



Biology and Management of the German Cockroach

Changlu Wang, Chow-Yang Lee, and Michael K. Rust (eds)

Book Review by Stephen L. Doggett

There are researchers in the field of urban pest control whose work I always follow. This includes the likes of Prof. Changlu

Wang (Rutgers University, USA), Prof. Chow-Yang Lee (University of California), and Prof. Michael Rust (University of California). However, when such icons team up on a project, you know that the outcome will be something truly special, and so it is with the release of the new text, *Biology and Management of the German Cockroach*. Furthermore, this work contains contributions from some of the greatest minds in the field of cockroach research. This includes Prof. Coby Schal, Prof. Edward Vargo, Prof. Dini Miller, Prof. Arthur Appel, Prof. Michael Scharf, and Judith Black, to name but a few of the 14 great authors who wrote sections of the book.

In case you did not know, there is something quite unique about *Blattella germanica*, commonly called the 'German' cockroach. Not only it is a cosmopolitan pest, it is a species uniquely adapted to humans and only occurs indoors. In fact, no population of the species is known to exist anywhere in the world outside of human-built structures. With this predilection for the human environment, the species has become a serious pest. The World Health Organization has recognised the German cockroach as a health threat as it can contaminate food, transmit pathogens, and the allergens it produces are

the source of respiratory complications such as asthma. Furthermore, the German cockroach poses a significant economic threat to food production facilities, catering services such as restaurants, and to residents. Many pest managers spend their whole career focusing on the control of this one insect pest.

The *Biology and Management of the German Cockroach* is the first book dedicated to this species published in the last 25 years. Over this time there have been huge developments in research on the pest, for example, think how baits have replaced insecticidal sprays in recent years. Thus the book summarizes the last 25 years of research and provides a comprehensive historical overview of the management of the species.

The book is divided into 13 chapters and is preceded by a Preface that provides an excellent overview of the book and a dedication to some of the most famous cockroach researchers in the world.

Chapter 1 is titled "*German cockroach infestations in the world and their social and economic impacts*", written by Chow-Yang Lee and Changlu Wang. This section provides an introduction to the pest, from its origins to its global spread around the world. In the process, many examples are given on how dominant this pest has become. For

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Editors: Changlu Wang, Chow-Yang Lee, Michael K. Rust

example, in a survey of 100 food establishments in Los Angeles during the early 1990's, some 62% were infested with German cockroaches. In one apartment over a 24 hour period, some 3,657 cockroaches were collected on six sticky traps that led the researchers to estimate that the population was over 120,000 – in the one home (ugh!). The authors infer that the rise in the German cockroach in Europe was due to central heating and increasing resistance to insecticides.



Prof. Changlu Wang

Chapter 1 also focuses on the huge economic impact of German cockroaches. One study in Georgia, USA, found that the species was responsible for 40% of the damaged caused by insects to the home, with the total damage estimated at the time to be USD\$124.65 million. Typically in the US cockroaches account for around 15.3% of the total pest control market, which was estimated to be USD\$16 billion in 2019.

One extraordinary cost that was mentioned, was the appalling low amount spent on cockroach management in low-income housing in the US that varies between USD\$1.50 to \$4.06 per apartment each month. The authors concluded that, "...the monetary incentives of cockroach IPM in these situations is so low that reasonable control efforts are often wanting." No wonder these sites often have major infestations!

Chapter 2 by Coby Schal and Zachary DeVries

focuses on the public health and veterinary importance of the German cockroach. They note the potential for the species to transmit human pathogens, although state that, "...there are no studies showing a clear epidemiological relationship between cockroaches and infectious disease in real-world settings." However, what is real, is that cockroach allergens can cause serious allergic reactions and trigger respiratory distress including asthma.

Asthma is the most frequent cause of hospitalisation in children and one study showed that 37% of children were allergic to cockroach allergens, while another investigation reported that 26% of the US population is sensitive to the allergens. Furthermore, other investigations have found that the majority of homes have detectable levels of cockroach allergens, with 10.2% having levels high enough to trigger asthma attacks. Other studies have found a strong association household income and cockroach infestations, such that low-income houses tend to have greater levels of infestations. The authors concluded that if more attention was paid to cockroach management, that millions of dollars could be saved on medical expenses.

The next chapter by Arthur Appel examines the biology, nutrition and physiology of the German cockroach. Naturally, information on the insect's biology forms the basis of all management plans and thus such information is critical to include.

Chapter 4, written by the Chief Editor, Changlu Wang, is directed towards those that undertake research on this insect and focuses on the rearing of the species. Without the insect, no research is done. Fortunately, the German cockroach is a relatively easy species to breed in captivity.

'Endosymbionts and the gut microbiome' is the title of Chapter 5, written by Jose Pietri and Madhavi Kakumanu. Cockroaches possess a range of endosymbionts (bacterial-like organisms that live within the creatures' cells) and microorganisms within the gut. In recent years, these have been of great research interest and investigated as a potential means of control. It is also thought that the gut microbiome could be involved in insecticide detoxification, and thus

confers a degree of insecticide resistance.

Cockroaches are gregarious insects that release a range of pheromones, some of which can be synthetically produced and used as an attractant in traps. Thus Chapter 6 by Coby Schal and Ayako Wada-Katsumata, examines behaviour and chemical ecology. In comparison, Chapter 7 by Edward Vargo, looks at dispersal and population genetics. It is quite extraordinary to think, considering how widespread the German cockroach is, that the first record of the species outside of Europe was only in 1842 from New York. This is a species that has undergone a rapid expansion, all due to human movements around the globe.

It is the chapters beyond this that will hold the greatest interest for the pest control industry.

Chapter 8, by Changlu Wang, discusses monitoring. This section provides a comprehensive review of the topic covering the types of monitoring, from resident interviews to sticky traps, with and without attractants. Changlu Wang reviews the best sampling techniques for traps, which is an area where many pest managers could improve on.

Chapter 9 is a very thorough review of chemical control methods by Chow-Yang Lee and Michael Rust. The reality is that while IPM is the desired dream for pest management, chemical control is still the most cost effective solution for cockroach control. Much of the chapter is taken up with tables that reviews the range of insecticides that have been tested for laboratory and field efficacy against the German cockroach for over the last 25 years. Active ingredients used, the formulations applied, and application equipment are also examined. There is also an excellent review of the various botanicals and natural products used against the species.

As baits are the mainstay of German cockroach management for the professional today, Chapter 10 by Arthur Appel and Michael Rust, which looks at management using baits, will have great appeal for the industry. As noted by the two authors, baits have several key advantages over traditional insecticides; baits can be precisely applied to

harbourages where the cockroach occurs. Baits can also be placed in tamper-resistant stations and are less likely to generate insecticide residues. They do not need to be diluted, nor applied with expensive equipment, are quick to apply, and require little to no prep work. Baits are also low-toxic, have little to no non-target impacts, and are odourless. The chapter not only examines the range of actives used over the years, but also reviews the formulations, and the attractants used in the baits, and discusses bait avoidance, which was a huge issue identified in the mid-1990's. Baiting strategies, including placement are reviewed along with their field performance.

As insecticide resistance is a major issue with German cockroaches, a chapter on this topic is a necessity. Chapter 11 by Michael Scharf and Ameya Gondhalekar examines the history of resistance, the resistance process and mechanisms, and how resistance can be monitored. They also reviewed the various methods of resistance management, namely how to avoid resistance from occurring.



Prof. Chow-Yang Lee

The penultimate chapter by Michael Rust, titled 'Alternative control methods' reviews new management strategies. This includes sanitation, biological control, and other forms of novel control options that maybe used in the future. However, unless major resistance occurs, I cannot

see the industry moving away from baits in the near future.

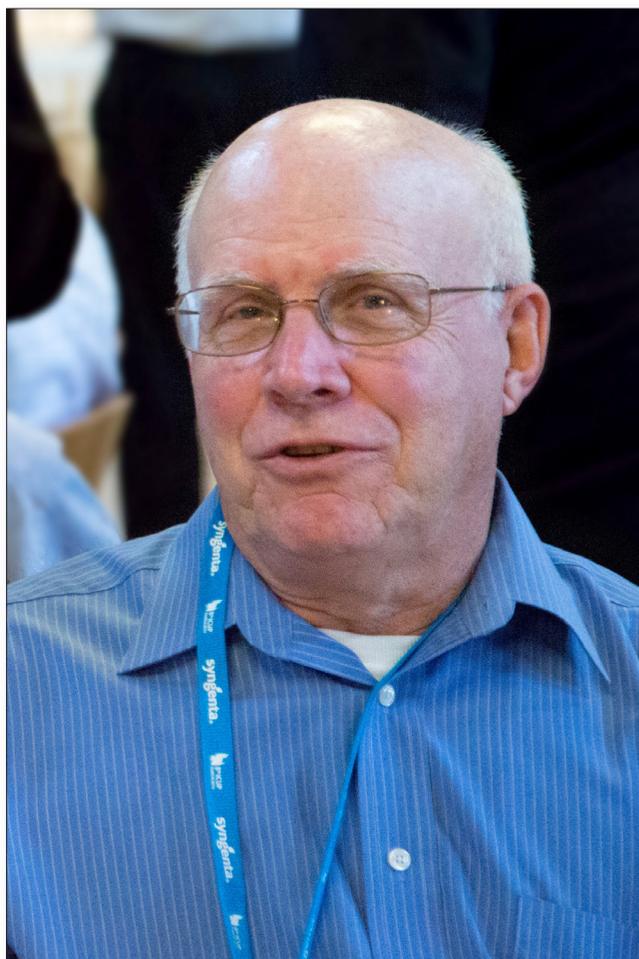
The final chapter is more practically orientated and reviews German cockroach control in two of the most difficult situations encountered by the pest manager; multi-unit dwellings and commercial kitchens. This chapter was written by investigators who have undertaken a huge amount of research in controlling the insect in low-income housing, namely Dini Miller, Judith Black, and Changlu Wang. The authors reviewed the IPM process for cockroaches and discussed how such a program can be set up in these situations.

Included is a very detailed discussion on why apartment buildings in the US have such bad cockroach problems (in short, mostly due to a lack of money for control). An example was given whereby two technicians in New Jersey serviced 258 apartments housed in 40 different buildings, all in the one day. This equated to less than 4 minutes per apartment, and the technicians only used two tubes of gel bait for the entire application. It is thus no surprise that little control was achieved.

An alternative baiting approach is discussed called 'assessment based pest management', whereby stick traps are set and the amount of insecticide applied is based on cockroach counts. If counts are above 500 from the one apartment, then two tubes of gel are applied (rather than two tubes to 258 apartments in the example above!). Such an approach has resulted in dramatically reduced cockroach numbers, but using these large volumes of insecticide gels may increase the risk of resistance in the future.

Finally, the book includes a glossary and a detailed index.

Naturally in any review of a book, it is necessary to offer some critiques, and to be honest, some of the chapters were challenging to read. I did think that the language in a few sections could have been made more accessible to the majority by using less technical terms, or by explaining the terms in a more simplistic language. However, it is important to release this is a reference book



Prof. Michael Rust

and some chapters by the nature of their topic are going to be extremely scientific and harder to read. Thus it is difficult to simplify aspects such as population genetics, physiology, or even endosymbionts. Fortunately those chapters that are going to be of most interest to the pest management industry, including baiting, chemical control, monitoring, alternative control measures, and management in multi-unit dwellings and commercial kitchens, are quite straightforward to read.

The other aspect is that the book is quite US centric, with all authors and editors presently working in the US. However, this is understandable in that the vast majority of research on the German cockroach has originated from the States.

After finishing reading the book (yes I do read

the entire text of those that I review!), there was an obvious question that popped up in my mind; why are German cockroaches called 'German' if they originated from Asia and first described from Denmark? As I could not find an answer in the text, I had to email Prof. Chow-Yang Lee for the answer. Here is his fascinating reply;

"The hypothesis that the German cockroach originated from South Asia was only recently made. Some of us believe it evolved from the Asian cockroach (Blattella asahinai) that resembles the German species almost completely morphologically (except the Asian cockroach has longer and narrower wings, and some other minor morphological differences in the tergal gland) and behaviour. The Asian cockroach is active both at day and night, lives outdoors in leaf litter and grassy areas, can fly, and is attracted to light. On the other hand, the German cockroach is unable to fly, not attracted to light, and only found indoors. As for the tergal gland differences, you can only tell when you dissect the insects. In other words, if you have a live sample, the only way to tell which species is which, would be to throw the cockroach high and see whether it flutters away. If it cannot, it is a German.

Thus why this hypothesis on the species origins? Unlike the Asian cockroach that are found outdoors in South China and Japan, no German cockroach has been found in natural habitats to date. The German cockroach is only found in indoors.

It was believed that the Asian cockroach could have been accidentally transported to Europe via the Silk Road, or any of the sea trading routes from China/East Asia. Upon arriving to Europe, they could have propagated, but the majority died due to the cold winter. Those that did survive would probably be those that lived indoors in the presence of fires/heating devices/boilers. Over time, this species adapted to live indoors before spreading to other parts of Europe and then the world. The earliest specimen of German cockroach is in Europe, not in Asia.

*Now, why it is called the German cockroach? Interestingly, the specimen that Linnaeus examined was not from Germany, but from Denmark. It was originally named *Blatta transfuga* by Brünnich in 1763. As you know, Linnaeus is a Swedish naturalist.*

*At that time, the Seven Year War (from 1756–1763) was going on in Europe. The war involves many parties (it is complicated), but essentially it was between Britain and France and Spain in North America/Caribbean. Sweden, Russia, Austria, Spain and France were on one side, while Great Britain, Prussia, Portugal and other allies were on the other side. You know that Prussia was historically a prominent German state. Between 1757 and 1762, the Sweden–Prussia conflict happened. No one knows for sure, but Linnaeus likely renamed the obnoxious cockroach after the enemy, hence the name *Blatta germanica*. That's why it is known as a "German" cockroach. However, this is just a speculation – no one will be able to find out, unless we are able to hear from Linnaeus himself.*

Thus the insect was likely called 'German' for purely derogatory reasons. Extraordinary! I do wonder if there will be an attempt in the future to rename the species due to rather nefarious reason behind the acquisition of its common name. Perhaps readers of the FAOPMA Magazine may offer a more politically correct suggestion?

The *Biology and Management of the German Cockroach* (ISBN: 9781486312061) is 307 pages, contains some 18 colour plates with over 40 images, and published by CSIRO Publishing and CAB International. It will appeal to researchers, pest managers, students, public health workers and anyone who has to deal with this nuisance insect pest.

Thank you to Ms Melinda Chandler from CSIRO Publishing for providing a complimentary copy of the *Biology and Management of the German Cockroach*.



Chow-Yang Lee

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