

Bed Bugs

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An adult bed bug feeding on a person's arm with its beak inserted into the skin.

Infestations of bed bugs are on the increase...

Human bed bugs (*Cimex lectularius*) have spread throughout the world and are significantly increasing in numbers in North America as well as in many other countries. Even though we do not fully understand all of the reasons behind this increase, we suspect a combination of contributing factors including a reduction in the use of urban pesticides, the more extensive world travel of different cultures and resistance to pesticides. This sudden increase in bed bug infestations has resulted in anxiety among the public, increased negative exposure of the hotel industry and a need to educate public health officials and pest control professionals on safe and effective control measures.

To complicate matters, there is a small group of closely related blood sucking bugs in the family Cimicidae including bat bugs and swallow bugs that can be confused with human bed bugs.



Swallow bug *Oeciacus vicarius* is a parasite of barn and cliff swallows

It is important to identify the type of bed bug because due to their different habits, proper identification determines where to direct control measures. For example, bat bugs (*Cimex pilosellus*) look similar to human bed bugs but control efforts must include elimination of bats from a structure to be effective.

During the last decade, there has been a significant increase in the number of bed bug infestations reported from homes, resort hotels, apartments, universities, airlines, public transportation and cruise ships. Over time, as society becomes more experienced in recognizing bed bug infestations early and professional pest control companies gain expertise in control, bed bug infestations in communities should decline. This web site is intended to help individuals and organizations to prevent infestations, to educate the public in the identification and biology of bed bugs, to help individuals and public health officials to recognize the symptoms of bed bug bites, and for the public and professional pest control firms to learn how to get rid of bed bugs if a dwelling becomes infested.

1. How to prevent bed bug infestations

Human bed bugs (*Cimex lectularius*) are constantly being transported and dispersed in luggage, bedding, mattresses, bed frames and other bedroom furniture items. Once transported to a dwelling, bed bugs typically live in cracks and crevices in the bedroom during the day and feed on people during the night time. Many individuals are worried about bringing bed bugs home during their travels. Although it is not as easy to transport bed bugs as one might expect, there are special considerations that one should follow to minimize the probability of accidentally introducing bed bugs into your home.

- During travel, before you check into a hotel, check into the mattress. Carefully remove the sheets and examine the head section of the bed, look at the seams of the mattress as well as both sides of the head board. If you see small insects in either of these locations, they are probably bed bugs. You may also see small blood drops and fecal stains.



Bed bugs clustered together under the steam of a mattress with small white eggs above.

- Bringing your favorite pillow along on your travels may increase the chances of this pillow becoming infested with bed bugs and the transport of these bed bugs back to your home. If you have a favorite pillow, make sure it is encased in a bed bug proof sealed pillow case.
- Remember not to place your luggage next to the bed during travels. Find a place as far from the head of the bed as possible and store your luggage in this location. This same principal applies to placement of portable radios and other items that could conceal bed bugs.
- If you see bed bugs or think you have been bitten by bed bugs during your travel, it is extremely important to report this incident to the hotel management or else other unsuspecting individuals may meet the same fate. Bed bug bites often itch days after you have checked out of a room. It is never too late to report your concerns.
- Do not bring used mattresses, bed frames or other bedroom furniture into your home unless you are first confident that bed bugs are not hiding in cracks and crevices. Bed bugs may be hiding inside of bed frame tubing or deep into wood slots holding screws or bolts.
- If you have visitors that are coming to stay with you, ask them not to bring along personal pillows and bedroom furniture. If you have any special concerns, ask them first about bed bugs to make sure they don't accidentally bring them into your home.
- If your home is a condo or apartment or otherwise connected to other residential units, you need to be vigilant against the possibility of bed bugs coming into your bedroom from adjacent areas beyond your control. You can place small survey traps in hiding places in your sleeping zones and check them periodically for pest activity. Traps close to the bed will be most effective.

If you are bitten by bed bugs during your travels, whether in a hotel, private residence or on public transportation, it is not likely that you will bring these bed bugs home if you follow the steps outlined above. In many cases the itches from bites are delayed until the next day and you may

incorrectly assume that you have transported bed bugs. Since bed bugs bite at night and hide by day, just entering an infested area during the day is not cause for alarm.



Two bed bug bites more than a week after feeding on the same arm shown above.

2. Recognizing bed bug bites

Frequently, the first evidence of the presence of bed bugs is the sudden appearance of very itchy bites on your torso. It is important to seek medical attention if bites alone are the only evidence of bed bugs. Dermatologists may recognize skin rashes, allergies and other conditions that are not insect bites. There are several other insects and arthropods that will produce itchy welts very similar to bed bug bites. This is because mosquitoes, fleas, lice, mites and bed bugs all inject saliva during the feeding process to thin human blood. This anti-coagulant material is largely responsible for the "itchiness" of bites. Individuals vary greatly in their skin response to different insect and arthropod saliva and over time some individuals may become either more or less affected.

Often a single bed bug will produce more than one bite during the night so it is not always a one to one relationship where each bite represents a different bed bug. If you have two bites close together, then of course two points make a line and you may assume that this bite pattern is consistent with bed bug feeding behavior. In many cases, just after feeding, the bed bug is unable to digest the entire blood meal and a small drop of blood passes through the body of the bed bug and onto the sheets below. These small round blood drops are a critical clue to the presence of bed bugs and a white sheet provides a good background contrast for detection of these stains.



Blood droplet immediately after feeding



Bed bug fecal and blood stains

Because individuals react differently to bed bug bites and their own reaction can decrease or increase in sensitivity over time, it is very difficult to diagnose the presence of bed bugs from looking at bites on patients in isolation from other data. A follow up inspection is in order whenever a health professional suggests that a bite is “consistent” with bed bug bites. Bird, squirrel and rodent mites can produce the same skin lesions and bite patterns as bed bugs.



An adult bed bug hiding under the seam of a mattress between blood meals.

3. How to identify and collect bed bugs

Even though bed bugs are small, adults are about 1/5th of an inch; they can be seen with the naked eye. Immature bed bugs are much smaller. They are light yellow in color unless they have recently fed on blood and then they are darker in the middle. After a recent feeding, you can almost see the red color of blood inside. As the blood ages, it darkens and a small quantity of undigested blood is excreted onto surfaces such as bed sheets, mattresses and on other surfaces. Adults are reddish brown and they also turn darker after a blood meal. All bed bugs are wingless, oval and flattened in appearance and crawl at a steady rate.



Bed bugs resting under a stuffed chair. Bed bug adult in center, 1st instar nymph and older nymph in upper left.

Bed bugs are active at night when they leave their daytime resting place deep inside cracks and crevices to seek out human blood. If bed bugs are seen during the day, it usually means that their hiding location has been disturbed, they have contacted a pesticide, or else they are very hungry and are desperately seeking a blood meal. Adult male and female bed bugs, as well as nymphs (young), feed on blood. By checking the bed linen in the middle of the night you have the best opportunity to find bed bugs on the move. Any nearby crack or crevice can serve as a daytime refuge for bed bugs. Look for bed bugs under folds in mattresses, along seams and in between bedposts and bed slats. Bed bugs are frequently found in easy chairs, sofas and other furniture used as sleeping locations. Other places to look for bed bugs during the day include behind baseboards, in night stands, inside pillow cases, along the edge of curtains and inside any piece of furniture that is located adjacent to the bed. When large numbers of bed bugs are present, they produce a distinctive pungent odor. Numerous dark fecal spots on linen or near cracks are another indication of a bed bug infestation. If only one or two bed bugs are found, it is difficult to estimate how many other bed bugs are in hiding. Large infestations of bed bugs have a tendency to disperse to other locations in the building, especially if the host person vacates their room for a period of time.

It is assumed that bed bugs are attracted to a combination of heat and carbon dioxide that represents a sleeping person. When a host is missing because a person has vacated the sleeping area, bed bugs will disperse over long distances for a considerable period of time in search of a new host. There are no simple traps available that this author is aware of that will reliably trap migrating bed bugs. Conventional sticky traps for common insects that crawl inside rooms are usually only effective if the bed bug infestation is rather large. Not only are very light infestations of bed bugs difficult to recognize, but the elimination of all bed bugs in a room is equally difficult to measure. The lack of bed bug bites is often the best tool we have to show that control efforts have succeeded.

Bed bugs should be collected into small leak-proof containers containing rubbing or other alcohol. Clear sticky tape is also a good way to capture individuals for later identification. Bed bug specimens should be sent to a knowledgeable expert for positive identification. There are many other small insects that could be mistaken for bed bugs and experience shows that only a small percentage of specimens sent in for identification are actually bed bugs. [Dr. Richard Pollack at the Harvard School of Public Health](#) can identify bed bugs sent in for identification.



Scout, a bed bug detection dog investigating a sofa for the presence of bed bugs.

4. Bed Bug Detection Dogs

Specially trained and certified bed bug detection dogs may significantly improve the ability of inspectors to discover low levels of bed bugs. Scientists who have independently measured the success of bed bug detection dogs report as much as a 98% success rate at finding even a single live bed bug. Dogs can be trained to detect only live infestations and will ignore dead bed bugs so that treatment effectiveness can be measured. There are only a few dogs available with this detection skill and they are expensive to rent or own. It must be remembered that bed bugs deep in walls or in building voids between floors are beyond detection range, even for dogs. At present, there is no known device that is more effective than a dog's nose at detection of single live bed bugs.

5. Bed bug biology and behavior

After feeding, a female bed bug will lay eggs in their daytime refuge of cracks and crevices. Females can lay more than a hundred eggs during their lifetime of more than a year. After a blood meal, several eggs per day are deposited. Each egg is whitish in color and flask-shaped. These eggs are visible to the human eye and can be found close to the hiding places of immature bed bugs, under seams of mattresses and in other similar places. The eggs are covered with a sticky liquid that when dry holds the eggs in place against a surface. An immature bed bug may take several months to mature to an adult and an adult bed bug can live for more than one year. During development, the young bed bug will feed frequently on the blood of humans although they can exist for many months between blood meals. This means it is not practical to starve bed bugs by staying away for short periods of time, instead this activity may serve to spread bed bugs more quickly in a facility.

Bed bugs molt into five different, ever larger, nymphal stages and then the final molt is to the adult stage. Male and female adults are similar in size and shape.



Bed bug eggs and fecal pellet

bed bug nymph

Bed bugs inject an anesthetic during feeding so that there is little or no sensation of their presence. Saliva is injected into the blood stream of their host to thin the blood and to prevent coagulation. It is this saliva that causes the intense itching and welts. The delay in the onset of itching gives the feeding bed bug time to escape into cracks and crevices. In some cases, the itchy bites can develop into painful welts that last several days. The good news is that this insect is not known to transmit human disease. There is considerable individual variation in the response to bed bug bites. Some individuals may respond less to the bites over time while others may increase in their reaction to bed bug bites. This makes it difficult to identify the exact date when bed bugs first appear since bites are usually the first clue that bed bugs are present.

Spiders, fleas, mites, ticks, mosquitoes or even lice can also cause itchy bites, and these pests require different control methods. There may also be cases where what appears to be a bed bug or other insect bite is not caused by bed bugs or other pests at all. Until a bed bug is positively identified by a knowledgeable expert, it is not recommended to treat a dwelling for bed bugs. The addition of pesticides in the sleeping rooms of individuals is a serious matter and should not be taken lightly.

6. How to control bed bugs

The first step in control is to eliminate the possibility of bed bugs physically climbing over a mattress or bed to feed. Sleeping sofas and stuffed chairs are more difficult to isolate if at all. Pull the bed away from shelving or the wall and coat the legs of the bed with a band of Vaseline or mineral oil about 2 inches wide. Another approach is to place large sticky traps under each leg of the bed. Use other effective means to prevent or exclude bed bugs from the sleeping area. This could include keeping a zone around the bed "bed bug-free" by careful examination and removal of bed bugs with a stiff brush and vacuum and by caulking cracks and by placing a barrier of chalk or silica aerogel around the bed posts at floor level. Double-sided carpet tape may be effective in trapping bed bugs and excluding them from sleeping areas. Clear sticky tape is a good way to capture individuals for later identification.



Bed bug expanding in size as it fills up with human blood.

Do-it-yourself pest control for bed bugs has a low probability of success. Knowing exactly where to treat, which are effective chemicals and when to apply a second treatment is the providence of experienced professional pest control operators. In Massachusetts, there are several registered pesticides for bed bug control that can be applied by professionals. The use of pesticides as a preventative treatment without clear evidence of bed bugs is not recommended. It is unlawful to apply a pesticide in any manner inconsistent with its labeling. The target pest (bed bugs) must be on the registered label and there must be evidence of bed bugs being present.

Residual or contact insecticides are applied first and should last about 30 days and provide control of bed bugs that contact the dried surface. There are insect growth regulators (IGR) that disrupts the normal growth and development of cockroaches and stored product pests, drain flies and fruit flies, as well as bed bugs. When residual pesticides are applied, the area surrounding the bed is a good place to begin. Mattresses should not be treated with insecticides. There are alcohol based sprays that are labeled and are effective in treating mattresses. A non residual

flushing agent or insecticide will kill exposed stages of bed bugs and perhaps force them onto surfaces treated with residual chemical.

Rather than replacing one mattress or bed with another that is also likely to become infested, consider encasing the mattress with a bed bug tight cover. Bed bugs inside the cover will be unable to feed and will die out. Make sure that this cover fits tightly so that extra folds do not provide more crevices for future bed bugs.

Since freezing weather will kill bed bugs, you may be able to place suspect furniture outdoors during the winter for a period of time to eliminate an infestation. Do not bring used furniture into the home unless it can be visually inspected inside and out as bed bug free. It is important not to abandon infested furniture and mattresses without first marking them as *infested with bed bugs*.

Heat treatment above 120 degrees Fahrenheit is reported as a very effective control for bed bug infestations. This heat must be able to penetrate the numerous cracks and crevices in a residence without damaging computers, plastics and other soft objects. Voids behind walls and other insulated spaces will be resistant to heat treatments and may end up as reservoirs for bed bugs and may create more dispersal.

7. Frequently asked questions

Question: Can I bring bed bugs home on my shoes?

Answer: Unlikely, bed bugs are active at night, during the day they are hiding in cracks and crevices. Bed bugs are more likely to be spread via pillows, mattresses, bed linen and bedroom furniture.

Question: Can cold kill bed bugs?

Answer: Yes, although the temperature must drop fast, stay below freezing for several days and the bed bugs must not be too deep inside insulated objects.

Question: How can I determine if my bites are caused by bed bugs?

Answer: Itchy bites can be caused by mites, mosquitoes, fleas and lice. To be absolutely sure, you need to collect a bed bug specimen and have it identified by an expert.

Question: How do you kill bed bug eggs? Do all these spray on products work?

Answer: Most insect eggs are safe inside a shell or chorion which protects them from pesticides. Bed bug eggs hatch in about one to three weeks depending upon the temperature. This would mean a follow up inspection after three weeks would be a good idea. Most residual pesticides last for one month; so theoretically, there should be pesticide still active to kill bed bug nymphs as soon as they hatch from eggs.

You can search the Internet for additional information under the bed bug's scientific name, *Cimex lectularius*. Please refer to the [Harvard School of Public Health for more information on bed bugs \(http://www.hsph.harvard.edu/bedbugs/\)](http://www.hsph.harvard.edu/bedbugs/).

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