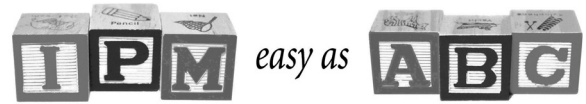


## IPM for Bed Bugs



### Introduction

Bed bug infestations are increasing in the U.S. and continuing to spread through single-family and multi-unit homes. More people are living with bed bugs than ever before, which means there is an increased likelihood that people may transport bed bugs from home to other locations. Children living with bed bugs at home will bring bed bugs to school and childcare facilities. Adults will be taking them to the doctor's office, the hospital, their public library, their workplace, and other locations they visit.

Because the focus of this publication is to address pest management in sensitive environments, the approach to managing bed bugs will differ greatly depending on whether bed bugs have been introduced into a facility or if a full-blown infestation is found.

### Identification and Biology

Bed bugs are reddish-brown, wingless, and very flat (Figure 8-1). Adults are about 3/8 to 1/4-inches long. The tiniest bed bugs are light colored — almost translucent — before feeding. After a blood meal, bed bugs have a distended body and can look like a completely different insect (Figure 8-2).

Bats and birds may serve as hosts for other blood-feeding bugs that look

nearly identical to bed bugs (Figure 8-3). It is important to make sure the infestation is actually *Cimex lectularius*, the human bed bug, because the first step in solving a bird or bat bug infestation is to eliminate bird nesting sites or bat colonies. Follow-up chemical treatments will often differ

depending on the location of the bat or bird infestation. Consult your local Extension educator or professional entomologist to verify the species in question.

Bed bugs are nocturnal and feed on sleeping individuals after following



Photo: Barbara Ogg

Figure 8-1. Bed bugs are flat and hide during the day in cracks and crevices. This is an adult bed bug.



Photo: Vicki Jedlicka

Figure 8-2. Each bed bug needs a blood meal about once a week. As it feeds, its body fills up and enlarges, and it looks quite different from the unfed bed bug.

carbon dioxide plumes and heat. They probably don't bite through nightwear, but feed on exposed skin. The bite is painless and the host is usually undisturbed during feeding.

Bed bugs are attracted to carbon dioxide, but also have heat sensors to help them find a warm-blooded host. They prefer humans, but will feed on dogs, cats, and birds. Bed bugs feed on blood as their only source of nutrition. An immature bed bug feeds once during each of its five developmental stages and after it feeds, each stage takes about a week to digest its blood meal. It then sheds its outer skin (exoskeleton), through a process called molting, and is again ready to feed. Each individual bed bug only comes out to feed every three to seven days. Female bed bugs lay 1-5 eggs each day and can live for two months or more. An egg-laying female needs periodic blood meals to continue to produce eggs.

During the time the bed bug digests its blood meal, it excretes brown or black feces on linens, mattresses, box springs, and other hiding places (Figure 4a-b). Male and immature bugs produce aggregation pheromones in the feces; these pheromones attract other bed bugs to these hiding places. Time of development depends on host availability and temperature. Because bed bugs only feed on blood, availability of humans or other warm-blooded hosts determines how quickly bed bug populations grow. When bed bugs can find a blood meal any time they are hungry and the home is at room temperature, they can grow from egg to adult in 5 to 6 weeks.

Bed bug eggs are light-colored and smaller than the size of a pinhead. These eggs develop red eyespots prior



Photo: Jim Kalisch

Figure 8-3. Bed bug (left) and bat bug look similar, but can be distinguished with magnification. Bat bugs have hairs longer than the width of their eye.

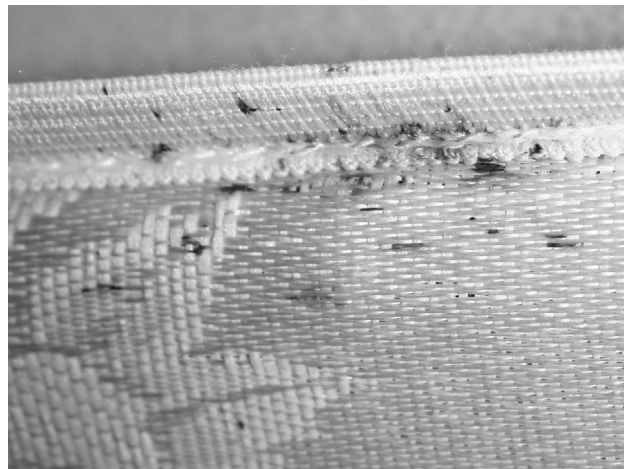


Photo: Barbara Ogg

Figure 8-4a. Typical bed bug spots near cording of a mattress.

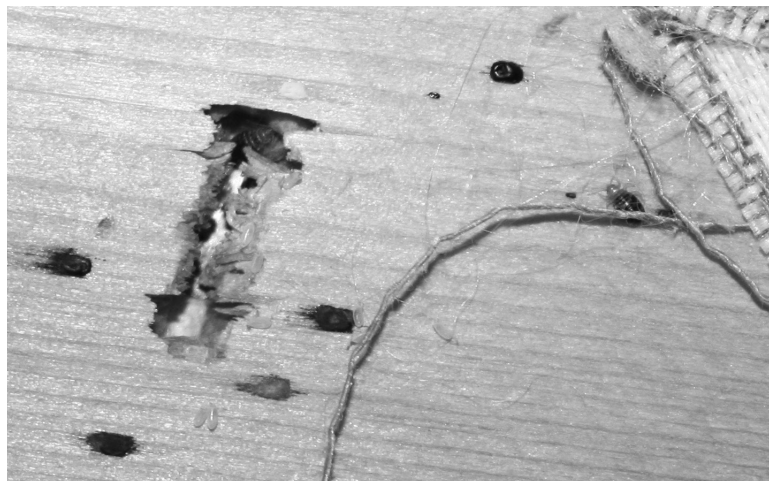


Photo: Barbara Ogg

Figure 8-4b. Signs of bed bugs on the wooden framing of box springs, fecal spots, spent eggs and two bugs (one is in the staple groove, the other is near the fabric thread.)

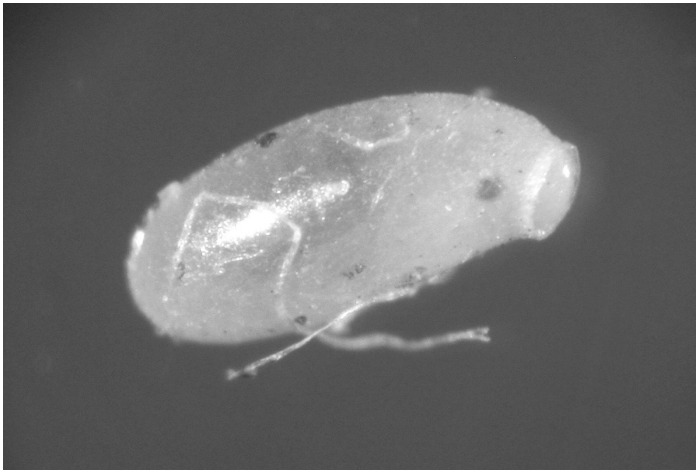


Photo: Jim Kalisch

**Figure 8-5. Human bed bug egg is pale pink with eyespots.**

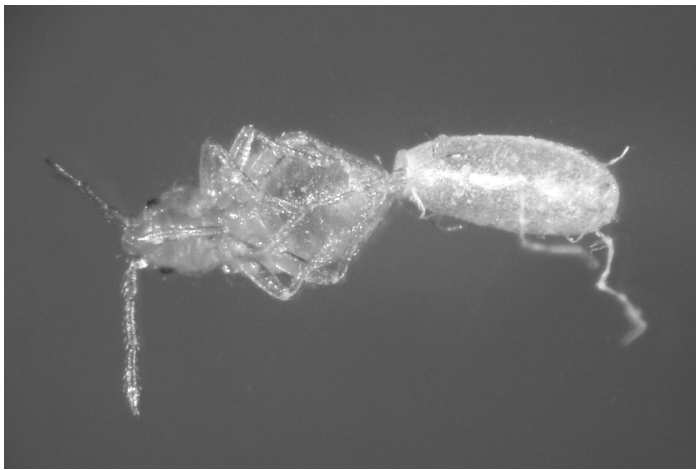


Photo: Jim Kalisch

**Figure 8-6. A bed bug hatches 5-7 days after being laid, the tiny bed bug is about the size of a pinhead. It needs to feed within a few weeks to be able to survive.**

to hatching (Figure 8-5). At room temperatures, eggs hatch in about five days (Figure 8-6).

How long can bed bugs live without feeding? Bed bugs, especially larger nymphs and adults can live several months at room temperature without feeding. Eventually if bed bugs cannot feed, they will die of dehydration. This happens more quickly at warmer temperatures. Researchers at Virginia Tech have found unfed bed bugs live longer at cooler temperatures than warmer ones. They also found field-collected, insecticide-resistant, unfed bed bugs lived a shorter time than insecticide susceptible strains. In their lab study, no bed bug lived longer

than 3 months at 78°F. In homes and apartments, it is likely that unfed bed bugs can live five or six months at room temperatures. When temperatures are cooler, they may live longer.

## **Infestation vs. Introduction**

### **Infestation**

A bed bug infestation is one where most, if not all of the life cycle stages are present (egg, nymphs and adults). Infestations are usually found in homes or other locations where people sleep every night. Regularly occupied motel and hotel rooms can

readily become infested; remember each bug only needs to feed weekly. Sensitive environments where infestations can be found include hospitals or nursing and retirement homes.

### **Introduction**

A bed bug *introduction* is one where a bed bug is brought into a facility, but cannot readily breed. Schools, most childcare facilities, and office buildings are examples where bed bugs may be introduced, but the population cannot grow because a blood meal is not available during most of the time when bed bugs are active. A hospital waiting room is another example. When a bed bug gets hungry, even during the day, it may crawl onto someone's clothing or backpack to be taken to another location. If it is a mated female and taken into a person's home, it may start an infestation. Introductions are worrisome to people who work in these places, but not as serious a problem as an infestation would be.

Why are bed bugs found in non-sleeping locations? As bed bug populations increase in a home, bed bugs crawl into purses, backpacks, briefcases, and onto clothing and travel with inhabitants to workplaces or other places where people spend time. They will then crawl away and hide in their new surroundings. Bed bugs can be transported with children to daycare or school where they crawl out of diaper bags or backpacks and hide.

### **Damage**

There is a wide variation of how individuals react to bed bug bites. Approximately 25% of people between the ages of 12-65 do not react to bed bug bites — no spots,

no itching whatsoever. A survey by the University of Kentucky found no difference between ethnic groups in bite reaction, but they did find a higher proportion (~42%) of non-reactive individuals in individuals greater than 65 years old. Because elderly people may also have reduced eyesight, it is possible for many to be living in a bed bug infested home without realizing there is a problem.

Among individuals who do react to the bite, the reaction can be mild — red spots that do not itch. For many people the bites are very itchy. In rare cases, some people get hives, a more serious reaction to the bites.

At least 27 agents of human disease have been found in bed bugs, including viruses, bacteria, protozoa, and parasitic worms. Researchers have not found that any of these agents reproduce or multiply within bed bugs, and very few survive for any length of time inside a bed bug. There is no evidence bed bugs are involved in the transmission (via bite or infected feces) of any disease agent, including hepatitis B virus and HIV, the virus that causes AIDS.

The toll on individuals living with a bed bug infestation is primarily psychological. Many people report being stressed and anxious and experiencing insomnia. Some may try to solve the problem by using inappropriate products, methods or application sites that can harm them and their home.

Eradicating bed bugs is expensive because it usually requires a skilled pest control professional who has the know-how to use specialized equipment and chemicals not available to the do-it-yourself consumer. For institutions, like schools and hospitals with large facilities, the cost

of widespread treatments can be prohibitive.

## Detection and Monitoring

Finding bed bugs early is an advantage because treatment is easier and will be less costly.

1. If someone has found a bed bug, the first step is to have an expert identify it to make sure it is a bed bug. If it is a bat or bird bug, contact a wildlife management company to inspect for birds or bats. Eradicating these is the first step in dealing with a bat or bird bug infestation.
2. Next, it is important to know if this was a bed bug introduction or if there is actually an infestation. First inspect the area near where the bug was found. If it was found on a student or person, inspect his desk, locker, and backpack. In residential living situations, inspect the bed, the mattress and box springs. Most bed bugs will be found in the immediate sleeping area, but a few are often found farther away from the bed. If residents often sleep on the sofa or a recliner, these should be inspected as well.

A visual inspection is the simplest method of detection, but it relies on someone experienced in doing bed bug inspections. Other methods of detection include:

1. Canine detection. Companies using dogs trained to detect the odor of live bed bugs have increased in the last few years. Some dogs work for “bed bug detection only” companies; other dogs are owned by pest control companies that may benefit when dogs find bed bugs. Research by the University of Flor-

ida showed canine detection to be 95-98% accurate in controlled conditions, but this high level of accuracy has been shown to be much lower in real-world field conditions. A Rutgers University research study using different dog-handler teams showed dogs sometimes gave a false alert, indicating bed bugs when they were not present (a false positive). Dogs sometimes also did not detect bed bugs that were present (a false negative). Researchers found a large variability between detection firms (i.e., some canine-handler teams performed better than others). Still, a properly trained and maintained canine detection team can be useful in conducting large scale inspections where other types of inspections are difficult or impractical. They may be most useful in detecting bed bug introductions in schools, office buildings, hospital waiting rooms and patient rooms, and childcare facilities.

2. Monitoring devices. A number of monitoring devices containing chemical lures have been developed for bed bug detection. Because bed bugs come out to feed every 5-7 days, small infestations may require monitors to be installed multiple nights before bugs are caught.

Some examples using carbon dioxide include the CDC 3000 (Cimex Science, Portland, OR.) and NightWatch™ (BioSensory, Putnam, CN). A do-it-yourself trap using dry ice was developed by Rutgers University (<http://njaes.rutgers.edu/pubs/publication.asp?pid=FS1117>).

A small, wall-mounted trap, Verifi™ (FMC, Philadelphia PA), uses carbon dioxide, an aggregation pheromone, and human scent. Research studies have shown these devices will catch bed bugs, although small infestations may require increasing the number of trapping nights. Because Verifi™ traps are meant to remain in place indefinitely, this makes them an advantageous tool for this purpose.

Climbup® Insect Interceptor is another trap that uses the attractiveness of sleeping humans and it catches bed bugs attempting to climb bed legs. This type of trap is highly efficient, and would be extremely useful in residential housing situations, such as dorms, retirement, or nursing homes.

## Management Options

There are two treatment approaches currently being used to eradicate bed bug infestations: insecticidal treatments and heat.

### *Insecticidal treatments*

Some non-pyrethroid insecticides have been shown to be effective against bed bugs when placed in cracks and crevices where bed bugs hide. Researchers have found high levels of resistance in bed bugs to pyrethroid insecticides, which include most of the over-the-counter products. Because bed bugs are resistant to these treatments, they are not likely to be very effective. However, currently the more effective, non-pyrethroid products are only available to pest control professionals. Any insecticidal treatment should be done by a licensed pest control applicator experienced in successfully eradicating bed bugs.

### *Heat treatments*

The second method is to use large heaters to heat the infested environment to temperatures lethal to bed bugs. Heat works because adult bed bugs die at about 120°F.; eggs die at 130°F. To make sure temperatures get hot enough everywhere where bed bug can hide, the air must be circulated with fans. Some heat systems use heat sensors or thermocouples, placed in different locations, which are used to track temperatures. A threshold temperature of at least 122°F must be maintained for 3-5 hours (or more) to make sure heat penetrates all the bed bug hiding places. Furniture is often pulled away from walls, dressers drawers are removed from dressers, and closet drawers are opened. Because of the risk of damage and fire when heaters are used, a licensed pest control company experienced in heat treatment should do this. Heat is a good non-toxic method, but is not practical in all situations. For example, it would be impractical to use heat in an office building or a school...the cost would be too prohibitive.

In the case of an introduction of bed bugs, as in a school classroom, it would be preferable to locate the isolated bed bug and remove it using a vacuum cleaner. A spot treatment in that location could be used to follow-up.

## Sensitive Environments

### **Schools and Non-24 Hour Child-care Facilities**

Actual bed bug infestations — eggs, nymphs and adult bed bugs — in schools and daycare centers are uncommon. It is more common for bed bugs to hitchhike to school from an infested home on a student's cloth-

ing or in a backpack. These bed bugs could be carried home by another student, teacher, or staff member, making the school a potential hub for bed bug spread.

What should be done if bed bugs are found on a student or child? If possible, it is advisable to discretely separate the child's backpack, outerwear and other items to prevent the transfer of bugs onto belongings of others. A large tub or sealed garbage bag may be used for this purpose.

1. An inspection protocol, developed by administration, should be followed. A nurse or equivalent should inspect the child's clothing and items brought to school to see if other bed bugs are present. The desk or locker area should be inspected as well. The child's parents should be contacted to see if they are aware of a bed bug problem at home. If possible, the child's clothing should be changed to a second set that is known to be bed-bug free.
2. If bed bugs are found, the surrounding environment should be vacuumed to remove bed bugs. In the case of a single bed bug introduction, this is all that might be necessary, but checking this area for new introductions would be prudent. If many bed bugs are found, or in the case of an infestation, a pest control company experienced in treating bed bugs should be contacted.

### **Hospitals**

There is a real potential for bed bug infestations in hospitals or other medical facilities where people sleep overnight. Bed bugs may hitch a ride on incoming patients or visitors or their belongings. Initial locations

for bed bug introductions include the emergency room, out-patient rooms, consultation rooms, and hospital rooms themselves. Visitors may introduce bed bugs to waiting rooms. Because many hospitals have a high room occupancy and high turnover, these institutions are at high risk of having bed bug infestations. The introduction of a single, mated female bed bug could result in a full-fledged infestation. But, if patient intake procedures are thorough, bed bugs may be discovered on the patient or a home infestation may be revealed, which would trigger actions to prevent movement of bugs. It is important to educate nursing and custodial staff so they will be able to identify bud bugs.

Recommended steps if bed bugs are found on a patient include: isolating the patient, if possible, bagging personal items, including purses and backpacks, and vacuuming rooms immediately after exposure.

### **Low income public housing, retirement homes and dormitories**

Bed bug infestations have been increasing in the last 10 years, and managers of high-density public housing, retirement homes, and dormitories or fraternities/sororities are likely to experience increased problems with them. It is important for institutions to take the time to develop a bed bug procedural policy. This policy will help management personnel make rational decisions when bed bugs are found.

Bed bug infestations get started in these high-density housing units in several ways. The most common ways include individuals simply moving in

from an infested home, purchasing infested used furniture, or bringing bed bugs back after traveling. Visiting family or friends is another way bed bugs can be brought into a unit.

Because the inhabitants are most likely going to see bed bugs, property managers should focus considerable efforts on educating their tenants to be able to recognize bed bugs. Individuals should be encouraged to capture insects they see and take specimens to a designated person who will have them identified. If people are complaining about getting bitten, those units should be inspected thoroughly for bed bugs. (Remember though, a quarter of the population age does not react to bites and won't ever complain about bites. And, among the elderly, this non-reactivity is even greater.)

If bed bugs are found in a unit, a thorough inspection of the facility should begin before treatments are done. Units on either side, across the hall, above, and below the infested unit should be carefully inspected. Because bed bugs are such good hitchhikers, units of close friends should also be inspected. Letting other inhabitants know of the infestation is a good idea, as it will remind them to check their beds and to let management know if they find insects. Inhabitants should be discouraged from purchasing their own pesticides, explaining to them that over-the-counter products are not very effective against bed bugs. A professional pest controller should only treat infested units. It is not advisable to treat all the units...not only is it a waste of money to treat non-infested units, treating only infested units will reduce pesticide exposure.

## **Discussion**

Because bed bugs are becoming so entrenched in our society, all institutions, schools, childcare centers, hospitals, universities, low-income public housing, and retirement homes eventually will be confronted with a bed bug problem. As time passes and bed bug infestations increase even more, these issues will become more and more common. It is important for administrators to realize that it is impossible to completely prevent a bed bug introduction; there are simply too many ways for bed bugs to hitchhike into a building. It is unwise to believe this is a problem that only happens to others. Vigilance and early recognition of bed bugs and their signs by key individuals will locate introductions and infestations early when most easily treated and before they have spread to other locations.

Even though bed bugs do not transmit diseases, most people have an aversion to them. If poor decisions are made early on, the situation can quickly become a public relations nightmare. All institutions should develop a carefully reasoned bed bug policy to guide management decisions to a intelligent and safe resolution of the problem.