needles, flower-like structures, star structures and web-like structures. An understanding of how crystal structures form in honey and at what rate in different floral types is being developed. In addition, the effect of ultrasound treatment on crystal structures is being examined, with initial results suggesting that the large plate-like crystals melt from the edges rather than break up into smaller crystals. Studies are in progress to determine whether ultrasound treatment of honey delays crystallisation through complete removal of crystal nuclei in the treated honey. Finally, a study of the process for making creamed honey and the effect of ultrasound treatment is in progress. The size and shape of crystals formed with and without stirring, and using different types of starters are being studied.

OFF-FARM ISSUES

Project Title	An investigation into the therapeutic properties of honey
RIRDC Project No.:	US-128A
Start Date:	31/07/2004
Finish Date:	31/07/2005
Researcher:	Dr Dee Carter
Organisation:	The University of Sydney School of Molecular and Microbial Biosciences Building G08 UNIVERSITY OF SYDNEY NSW 2006
Phone:	(02) 9351 5383
Fax:	(02) 9351 4571
Email:	d.carter@mmb.usyd.edu.au
Objectives	• To increase the use and acceptance of honey as a therapeutic agent in conventional medicine.
Current Progress	Australian honeys are being tested for antibacterial and antifungal activity using assays based on internationally recognised methods. Ten honeys have been tested to date and we are currently seeking additional honeys to perform an extensive screen. Forty isolates of *Candida* spp. (a fungal pathogen) were found to be susceptible honey, in particular jarrah honey, which contains a high level of hydrogen peroxidase. Importantly, honey killed this pathogen, whereas most conventional antifungals can only suppress growth. A draft manuscript of this study has been completed for submission to Antimicrobial Agents and Chemotherapeutics. Twenty clinical isolates of *Propionibacterium acnes* (an anaerobic pathogen) were found to be significantly more susceptible to honey than to an artificial honey control; again jarrah was the most effective honey. We have initiated collaboration with researchers at Concord Hospital to supply other emerging and drug resistant pathogens. Finally, our investigation into the effects of honey on the host parasite reaction has found honey to stimulate the release of tumor necrosis factor α, an important marker of cell activation, from cell culture lines. This is likely to be a factor influencing the ability of honey to stimulate wound healing.

New Projects –2005/2006

New projects being funded or under consideration in the 2005/2006 financial year are as follows:

Title	Researcher	Phone
Drone honeybees - semen production (Extension to DAN-205A)	Mr John Rhodes	(02) 6763 1206
Development of treatment options for European foulbrood (HBE05-05)*	Dr Michael Hornitzky	(03) 9251 7420
Long-term flowering patterns of south-east Australian melliferous flora (HBE05-06)*	Ms Melanie Birtchnell	(02) 4640 6311
The antimicrobial and immunostimulatory properties of honey (HBE05-09)*	Dr Dee Carter	(02) 9351 5383

Note: An asterisk (*) indicates that the Corporation is still to finalise amendments to the project in terms of, for example, a lower budget or project design.

Non-RIRDC Publications and Videos

The following publications and videos have been jointly funded by RIRDC but are not available from RIRDC. Ordering details as indicated.

Beekeeping in the NSW State Forest Districts

by NSW Agriculture, $5 each, phone (02) 4823 0616 to order

A series of reports which include information on beekeeping activities and honey and pollen flora of importance to beekeeping within each state forest district of New South Wales. Each report is approximately 20-26 pages.

Current reports in the series are:

- Queanbeyan/Badja State Forest Management Area – Apiary Management Potential (1995)
- Central Murray Valley Forestry Area – Apiary Management Survey (1995)
- Forbes Forestry District – Apiary Management Survey Results (1996)
- Beekeeping in the Bulahdelah State Forests (1997)
- Beekeeping in the Kempsey State Forests (1997)
- Beekeeping in the Narrandera State Forests (1997)
- Beekeeping in the Taree State Forests (1997)
- Beekeeping in the Tumut-Tumbarumba State Forests (1997)
- Beekeeping in the Wauchope State Forests (1997)
- Beekeeping in the Glen Innes State Forests (1997)
- Beekeeping in the Mildura Forestry Management Area (1997)
- Beekeeping in the Inverell State Forests (1997)
- Eden-Bombala Forestry District - Study of Beekeeping Usage and Importance (1997)
- Beekeeping in the Dubbo State Forests (1998)
- Beekeeping in the Urbenville State Forests (1998)
- Beekeeping in the Morisset State Forests (1998)
- Beekeeping in the Bathurst/Oberon State Forests (1998)
- Beekeeping in the Grafton State Forests (1998)
- Beekeeping in the Urunga State Forests (1998)
- Beekeeping in the Casino State Forests (1998)
- Beekeeping in the Gloucester/Walcha State Forests (1998)
- Beekeeping in the Dorrigo State Forests (1998)

Chalkbrood Disease of Bees

by NSW Agriculture, $25 (includes postage), phone (02) 6391 3433 or 1800 028 374 to order

Enables beekeepers to identify the symptoms of Chalkbrood, outlines measures to take to reduce the impact of this disease and outlines the epidemiology of this disease and how to correctly examine hives to detect Chalkbrood. 10 minutes

Bee Parasites Exotic to Australia

by NSW Agriculture, $30 (incudes postage), phone 02) 6391 3433 or 1800 028 374 to order

Enables beekeepers to identify external exotic parasites (varroa, trachael mites and tropilaelaps) and exotic bees (Asian, giant and dwarf honeybees) and be able to contact the right authorities should they see them in Australia. Includes biology of the parasites, how to inspect hives, how they spread and control measures should they enter Australia. Also covers how to legally import honeybees with approval from AQIS. 20 minutes

Endemic Bee Diseases (VDO5) 1992

by NSW Agriculture, $30 (includes postage), phone (02) 6391 3433 or 1800 028 374 to order

Enables beekeepers to identify endemic bee diseases (American Foulbrood, European Foulbrood, Sac Brood, Wax Moths, Braula Coeca (Tasmania only)) and other brood disorders. Enables beekeepers to identify the symptoms of the disease and pests, outlines measures to take to reduce the impact of this disease and outlines the epidemiology of the diseases and pests. How to correctly examine hives to detect problems. 49 minutes

Package Bee Production in Australia

by NSW Agriculture, $30 (includes postage), phone (02) 6391 3433 or 1800 028 374 to order

Enables beekeepers to follow a step-by-step guide on how to produce, handle and care for package bees, how to prepare package bees for shipment to overseas destinations. Inspection and certification requirements to overseas countries who buy package bees and Queen bees from Australia. 27 minutes

RIRDC PUBLICATIONS AND ORDER FORM

Antioxidants in Australian Floral Honeys – Identification of health-enhancing nutrient components	05/040 (2005, 94 pgs)	$21
A Preliminary Assessment of the Glycemic Index of Honey	05/027 (2005, 33 pgs)	$16
Oxytetracycline Sensitivity of Paenibacillus Larvae.SUBSP. Larvae Isolates	05/021 (2005, 12 pgs)	$16
Improving Queen Bee Production	04/153 (2004, 23 pgs)	$16
Disappearing Disorder	04/152 (2004,18 pgs)	$16
Evaluating Alternative antibiotics for Control of EFB	04/095 (2004, 54pgs)	$16
A beekeeper's guide to understanding control measures for European Foulbrood	04/091 (2004, 43pgs)	$21
Floral Resources used by the South Australian Apiary industry	04/089 (2004, 74pgs)	$21
Honeybee Research Report 2004	04/078 (2004, 33 pgs)	Free
Valuing Honeybee Pollination	03/077 (2003, 47pgs)	$16
Small Hive Beetle in the USA	03/050 (2003, 69 pgs)	$21
Introduction & Early Performance of Queen Bees	03/049 (2003, 45pgs)	$16
Honey Industry Survey	03/039 (2003, 39pgs)	$21
Commercial Beekeeping in Australia	03/037 (2003, 86 pgs)	$21
Fatty Acids – an alternative control strategy for honeybee disease	03/028 (2003, 19 pgs)	$16
R&D Plan for the Honeybee Program 2002-2007	02/081 (2002, 21 pgs)	Free
Breeding hygienic disease resistant bees	02/048 (2002, 35pgs)	$16
Techniques for the detection of adulterated honey	02/047 (2002,16pgs)	$16
The Use of Honeybees as a Transfer Vector for Control of Core Rot in Apples	02/046 (2002,54pgs)	$16
Literature Review of Chalkbrood-a Fungal Disease	01/150 (2001, 20pgs)	$16
Pollen Analysis of Eucalypts in Western Australia	01/053 (2001, 63pgs)	$16
Honeybee Disease Barrier Management Systems	01/052 (2001, 23pgs)	$16
Hot Wax Dipping of Beehive Components	01/051 (2001, 28pgs)	$16
Beekeepers Use of Honey & Pollen Flora Resources in Victoria	01/050 (2001, 104pgs)	$21
Quality Survey of Australian Honeys	01/049 (2001, 42 pgs)	$16
Controlling American Foulbrood	01/048 (2001,14pgs)	$16
Nutritional Value of Bee Collected Pollens	01/047 (2001, 166pgs)	$21
Nosema Disease in Honeybees-Genetic Variation & Control	01/046 (2001, 36pgs)	$16
Honeybee Research Reports (Version 2)	C01/001	$26
Pollination Manual 2001	C00/001	$26
Floral Resource Database for the NSW Apiary industry	99/174 (1999, 154pgs)	$21
Australian Liquid Honey	99/145 (1999, 83pgs)	$21
Natural Resource Database for the QLD Apiary industry	99/043 (1999, 68pgs)	$16
European Foulbrood	99/020 (1999, 23pgs)	$16
Impact of Commercial Honeybees on Flora & Fauna	99/015 (1999, 31pgs)	$16
Treating American Foulbrood	98/144 (1998, 12pgs)	$16
Strategic Planning & Action Meeting for Honeybee Nutrition	98/128 (1998, 22pgs)	$16
Beekeeping & Secure Access to Public Land	97/026 (1997, 52pgs)	$16

SHORT REPORTS (FREE)

Control of European Foulbrood with OTC & Apiary Management	S03/135
Successful introduction & Performance of Queen Bees in a Commercial Apiary	S03/126
Bulk Honey Containers	S97/010

IN PRESS (Please contact Vicki Byrne on (02) 6271 6398 for information on ordering)

Honeybee Research Reports (Version 3)	TBA
Fat bees/skinny bees	TBA
Nosema - Literature review and survey	TBA
Short Report - Update on control of Small Hive Beetle (Short Report S05/139)	Free

Australian Government
Rural Industries Research and Development Corporation

Rural Industries Research & Development Corporation
PO Box 4776
KINGSTON ACT 2604
Tel: 02 6272 4819
Fax: 02 6272 5877
Email: publications@rirdc.gov.au
ABN: 25 203 754 319

Publication Order Form

I would like to order the following books

No. of Copies	Publication No.	Title	Price
			$
			$
			$
			$
			$
			$
			$
		Total Order	$
		Less discount (if applicable*)	$
		Discounted price	$
		Total Cost	**$**

Price of book includes postage and handling, and GST. **

I am paying by:

☐ Cheque (attached, payable to RIRDC)

Credit Card (fill in details below)
Bankcard; ☐ MasterCard; ☐ Visa; ☐ AMEX

Name of Card Holder:

Card No: _____

Expiry Date: _____

Signature: _____

Please send my publication(s) to:

Name: _____

Position: _____

Address: _____

Email: _____

Phone: _____

Fax: _____

Please add my name to your mailing list for:
☐ *Shaping the Future—the RIRDC newsletter*
☐ *RIRDC Online* —RIRDC's email newsletter

- Payments in Australian dollars only
- Prices subject to change without notice
- Please allow two weeks for delivery

*** Discounts**
20% discount for 10 or more of one title
20% discount for booksellers
20% discount for educational institutions
50% discount for students
supply student ID no: _____
institution: _____

** The prices of RIRDC publications include GST, handling and domestic postage. For overseas postage rates, please contact RIRDC.

A tax invoice will be included with your books.