

## Questionnaire survey of common bedbug (*Cimex lectularius*) infestations in Israel

KOSTA Y. MUMCUOGLU<sup>1</sup> AND URI SHALOM<sup>2</sup>

<sup>1</sup>*Department of Microbiology and Molecular Genetics, The Kuvin Center for the Study of Infectious and Tropical Diseases, The Institute for Medical Research Israel–Canada, The Hebrew University—Hadassah Medical School, P.O. Box 12272, Jerusalem 91120, Israel. E-mail: kostam@cc.huji.ac.il*

<sup>2</sup>*Division of Pest Surveillance and Control, Ministry of Environmental Protection, P.O. Box 91340, Jerusalem 34033, Israel*

### ABSTRACT

The number of reports of human bedbug infestations has dramatically increased worldwide since the mid-1990s. Personal reports by Pest Management Professionals (PMPs) in Israel indicated that in recent years bedbugs have spread all over the country. The aim of this investigation was to study the epidemiology of bedbug infestations and to gain insights into the control of this biting arthropod, by analyzing a questionnaire sent to all registered PMPs in Israel. A confidential 17-question questionnaire was sent by mail to all PMPs. Data were collected from January to June 2009. Out of 1,147 questionnaires sent, 143 (12.5%) were returned and analyzed. The respondents were active in this profession for periods ranging from 1 to 52 years (average 18.1 years). Seventy-seven (53.8%) of the respondents reported that they had seen and treated at least one bedbug infestation in the country during the period covered by the questionnaire. During the years 2006–2008, a 50–150% increase occurred in the reported cases of infestations in comparison to the period of 2001–2005. Bedbugs were mainly reported in new (10) and old (31) hotels, in new (31) and old (84) residences, in new (8) and old (8) prisons, as well as in industrial buildings (13). Banned use of organophosphates inside houses and work places as well as increasing numbers of foreign workers and new immigrants from developing countries were considered as further reasons for the increased number of bedbug infestations. The most commonly used pesticides by the PMPs were pyrethroids, followed by organophosphates and carbamates. Increased public awareness, education of PMPs and clients, appropriate treatment of the infestation, surveillance, prevention, and use of insecticides other than pyrethroids, are all needed to minimize the risk of acquiring or transporting bedbugs, and to prevent their re-establishment in Israel.

**KEYWORDS:** *Cimex lectularius*, bedbug, questionnaire, pest management professionals, epidemiology, control, Israel

## INTRODUCTION

*Cimex lectularius*, the common bedbug, was a well-known biting arthropod in human dwellings throughout the world until the end of WWII. The prevalence of bedbug infestations decreased dramatically in developed countries until the 1980s, largely due to the introduction and widespread use of modern insecticides such as DDT, and probably the improvement in housing conditions (Usinger, 1966; Reinhardt and Siva-Jothy, 2007).

The number of reports of human bedbug infestations has increased dramatically after the mid-1990s in the United States, the United Kingdom, Australia, and also in other European countries. This has been attributed to increased international travel and trade since the end of the cold war, resistance to insecticides, and the shift from broad-spectrum insecticides to more selective control tactics such as insect-specific baits for cockroaches and hormonal growth regulators for fleas (Paul and Bates, 2000; Boase, 2004; Doggett et al., 2004; Potter, 2005; Ter Poorten and Prose, 2005; Hwang et al., 2005; Masetti and Bruschi, 2007; Romero et al., 2007; Doggett and Russell, 2008; Kilpinen et al., 2008; Potter et al., 2010).

Several hypotheses have been proposed to explain the seemingly sudden resurgence of bedbugs, including increased travel to and from areas of the world where bedbugs remained common, increased exchange of second-hand furniture, a shift from premise-wide use of broad-spectrum insecticides to more selective control tactics for other urban pests, and the high resistance of field strains to commonly used pyrethroid insecticides (Potter, 2005; Reinhardt and Siva-Jothy, 2007; Romero et al., 2007).

Bedbug infestations were very common in what is today Israel, until WWII (Kaufmann, 1938; Dolev, 2007). With the intensive use of DDT and lindane, which were also readily available to the public, this pest became very rare, and the few remaining populations were most probably those that became resistant to DDT (Levinson, 1953; Gratz, 1958, 1959).

Passive dispersal is the most important means by which bedbugs reach new habitats between geographically disparate locations. They can be transported on clothes, luggage, and furniture (Potter, 2005; Ter Poorten and Prose, 2005). However, in multiple occupancy dwellings, active dispersal is a major issue due to poor pest control (Doggett and Russell, 2008). Backpackers, immigrants, guest workers, and the homeless have been specifically identified as sources of infestation (Bartley and Harlan, 1974; Doggett et al., 2004; Hwang et al., 2005), although infestations of expensive hotels also shows that people from higher socioeconomic classes could also be infested and transfer bedbugs to other locations.

The initial bite of a bug is often not felt, but later it can itch, swell, burn, become inflamed, or form a weal, and is very disturbing for the patient. There may be a central spot at the site of the bite. Recurrent bites are often concentrated on the arms, legs, and back, as well as on the face around the eyes. Lesions may present in clustered arrangements; sometimes in linear or semi-circular order. Effects of a bite vary between individuals but may persist for a week or more in susceptible persons. Rarely, when a person is hypersensitive, an asthmatic reaction may occur. The host's initial reddish in-

flammatory reactions to bedbug bites are probably caused by vasodilatory substances in their saliva. Apart from the discomfort caused by the bite, bedbugs have been known to cause secondary infections and psychological disorders (Goddard and deShazo, 2009). Chronic *Cimex* infestation can cause nervousness, lethargy, pallor, diarrhea, and even iron deficiency (Paul and Bates, 2000; Masetti and Bruschi, 2007; Reinhardt and Siva-Jothy, 2007).

Recently, we received several reports from Pest Management Professionals (PMPs) in Israel indicating that bedbugs are spreading all over the country. The aim of the present study was to evaluate whether there is a true increase in bedbug infestations as well as to gain some insights into the problem by evaluating the answers to a questionnaire sent to all registered PMPs in Israel.

## MATERIALS AND METHODS

The data in this study were collected during a period of 6 months, from January to June, 2009. A confidential 17-question questionnaire related to the epidemiology and control of bedbugs in Israel was mailed to all PMPs who held licenses at that time (Appendix 1). We received a response of 143 (12.5%) to the 1,147 questionnaires sent. The respondents were actively practicing PMPs for periods ranging from 1–52 years (average 18.1 years) and their services at the time of distributing the questionnaires covered the entire country.

## RESULTS

Seventy-seven of the respondents (53.8%) reported to have seen and treated at least one bedbug infestation in the country during the above-mentioned period. Most (80.2%) believed that bedbugs are rare or very rare in Israel, whereas a much smaller number (19.8%) believed they are quite prevalent.

During the years 2006–2008, a 50–150% increase occurred in reported cases of bedbug infestations compared to the period of 2001–2005 (Fig. 1). Figure 2 shows the areas and localities in Israel, in which PMPs conducted treatments against bedbug infestations.

Presence of the insect was reported mainly in hotels, (new (10) and old (31)), in residences (new (31) and old (84)), and in prisons (new (8) and old (8)), as well as in industrial buildings (13). Infestations were also reported, albeit less frequently, in youth hostels, storerooms, courthouses, army barracks, and caravans for new immigrants, as well as in boarding and non-boarding schools.

PMPs had varied opinions about the main cause of the bedbug resurgence. Many PMPs (42.8%) assumed bedbugs were imported by traveling/tourism, 26.7% thought their reappearance was due to resistance to insecticides, and 30.5% thought it was due to unawareness to the problem, the ban on use of organophosphates inside houses and work places, and the increasing numbers of foreign workers/new immigrants from developing countries.

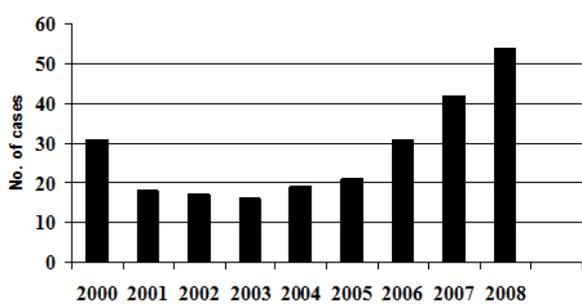


Fig. 1. Number of reported treatments of bedbug infestations in the years 2000–2008 in Israel.

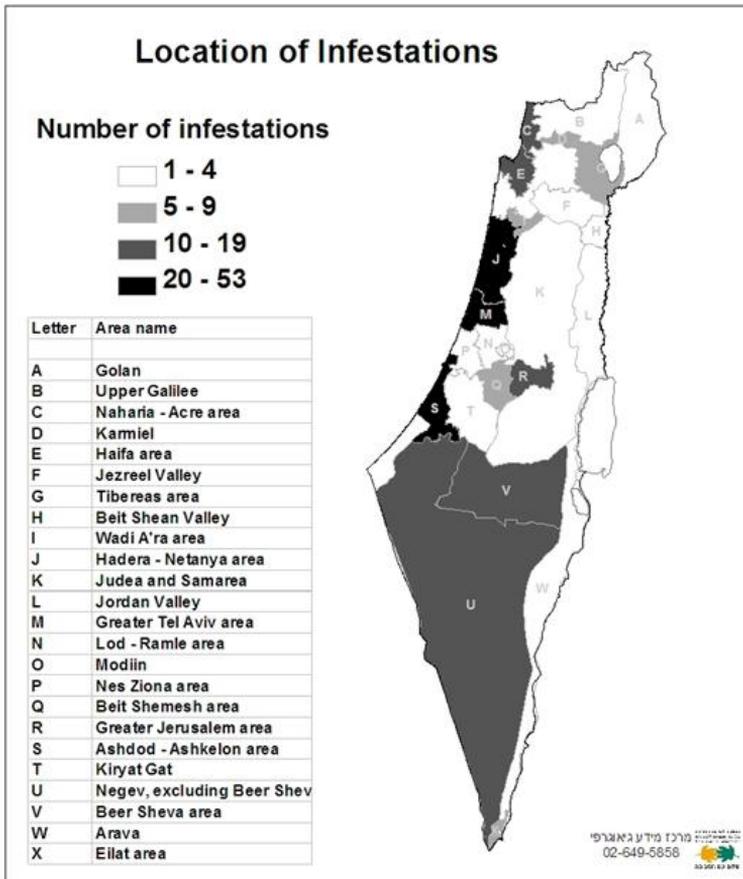


Fig. 2. Areas and localities in Israel, in which PMPs conducted treatments against bedbug infestations.

Twenty-one PMPs thought that bedbugs were imported from Africa (Ethiopia and Egypt), 19 from Asia (Palestinian Authority, Jordan, China, Thailand, India, Turkey, and Vietnam), 3 from the Americas (USA and Brazil), and 18 from Europe, including 12 from eastern Europe (Moldavia, Romania, and Russia) and 6 from western Europe (France, Italy, Portugal, and UK).

The most commonly used pesticides were pyrethroids such as permethrin, cypermethrin, cyfluthrin, deltamethrin, and transfluthrin (60 reports). Many PMPs (34) used organophosphorous insecticides (chlorpyrifos, diazinon, and Malathion) at least until the end of 2007, when the use of diazinon and chlorpyrifos for this purpose was banned. A smaller number of PMPs used other products (4 IGRs and JHAs (pyriproxypane)): 9 used carbamates (propoxur), 2 used gas formulations (phostoxin and methyl bromide), and 5 used unidentified chemicals.

Other control measures used by PMPs were sun exposure (14), washing (4), cleaning (3), and ventilation (3).

## DISCUSSION

Our findings from the survey responses indicate an increase of 50–150% in reported cases of bedbug infestations in homes and public buildings in Israel in recent years. This is in agreement with a trend observed in other developed countries, as resurgence in populations of *C. lectularius* has been reported over the past 10 years in many areas of North America, Australia, and Europe (Paul and Bates, 2000; Doggett et al., 2003, 2004, 2008; Boase, 2004; Potter, 2005; Ter Poorten and Prose, 2005; Hwang et al., 2005; Masetti and Bruschi, 2007; Romero et al., 2007; How and Lee, 2010; Potter et al., 2010). The increase in bedbug infestations was documented in apartment houses, single-family residences, rooming houses, hotels, and shelters for homeless people (Hwang et al., 2005; Romero et al., 2007). In the present study, more cases of bedbug infestations were reported in old houses, hotels, and prisons than in new accommodations. The fact that more bedbug infestations were reported from the Tel Aviv, Ashkelon, Haifa, and Jerusalem areas could be explained by the denser population in these cities.

Most of the respondents indicated that they used pyrethroids for the control of bedbugs, followed by organophosphates and carbamates. Organophosphates were banned for use in houses in Israel at the end of 2007. Because in the present questionnaire PMPs were asked what insecticides they used since 2000, some of them indicated that they used such chemicals. Today only pyrethroids such as permethrin, deltamethrin, tetramethrin, and bio-allethrin, as well as the carbamate propoxur, are allowed for the control of non-flying insects such as bedbugs in Israel. Pyrethrins, pyrethroids (e.g., permethrin), and organophosphates (e.g., malathion and dichlorvos) are widely used for the control of *C. lectularius* elsewhere in the world (Ter Poorten and Prose, 2005). When compared to a susceptible colony of bedbugs, extremely high levels of resistance to two pyrethroid insecticides, deltamethrin and lambda-cyhalothrin, were detected in bedbug populations collected from human dwellings in Kentucky and Ohio (USA) and cypermethrin resistance was observed in the UK (Boase, 2004). Due to the cross-resistance between DDT

and pyrethroid insecticides (Busvine, 1977), and because DDT resistance was reported decades ago in different countries, including Israel (Cwilich et al., 1957; Gratz, 1959; Mallis and Miller, 1964), it is probable that resistance alleles may still be present in current bedbug populations. This may explain why 26.7% of the respondents believed that resistance is one of the reasons for the bedbug infestations and why pyrethroids failed to control bedbug infestations in Israel (Mumcuoglu, 2008). Indeed, the fact that most PMPs use pyrethroids for the control of bedbugs in Israel and that organophosphates are now banned for use may explain why infestations have recently become more prevalent in the country. It is noteworthy that at least until 2008, PMPs in Israel did not regularly employ IPM methods that have become an integral part of bedbug control in other countries (Anonymous, 2006; Wang et al., 2009; Potter et al., 2010).

According to Usinger (1966), the tropical bedbug (*Cimex hemipterus*) is native to tropical countries of Central and South America, Africa, and southern Asia. Although this species was occasionally reported in countries from subtropical and temperate geoclimatic regions (Doggett et al., 2003; How and Lee, 2010), there is no indication that it became established in these areas. In Israel, *C. hemipterus* was found in four poultry houses and was also detected a few times in houses of people who worked in the infested poultry houses (Rosen et al., 1987). In the present study, none of the reported cases by PMPs were from poultry houses, and six samples of bedbugs collected from human dwellings during and after this survey were identified as *C. lectularius* (Usinger, 1966). Nevertheless, it is still possible that some of the reported cases were due to infestations by *C. hemipterus*.

In conclusion, increased public awareness and education of PMPs, including appropriate treatment of infested buildings by surveillance, prevention, and use of insecticides other than pyrethroids, IPM, and development of industry standards are needed in order to minimize the risk of acquiring or transporting bedbugs and to prevent them from spreading in Israel. Because infestations are relatively rare, it is still possible to reduce the risk drastically with appropriate control measures and education.

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### REFERENCES

- Anonymous. 2006. Bed bugs—importance, biology, and control strategies. Washington, DC: Armed forces pest management board technical guide No. 44. (Available from: <http://www.afpmb.org>)
- Bartley, J.D. and Harlan, H.J. 1974. Bed bug infestation: its control and management. *Military Medicine* 139: 884–886.
- Boase, C.J. 2004. Bed bugs—reclaiming our cities. *Biologist* 51: 9–12.
- Busvine, J. 1977. Urban pests of public health importance. *Royal Society Health Journal* 97: 130–134.

- Cwilich, R., Mer, G.G., and Meron, A.V. 1957. Bedbugs resistant to gamma-BHC (Lindane) in Israel. *Nature* 179: 636–637.
- Doggett S.L. and Russell R.C. 2008. Pp. 407–425. The resurgence of bed bugs, *Cimex spp.* (Hemiptera: Cimicidae) in Australia: experiences from down under. Proceedings of the 6th International Conference on Urban Pests. Budapest, Hungary, 13–16 July 2008.
- Doggett, S.L., Geary, M.J. and Russell, R.C. 2004. The resurgence of bed bugs in Australia: with notes on their ecology and control. *Environmental Health* 4: 30–38.
- Doggett S.L., Geary M.J., Crowe W.J., Wilson P., and Russell R.C. 2003. Has the tropical bed bug, *Cimex hemipterus* (Hemiptera: Cimicidae), invaded Australia? *Environmental Health* 3: 80–82.
- Dolev, E. 2007. Allenby's military medicine: life and death in World War I Palestine. I.B. Tauris Publishers, London, pp. 86–87.
- Goddard, J. and deShazo, R. 2009. Bed bugs (*Cimex lectularius*) and clinical consequences of their bites. *JAMA* 301: 1358–1366.
- Gratz, N.G. 1958. Insecticide resistance among insects of public health importance in Israel and neighbouring countries. *Tavruah* 4: 26–32.
- Gratz, N.G. 1959. A survey of bed-bug resistance to insecticides in Israel. *Bulletin of the World Health Organisation* 20: 835–840.
- How, Y.-F. and Lee, C.-Y. 2010. Survey of bed bugs in infested premises in Malaysia and Singapore. *Journal of Vector Ecology* 35: 89–94.
- Hwang, S.W., Svoboda, T.J., De Jong, L.J., Kabasele, K.J., and Gogosis, E. 2005. Bed bug infestations in an urban environment. *Emerging Infectious Diseases* 11: 533–538.
- Kaufmann, L. 1938. Housing in Jewish Palestine. The Jewish Agency for Palestine, Jerusalem, pp. 25–31.
- Kilpinen, O., Jensen, K.M.V., and Kristensen, O. 2008. Pp. 395–399. Bed bug problems in Denmark, with a European perspective. Proceedings of the 6th International Conference on Urban Pests. Budapest, Hungary, 13–16 July 2008.
- Levinson, Z.H. 1953. The control of bedbugs (*Cimex lectularius* L.) with DDT and GBH in Israel. *Rivista Parassitologica* 14: 233–234.
- Mallis, A. and Miller, A.C. 1964. Prolonged resistance in the house fly and bed bug. *Journal Economic Entomology* 57: 608–609.
- Masetti, M. and Bruschi, F. 2007. Bedbug infestations recorded in central Italy. *Parasitology International* 56: 81–83.
- Mumcuoglu, K.Y. 2008. A case of imported bed bug (*Cimex lectularius*) infestation in Israel. *Israel Medical Association Journal* 10: 388–389.
- Paul, J. and Bates. J. 2000. Is infestation with the common bedbug increasing? *British Medical Journal* 320: 1141.
- Potter, M.F. 2005. A bed bug state of mind: emerging issues in bed bug management. *Pest Control Technology* 33: 82–85, 88, 90, 92–93, 96–97.
- Potter, M.F., Rosenberg, B., and Henriksen, M. 2010. Bugs without borders, defining the global bed bug resurgence. *Pestworld* Sept/Oct: 8–20.
- Reinhardt, K., and Siva-Jothy, M.T. 2007. Biology of the bed bugs (Cimicidae). *Annual Review of Entomology* 52: 351–374.
- Romero, A., Potter, M.F., Potter, D.A., and Haynes, F. 2007. Resistance in the bed bug: a factor in the pest's sudden resurgence? *Journal of Medical Entomology* 44: 175–178.
- Rosen, S, Hadani, A., Gur Lavi, A., Berman, E., Bendheim, U., and Hisham, U.Y. 1987. The occurrence of the tropical bedbug (*Cimex hemipterus* Fabricius) in poultry barns in Israel. *Avian Pathology* 16: 339–342.

- Ter Poorten, M.C. and Prose, N.S. 2005. The return of the common bedbug. *Pediatric Dermatology* 22: 183–187.
- Usinger, R.L. 1966. *Monograph of Cimicidae* (Hemiptera, Heteroptera). College Park, MD, Thomas Say Foundation, 585 pp.
- Wang, C., Gibb, T., and Bennett, G.W. 2009. Evaluation of two least toxic integrated pest management programs for managing bed bugs (Heteroptera: Cimicidae) with discussion of a bed bug intercepting device. *Journal of Medical Entomology* 46: 566–571.

## APPENDIX

Questionnaire for pest management professionals regarding the presence of the bedbug, *Cimex lectularius*, in Israel.

1. Name of the company or business.
2. Number of people working in the company.
3. Name and cell phone number of person filling in this form (not mandatory).
4. Has been active in this occupation since
- 5\*. Covered areas: Nahariya–Acre, Haifa and surroundings, Tiberias, Wadi ‘Ara, Hadera–Netanya and surroundings, Tel Aviv metropolitan area, Beit Shemesh and surroundings, Jerusalem and surroundings, Ashdod–Ashkelon and surroundings, Be’er Sheva and surroundings, Negev (with the exception of Be’er Sheva), Eilat, entire country, other.
- 6\*. Did you find and treat bedbug infestations? Yes/No. If yes, please fill in the following table:

	New hotels	Old hotels	New private houses	Old private houses	Industrial buildings	Old prisons	New prisons	Other
2000	Y/N	Y/N	Y/N	Y/N	Y/N	Y/N	Y/N	Y/N
2001	Y/N	Y/N	Y/N	Y/N	Y/N	Y/N	Y/N	Y/N
2002	Y/N	Y/N	Y/N	Y/N	Y/N	Y/N	Y/N	Y/N
2003	Y/N	Y/N	Y/N	Y/N	Y/N	Y/N	Y/N	Y/N
2004	Y/N	Y/N	Y/N	Y/N	Y/N	Y/N	Y/N	Y/N
2005	Y/N	Y/N	Y/N	Y/N	Y/N	Y/N	Y/N	Y/N
2006	Y/N	Y/N	Y/N	Y/N	Y/N	Y/N	Y/N	Y/N
2007	Y/N	Y/N	Y/N	Y/N	Y/N	Y/N	Y/N	Y/N
2008	Y/N	Y/N	Y/N	Y/N	Y/N	Y/N	Y/N	Y/N

7. Do you think that bedbugs are present in Israel?  
 no     very rarely     rarely     common     very common
8. Which areas did you treat more than 3 times?
9. Do you think that bedbugs are more common today than in previous years? Yes/No.  
If yes, since when have bedbug infestations become more common in this country?
- 12\*. If you think that there are more bedbug infestations today than in previous years, what are the reasons for this increase?  
 resistance to insecticides  
 introduction from other countries via tourists  
 other:
13. Do you think that bedbugs enter Israel from neighboring countries? Yes/No. If yes, from which countries?
14. Do you think that bed bugs enter Israel with tourists? Yes/No. If yes, from which countries?
15. Which insecticide(s) do you use for the control of bedbugs?

16\*. Do you use additional control measures (e.g., vacuuming, filling holes and floor crevices, discarding old furniture and mattresses, heat, steam, other)?

17. Would you like to receive information about bedbug biology and control? Yes/No.

If yes, please provide your E-mail or postal address.

\*If appropriate, specify more than one option.