CSIRO

Surveillance of parasites and diseases of honeybees in Papua New Guinea and Indonesia

Dr Denis L Anderson

September 2008

Contents

Glossary of acronyms 2

1.0 Executive summary 3

2.0 Objectives 8

3.0 Background 8
- 3.1 European honeybees and their microbial pathogens in PNG 8
- 3.2 European honeybees and their microbial pathogens in Papua 10
- 3.3 History of the invasion of New Guinea by Asian honeybees and parasitic bee mites 10

4.0 Methodologies 15
- 4.1 Field inspections in PNG 15
- 4.2 Laboratory tests on PNG samples 16
- 4.3 Field inspections in Indonesia and laboratory testing 17

5.0 Outcomes 18
- 5.1 Field inspections in PNG 18
- 5.2 Laboratory tests on PNG samples 21
- 5.3 Field observations in Indonesia supported by laboratory tests 22

6.0 Risks to the Australian honeybee industry of parasites and diseases associated with honeybees in New Guinea 25

7.0 Recommendations 28

8.0 References 29

Acknowledgements 31

Attachment 1 Survey activities of Dr Anderson in PNG 32

Attachment 2 Attendees at official meetings held in PNG as part of the survey 33

Attachment 3 Details of *Apis cerana* and *Apis mellifera* colonies inspected and sampled in PNG 34

Attachment 4 Identity of *Varroa* mites in *Apis mellifera* colonies in PNG 35

Attachment 5 Survey activities of Dr Anderson in Indonesia 36

Attachment 6 Details of *Apis cerana* and *Apis mellifera* colonies inspected and sampled in Indonesia 37

Attachment 7 Identity of *Varroa* mites in *Apis mellifera* colonies in Indonesia 38

Attachment 8 NDAL press release in PNG 39

Glossary of acronyms

ACIAR	Australian Centre for International Agricultural Research
AQIS	Australian Quarantine and Inspection Service - DAFF
BAU	Bogor Agricultural University – Indonesia
COI	Cytochrome oxidase I
COII	Cytochrome oxidase II
CP	Central Province - PNG
CSIRO	Commonwealth Scientific and Industrial Research Organization - Australia
DAFF	Department of Agriculture, Fisheries and Forestry - Australia
DNA	Deoxyribonucleic acid
EHP	Eastern Highlands Province - PNG
FPDA	Fresh Produce Development Agency - PNG
MtDNA	Mitochondrial DNA
NAQIA	National Agriculture Quarantine and Inspection Authority - PNG
NARI	National Agricultural Research Institute - PNG
NDAL	National Department of Agriculture and Livestock - PNG
PDAL	Provincial Division of Agriculture and Livestock - PNG
PNG	Papua New Guinea
WHP	Western Highlands Province - PNG
WP	Western Province – PNG

1.0 Executive summary

This is a report on a consultancy commissioned by the Australian Department of Agriculture Fisheries and Forestry (DAFF). The objectives were:

(a) To survey social honeybees (*Apis* spp.) for parasites and diseases in PNG and the Indonesian Province of Papua and;

(b) Report to AQIS on risks to the Australian honeybee industry of parasites and diseases associated with honeybees in the localities surveyed.

Background and methodologies

Social honeybees are not indigenous to New Guinea. The two species present there, the European honeybee (*Apis mellifera*) and Asian honeybee (*Apis cerana*), were introduced by humans. Their health status is a biosecurity issue for the Australian honeybee industry.

In this consultancy, European honeybees were surveyed in PNG from 28 May–14 June 2008. A total of 44 hived colonies from 19 different sites were visually inspected for signs of pests, parasitic mites and microbial diseases. Samples of diseased brood, parasitic mites and adult bees were collected from each colony and transported under quarantine to Canberra for laboratory testing.

Subsequent survey activities in Indonesia were largely determined by events from the PNG survey. Hence, some additional surveying was required in Java. European honeybees were surveyed in Java and Papua from 4–20 July 2008. A total of 26 hived colonies at 7 sites were visually inspected and sampled for laboratory testing.

Samples of adult bees and parasitic mites were also collected from Asian honeybee colonies in PNG and Indonesia. Their identities were determined in the laboratory and compared with those obtained in previous surveys.

Outcomes from the PNG survey

- A new form of *Varroa jacobsoni* that is harmful to European honeybees was discovered in PNG. This 'new' mite differs from a harmless form of *V. jacobsoni* that has been present on Asian honeybees in PNG since the 1980's, in that it can reproduce on the worker and drone broods of European honeybees, whereas the previous form could not. This new mite is lethal to European honeybee colonies and is causing hardship for PNG beekeepers. It is widespread and well established and cannot be eradicated. It was also not detected in Papua or Java from where the *V. jacobsoni* in New Guinea originated, which indicates that the previously mite in PNG has undergone a recent 'shift' in its reproductive behaviour on European honeybees.
- The serious parasitic bee mites *Varroa destructor*, *Acarapis woodi* and *Tropilaelaps* spp., were not detected in PNG.
- Approximately 27% of European honeybee colonies inspected in PNG were infected with *Nosema* spp., and about 16% were affected by sacbrood disease. No other serious microbial pathogens of European honeybees were detected in PNG.

- Asian honeybees present in PNG were identified as the 'Java strain of *Apis cerana*'. They were carrying the Java strain of *Varroa jacobsoni*, but not *Varroa destructor* or *Tropilaelaps* spp.

Outcomes from the Indonesian survey

- There was no evidence that the new harmful form of *Varroa jacobsoni* discovered in PNG was present in Java or Papua.
- The serious parasitic mite *Varroa destructor* was found in European honeybee colonies located at Timika on the south coast of Papua. These colonies had been recently introduced from Cibubur near Jakarta in Java. They were also infested with the parasitic mite *Tropilaelaps mercedesae.*
- *Tropilaelaps mercedesae* was found to be the most serious pest of European honeybee colonies located in the highlands of Papua.
- Asian honeybees present in Java and Papua were identified as the 'Java strain of *Apis cerana*' and they were carrying the Java strain of *Varroa jacobsoni*, but not *Varroa destructor* or *Tropilaelaps* spp.

Risks to the Australian honeybee industry

- The new form of *Varroa jacobsoni* in PNG presents a potentially higher biosecurity risk to the Australian beekeeping industry than *Varroa destructor.* This mite would cause similar losses to those that *Varroa destructor* would cause to beekeepers (and horticulture industries) following its arrival in Australia, but it carries an additional threat in that it may also vector or transmit new pathogens

(particularly viruses) from the Java strain of Asian honeybee to European honeybees, a risk that could potentially threaten the trade of Australian honey and live bees.

- The presence of *Tropilaelaps* mites in European honeybee colonies on the south coast of Papua does not present an increased biosecurity risk for the Australian honeybee industry.

- The presence of *Varroa destructor* in European honeybee colonies at Timika presents a potentially increased biosecurity risk for the Australian honeybee industry, but further clarification is needed.

Recommendations

To reduce the risks to the Australian honeybee industry associated with outcomes of this survey it is recommended that:

- Australia provide assistance to PNG in stabilizing the current *Varroa* mite outbreak;
- An economic assessment of the impact of the new *Varroa* mite in PNG on the wider PNG economy be carried out;
- Training be provided for PNG Apiary Officers on *Varroa* mite biology, diagnosis and control.
- Research be conducted on the new form of *Varroa* mite in PNG. This research should be aimed at reducing the impact of the mite in PNG and at providing

information that will lead to a better understand of the biosecurity risks of the mite to the Australian honeybee industry and Australian horticultural industries.

- Mite-infested European honeybee colonies at Timika (Papua) be replaced free of charge with colonies from Western Australia, provided all the mite-infested colonies at Timika are destroyed.

2.0 Objectives

The objectives of the survey were to:

(a) Survey social honeybees (*Apis* spp.) for parasites and diseases in PNG and the Indonesian Province of Papua.

(b) Report to AQIS on risks to the Australian honeybee industry of parasites and diseases associated with honeybees in the localities surveyed.

3.0 Background

Social honeybees in the genus *Apis* are not indigenous to New Guinea. The two species currently found there, *Apis mellifera* and *A. cerana*, have been introduced during the past 70 years through activities associated with international aid programs or with human transmigration. What follows, is a brief overview of the history of honeybees, beekeeping and pathogens and pests associated with honeybees in Papua New Guinea (PNG), and the Indonesian province of Papua (once known as West Papua or Irian Jaya).

3.1 European honeybees and their microbial pathogens in PNG

European (or Western) honeybees (*A. mellifera*) were first introduced into PNG in the late 1940's from Australia (Mitchener, 1963; 1964). Further introductions of 'Italian-type' colonies were made from New Zealand in 1976 under a New Zealand-PNG Government bilateral aid project (Clinch, 1979). Since then, the only legal introductions have been from Australia (Anderson, 1989; Anderson, 1998). Hence,

all present-day European honeybees in PNG are descendants of bees that were originally imported from Australia and New Zealand.

Beekeeping is a successful cottage-type industry in PNG, as it is highly suited to the mostly subsistence way of life. Hived honeybee colonies are concentrated in the highlands, particularly in the Eastern Highlands Province (EHP), which has a temperate-like climate similar to that in which honeybees evolved in Europe. Beekeepers also regularly move hived honeybees from highland to lowland regions of PNG, but they do not survive long in the hot, humid, tropical, coastal conditions, for which they are not well-adapted. The distribution of feral honeybees in PNG also indicates that they too cannot survive in lowland regions, as they are tightly confined to the highlands. Currently there are about 4,000 hived *A. mellifera* colonies in PNG distributed among 500 small holders. These colonies yield about 50 tonnes of honey annually, which is valued at about K0.5 million (Attachment 8).

Until 1985 the only significant microbial honeybee diseases reported from PNG were sacbrood disease, caused by sacbrood virus (Bailey et al., 1979) and nosema disease, caused by the microsporidian *Nosema apis* (Clinch, 1979). However, American foulbrood disease, caused by the bacterium *Paenibacillus larvae* has since been reported, as have the minor viral pathogens black queen cell virus, Kashmir bee virus and chronic bee paralysis virus (Anderson, 1989). To date, European foulbrood disease, caused by the bacterium *Melissococcus pluton* has not been reported in PNG, neither has the fungus disease chalkbrood, caused by *Ascosphaera apis*.

3.2 European honeybees and their microbial pathogens in Papua

Much less is known about beekeeping with *A. mellifera* in Papua than in PNG.

European honeybees were probably first introduced into Papua from Australia in 1974 by an Australian missionary. The number of colonies imported is not known, but those that were imported were introduced into the Baliem Valley near Wamena (information provided by Mr Barat, beekeeper at Wamena). Further colonies were introduced into the Baliem Valley from Java during the 1980's and yet more colonies were introduced to Biak and Yapen Islands (off the north coast of Papua) from Java during the early 1990's. The 1980's import also introduced the small parasitic Asian bee mite, *Tropilaelaps mercedesae* (this mite was formerly mis-identified as *T. clareae*, Anderson 1994) and the 1990's import introduced *Varroa destructor* to the offshore islands (Anderson and Fuchs, 1998). However, *V. destructor* was subsequently eradicated from those islands during 1995-96. No serious microbial pathogens of European honeybees have been reported from Papua. When this survey commenced it was thought that there were about 300 hived *A. mellifera* colonies in Papua and that these were located in the highlands (but only in the Baliem Valley), at Koya Timor and Koya Barat near Jayapura, and on Yapen island.

3.3 History of the invasion of New Guinea by Asian honeybees and parasitic bee mites

What follows is a brief summary of the invasion of New Guinea by Asian honeybees and parasitic bee mites. This information was extracted from several official reports

of research carried out on bees and bee mites in New Guinea since the early 1990's and funded by ACIAR.

(a) The Asian honeybee in New Guinea

The Asian honeybee (*A. cerana*) was first introduced into Papua from Java during the 1970's as part of Indonesia's transmigration program. Feral colonies of the bee subsequently swarmed into neighbouring PNG and throughout mainland New Guinea and its offshore islands, including Biak and Yapen (off the north coast of Papua) and Boigu, Saibai and Dauan (in Torres Strait). The Asian honeybee in New Guinea carries the parasitic mites *Varroa jacobsoni* and *V. underwoodi*, but not *V. destructor* or the tracheal mite, *Acarapis woodi*, or any species of *Tropilaelaps* mite. DNA fingerprinting has shown that the strain of Asian honeybee in New Guinea and neighbouring localities (including the Solomon Islands) is the 'Java strain of *A. cerana*', the same strain as found in Java.

(b) Varroa mites

The ectoparasitic bee mite *V. jacobsoni* was first introduced to New Guinea when *A. cerana* was introduced in the 1970's. However, it was found to be harmless to the resident *A. mellifera* bees as it lacked the ability to reproduce on their brood (Anderson, 1994). This finding prompted a detailed DNA-based taxonomic studies of mites long known as '*Varroa jacobsoni*'.

Initial studies focussed on mites that were infesting different populations of *A. cerana* (the native host of *Varroa* mites) throughout Asia. These mites were found to be a complex of more than 18 different genotypes that belonged to 2 different species. As a result, *V. jacobsoni* was redefined as encompassing genotypes that infest *A. cerana indica* throughout the Malaysia-Indonesia-New Guinea region. A new name, *V. destructor*, was given to mites that infest different populations of *A. cerana cerana* in northern regions on mainland Asia. The taxonomic position of a further 3 genetically distinct mites on *A. cerana* in the Philippines remains uncertain.

Each *Varroa* genotype in Asia is hosted by a specific genotype of *A. cerana*, and a *Varroa* genotype that is naturally hosted by a specific genotype of *A. cerana* seems to unable to utilize another genotype of *A. cerana* as a host (for reasons unknown).

Only two genotypes of the new species *V. destructor*, the Korea (or K) and Japan (J) genotypes, can utilize *A. mellifera* as a host, both inside and outside of Asia (Anderson and Trueman, 2000). The reason why other mites in the complex cannot utilize *A. mellifera* as a host is that they lack the ability to reproduce on that bee's brood. Furthermore, mites of the K and J genotypes on *A. mellifera* lack genetic variation compared to other members of the K and J genotypes on *A. cerana* in Korea and Japan respectively. Indeed, on *A. mellifera*, mites of the K and J genotypes are two partially isolated 'genetic clones', which suggests that each type originated from single K and J mother mites respectively. This indicates that only 2 individual mites from the complex of mites on *A. cerana* in Asia have successfully switched host to *A. mellifera* (Solignac et al., 2005). The *Varroa* mites infesting *A. cerana* in New

Guinea were confirmed as the 'Java type of *V. jacobsoni*' (Anderson and Trueman, 2000) and their natural host is the 'Java genotype of *A. cerana*'.

The tight host-specificity of *Varroa* mites to a particular Asian honeybee genotype was clearly demonstrated in Papua in the 1990's when the K type of *V. destructor* was successfully eradicated from *A. mellifera* colonies on Biak and Yapen Islands, after it had first been introduced there on *A. mellifera* imported from Java. The eradication succeeded even though both islands were inhabited by feral *A. cerana* colonies that were carrying *V. jacobsoni.* This clearly demonstrated that the Java stain of *A. cerana* could not act as a host for the K type of *V. destructor.*

(c) Tropilaelaps mites

The ectoparasitic bee mite *T. mercedesae* (formerly thought to be *T. clareae*, Anderson and Morgan, 2007) was first introduced to the island of New Guinea on European bees imported into Papua from Java during the 1980's. These European bees were initially placed near Jayapura (at Koya Barat) and in the Baliem Valley in the central highlands (at Wamena). The mite eventually killed the colonies at Jayapura and, without a host, died-out. The area around Jayapura was also inhabited by *A. cerana* at that time. However, as *Tropilaelaps* cannot utilize *A. cerana* as a host, it had no alternative host it could utilize after killing the *A. mellifera* colonies.

Mites in the colonies at Wamena soon spread east through the feral *A. mellifera* population of the highlands into western PNG. As they spread they completely wiped-out the feral *A. mellifera* population along with any hived *A. mellifera* colony

in their path. However, the spreading front of the mites died-out near Oksapmin in the mid 1990's, before the mites could reach the main beekeeping areas of the Eastern Highlands. It is thought that the front died-out because it reached an area near Oksapmin that was free of feral *A. mellifera*. Again, even though that area contained *A. cerana*, the mites could not utilize it as a host and so died-out. During the initial invasion of PNG, mites were also found in *A. mellifera* colonies at Vanimo on the north-west coast of PNG, not far from Jayapura (Delfinado-Baker and Aggarwal, 1987). These mites had arrived at Vanimo in *A. mellifera* colonies that had been illegally imported from Jayapura. However, like at Jayapura, the mites eventually died-out after killing the *A. mellifera* colonies.

The unsuccessful invasion of PNG by *T. mercedesae* meant that, by the mid-1990's, the mite in New Guinea was only left existing in hived *A. mellifera* colonies located in the highlands of Papua. It was still surviving there because the resident hived *A. mellifera* colonies were being treated with acaricides by beekeepers. Since its introduction into that region, the mite had managed to reduce the number of hived *A. mellifera* colonies from 2,000 to less than 200. An attempt was made during 1995-96 to eradicate the mite from the remaining *A. mellifera* colonies in the highlands by the prolonged use of chemical acaricides, but this was unsuccessful. Nevertheless the trial eradication demonstrated to local beekeepers how effective chemical acaricides could be in reducing mite numbers. As a result, hived *A. mellifera* colonies have increased in number in the highlands since the eradication attempt. At the start of this survey it was thought that there were about 300 hived *A. mellifera* colonies in the highlands of Papua.

In 2005 approximately 80 *A. mellifera* colonies infested with *T. mercedesae* were moved from the highlands of Papua to Koya Timor near Jayapura. However, at the start of this survey the fate of those colonies was not known.

4.0 Methodologies

4.1 Field inspections in PNG

Activities and movements of Dr Anderson throughout the PNG survey are summarized in Attachment 1.

Before surveying commenced a meeting was held at the headquarters of PDAL Goroka to outline the aims and objectives of the survey. Attendees are shown in Attachment 2.

Surveying of hived *A. mellifera* colonies in PNG was conducted from 28 May–14 June 2008. A total of 44 colonies from 19 different sites were visually inspected for signs of parasitic mites and microbial diseases. Details of localities of the colonies sampled are shown in Attachment 3A.

Generally, when a hived colony was sampled, the owner beekeeper was first questioned on the health, honey yields and movements of the colony and of other colonies in the apiary. The hive was then opened and the adult bee population on combs visually inspected for the presence of external mites. Brood frames were removed and visually inspected for signs of microbial disease and mite infestation.

The caps were then removed from about 300 brood cells using a pair of fine forceps, the brood removed, and the bottoms of cells inspected for tell-tail signs of mite infestation (mite excreta and the presence of white mite nymphs). The reproductive status of an invading mother mite was noted (that is, whether she was reproducing or not reproducing). Mites were placed into labelled vials containing 70% ethanol. Approximately 60 adult worker bees and dead brood (if present) was also similarly collected. Each sample of bees or mites was transported under quarantine permit to the CSIRO laboratories in Canberra, where it was stored at -20°C.

A total of 5 feral *A. cerana* colonies were also sampled during the PNG survey. Details of these colonies are shown in Attachment 3B. Samples of live adult bees and mites were collected from each colony and transported to the laboratory as described above for *A. mellifera* samples.

4.2 Laboratory tests on PNG samples

At the CSIRO bee laboratory in Canberra extracts were obtained from diseased bee brood and tested for the presence of most known bee viruses, using standard gel-diffusion Ouchterlony tests, as described by Anderson (1984). Adult bees were examined for tracheal and external parasitic mites and for the presence of *Nosema* spores as described by Anderson (1990). The identity of *Varroa* mites was determined from their mtDNA COI gene sequence, as described by Anderson (2000). The identity of *A. cerana* bees was determined from their mtDNA COII gene sequence using methods developed by Anderson (2004).

4.3 Field inspections in Indonesia and laboratory testing

Survey activities in Indonesia were largely determined by events in the earlier PNG survey. Hence, some additional surveying was required in Java to determine whether the reproductive behaviour of the Java type of *V. jacobsoni* had changed from that reported in previous studies. Activities and movements of Dr Anderson throughout the Indonesian survey are summarized in Attachment 5.

Surveying of hived *A. mellifera* colonies in Java and Papua was conducted from 4–20 July 2008. A total of 26 colonies at 7 sites were visually inspected for clinical symptoms of mite infestation and microbial disease. Details of the localities of these colonies are shown in Attachment 6A. The sampling of colonies was focussed on determining whether female mites (in particular, *Varroa* mites) were reproducing or not reproducing in capped brood cells. For this, up to 300 cells were examined as described for the PNG survey and, any *Varroa* mites detected, were collected and identified as also described. The identity of *Tropilaelaps* mites collected was determined from mtDNA COI gene sequences, as described by Anderson and Morgan (2007).

Eleven (11) feral *A. cerana* colonies were also inspected and sampled in Indonesia. Details of these colonies are shown in Attachment 6B. Samples were tested in the same way as those collected from *A. cerana* colonies in PNG.

5.0 Outcomes

5.1 Field inspections in PNG

On the first day of inspection in PNG (28 May 2008 at Goroka, EHP) there were clear signs that a harmful *Varroa* mite was present in the *A. mellifera* colonies. Eight colonies were inspected that day and inspections started late (because of a meeting held with PDAL in Goroka in the morning – see Attachment 2) and ended late. All colonies inspected were infested with adult female mites that were producing offspring inside capped worker and drone brood cells. Female mites were also present in high numbers on the external bodies of adult worker bees. Most of the colonies were either weak or dying and their broods showed clinical symptoms of 'parasitic mite syndrome', which is a range of abnormal brood symptoms found in association with *V. destructor* infestations.

Without laboratory evidence as back-up, it was assumed that these infestations were due to the presence of the K type of *V. destructor* because, at that time, the K and J types of *V. destructor* were the only *Varroa* mites known to be capable of reproducing on *A. mellifera* and, of the two types, K was the most common and widespread. Also, previous research over a 10-year period in PNG had shown that the *Varroa* mite carried by *A. cerana* in PNG (the Java type of *V. jacobsoni*) was harmless to *A. mellifera*, as females of that species lacked the ability to reproduce on *A. mellifera* brood.

These initial observations changed the course of the survey. Subsequent survey work primarily focussed on confirming that indeed a new *Varroa* mite was present in the *A. mellifera* colonies and the extent of the outbreak. Beginning early on the morning of 29 May 2008 *A. mellifera* colonies in other parts of the EHP were inspected. They were also found to contain reproducing *Varroa* mites. Again, these inspections ended late in the day. The following day (30 May 2008), AQIS and PDAL management were informed of the situation. PDAL immediately called a meeting in Goroka to begin formulating a response (Attachment 2). During the remainder of the survey inspections of *A. mellifera* colonies in Chimbu, Western Highlands, Enga, Madang, Morobe and Central Provinces showed that the reproducing *Varroa* mites were widespread, well established and could not be eradicated.

During the survey work no *A. mellifera* colonies were found at Rabaul (East New Britain Province), Daru (Western Province) or Lae (Morobe Province), despite reports that colonies had been previously moved to Rabaul and Lae from EHP. Local Apiary Officers also reported that *A. mellifera* colonies that were previously located at Telefomin and Oksapmin in Sandaun Province were now dead. An ex-PDAL officer reported that four *A. mellifera* colonies had recently been moved from Goroka to Ok Tedi Mine in the North Fly District of Western Province. These colonies could not be inspected in this survey, but they are likely to be infested with reproducing mites.

The current distribution of the reproducing form of *Varroa* in PNG appears to have been influenced by movements of infested hives or queen bees. For instance, 16 single *A. mellifera* colonies were moved from PDAL Goroka to PDAL at Wabag on 23 May 2007. Beekeepers in Port Moresby and Wau also reported received queen

bees from EHP beekeepers during the past year. The infested *A. mellifera* colonies at Madang had also been recently moved there from the EHP.

Evidence also suggested that the reproducing form of *Varroa* mite was causing hardship to PNG beekeepers. Many apiaries inspected contained stacks of empty hives that once contained living bee colonies. Most beekeepers reported that they had first noticed unexplained colony losses 2 years previously (in 2006), and that the losses had continued. The EHP PDAL Beekeeping Co-ordinator (Mr Tela Louie) also reported that PNG's annual honey yields had declined since 2006, which corresponds to the time that colony losses were first noticed. Given that it usually takes up to 3 years for colony losses to be noticed following introduction of *V. destructor* (Goodwin and Van Eaton, 2001), it is likely that the reproducing form of *Varroa* mite has been present in PNG since at least 2003. There was no evidence to suggest how it might have entered the country.

The discovery of the reproducing form of *Varroa* mite in PNG initiated a series of high-level Government meetings (4 in total) to discuss different aspects of the outbreak and how to deal with it. Attendees at each of these meetings are shown in Attachment 2.

On 5 June 2008, NDAL held a press conference in Port Moresby to raise public awareness of the *Varroa* outbreak in the highlands (see Attachment 8). News articles on the outbreak were published the following day in the 'Post Courier' and 'The National' newspapers.

Apart from the symptoms of 'parasitic mite syndrome', signs of other serious bee diseases were not evident in *A. mellifera* colonies inspected in PNG. Nevertheless, some colonies showed mild clinical signs of sacbrood disease (caused by sacbrood virus), a disease not considered harmful to bee colonies.

5.2 Laboratory tests on PNG samples

The female *Varroa* mites that were observed producing offspring in *A. mellifera* colonies in PNG were identified by DNA sequencing and morphological measurements as the Java type of *V. jacobsoni*. The results are summarized in Attachment 4.

This outcome was unexpected and indicates that one or more female *V. jacobsoni* mites had undergone a recent 'shift' in their reproductive behaviour on *A. mellifera*. This shift could have first occurred in PNG or in neighbouring Papua or even in Java. If it occurred in Papua or Java then the mites with the new reproductive abilities would have had to spread, or been introduced, on *A. mellifera* into PNG. Subsequent surveying in Papua and Java (described below) would show that the shift actually occurred in PNG.

It remains to be seen whether the current *Varroa* mite outbreak in PNG has resulted from one or more female mites that developed a new-found ability to reproduce on *A. mellifera* brood. As mentioned earlier, the current world epidemics of K and J types of *V. destructor* on *A. mellifera* each resulted from shifts of a single K and J female mite respectively from the K and J mite populations on *A. cerana* in north-east

regions of Asia more than 50 years ago. It also remains to be seen whether the reproducing *Varroa* mites now present on *A. mellifera* in PNG can also reproduce on *A. cerana.*

Other laboratory tests on samples of *A. mellifera* adult bees and dead brood collected throughout PNG during the survey showed that 27% of colonies inspected were infested with *Nosema* spp., and 16% were affected by sacbrood disease, caused by sacbrood virus. No other microbial pathogens were detected. The tracheal mite (*Acarapis woodi*) and *Tropilaelaps* mites were also not detected in PNG.

DNA sequencing confirmed that the five *A. cerana* colonies inspected in PNG (Attachment 3B) were the Java genotype of *A. cerana.* Only *Varroa* mites were found in them and these were identified as the Java type of *V. jacobsoni.* The colonies did not contain *A. woodi* or *Tropilaelaps* spp., mites.

5.3 Field observations in Indonesia supported by laboratory tests

As stated above, survey activities in Indonesia were largely determined by events from the PNG survey. Hence, some additional surveying was required in Java to determine whether the reproductive behaviour of the Java type of *V. jacobsoni* had changed from that reported in previous studies.

Inspections were initially carried out on 6 *A. mellifera* colonies located in a large apiary at Sukabumi in West Java. No evidence was found that the Java type of *V. jacobsoni* had changed its reproductive ability on *A. mellifera.* Both *V. destructor* and

V. jacobsoni female mites were observed in and collected from those colonies. However, only the *V. destructor* females were producing offspring on the bee brood (laboratory results supporting these observations are given in Attachment 7).

DNA sequencing confirmed that one of two *A. cerana* colonies inspected at Sukabumi (Attachment 6B) was the Java genotype of *A. cerana* (it is assumed that the second colony was also of the same genotype). *Varroa* mites collected from both colonies were identified as the Java type of *V. jacobsoni.* No tracheal or *Tropilaelaps* mites were found in the colonies.

After arriving in Papua, staff of Dinas Peternakan Jayapura advised that the only remaining *A. mellifera* colonies present in Papua were located in the highlands (in the Baliem Valley) and at Timika on the south coast. Hence, subsequent field-work was primarily directed at obtaining information on the reproductive behaviour of mites infesting those colonies. Nevertheless, samples of adult bees and mites were also collected from *A. cerana* colonies located at Koya Timor near Jayapura so that their identity could be compared with those collected in Java and PNG. Details of the *A. mellifera* and *A. cerana* colonies inspected in Papua are given in Attachment 6.

A total of 15 *A. mellifera* colonies were inspected in the Baliem Valley. It soon became evident that the Java type of *V. jacobsoni* had not changed its ability to reproduce on *A. mellifera* work brood from that reported in previous studies, as all the female mites observed in capped worker cells (and that were later identified as the Java type of *V. jacobsoni*) were not producing offspring (see Attachment 7). However, 38% of female mites observed in capped *A. mellifera* drone cells in

colonies located in a single apiary at Mulima Village were producing offspring. These mites were also later identified as the Java type of *V. jacobsoni*. Female mites observed in capped drone cells in colonies in 3 other apiaries in the Baliem Valley (also later identified as the Java type of *V. jacobsoni*) were not producing offspring. Hence, even though *V. jacobsoni* in Papua was not harming the *A. mellifera* colonies, there were indications from the one apiary at Mulima Village that the mite may be developing an ability to reproduce on *A. mellifera* brood (note also that female *V. jacobsoni* can only reproduce on the drone brood of *A. cerana*, not on worker brood). However, further monitoring is needed to confirm this.

All 15 *A. mellifera* colonies inspected in the Baliem Valley were also infested with *Tropilaelaps* mites. These mites, which were reproducing on both drone and worker capped broods, were subsequently identified by DNA sequencing as *T. mercedesae*.

The *A. mellifera* colonies at Timika had been imported from Cibubur (near Jakarta, Java) in March 2008. A total of 12 colonies were imported, but four of these had since died. Inspections were carried out on 5 of the 8 live colonies. Many large reproducing female *Varroa* mites and 2 small non-reproducing *Varroa* mites were observed in capped worker brood cells. None of the colonies contained drone brood. The larger mites were later identified by DNA sequencing as the Korea type of *V. destructor* and the small non-reproducing mites as the Java type of *V. jacobsoni* (see Attachment 7 for results). Hence, *V. destructor* is now present on mainland Papua.

The five *A. mellifera* colonies inspected at Timika were also infested with *Tropilaelaps* mites. These were later identified by DNA sequencing as *T.*

mercedesae. Hence, *Tropilaelaps* mites are now not solely confined to the highlands of Papua.

DNA sequencing confirmed that one of the eleven *A. cerana* colonies inspected at Koya Timor near Jayapura (Attachment 6B) was the Java genotype of *A. cerana* (it is assumed that the other 10 colonies were also of the same genotype). Only *Varroa* mites were collected from these eleven colonies and these were identified as the Java type of *V. jacobsoni.* The colonies were not infested by *A. woodi* or *Tropilaelaps* mites.

6.0 Risks to the Australian honeybee industry of parasites and diseases associated with honeybees in New Guinea

The discovery in PNG of a new form of *V. jacobsoni* that can reproduce on the worker and drone brood of *A. mellifera* presents a new and serious biosecurity risk for the Australian honeybee industry.

Prior to this discovery, the most significant risk of a damaging *Varroa* mite entering Australia was by a *V. destructor* infested *A. mellifera* colony arriving on a vessel at an Australian seaport, and the colony swarming undetected onto land. The high risk associated with this threat was the driving force behind the establishment of the National Sentinel Hive Program by DAFF in 2000. This program was established to enhance surveillance for honeybee parasites (most notably *Varroa* mites) and exotic bees in the vicinity of seaports.

The biosecurity risk of *V. destructor* to Australia has not been diminished by the discovery of the new form of *V. jacobsoni* in PNG. However, the actual risks to the Australian honeybee industry of this new form of mite in PNG cannot be fully resolved without further research. From a biosecurity view-point, the most pertinent questions that need to be answered on the mite in PNG are:

- Is its life-cycle and effects on *A. mellifera* the same as for *V. destructor* on *A. mellifera*?
- Is it able to reproduce and exist on the Java genotype of *A. cerana*?
- Can it be effectively controlled on *A. mellifera* in the same way that *V. destructor* is controlled?
- Has it transmitted any new microbial pathogens (particularly viruses) from *A. cerana* to *A. mellifera*?
* Does it transmit or activate known microbial pathogens of *A. mellifera*?
- Did it originate from a single female mother mite in PNG, or are female *V. jacobsoni* as a whole in New Guinea developing an ability to reproduce on *A. mellifera* brood?

Pending further information from applied research it is assumed here that the mite in PNG behaves in a similar way to *V. destructor* and that it can exist and be hosted by the Java type of *A. cerana*. Given this, then the mite in PNG potentially presents a more serious risk to the Australian beekeeping industry than *V. destructor* because, in addition to causing similar losses to those that *V. destructor* would cause to beekeepers (and horticulture industries) following its arrival in Australia (Cook et al., 2007), it carries an additional threat that it may also vector or transmit new pathogens (particularly viruses) from the Java genotype of *A. cerana* to the local *A. mellifera*, a

risk that could potentially threaten the trade of Australian honey and live bees. No estimate of the value of sales of export queen bees or package bees is available, but Australian beekeepers produce about 30,000 tonnes of honey annually (valued at $53 million) of which approximately 11,000 tonnes is exported, making Australia the 4th largest exporter of honey (Benecke 2007; http://www.beekeeping.org/countries/australia.htm).

The presence of *T. mercedesae* in *A. mellifera* colonies on the south coast of Papua brings that mite dangerously close to Australia. However, *Tropilaelaps* mites cannot survive for more than a few days in the absence of bee brood because they lack the ability to feed on adult bees. Furthermore, evidence suggests that the Java genotype of *A. cerana* does not act as a host or vector *Tropilaelaps* mites. For these reasons, the presence of *T. mercedesae* in *A. mellifera* colonies at Timika does not present an increased biosecurity risk for the Australian honeybee industry.

Finally, the presence of *V. destructor* in European honeybee colonies at Timika presents a potentially increased biosecurity risk for the Australian honeybee industry, but further clarification. At the present time is not known for certain whether the Java genotype of *A. cerana* can vector *V. destructor*. If it can, then the mites' presence at Timika on the south coast of Papua provides an increased risk to the Australian beekeeping industry, as swarms of *A. cerana* emanating from Papua are regularly intercepted at Australian seaports. During this survey, the beekeeper that owned the infested colonies at Timika offered to kill the colonies provided they were replaced with new colonies free of charge from Australia.

7.0 Recommendations

To reduce the risks to the Australian honeybee industry associated with outcomes of this survey it is recommended that:

- Australia provide assistance to PNG in stabilizing the current *Varroa* mite outbreak;
- An economic assessment of the impact of the new *Varroa* mite in PNG on the wider PNG economy be carried out;
- Training be provided for PNG Apiary Officers on *Varroa* mite biology, diagnosis and control.
- Research be conducted on the new form of *Varroa* mite in PNG. This research should be aimed at reducing the impact of the mite in PNG and at providing information that will lead to a better understand of the biosecurity risks of the mite to the Australian honeybee industry and Australian horticultural industries.
- Mite-infested European honeybee colonies at Timika (Papua) be replaced free of charge with colonies from Western Australia, provided all the mite-infested colonies at Timika are destroyed.

8.0 References

Anderson DL (1984). A comparison of serological techniques for detecting and identifying honeybee viruses. J Invert Pathol 44:233-243.

Anderson DL (1989). Mites and pathogens of the European honeybee *Apis mellifera* and the Eastern hive bee *Apis cerana* in Papua New Guinea. NZ MERT Rep. 73pp.

Anderson DL (1990). Pests and pathogens of the honeybee (*Apis mellifera* L) in Fiji. J Apic Res 29:53-59.

Anderson DL (1994). Non-reproduction of *Varroa jacobsoni* in *Apis mellifera* colonies in Papua New Guinea and Indonesia. Apidologie 25:412-421.

Anderson DL (2004). Control of bee and bee mites in Indonesia and the Philippines. Final ACIAR report for AS2/1999/060. 23pp.

Anderson DL, Fuchs S (1998). Two genetically distinct populations of *Varroa jacobsoni* with contrasting reproductive abilities on *Apis mellifera*. J Apic Res 37:69-78.

Anderson DL, Morgan MJ (2007). Genetic and morphological variation of bee-parasitic *Tropilaelaps* mites (Acari: Laelapidae): new and re-defined species. Exp Appl Acarol 43:1-24.

Anderson DL, Sukarsih (1996). Changed *Varroa jacobsoni* reproduction in *Apis mellifera* colonies in Java. Apidologie 27:461-466.

Anderson DL, Trueman JWH (2000). *Varroa jacobsoni* is more than one species. Exp Appl Acarol 24:165-189.

Bailey L, Carpenter JM, Woods RD (1979). Egypt bee virus and Australian isolates of Kashmir bee virus. J Gen Virol 43:641-647.

Benecke FS (2007). Commercial beekeeping in Australia. RIRDC Pub No 07/059

Clinch PG (1979). *Nosema apis* and mites in honeybee colonies in Papua New Guinea. J Apic Res 18:298-301.

Cook CC, Thomas MB, Cunningham, SA, Anderson DL, DeBarro PJ (2007). Predicting the economic impact of an invasive species on an ecosystem service. Ecol Appl 17: 1832-1840.

Delfinado-Baker M, Aggarwal K (1987). Infestation of *Tropilaelaps clareae* and *Varroa jacobsoni* in *Apis mellifera ligustica* colonies in Papua New Guinea. Am Bee J 127:443.

Goodwin M, Van Eaton C (2001). Control of *Varroa.* A guide for New Zealand Beekeepers. NZ MAF 117pp.

Mitchener CD (1963). The establishment and spread of European honeybees in Australian New Guinea. Bee World 44:81.

Mitchener CD (1964). A further note on *Apis mellifera* in New Guinea. Bee World 45:114.

Solignac M, Cornuet J-M, Vautrin, D, Le Conte, Y, Anderson DL, Evans J, Cros-Arteil S, Navajas M (2005). The invasive Korea and Japan types of *Varroa destructor*, ectoparasitic mites of the Western honeybee (*Apis mellifera*), are two partly isolated clones. Proc R Soc B 272:411-419.

Acknowledgements

The author thanks AQIS staff in Canberra for their assistance throughout the survey, in particular Andrew Moss, Nick Harris, Luigi Paglia and Bart Rossel.

Special thanks also to the numerous colleagues in PNG and Indonesia who assisted with various aspects of the survey. In PNG, thanks to Andrew Yamanea (NAQIA), Dr Nime Kapo (NAQIA), Paskalis Ominipi (NAQIA), Mawe Gonapa (PDAL), Tella Loie (PDAL), Jonah Buka (PDAL), Jesse Yawane (PDAL), Aya Sam (PDAL) and beekeepers that allowed access to their colonies. In Indonesia, thanks to Dr Rita Raffiudin (BAU), Mita and Rut (BAU), Dinas Peternakan staff in Papua and beekeepers that allowed access to their colonies.

The author also thanks Cate Smith and Dr Stephen Cameron of CSIRO Entomology for their assistance in the identification of bees and mites.

Attachment 1

Survey activities of Dr Anderson in PNG

DATE	ACTIVITY
26.05.08	Travelled to Port Moresby to commence survey.
27.05.08	Travelled to Goroka.
28.5.08	Attended 'meeting 1' - held at PDAL Office Goroka. Sampled *Apis mellifera* colonies in Goroka township (EHP).
29.5.08	Travelled to Kainantu. Sampled *A. mellifera* colonies at Aiyura, Kainantu and Hagenofi (EHP).
30.5.08	Attended 'meeting 2' – held at PDAL Office Goroka (see Appendix 2). Sampled *A. mellifera* colonies in the Lufa Valley (EHP).
31.5.08	Travelled to Bena (EHP) and sampled *A. mellifera* colonies. Travelled to Goroka and sampled an *A. cerana* colony
01.06.08	Travelled to Mt Hagen (WHP). On the way sampled *A. mellifera* colonies at Kabiufa (EHP), Kanagi (at border of EHP and Chimbu Province) and Banz (WHP)
02.06.08	Travelled to Wabag (Enga Province) and sampled *A. mellifera* colonies. Travelled to Mt Hagen
03.06.08	Travelled to Goroka
04.06.08	Sampled 2 *A. cerana* colonies at Goroka. Attended 'meeting 3' – held at PDAL Office, Goroka. Travelled to Madang and sampled *A. mellifera* colonies
05.06.08	Travelled to Port Moresby. Attended a press conference with Director of PDAL (EHP) and EHP Deputy Administrator
06.06.08	Travelled to Daru (Western Province) and sampled an *A. cerana* colony
07.06.08	Sampled an *A. cerana* colony at Daru. Travelled to Port Moresby
08.06.08	Travelled to Lae and arranged transport to Wau Valley
09.06.08	Travelled to Wau Valley (Morobe Province) and sampled *A. mellifera* colonies. Travelled to Lae
10.06.08	Travelled to Port Moresby. Travelled to Rabaul (East New Britain Province)
11.06.08	All day at Rabaul, checked for presence of *A. mellifera* at Sonoma College, OISCA Training College, NARI Offices and at Vidal University campus
12.06.08	Travelled to Port Moresby
13.06.08	Attended 'meeting 4' – held at NDAL Port Moresby Office at Konidibu (am). Attended 'meeting 5' – held at NAQIA Port Moresby Office Waigani (pm). Sampled *A. mellifera* colony in Port Moresby
14.06.08	Travelled to Sogeri (near Port Moresby) and checked for presence of *A. mellifera.*
15.06.08	Travelled to Canberra (Survey completed)

Attachment 2

Attendees at official meetings held in PNG as part of the survey

NAME	ORGANIZATION	ATTENDED MEETING NO.*
Mr Andrew Yamanea	NAQIA, Port Moresby	5
Dr Nime Kapo	NAQIA, Port Moresby	5
Mr Paskalis Ominipi	NAQIA, Goroka	1 & 2
Mr Mawe Gonapa	NDAL, Goroka	1, 2, 3, 4 & 5
Mr Moses Woruba	FPDA, Goroka	2 & 4
Dr John Bailey	NARI, Aiyura	2
Dr Denis Anderson	CSIRO, Canberra	1, 2, 3, 4 & 5
Mr Tella Loie	PDAL, Goroka	1, 2, 3, 4 & 5
Mr Bubia Muhuju	PDAL Goroka	1, 2, 3, 4 & 5
Mr Ekesu Margu	PDAL, Goroka	1
Mr Damaris Lole	PDAL, Goroka	1
Mr Joachim Waugla	NDAL, Goroka	1, 2 & 3
Ms Maggie Seko	EHNIA, Goroka	1
Mr Nefion Tarapi	PDAL, Goroka	1, 2 & 3
Mr Jesse Yawane	NDAL, Goroka	1, 2 & 3
Mr Daisy Kiniafa	PDAL, Goroka	1 & 2
Mr Jonah Buka	EHP Beekeepers Assoc., Goroka	1, 2, 3, 4 & 5
Mr Enoch Yabimo	PDAL, Goroka	1 & 3
Mr Aya Sam	PDAL, Goroka	1 & 2
Mr.Enoch Asineha	Beekeeper, Goroka	1
Mr Atura Kena	PDAL, Goroka	1
Mr Kiseve Tonaga	Beekeeper, Okapa	1 & 2
Mr George Waenavi	NDAL, Goroka	2
Mr Ian Mopafi	OK TEDI Mining Ltd	2 & 4
Mr Ekewu Merger	PDAL, Goroka	2
Mr Atura Kena	PDAL, Goroka	2
Mr Wally Solate	NDAL, Goroka	2
Mr Johah Xiegiha	NDAL Goroka	2
Mr Triya Papaya	NARI, Aiyura	2
Mr Reuben Jim	PDAL, Goroka	2
Mr Moizor Warigi	PDAL, Goroka	2
Mr Joe Alu	CIC, Goroka	2
Mr Farapo Fareho	PDAL/, Goroka	2
Mr Goiya Epia	UNGAI	2
Hon. Bonny Oveyara	Member of Parliament, Okapa	3
Mr John Gimiseve	Deputy Provincial Administrator, Goroka	3
Mr Solomon Tato	Deputy Provincial Administrator, Goroka	3
Mr Benjamin Bakuta	Lufa Honey, Lufa Valley	3
Mr Reuben Kekau	PDAL, Goroka	3
Mr Ivan Aeno-Aenamero	PDAL, Goroka	3
Mr Igu Yowane	PDAL, Goroka	3
Mr Jonah Neglha	PDAL, Goroka	3
Mr Lucas Kindiwa	FPDA, Goroka	4
Mr Poela Utama	FPDA, Port Moresby	4
Mr Jonas Kraip	FPDA, Port Moresby	4
Mr Soldier Buruka	NDAL, Port Moresby	4 & 5
Mr George Mosusu	NDAL, Port Moresby	4 & 5
Dr Solomon Balagawi	NARI, Port Moresby	5
Mr David Kanawi	NAQIA, Port Moresby	5
Ms Marjorie Kame	NAQIA, Port Moresby	5
Mr Nick Maniba	NDAL, Port Moresby	5

* **Meeting 1** - held at PDAL Office Goroka on 28/5/08; **Meeting 2** - held at PDAL Office Goroka on 30/5/08; **Meeting 3** - held at PDAL Office Goroka on 4/6/08; **Meeting 4** – held at Port Moresby NDAL Office at Konidibu on 13/6/08; **Meeting 5** – held at Port Moresby NAQIA Office at Waigani on 13/6/08.

Attachment 3

(A) Details of the number and location of hived *Apis mellifera* colonies inspected and sampled in PNG

Date Sampled	Apiary Site:	Number of Colonies Sampled	Location
28/5/08	1	4	Goroka, EHP
28/5/08	2	4	Goroka, EHP
29/5/08	3	4	Aiyura, EHP
29/5/08	4	3	Aiyura, EHP
29/5/08	5	2	Kainantu, EHP
29/5/08	6	1	Between Kainantu – Hagenofi, EHP
29/5/08	7	2	Hagenofi, EHP
29/5/08	8	1	Between Hagenofi – Goroka, EHP
30/5/08	9	2	Kami, Lufa Valley, EHP
30/5/08	10	3	Lufa Valley, EHP
31/5/08	11	2	Bena District, EHP
1/6/08	12	2	Kabiufa, EHP
1/6/08	13	2	Kenagi (border EHP & Chimbu Prov.)
1/6/08	14	2	Banz, WHP
2/6/08	15	1	Wabag, Enga Province
2/6/08	16	1	Wabag, Enga Province
5/6//08	17	3	Madang, Madang Province
9/6/08	18	4	Wau Valley, Morobe Province
13/6/08	19	1	Port Moresby, CP
TOTALS:	**19**	**44**	

(B) Details of the number and location of feral *Apis cerana* colonies inspected and sampled in PNG

Date Sampled	Apiary Site:	Number of Colonies Sampled	Location
31/05/08	1	1	Goroka, EHP
04/06/08	2	2	Goroka, EHP
06/06/08	3	1	Daru, WP
07/06/08	4	1	Daru, WP
TOTALS:	**4**	**5**	

Attachment 4

Size and identity of adult female *Varroa* mites found reproducing in *Apis mellifera* colonies at 19 sites in PNG (Site numbers are as shown in Appendix 3). Also shown for comparison are the size and identity of adult female *Varroa* mites of a New Zealand isolate of *V. destructor* collected in 2000 (A) and a PNG (Mt Hagen) isolate of *V. jacobsoni* collected in 1995 (B).

Apiary Site:	Average size (length x width in µm) of 10 adult female mites	Haplotype (determined by DNA finger-printing)*
1	1047.2 x 1475.6	Java type of *V. jacobsoni*
2	1063.8 x 1506.8	Not determined
3	1075.7 x 1456.5	Java type of *V. jacobsoni*
4	1061.4 x 1499.4	Not determined
5	1066.2 x 1497.0	Java type of *V. jacobsoni*
6	1059.1 x 1511.3	Not determined
7	1066.2 x 1475.6	Java type of *V. jacobsoni*
8	1062.6 x 1501.7	Not determined
9	1062.6 x 1482.7	Java type of *V. jacobsoni*
10	1063.8 x 1502.9	Not determined
11	1065.0 x 1504.2	Java type of *V. jacobsoni*
12	1063.3 x 1475.6	Java type of *V. jacobsoni*
13	1064.8 x 1502.9	Java type of *V. jacobsoni*
14	1063.8 x 1482.7	Java type of *V. jacobsoni*
15	1064.8 x 1485.1	Not determined
16	1064.3 x 1499.4	Java type of *V. jacobsoni*
17	1064.5 x 1505.3	Java type of *V. jacobsoni*
18	1065.0 x 1457.0	Java type of *V. jacobsoni*
19	1064.8 x 1457.5	Java type of *V. jacobsoni*
A	1165.6 x 1725.5	Korea type of *V. destructor*
B	1064.3 x 1497..0	Java type of *V. jacobsoni*

* Haplotype was determined from a single mite from each locality. Mites from some localities were not determined by mtDNA fingerprinting, however, they were identified as the Java haplotype of *V. jacobsoni* from their body size and morphology.

Attachment 5

Survey activities of Dr Anderson in Indonesia

DATE	ACTIVITY
21.05.08	Travelled to Jakarta ahead of survey to organise clearances and permits. Travelled to Bogor
22.05.08	All day at BAU organising survey. Presented a seminar at BAU
23.05.08	Travelled to Canberra
04.07.08	Travelled to Jakarta to commence survey
05.07.08	In Jakarta arranging flights to Papua
06.07.08	Travelled to Bogor
07.07.08	All day at BAU finalizing travel to Papua
08.07.08	Travelled to Sukabumi (West Java) and sampled *Apis mellifera* and *A. cerana* colonies
09.07.08	Travelled to Papua
10.07.08	Attending a meeting with Dinas Peternakan staff in Jayapura to discuss survey (am).
11.07.08	Obtained surat jalan from police (am). Travelled to Koya Timor (near PNG Border) and sampled *A. cerana* colonies (pm)
12.07.08	Travelled to Wamena in Baliem Valley
13.07.08	Sampled *A. mellifera* colonies at Mulima Village in Baliem Valley
14.07.08	Sampled *A. mellifera* colonies at Meakama, Sinakma and Holekama Villages in Baliem Valley
15.07.08	Sampled *A. mellifera* colonies at Wamena township in Baliem Valley. Travelled to Jayapura (pm)
16.07.08	Travelled to Timika and sampled *A. mellifera* colonies
17.07.08	Travelled to Jayapura. Attended meeting with Dinas Peternakan staff in Jayapura to present survey findings
18.07.08	Travelled to Jakarta. Travelled to Bogor
19.07.08	Attended a meeting with BAU staff at Bogor to present survey findings. Travelled to Jakarta
20.07.08	Travelled to Canberra (survey completed)

Attachment 6

(A) Details of the number and location of hived *Apis mellifera* colonies inspected and sampled in Indonesia

Date Sampled	Apiary Site:	Number of Colonies Sampled	Location
08/07/08	1	6	Sukabumi, East Java
13/07/08	2	3	Mulima Village, Baliem Valley, Papua Province
14/07/08	3	3	Meakarma, Baliem Valley
14/07/08	4	1	Sinakma Village, Baliem Valley
14/07/08	5	5	Holekama Village, Baliem Valley
15/07/08	6	3	Wamena Town, Baliem Valley
16/07/08	7	5	Timika, Papua Province
TOTALS:	**7**	**26**	

(B) Details of the number and location of hived *Apis cerana* colonies inspected and sampled in Indonesia

Date Sampled	Apiary Site:	Number of Colonies Sampled	Location
08/07/08	1	2	Sukabumi, East Java
11/07/08	2	9	Koya Timor, Papua Province
TOTALS:	**2**	**11**	

Attachment 7

Size and identity of adult female *Varroa* mites that were found reproducing (R) or not reproducing (NR) in *Apis mellifera* colonies at the 7 sites in Indonesia (Site numbers are as per Appendix 5).

Apiary Site:	Reproductive status of female mites (R = reproducing; NR = not reproducing)[1]	Average size (length x width in µm) of adult female mites	Haplotype (determined by DNA finger-printing)
1	R**	1169.2 x 1719.6 (n=10)	Korea *V. destructor*
1	NR**	1059.1 x 1492.2 (n=2)	Java *V. jacobsoni*
2	R*	1063.8 x 1482.7 (n=5)	" "
2	NR*	1063.3 x 1501.7 (n=13)	
2	NR**	1063.1 x 1485.1 (n=10)	" "
3	NR**	1063.6 x 1497.0 (n=7)	" "
4	NR***	1062.6 x 1501.7 (n=2)	" "
5	NR***	1059.1 x 1487.5 (n=10)	" "
6	NR***	1065.0 x 1508.9 (n=10)	" "
7	R**	1166.7 x 1715.2 (n=10)	Korea *V. destructor*
7	NR**	1063.8 x 1494.6 (n=1)	*Java V. jacobsoni*

[1] ** mites collected from capped **worker cells**.
* mites were collected from capped **drone cells**.
*** mites were collected from capped **worker and drone cells**.

Attachment 8
NDAL Press Release in PNG

DESTRUCTIVE MITE THREATENS PNG HONEY AND FOOD INDUSTRIES

Honeybee Pest Outbreak

A small parasitic mite that kills honeybees has been discovered in PNG.

This mite, with a scientific name of *Varroa destructor*, was found in honeybee hives in the Eastern Highlands Province by an Australian Government researcher, Dr Denis Anderson, on Wednesday 28th of May 2008. The discovery has since been confirmed by Officers of the National Department of Agriculture and Livestock (NDAL) and the Provincial Division of Agriculture and Livestock.

It is believed that the mite is present throughout the highlands, is well established, and cannot be eradicated. Its mode of entry into PNG is not known at present.

This varroa mite could cause the total collapse of the growing PNG Honey Industry if not brought under control. The mite will also affect food security and economy at large, because yields important crops (such as yields from coffee, fruits and vegetables) will decline as a result of a reduction in pollination services provided by the honeybees.

The PNG Honey Industry depends on the European honeybee (*Apis mellifera*) and is a cottage type industry that is highly suited a subsistence way of life. The Industry supports more than 500 bee farmers who own a total of about 4,000 hives. These hives produce about 50 tonnes of honey per annum valued at about K0.5 million.

The Honey Industry is mainly concentrated in the Eastern Highlands but some beekeeping activities are carried out in Chimbu, Western Highlands, Southern Highland and Enga Provinces. Bee farming also has the potential for expansion to other parts of PNG like Oro, North Solomons, Central, Morobe, Madang and Sandown Provinces.

The Government of Papua New Guinea must take immediate measures to contain this mite pest before it completely destroys the Honey Industry and reduces crop yields.

Description of the Mite

Varroa mites are external parasites that feed on the blood of honeybees. They produce their offspring on the young larvae of the honeybees. As they produce their young they can also transmit viral diseases, which rapidly kill the developing bees.

Four species of varroa mites are known to science and each is a native parasite of a particular strain of Asian honeybee (*Apis cerana*) in different parts of Asia. The mites do little harm to their native honeybee hosts.

However, one species of varroa mite, *Varroa destructor*, has developed into a harmful pest of the European honeybee. About 50-60 years ago this species shifted host from the Asian honeybee to the European honeybee in north-east Asia. It has since rapidly spread throughout the world.

With the recent discovery of the varroa mite in PNG, Australia is now the only country in the world free from infestation.

The destructive varroa mite has decimated European honeybee populations throughout the world. When it arrives in a country it rapidly kills feral honeybees (hived honey which have become wild) that cannot be protected.

Managed honeybees (in hives) that become infested with the mite can only be kept alive by the use of control measures, which increase the cost of honey production.

When the mite first entered the United States of America in 1987 it caused an immediate 25% decline in the numbers of managed hives and a reduction in hive vigour. Between 1987-1995 hive numbers fell from approximately 5 to 2 million hives. This was despite the fact that methods were being used to control the mite.

Theoretically, using the above USA case, PNG's honeybee hives could be reduced from 4000 to 1600 hives even with control in place. With no control, all 4,000 hives can be expected to be wiped out within 5 years.

Even thought the Asian honeybee arrived in PNG through our Irian Jaya-PNG border in 1998, it did not introduce *Varroa destructor.* Instead, it brought along the less harmful species, *Varroa jacobsoni.*

The only effect from the arrival of the Asian honeybee to PNG was a decline in honey production by European honeybees, due to competition for the same food source (flower nectar and pollen). However, this effect was not too serious because our European honeybees were better collectors of nectar and pollen than the Asian honeybees.

Impact of Mite on PNG Economy

The destructive varroa mite has the potential to completely wipe out European honeybees in PNG, ending the whole Honey Industry.

Initially, the mite will destroy all feral colonies (wild swarming honeybees) and will then start reducing hived honeybees, thus affecting the livelihood of most honeybee farmers.

However, the greatest economic effect that the mite will cause in PNG is a reduction of crop yields that will result from decreased levels of pollination by honeybees.

Although little work has been done in PNG to establish the economic importance of pollination in food and cash crop production, yields from these crops will be significantly reduced if the mite is not controlled. Coffee yields could decline by up

to 50%, and yields of other crops, such as, beans, water melon, cucumber, paw-paw, corn, and pumpkin, will decline.

In Australia, honeybees contribute about $4 billion per annum to the Australian economy through their pollination of important agricultural crops.

Course of Action

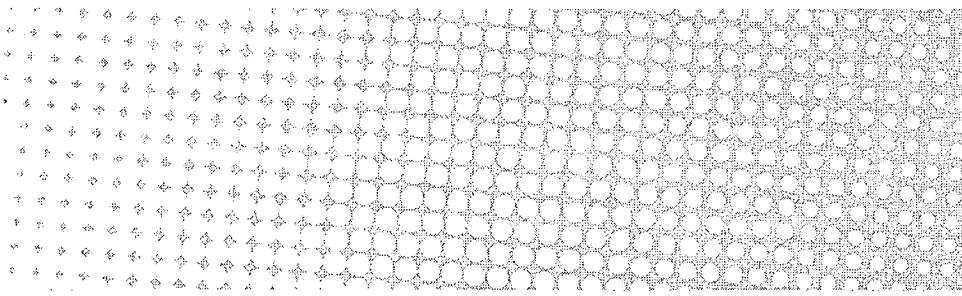
PNG honeybee farmers will now have to live with the varroa mite.

In other countries the mite is controlled with chemicals and Integrated Pest Management methods. The chemicals are expensive and will need to be imported into PNG.

Also, bee farmers and National and Provincial Government Extension Officers will need to be trained in mite control methods.

Research will be needed to develop cheaper control methods and to develop systems for adapting known control methods to PNG conditions.

Therefore, the Government of Papua New Guinea must diligently take immediate measures to contain this mite pest before it completely destroys the Honey Industry and reduces crop yields.



Contact Us

Phone: 1300 363 400
+61 3 9545 2176

Email: enquiries@csiro.au

Web: www.csiro.au

Your CSIRO

Australia is founding its future on science and innovation. Its national science agency, CSIRO, is a powerhouse of ideas, technologies and skills for building prosperity, growth, health and sustainability. It serves governments, industries, business and communities across the nation.