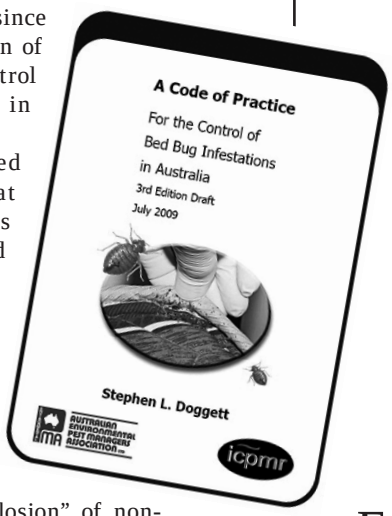
Draft of new Code of Practice puts wind up bed bugs



It has been one and half years since the launch of the second edition of A Code of Practice for the Control of Bed Bug Infestations in Australia (CoP).

Research on and into bed bugs has flourished during that time, with numerous articles produced on both chemical and non-chemical means of control, on the biology and physiology of the pest, as well as the clinical aspects from the insect bite.

Australia's Mr Bed Bug, Stephen Doggett, said the last 18 months has also seen what he describes as "an explosion" of non-chemical devices such as traps, monitors and barriers being introduced onto the bed bug management market.

"Bed bug management is clearly the most rapidly evolving, dynamic and exciting area of research for any pest in the world today," Mr Doggett said.

"All these innovations and the fact that bed bugs are still very problematic, has made it necessary for us to update the Code of Practice to maintain its relevance," he said.

Mr Doggett said a draft of the third edition of the CoP is now available for download from www.bedbug.org.au.

He said the latest version has seen many changes, including:

- The need for pest managers to have a 'bed bug management plan';
- The need for those in the accommodation industry to have a 'pest management policy;
- Updated information on control via heat;
- An enhanced section on pest identification;
- What to look for in a mattress encasement;
- Information on bed bug traps and barriers;
- A section on how to choose a pest manager for bed bug control;
- New information on insecticide efficacy and resistance;
- Bed bugs in rental properties;
- Bed bug management in and on aircraft; and
- Potentially effective insecticides.

In addition, the whole section on bed bug prevention has been totally revised to take in account the four key phases of a bed bug infestation (i.e. the introduction, establishment, growth and spread of an infestation).

"As required by the AEPMA CoP Working Party Guidelines, the working party is endeavouring to ensure broad acceptance of the document by seeking feedback from industry stakeholders," Mr Doggett said.

As a result, the draft third edition is now open for public comment.

All submissions should be sent to Stephen Doggett, c/o Department of Medical Entomology, Westmead Hospital, PO Box 533, Wentworthville NSW 2145, or emailed to: stephen.doggett@swahs.health.nsw.gov.au.

Closing date for submissions is October 15, 2009.

The working party will consider all submissions in the development of the final release of third edition, which is expected late 2009.

Bed bugs that bite back

Confirmation of insecticide resistance in Australia in the Common bed bug, *Cimex lectularius.*

** David G. Lilly[1], Stephen L. Doggett[2], Myron P. Zalucki[3], Chris J. Orton[4] and Richard C. Russell[2]*

Every well-informed pest manager across Australia knows bed bugs (*Cimex lectularius* and *Cimex hemipterus*) have returned with a vengeance.

From being a virtual unknown pest prior to 2000, bed bugs have resurged back into modern life and are now infesting almost all sectors of society around the world. Hotels (one to five star), motels, lodges, backpackers, supported housing, trains, boats, buses, hospitals and even cinemas are no longer immune from the advancing bed bug.

What many people are rightly wondering though is why?

Reasons for the resurgence are multiple and complex. However, several common factors are regularly suggested. Changes in insecticide technology and application towards pest-specific products, as well as cheap airfares leading to an increase in international passenger numbers and travel to more isolated countries where bed bugs have never declined may all have enabled bed bugs to spread and proliferate around the world.

Table 1: Insecticides selected for susceptibility testing against Common bed bugs (*C. lectularius*).

Compound	Chemical group	Group	Australian products registered for bed bugs
Pirimiphos-methyl	Organophosphate	1B	Actellic
Bendiocarb	Carbamate	1A	Ficam W, Ficam D
Permethrin	Synthetic pyrethroid	3A	*Numerous*
Deltamethrin	Synthetic pyrethroid	3A	*Numerous*
Imidacloprid	Neonicotinoid	4A	None

However, while debate continues around the above factors (Boase 2008), there is almost unanimous agreement that insecticide resistance has played a major role in the resurgence of the bed bug.

The development of resistance in bed bugs was already well documented to DDT, other organochlorins and natural pyrethrin in the 1950s (Busvine 1958). As DDT belongs to the same insecticide class as the synthetic pyrethroids, it was perhaps not surprising that resistance would be reported in this latter group.

Indeed this has been recently confirmed in both the UK and US (Boase *et al.*, 2006, Potter *et al.*, 2006) and resistance to the carbamates has also been observed.

Resistance has been suspected in Australia, with many anecdotal reports of treatment failures due to poor product performance and a high degree of difficulty in achieving treatment success (May 2005, Doggett & Russell 2007).

Insecticide efficacy investigations on an Australian derived strain of *C. lectularius* also found evidence of resistance to a range of formulated products (Lilly *et al.* 2009a,b). However, no Australian study has so far attempted to determine either the presence or degree of resistance present in Australia, which was the aim of these investigations.

Table 2: Comparison of adult LD50 (± 95% confidence interval) values between a known susceptible (Monheim) and suspected resistant (Sydney) strain of bed bugs.

Compound	n	LD_{50} (μg/μL)	95% CI
Sydney Strain			
Pirimiphos-methyl	160	0.2935	0.2466 – 0.3494
Bendiocarb	200	6.5422	0.6585 – 65.00
Permethrin	160	622.44	51.68 – 7497.38
Deltamethrin	160	243.24	26.65 – 2219.80
Imidacloprid	200	0.01536	0.01240 – 0.01901
(Control n = 200, 7 deceased at 24h = 3.5% mortality)			
Monheim Strain			
Pirimiphos-methyl	240	0.1063	0.0863 – 0.1310
Bendiocarb	200	0.0274	0.02258 – 0.03330
Permethrin	200	0.0004397	0.0003486 – 0.0005545
Deltamethrin	240	0.0005630	0.0004320 – 0.0007338
Imidacloprid	200	0.005719	0.004668 – 0.007007
(Control n = 200, 6 deceased at 24h = 3.0% mortality)			

To determine the presence and degree of resistance present in Australia a susceptible laboratory strain of common bed bugs (designated Monheim strain and kindly provided by Drs Guenther Nentwig and Reiner Pospischil of Bayer CropScience, Monheim, Germany) was compared with a modern field derived strain, (designated the Sydney strain) via a topical dose response assay.

The LD_{50} (the lethal dose to kill 50% of the test animals after 24 hours) was determined for compound and bed bug strain.

Five compounds (table 1), encompassing the major classes of insecticide registered in Australia for bed bug control, were selected for testing. Also included was imidacloprid to which neither strain should ever have received exposure, and hence would act as a positive insecticide control.

Results and discussion

All compounds tested against the Monheim strain demonstrated high levels of insecticidal activity. However, for the Sydney strain only pirimiphos-methyl and imidacloprid showed high levels of activity.

Bendiocarb, permethrin and deltamethrin all failed to return either a clear dose response or greater than 60% mortality at the maximum initial rate of 100μg/μL.

A large difference in susceptibility, as determined by the factor between LD_{50} values of the two bed bug strains (table 3), was found for both the synthetic pyrethroids (permethrin and deltamethrin), and to a lesser extent the carbamate bendiocarb as well.

Minor differences were found between the two bed bug strains for pirimiphos-methyl and imidacloprid.

This study confirms resistance to synthetic pyrethroids and carbamate insecticides in the common bed bug in Sydney, Australia.

Based on determination of LD_{50} values, the Sydney strain was approximately 238 times less susceptible to bendiocarb, 432,000 times less susceptible to deltamethrin, and 1.4 million times less susceptible to permethrin than the imported Monheim strain.

Significant but comparatively small (2.7 times) differences were also identified for pirimiphos-methyl and imidacloprid, which may be indicative of a slight fitness, genetic, or physiological difference between the two bed bug strains but not insecticide resistance *per se*.

Importantly the result for bendiocarb provides an explanation for a perceived difference between laboratory efficacy and field observations of insecticidal performance (Lilly *et al.* 2009a,b). Despite resistance being confirmed, the degree of resistance to bendiocarb was not especially high.

As a consequence, the LD_{50} returned against a resistant strain (6.54μg/μL) falls in the range just above the actual dose of active (4.8μg/μL) that would be applied in a field situation when the formulated product is prepared and applied as per Ficam W label instructions.

Hence, despite carbamate ▷

Alarmed … but also alert

Tony Abrahams, director of Bed Bug Barrier, is alarmed.

He is also, however, quite alert.

Tony's alarm was raised when he discovered the massive increase in bed bug infestations over the past decade (4600% between 2000 and 2006) especially in the accommodation industry … from five star hotels to backpacker hostels and everything in between.

He was also alarmed by what he perceived to be as a "head in the sand" attitude, especially among property managers.

Closer investigation (prompted no doubt by: "Hey, there's a problem here. Wonder what we could do to fix it, and turn it into a business opportunity?") alerted Tony to an opportunity which ended up with him not only developing a bed bug management tool but also take out the judges' award for Inventor of the Episode on the ABC's New Inventors program.

Tony Abrahams describes his Bed Bug Barrier as: "a simple design, a low cost discreet option which embeds a non-toxic and non-drying glue aimed at capturing the little critters."

Tony said he worked out that part of the reason property owners appeared to be less than proactive was "a result of lack of options and current eradication methods being unsuccessful and poor pest control practices".

"Some practices have helped spread bedbugs because some insecticides repel the bugs, which then disperses them to other areas.

"There is also a problem with insecticide resistance.

"I thought to myself: 'is there any wonder there is the head in the sand mentality. Not only are there limited successful options available to eradicate and control the problem there is also the stigma associated with admitting there is a problem'," he said.

Tony found the cost of current treatments can be anything from $300 up to a worst case $20,000 or more.

"And if an accommodation property had an infestation and had the room(s) treated how would they know if the treatment was successful?", he pondered.

He also asked himself, "What is available on the market that can measure the success of the treatment?"

"Once the room has been treated what products are available to monitor whether the bed bugs return?

"So I set out on my search to find such a product and to my amazement there weren't any.

"With a head full of knowledge on the little critters and an understanding of their behaviour, breeding and feeding patterns and resting areas I put my knowledge to good use and designed a device that I believe is truly revolutionary: the Bed Bug Barrier.

"I'm not claiming to solve all people's bed bug problems as the Bed Bug Barrier is not a cure or a preventative method.

"Rather, it is a control and monitoring device to be used as part of an overall pest management program."

Tony describes his Bed Bug Barrier as: "a simple design, a low cost discreet option which embeds a non-toxic and non-drying glue aimed at capturing the little critters as they try and climb up the bed leg to get to their favourite spot where it's nice and warm and feed off our blood."

◁ resistance being present in a field population, some level of control may be achieved with correct label application of the formulated product.

If the solution is applied at a level where bugs are exposed to a dose greater than 1μL (a likely situation), a suitably high enough dose may be administered to achieve control.

From a pest management perspective however, the above practice is not sustainable as there remains a high risk of treatment failure due to the presence of resistance. Even with heavy application of a formulated product, if it is likely the targeted bed bugs are resistant to some degree to carbamates, then there is a predisposition to treatment failure and the successful perpetuation, enhancement, and spread of the resistance mechanism.

Failure of the synthetic pyrethroid products to control an infestation may also facilitate or increase the spread of resistant bed bugs. Bed bugs are known to be repelled by synthetic pyrethroids (Bauman 2002, Kramer 2004) and susceptible bugs will avoid resting on areas with residual levels of deltamethrin (Romero *et al.* 2009).

Although resistant populations may still find existing harbourages attractive, they will also exhibit increased activity upon exposure to a sub-lethal dose and can be dispersed (Romero *et al.* 2009). ▷

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