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THE EMERGENCE OF URBAN ENTOMOLOGY IN ASIA AND ITS FUTURE

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Abstract Prior to 1960s, non-crop entomological research in Asia primarily focused on vector-borne diseases like malaria, filariasis, dengue, and typhus, due to limited resources. Early research on urban insect pests in Asia, particularly in the 1960s, centered on cockroaches, examining their feeding behavior and insecticide resistance. Termite research initially focused on species affecting forests and plantations, with most studies conducted by forestry researchers concentrating on taxonomy. The structural pest control industry in Asia began post-WWII in the 1940s. Unlike vector control, which was government-driven, managing urban pests like termites, bed bugs, and rodents was left to individuals. During the 1970s, as socio-economic conditions improved, demand for pest management services grew, but the industry struggled to keep pace with evolving technologies and pest biology, often relying on Western literature with limited relevance to the local context. The pest management industry's challenges drove the rise of urban entomology in Asia in the 1990s. Key developments included academic leadership, phasing out chlordane as a soil termiticide, introducing termite baits, and licensing pest management professionals. Moving forward, urban entomology in Asia must address declining research funding, the impacts of climate change on pests and invasive species, and the growing need for trained entomologists.

Key words History, termiticide, insecticide resistance, chlordane, bed bugs, termites, cockroaches

INTRODUCTION

Urban entomology is a subdiscipline within entomology that studies household and structural pests (Ebeling, 1975). Its origin is associated with the publication of the seminal textbook '*Urban Entomology*' by Walter Ebeling in 1975. In Asia, non-crop entomological research was not the main emphasis of entomologists until after the 1960s. Most non-crop insect-related problems that affected humans then were vector-borne diseases (Reid, 1968; Kim, 2022). Due to limited resources, research funds mainly went to investigations on controlling vectors of malaria, filariasis, dengue, and typhus.

Rust et al. (2024) provided an in-depth review of the history of urban entomology, the factors that impacted its development, and how it will evolve in the future. In this paper, I will discuss the factors driving the emergence of urban entomology in Asia, particularly some of the important turning points in its development and future.

HISTORICAL ACCOUNTS

Historically, bed bugs have had notable cultural and historical significance in Asia. The earliest record of the control of bed bugs in China was found in the book *Compendium of Materia Medica* in 1758. However, there is limited documentation regarding the prevalence of bed bugs in China before the establishment of the People's Republic of China in 1949, with only a handful of studies available before 1976 (Wang and Wen, 2011). In 1958, the Chinese government initiated the Four Pests Campaign, which designated rats, sparrows, flies, and mosquitoes as their targeted pests. In 1960, the campaign dropped sparrows and replaced it with bed bugs (Cao and

Liu, 2000) because the 2-year campaign had caused ecological imbalance that led to a massive increase in locust populations, which exacerbated the 1959–61 Great Chinese Famine (up to 55 million people died of starvation), besides due to drought and flood (Bikul 2024). To combat these pests, city governments initiated large-scale elimination campaigns. Trained personnel conducted surveys and demonstrated treatment methods, while residents were provided with insecticides to perform control measures in their homes. In 1978, the National Four-Pest Elimination Research Cockroach and Bed Bug Working Team was established to address cockroach and bed bug infestations (Hu, 1989).

The introduction of bed bugs into Japan dated back to the 1860s, when Dutch warships docked at Nagasaki, the only port open to international trade in southern Japan. Increased foreign trade facilitated the spread of bed bugs (Konishi, 1977). By the early 1900s, major infestations were reported in cities with active international ports, including Nagasaki, Kobe, Nagoya, Yokohama, and Niigata (Aoki, 1901). By the 1940s, Tokyo had only a handful of pest management professionals (PMPs), and bed bugs were one of their primary targets in urban areas. After World War II, infestations peaked in cities like Kobe, where approximately 20% of the city's 400,000 homes were infested (Uemura, 1974). One of the earliest and most comprehensive study on the biology of common and tropical bed bugs was by Omori (1941). The discovery of chlorinated hydrocarbon insecticides, such as DDT and BHC, proved instrumental in controlling these outbreaks. Bed bug infestations had become rare in Japan by the 1960s, particularly before the 1964 Tokyo Olympics (Lee et al., 2018). However, this changed in 2008, as a global resurgence of bed bugs reignited the need for effective pest control strategies (Lee et al., 2018).

In Southeast Asia, bed bugs were a significant insect pest of medical importance associated with human activity between the 1940s and 1970s. They were especially prevalent in hospitals and worker quarters on crop plantations in Malaya. The Pest Control Association of Malaysia reported that during the 1960s and 1970s, bed bugs were the primary pest targeted in Malaysian cinemas. By the late 1970s, similar to that observed in Japan, their prevalence as a pest in Southeast Asia began to decline gradually (Lee et al. 2018).

In China, records of termite damage date back 2,000–3,000 years, with the earliest documented case in 241 BCE. During this time, termites, particularly *Odontotermes* species, were infamous for tunneling through river dikes and dam walls, often causing collapses that led to significant structural failures. The Chinese did not distinguish termites from ants or other wood-destroying insects until the Northern Song Dynasty in 1101 CE. By 1174 CE, they had significantly advanced in understanding termites, publishing detailed records on their biology, ecology, and control methods. These early works laid the foundation for modern termite management. Termite control companies were set up in 1930s in Hong Kong, Macau, and Guangzhou, and training of termite control started in the 1950s by experts from Academica Sinica and Guangdong Entomological Institute (Li et al. 1994). In Southeast Asia, the earliest termite research was on species attacking trees in forests and plantations, mainly on the taxonomy of these species (Ahmad, 1965; Tho, 1989). Research on termites affecting buildings and structures in the urban environment in Southeast Asia began in the 1990s when chlordane usage was prohibited.

Among the earliest published research on urban entomology in Asia were studies of cockroach feeding behavior and food preferences in Japan (Tsuji, 1965; 1966) and the insecticide resistance of the German cockroach (Yasutomi et al., 1966). Later investigations focused on the species composition of cockroaches in Southeast Asia (Oothuman et al., 1984; Yap et al., 1991).

FACTORS DRIVING THE EMERGENCE OF URBAN ENTOMOLOGY IN ASIA

The structural pest control industry in Asia emerged in the 1940s after World War II. At the time, pest management professionals (PMPs) were often referred to as exterminators and later as pest control operators (PCOs). While government agencies primarily managed the control of vector-borne disease insects, the responsibility for addressing urban pests like termites, bed bugs, and rodents fell to individuals. In contrast, cockroaches and ants were a relatively minor concern to Asian people before the 1970s. As socio-economic conditions improved, the demand for professional pest management services grew. The pest control industry sought to adapt to new technology and expand its understanding of pest biology. However, they largely relied on literature from the United States or Europe, such as *Mallis's Handbook of Pest Control* and *Truman's Scientific Guide to Pest Management Operations*, and the *Rentokil Library book series.* The information in these books was often irrelevant to the pest species encountered in Asia. The emergence of urban entomology in Asia was a direct response to the unique issues and challenges faced by the pest management industry in the region.

To have their voices heard, pest management professionals in many Asian countries started pest management associations between the 1970s and 1990s. This was followed by the establishment of the Federation of Asian and Oceania Pest Managers' Association (FAOPMA), in 1987 by several leaders from the pest management associations. FAOPMA unites pest management associations from different Asian countries so that they can speak as one voice of the industry. The inaugural FAOPMA Convention took place in 1989 in Taiwan.

In Southeast Asia, the leaders of the pest management associations of Malaysia and Singapore launched the Pest Summit conference in 2003 in Langkawi, Malaysia. By 2006, associations from Thailand, the Philippines, and Indonesia joined forces with Malaysia and Singapore to organize the 2nd Pest Summit in Singapore. These conferences brought together pest management professionals (PMPs), manufacturers, and academics to foster collaboration and work toward common goals. In 2016, the FAOPMA Convention merged with the Pest Summit, and from 2017 onwards, the event has been known as the FAOPMA-Pest Summit. However, in 2023, discontentment with the FAOPMA organization led to the formation of a new group called the Asian Pest Management Association (APMA). Another significant organization is the Pacific-Rim Termite Research Group (PRTRG), established in 2004. This group organizes biennial conferences that are widely attended by termite researchers in Asia.

The next factor that drove the emergence of urban entomology in Asia was academic leadership. Dr. William Robinson (formerly a professor at Virginia Tech, USA) played a crucial role in developing urban entomology in China. He served as a visiting professor at Zhejiang Agricultural University (now Zhejiang University) from 1984 to 1998 and inspired many students to pursue research in urban entomology. Zhejiang University hosts one of China's few urban entomology programs, presently led by Dr. Jianchu Mo. Another key academic leader was Dr. Han-Heng Yap (formerly a professor at Universiti Sains Malaysia [USM]). After Dr. Yap's retirement in 1996, one of Dr Yap's students, Chow-Yang Lee, was recruited to establish the Urban Entomology Laboratory at USM. Over the next 25 years, Lee mentored many students who later became faculty members and expanded urban entomology programs in Malaysia, Taiwan, Thailand, Indonesia, and the United States. Today, USM is recognized as one of the leading institutions in Asia for urban entomology research.

Fourth was the ban on chlordane as a soil termiticide. From the late 1960s to the 1980s, chlordane, a chlorinated hydrocarbon, was a long-live and effective soil termiticide for both pre-

and post-construction treatments to control subterranean termites in Asia. However, due to its impact and persistence in the environment, its use was progressively restricted across the region starting in the 1980s. For instance, Japan (1986), Taiwan (1988), Malaysia (1997), Philippines (1999), Thailand (2000), Indonesia (2001), and Singapore (prior to 2005), among others. After its ban, PMPs in Asia were left with no effective options and became aware of their limited understanding of the termite species that affected buildings and structures, their biology, and effective control strategies (Lee & Lee 2025). This realization sparked a demand for such information, especially from entomologists in universities, leading to a surge in termite-related research.

Next is the regulatory requirement. Between 1998 and 2010, many countries in Asia (starting with Southeast Asian countries) began licensing their PMPs through their respective environmental protection agencies (EPA), food and drug authorities (FDA), or similar regulatory bodies. The primary goal of this initiative was to ensure that only trained and licensed individuals were authorized to apply pesticides in human environments. To qualify for the pesticide applicator licensing examination, candidates must have a minimum educational requirement, typically a high school diploma. This stipulation gradually phased out individuals with lower qualifications in the industry, who were eventually replaced by entomology graduates trained in pest biology and behavior, IPM, and pesticide science (Lee & Lee 2025). The demand for entomology graduates started to rise in the early 2000s, driven by the implementation of pesticide applicator licensing requirements. Entomology graduates with a strong background in urban entomology from USM became the main talent pool for pest management companies in Malaysia and Singapore. Similarly, graduates from the University of the Philippines' BSc in Entomology program and Zhejiang University in China were also readily recruited by pest management companies in their respective regions.

The last factor is the introduction of termite bait. Between 2000 and 2006, the termite baiting system was introduced in Asia, marking a revolutionary shift in the pest management industry. Termite baiting allowed PMPs to charge higher prices, increasing their profits and fueling rapid expansion for pest management companies. Some companies saw significant growth, within just several years (Lee & Lee 2025). It was also during this time that pest-related information became accessible online. Many PMPs discovered that their potential customers were often better informed about pests than they were. This realization underscored the necessity of employing entomology graduates, who could act as field biologists and marketing specialists, bringing valuable expertise to pest management companies.

CHALLENGES AND THE FUTURE

Moving forward, urban entomology in Asia must address several significant challenges. With the exception of a few countries, such as Taiwan and Thailand, obtaining federal-level funding for urban entomology research is nearly impossible in most Asian nations. Federal agencies generally prioritize funding for fundamental or applied research that benefits the agricultural and manufacturing sectors. As a result, urban entomology research in Asia relies primarily on funding from chemical manufacturers and the pest management industry. However, these funds have been steadily decreasing due to the consolidation of chemical manufacturers following numerous mergers and acquisitions, which has led to fewer companies providing financial support for such research.

Global trade and modern transportation system have facilitated the dispersal of pest organisms. Over the last several years, invasive pest species have been detected in various parts

of Asia. For example, red imported fire ant (*Solenopsis invicta*) was found in different ports in Japan in 2017 (Murakami, 2018) and in the same year, it was also detected in Busan, Korea (Office of Governmental Coordination, 2018). More recently, the well-established populations of Western drywood termite (*Incisitermes minor*) were reported in Seoul, South Korea.

Today, some 51% of Asia's population lives in urban areas, which is expected to increase to more than 66% by 2050. As Asia becomes more urbanized, there will be a growing need for more urban entomologists and PMPs. However, only a limited number of Asian universities offer training in urban entomology. In fact, many universities are downsizing their faculty numbers, and some are forgoing applied entomology research in favor of more fundamental research, as it is preferred by government funding agencies.

CONCLUSION

Urban entomology in Asia has evolved significantly over the past few decades, driven by the growing need to address urban pest issues. Key milestones, including the ban on chlordane, the introduction of termite bait systems, and the establishment of licensing requirements for pest management professionals, have propelled the field forward. However, challenges such as limited funding, the rise of invasive species, and the lack of comprehensive training programs must be addressed to ensure continued progress. Concerted efforts from researchers, policymakers, industry leaders, and government are required for urban entomology to adapt to the changing dynamics of urbanization, globalization, and climate change.

REFERENCES CITED

Ahmad, M. 1965. Termites (Isoptera) of Thailand. Bull. Am. Mus. Nat. Hist. 131:1–113.

Aoki, T. 1901. Possibility of the plague transmission by bed bugs (in Japanese). Konchu Sekai 5(48): 328–334.

Bikul H. 2024. China's smash sparrows campaign and nature's revenge. Thought Might. https://thoughtmight.com/nature/china-smash-sparrows-campaign-nature-revenge

Cao, A.-L. and Liu, Y.-N. 2000. Four-Pest Elimination Campaign in 1958 (in Chinese)**.** History Overview 10: 37–40.

Doggett, S.L. and Lee, C.Y. 2023. Historical and contemporary control options against bed bugs, *Cimex* spp. Annu. Rev. Entomol. 68: 169–190.

Ebeling, W. 1975. Urban Entomology. Berkeley, CA: University of California Press.

Hu, X.Y. 1989. Ten year summary of the work by National Cockroach and Bed Bug Control Research Working Team (in Chinese). *Chinese.* J. Vect. Biol. Contr. 1: 44–47.

Kim, J.R. 2022. Malaria and Japan's colonial frontier: Manchuria, 1900s–1940s. Soc. Sci. Diliman 14: 26–48.

Konishi, M. 1977. Bed bugs, in Mushi no bunkashi. Tokyo: Asahi Shunbun Co.

Lee, C.Y. and Lee, S.H. 2025. Termite baiting – how it changed the landscape of the pest management industry and termite research in Southeast Asia. J. Econ. Entomol. (submitted).

Lee, CY., Hirao, M., Wang, C., and Xu, Y. 2018. The bed bug resurgence in Asia. Pp. 69–79. *In* Doggett, S.L., Miller, D.M. and Lee, C.Y. (eds.) Advances in the Biology and Management of Modern Bed Bugs. Oxford, UK: Wiley-Blackwell.

Lee, S.B., Jeong, S., Lee, H., Kang, Y., Lee, S., Jeong, N.R., Lee, J., Park, S., Kim, J., Han, I., Kim, H., Kim, J., Seo, M.S., Jo, C.W., Kim, S.J., Kwon, H.N., Cook, M.E., Lim, K., Su, N.Y., and Lee, W. 2024. Well-established populations of the western drywood termite, *Incisitermes minor* (Blattodea: Kalotermitidae), in Korea. J. Asia-Pac. Entomol. 27: 102264.

Li, G.X., Dai, Z.R., and Yang, B. 1994. Introduction to termite research in China. J. Appl. Entomol. 117: 360–369.

Murakami, T. 2018. Three case studies for control of invasive alien ant species, fire ant (*Solenopsis invicta*, Formicidae) in Japan. Decision Science 4: 33–42.

Office for Governmental Coordination. 2018. Cooperative quarantine plan among governmental agencies for red imported fire ants.

Omori, N. 1941. Comparative studies on the ecology and physiology of common and tropical bedbugs, with special references to the reactions to temperature and moisture. *J. Med. Assoc. Formosa* 60: 555–729.

Oothuman, P., Jeffery, J., Daud, M.Z., Rampal, L., Shekhar, C. 1984. Distribution of different species of cockroaches in the district of Kelang, Selangor. J. Malay. Soc. Hlth. 4, 52–56.

Reid, J.A. 1968. Anopheline mosquitoes of Malaya and Borneo. Studies from the Institute for Medical Research No. 31. Government of Malaysia.

Rust, M.K., Lee, C.Y., Bennett, G.W., and Robinson, W.H. 2024. The emergence and sustainability of urban entomology. Annu. Rev. Entomol. 69: 59–79.

Tho, YP. 1989. Termites of Peninsular Malaysia. Malayan Forest Records 36: 1–224.

Tsuji, H. 1965. Studies on the behavioral pattern of feeding of three cockroaches, *Blattella germanica*, *Periplaneta americana*, and *P. fuliginosa* with special reference to their responses to some constituents of rice bran and carbohydrates. Jpn. J. Sanit. Zool. 16: 255–262.

Tsuji, H. 1966. Attractive and feeding stimulative effect of some fatty acids and related compounds on three species of cockroaches. Jpn. J. Sanit. Zool. 17: 89–97.

Uemura, T. 1974. Bed bug story (in Japanese). Pest Control 3(3): 16–21.

Wang, C. and Wen, X. 2011. Bed bug infestations and control practices in China: implications for fighting the global bed bug resurgence. Insects 2: 83–95.

Yasutomi, K., Inuoue, Y., Ohtaki, Y., and Asahina, S. 1966. A comparative study of insecticide resistance in the German cockroach in Japan. Jpn. J. Sanit. Zool. 17: 214–217.

Yap, H.H., Chong, N.L., Loh, P.Y., Baba, R., Yahaya, A.M. 1991. Survey of domiciliary cockroaches in Penang, Malaysia. J. BioSci. 2, 71–75.