

BED BUG PROBLEMS IN DENMARK, WITH A EUROPEAN PERSPECTIVE

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Abstract Based on historical data on the number of inquiries to the advisory service at the Danish Pest Infestation Laboratory we have tried to analyse the variation in bed bug infestations in Denmark since the 1950s. The bed bug problems in Denmark have gone from low levels in the 1950s, gradually increasing to a peak in the mid-1980s. From there on the problems diminished, but were still present. In the last 10 years the problems are increasing again. The available information from other European countries seems to indicate that this is the same situation in many countries. One possible reason for the recent increase in the bed bug problems is resistance against the available insecticides. To investigate this possibility we collected bed bugs from 20 different locations in Denmark and tested their sensitivity against chlorpyrifos, permethrin and deltamethrin; the most important insecticides registered in Denmark for bed bug control. Compared with a sensitive US strain there was widespread resistance against permethrin and deltamethrin whereas only cases of reduced sensitivity to chlorpyrifos were found. The resistance to pyrethroids is comparable with recent results from the US and UK, indicating that it might be found also in many other countries. This means that the pyrethroids are not a good solution for controlling bed bugs whereas chlorpyrifos continues to be active. However, chlorpyrifos will probably not be available for Danish pest control operators anymore, leaving no effective insecticides for the treatment of bed bug infestations. Therefore, there is an urgent need for the development and registration of new control methods.

Key Words *Cimex lectularius*, resurgence, pyrethroids, organophosphates

INTRODUCTION

After a long period out of focus there has been a growing interest in the last 5-10 years for the bed bug, *Cimex lectularius* L., not just in the scientific world, but also in the news media. Although the bed bugs are not considered important for transmission of diseases, they often cause residents serious distress. Frequently, bed bugs are incorrectly associated with poor hygiene, leading to disgust and shunning. Better public knowledge and awareness about this blood-sucking Hemipteran are important for relieving the distress of those affected and for improving the early detection of bed bug problems, thus reducing the spread. We have tried to combine information on bed bugs gained over a long period in our advisory service with experience from a resistance survey carried out in Denmark during the past 3 years as well as information from literature and personal contacts on the situation in other European countries.

BED BUGS IN DENMARK AND EUROPE

From Denmark we have data on the inquiries on pest problems to the advisory service at the Danish Pest Infestation Laboratory (DPIL). The advisory service is free of charge for both private persons and companies, and data on the number of inquiries for different pest species have been stored for each month since 1965, and back to 1953 there are annual data available. A problem, however, with the data is the variation in the overall activity, for example a drop in the total number of inquiries from around 12,000 in the late 1990s to around 6,000 in recent years. The most important reason for this decrease is the introduction of an internet-based advisory system, growing in popularity all the time. Around the peak in the mid-1980s (Figure 1) the number of inquiries on bed bugs alone was around 300 cases per year whereas in the last years the number has stayed at approx. 120-130 cases per year. However, 2007 resulted in 13,000 downloads of the bed bug fact sheet from the DPIL homepage, indicating that part of the need for advice is now being fulfilled via the internet. In order to compensate for this variation, Figure 1 shows the bed bug inquiries as the fraction of the total number of inquiries for each year. Obviously, these data can be affected by a number of factors such as

public awareness of different pest species or general knowledge of a given pest species, i.e. inquiries/hits on cat fleas have decreased because cat and dog owners know how to treat for them. Therefore, the data should mainly be interpreted as an indication of the magnitude of control problems with bed bugs.

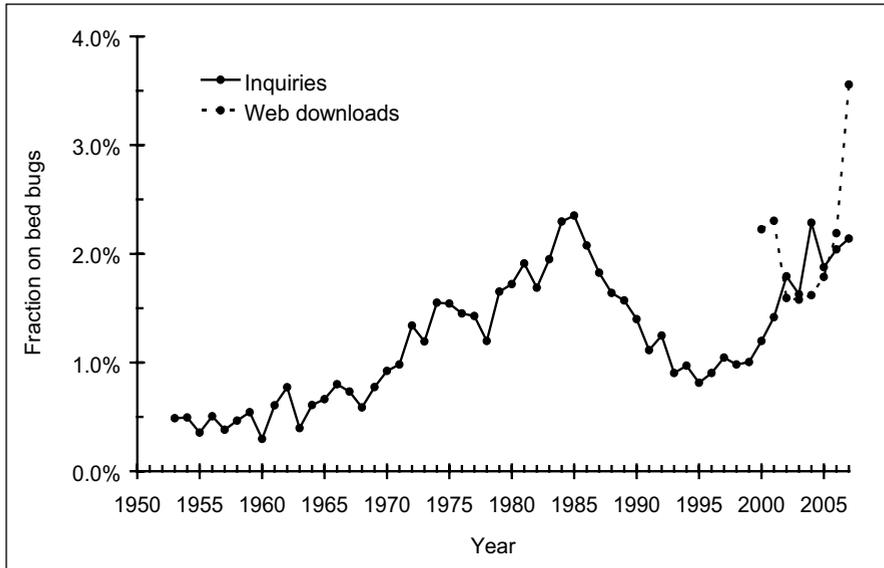


Figure 1. Inquiries to the advisory service at the DPIL and downloads of fact sheets about bed bugs as a fraction of the total number of inquiries or downloads for each year.

Denmark. As reported by Boase (2007) the bed bug problems were quite low in the 1950s and up through most of the 1960s. From the late 1960s to 1985 the bed bug problems in Denmark gradually increased. In 1987 there was some speculation that this increase originated in increasing traffic to and from Southern European countries, both from tourism and guest workers in Denmark (Arevad, 1987). Furthermore, the bed bug certificate that used to be mandatory in connection with inhabitants leaving an apartment had become more slack after a period with very low numbers of bed bug cases in the 1950s (Winding and Mourier, 1970). In the 1970s the insecticides mainly used were organochlorides and organophosphates. The use of organochlorides ended in the late-1970s. In 1982 synthetic pyrethroids were introduced in Denmark possibly explaining the very distinct drop in the bed bug cases from 1985 to 1995. From 1995 and until today we are now seeing a resurgence of bed bug problems. This is also indicated in the number of downloads of the bed bug fact sheet, which has increased dramatically from 2002 to 2007 (Figure 1, dotted line). The same trend is reported by the pest control operators (PCOs) in Denmark, although only few and confidential data are available.

We have tried to collect information from around Europe on the bed bug situation. The general picture is that there are no dedicated bed bug surveys. This means that we only have more or less anecdotal reports against which great precautions should be taken. Nevertheless, all contacts report that the bed bug incidence has increased in recent years.

Sweden. From Sweden we have reports from a large PCO demonstrating approx. 100% increase in bed bug cases from 2002 to 2006. The number increased from 383 cases in 2002 to 770 cases in 2006. Half the cases were from Stockholm.

Norway. The Norwegian Folkehelseinstituttet (Folkehelseinstituttet, 2008) publishes a collection of data from a series of PCOs. Unfortunately, these data are only available for the year 2007 where they had a total of 392 cases with the most cases occurring in July to November (Figure 2). Interestingly, the same pattern is found in the inquiries to the DPIL advisory service on bed bugs; there are approx. twice as many cases in the months July to November compared with the rest of the year (Figure 2) over the last five years 2003-2007. The same pattern can be followed more or less every year back to 1965 (not shown). The reason

for this monthly distribution of activity is not known, but it may reflect the introduction of bed bugs in connection with summer holiday travels or higher reproduction rate and overall activity of the bed bugs in the summer and autumn months compared with the colder winter months.

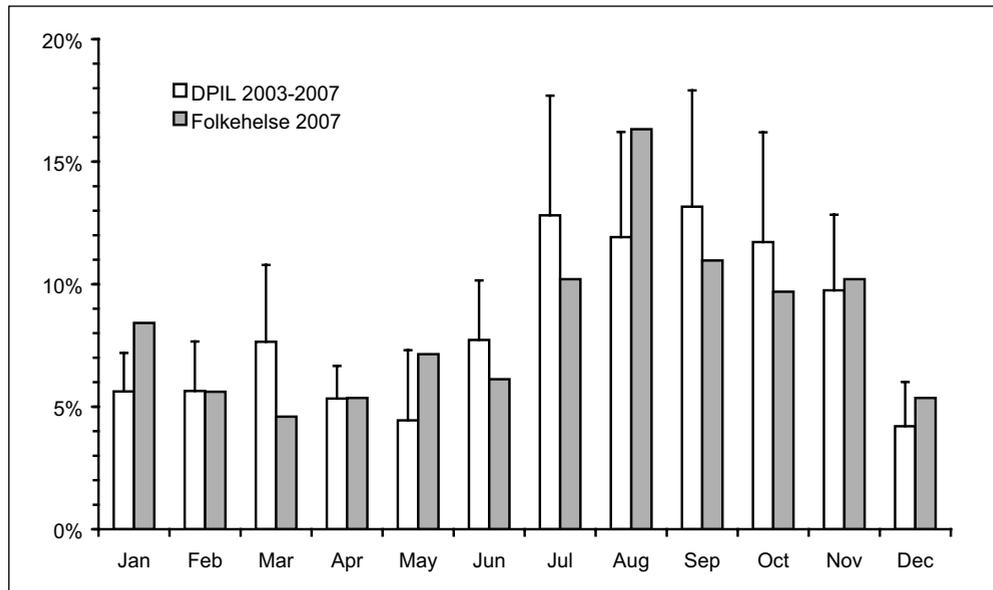


Figure 2. Average (+SD) monthly distribution of the bed bug inquiries to the advisory service at the DPIL calculated for the period 2003-2007, and the monthly distribution of cases from Norwegian PCOs in 2007 (total number of cases is 392) (Folkehelseinstituttet, 2008).

United Kingdom. From the UK there are several reports on increasing incidence, mainly based on reports from PCOs (Bates, 2000; Boase, 2004, 2007; Reinhardt and Siva-Jothy, 2007). In most cases the incidences started to increase around the end of the century. Besides this information, we have personal but only anecdotal reports from Germany (Marion Kotrba, pers. comm.) and Spain (Milagros Fdez de Lezeta, pers. comm.) about increasing bed bug problems.

United States and Australia. Despite the general picture of increasing bed bug problems in Europe, the situation seems much worse in the US and Australia, judging from what we have seen so far. From Australia interviews with a large number of PCOs found a 45 times increase in the number of bed bug cases from 1999 to 2006 (Dogggett, 2007). From the US there are numerous newspaper articles about bed bug “epidemics” in some of the major cities, but we have not seen any published data on them. No such extreme developments in Europe have come to our knowledge, but as mentioned the information is scarce, and we cannot conclude that Europe is not heading for a similar situation.

CONTROL FAILURE

One of the reasons for the increase in bed bug problems could be resistance against the available insecticides. In Denmark we have two groups of insecticides registered for application against bed bugs: synthetic pyrethroids and organophosphates. As to the latter, chlorpyrifos is the only one available now, and that is not for long as it has been withdrawn from the Danish market.

In a recent survey for the resistance status among bed bug populations in Denmark, live bed bugs were collected from private houses and apartments. The locations were found based on inquiries to the advisory system at the DIPL or to PCOs. The bugs were collected by personnel from the DPIL or PCOs.

In our survey, 20 field-collected bed bug strains, primarily from the Copenhagen area but also from the rest of the country, were tested for resistance against permethrin and deltamethrin as well as chlorpyrifos. The level of resistance was not measured accurately, but estimated with a discriminating dose test that was designed to show whether control failure could be expected. Among the field-collected strains we observed

widespread resistance against the pyrethroids, permethrin, and deltamethrin. Chlorpyrifos was definitely more effective than the pyrethroids but compared with the reference strain the sensitivity was reduced in more than half of the field-collected populations. Testing the strains with the commercial product (Empire 20) containing micro-encapsulated chlorpyrifos showed that the product still produced full mortality under laboratory conditions.

Resistance against synthetic pyrethroids have been reported also from the US (Romero et al., 2007) and UK (Boase et al., 2006). When the global movement of bed bugs through travels is also taken into consideration, this probably means that the resistance against this group of insecticides is common in many parts of the world.

BED BUG INFESTATIONS

In many of the bed bug locations visited in our resistance survey, the introduction of bed bugs could be attributed to travels, often made around 6 months earlier. Obviously, it is very difficult to make sure where the bed bugs come from. In the most straight-forward cases the persons had been bitten during travelling e.g. at the hotel, and the biting sometimes continued after the return home. In the less obvious cases, the delay from the return home to the bed bugs being detected might be explained by only one or very few individual bed bugs in the original introduction. Half a year represents one or two generations of bed bugs, where after the populations are big enough to cause serious discomfort leading to detection. Detection of the bed bugs also depends on how strongly the persons react to the bites. There have been a couple of cases where the populations have developed into huge numbers because the persons were not reacting to the bites, thereby giving the population time to reach high numbers. At the other extreme, some persons react so strongly to the bed bug bites that only one or very few individual bugs could be found even with careful inspection.

In two cases with heavy infestations, the bed bugs had spread to other apartments over, under or next to the original source of introduction; they can even spread between stairways. Since the bugs are wingless, they need to be carried around or find physical passages between apartments. To our knowledge, there are no specific studies as to where the bed bugs are found in houses or apartments, however, a search for bed bugs in many locations clearly demonstrates that narrow openings underneath the bed is the usual place to find them. Depending on the type of bed, the hiding places can be joints of the bed frame, screw-holes, or seams of mattresses etc. The hiding places can be characterized as narrow openings that the bed bugs come across when they move away from the host. It is clear that the bed bugs are displaying some kind of aggregation behaviour, probably triggered by both their thigmotactic behaviour (Usinger, 1966) and by aggregation pheromones (Levinson and Bar-Ilan, 1971). However, they are usually not found in one big cluster, but more likely in a casual grouping of individuals. When a bed is placed against a wall, the bed bugs can also be found between the bed and wall or behind pictures etc. Even though these are the most usual hiding places, bugs in small numbers can by accident be carried all over the house or apartment. One risk in particular is that when people are being bitten in their bed, they often start sleeping on a sofa or on a mattress in another room. This is, obviously, a serious risk of spreading out the bed bugs even further. As it is the case with other pest insects like e.g. head lice we need more information about how bed bugs disperse between locations, so more research is required.

FUTURE SITUATION

If, in the years to come, the situation in Denmark is that only pyrethroids are available for bed bug control, serious problems with control failure must be expected. Unless new effective insecticides are introduced, the Danish PCOs will probably have to turn to alternative methods such as steam or desiccant dusts for control of bed bugs; methods that require a more detailed knowledge of the biology of the bugs than usually needed in connection with insecticides.

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