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(G. Alpert, Harvard University, Bugwood.org)

Taking the Bite Out of Bed Bugs

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The common bed bug, *Cimex lectularius*, the species most adapted to living with humans, has resurged throughout the world and in many parts of the U.S. in recent years. This species was introduced to the U.S. in the 17th century by early colonists. Effective chemical control of bed bugs began with the widespread use of DDT. Since DDT was banned in the U.S. in 1972, bed bugs have been controlled with pyrethroid insecticides. Increased global travel, resistance to pyrethroid insecticides, widespread use of insecticidal baits instead of foliar spray treatments for ant and cockroach control, and lack of public awareness are key factors that have contributed to the resurgence of bed bug infestations in homes, hotels and other public buildings.

Description

Adult bed bugs are oval, flattened, brown, wingless insects that are about 1/4 to 3/8 inch long (Fig. 1). Nymphs resemble adults but are much smaller, only 1/16 inch long, and colorless except after feeding (Fig. 2). Eggs are white, about 1/32 inch long and upturned at the tip (Fig. 3). Bed bugs have piercing-sucking mouthparts that they use to pierce the skin of their hosts to consume a blood meal (Fig. 4). After feeding, the abdomen elongates and the insect is more cigar-shaped and noticeably darker due to the ingestion of blood (Fig. 5).

Similar Species

Bed bugs belong to the family Cimicidae, which contains many similar species. In our area, bat bugs (*Cimex adjunctus*) and swallow bugs (*Oeciacus vicarius*) are occasionally found in homes. As their names imply, bat bugs attack bats and swallow bugs attack swallows. These species are very similar in appearance to the common bed bug. Therefore, all bed bug identifications should be confirmed by an entomologist. All are blood feeders. The presence of bat bugs indicates the presence of bats roosting in the home, probably in the attic. Swallow bugs can move into the home after the birds have fledged and left their nests. Bat bugs and swallow bugs can and will feed on humans.



Figure 1. Adult bed bug
(P. Beauzay, Dept. of Entomology, NDSU)



Figure 2. First instar nymph bed bug feeding on human
(G. Alpert, Harvard University, Bugwood.org)

Figure 3. Hatched eggs of bed bugs

(G. Alpert, Harvard University, Bugwood.org)



Figure 4. Close-up of bed bug feeding on human

(G. Alpert, Harvard University, Bugwood.org)



Figure 5. Engorged adult bed bug after feeding

(W. Cranshaw, Colorado State University, Bugwood.org)

Life Cycle

Bed bugs are nocturnal feeders and feed every five to 10 days. During the day, they hide in cracks, crevices, mattress seams, bed frames and other protected spaces. A single female can lay 200 to 500 eggs during her lifetime. Adult bed bugs can live up to 11 months and survive as long as six months without a meal. Eggs are visible to the naked eye and laid in batches of 10 to 50 in hiding areas. Eggs are coated with a sticky substance that helps them adhere to the surface of mattresses, box springs and other objects. Nymphs hatch and emerge from eggs from six to 17 days, depending on temperature. Newly emerged nymphs feed and molt through five instars. A blood meal is needed prior to each molt. Each instar can endure several months without a blood meal. Development time from egg to adult takes about 21 days at 86 F to 120 days at 65 F. Bed bugs may have three or more generations per year.

Bite Symptoms

Bed bug bites are painless and almost always occur while a person sleeps. Individuals may differ in their sensitivity to bites. Exhaled carbon dioxide, body heat and other chemical cues attract bed bugs to their hosts. Bed bugs inject saliva containing an anticoagulant and an anesthetic when they bite, and this causes the bite area to become irritated. Bed bugs feed mainly on exposed skin of the face, neck and arms. Feeding takes about five to 10 minutes. Typically, a small welt develops at the site of each bite. Rows of three or four welts are characteristic of bed bug bites (Fig. 6). Although bed bug bites may cause anxiety, stress and insomnia in their victims, **bed bugs are not known to transmit any diseases**. The fecal droppings of bed bugs pollute homes with allergens and may cause severe allergic reactions and asthma in some individuals.

Integrated Pest Management (IPM)

Bed bugs do not travel far and spread slowly by themselves. Careful inspection to detect bed bugs early and reducing clutter where bed bugs hide can

help manage bed bug infestations. Integrated pest management includes being alert for bed bugs or signs of bed bugs, and preventative, nonchemical and chemical control strategies.

Detecting Bed Bugs – Hiding Spots

Bed bugs are secretive and may be found in any room in the house. However, research has shown that 85 to 90 percent of bed bugs are found in the bedroom on the mattress, box springs or within 15 feet of the bed. Dwellings with a high rate of occupant turnover, such as hotels, motels, hostels, dormitories, shelters, apartment complexes and prisons, are at higher risk of having bed bug infestations. If living in an apartment building, adjacent apartment units also should be inspected. Bed bugs can infest airplanes, ships, trains and buses as well.

Initially, bed bugs are located in bedding and mattress seams (Fig. 7). As bed bugs multiply, they spread to bed frames, plaster cracks, baseboards, partitions, loose wallpaper, dressers and even picture frames. Any habitat that offers darkness and isolation is a potential hiding place. They are spread readily to new locations in clothing, luggage, used beds and second-hand furniture. Since bed bugs can survive up to six months without feeding, they already may be present in vacant and apparently clean apartments.

Thoroughly examine mattress seams, box springs, bed frames, luggage, furniture cushions, peeling wallpaper, picture frames, wall baseboards, electronic appliances (TVs, radios and clocks) and other potential hiding areas for bed bugs. Flashlights should be used to inspect any dark hiding places. Also look for small rusty stains on mattresses and box springs about the size of this dot ● (Fig. 8). These stains are made when bed bugs excrete liquid fecal drops after consuming a blood meal (Fig. 9). If sleeping people accidentally crush bed bugs, reddish stains on bed sheets or mattresses can be observed. Eggs and casted skins of nymphs are another sign of bed bug activity. If a bed bug infestation is heavy, a pungent, sweet smell may be noticeable. Again, inspect all potential hiding areas thoroughly. Although expensive, dogs have been trained to detect the scent of bed bugs and may be useful in difficult cases.

Bed Bug Traps

Several types of bed bug traps are available. Sticky traps or glue boards have not been very successful in monitoring for bed bugs (Fig. 10). Because bed bugs are attracted to carbon dioxide and chemical cues such



Figure 6. Bed bug bites on human arm causing inflammation

(W. Cranshaw, Colorado State University, Bugwood.org)



Figure 7. Adult, nymphs and blood spots on fabric of box spring

(G. Alpert, Harvard University, Bugwood.org)

as lactic acid and octenol, baited pitfall traps, such as the Nightwatch™ trap (www.biosensory.com) have been developed and are commercially available. Another type of trap called the Climbup™ uses humans as the bait (www.insect-interceptor.com). This trap uses bed bug behavior of climbing the legs of a bed. It has two concentric plastic bowls, with the inner side of each bowl coated with talcum powder to prevent bed bugs from climbing up and escaping. The inner bowl captures bed bugs hiding on the bed as they move off the bed, and the outer bowl captures bed bugs moving to the bed from other areas (Fig. 11). Use of new, improved traps may help with bed bug detection and monitoring, and when used with other strategies, may help reduce the bed bug population.

Prevention

Prevention is the best strategy to avoid getting a bed bug infestation in your home.

- **Avoid bringing infested clothes, furniture and baggage into your home.** Carefully inspect any used beds and furniture prior to purchase from thrift stores and garage sales. Used furniture such as bed frames, box springs and mattresses are at high risk for harboring bed bugs and their eggs.
- **Eliminate bird nests or bat roosting sites, and seal potential openings in roofs and attics.** Keep your home free of birds, bats and rodents that are alternate hosts for bed bug species that also feed on humans.
- **Watch for bed bugs while traveling.** In hotel or motel rooms, look for bed bugs in the hiding spots mentioned above, and any signs, such as fecal spots, cast skins and eggs. Remember to inspect the mattress and behind headboards for bed bugs as soon as you check into the room. Avoid placing your luggage on the bed or floor near the bed. Instead, store luggage in the bathtub. Also carefully inspect your clothing and baggage when returning from your trip. Unpack clothing directly into a washing machine. Up-to-date information on recent bedbug infestations at hotels and other locations around the U.S. can be found at www.bedbugregistry.com/.

Nonchemical Strategies

Bed bug infestations can be reduced by practicing these nonchemical strategies, especially sanitation:

- **Washing and drying clothing and bedding on a regular basis at high temperatures**
All bed bug stages are highly sensitive to extreme temperatures. Nymphs are more vulnerable than adults. Laundering bedding and clothing in hot water and drying them at 113 F for 60 minutes will kill all life stages of bed bugs. A shorter time period is required at higher temperatures (140 F for 20 minutes). Steam cleaning is a good option if it is done thoroughly at a



Figure 8. Adult, nymphs and blood spots on the underside of a recliner

(G. Alpert, Harvard University, Bugwood.org)

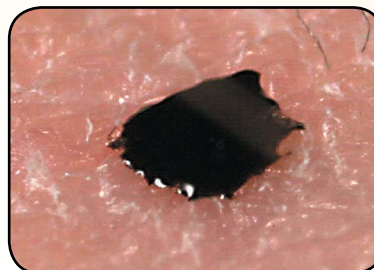


Figure 9. Close-up of bed bug dropping produced after feeding on human

(G. Alpert, Harvard University, Bugwood.org)



Figure 10. First instar bed bugs caught on a sticky trap

(G. Alpert, Harvard University, Bugwood.org)



Figure 11. Climbup™ trap for monitoring bed bugs

(www.insect-interceptor.com)

high temperature. Heat is better at killing bed bugs than cold. Cold temperatures must be below 0 F for at least four days to eliminate infestations. All stages are killed at minus 25.6 F after 15 minutes.

- **Vacuuming frequently and thoroughly**
Vacuuming is an effective way to remove bed bugs. After vacuuming, place the vacuum bag in a heavy-duty plastic bag, seal tightly and discard in a container outdoors.
- **Repairing cracks and crevices in the walls**
Repair any cracks and crevices in your home that may provide safe harbor for bed bugs. Seal cracks using plaster or spackling, and glue down loosened wall paper.

- **Use mattress covers designed to contain bedbugs**

Protective mattress covers work by trapping bed bugs in the encasement and preventing them from feeding. The bed bugs eventually will die. Keep the mattress covered for at least one year to ensure all bed bugs are dead.

Touching your bed to the wall, and linens, bed skirt and blankets to the floor, encourages bed bugs to crawl into your bed. Therefore, move your beds away from walls and keep sheets and blankets off the floor.

Chemical Control

Bed bugs are difficult to eliminate using insecticides, especially if they are an insecticide-resistant population. Once a live bed bug is found during inspection, control must be initiated quickly because bed bugs will move from their hiding spots once disturbed. All areas where bed bugs could be hiding should be treated. This includes the tufts and seams of mattresses, bed frames, box springs, furniture, baseboards, carpet edges, around window and door casings, and loose wallpaper. Before using any insecticide, READ THE LABEL FIRST AND THEN FOLLOW THE DIRECTIONS FOR USE. Make sure the insecticide lists bed bugs on the label. If bed bugs are not on the label, the product probably is not effective against bed bugs. **Never use an insecticide in the home that is labeled for outdoor use only.** This could be very dangerous for your health and it's against the law. More than 300 products are registered by the Environmental Protection Agency for use against bed bugs. Many of these insecticides are legal for homeowners to use. The EPA has developed a searchable database called "Bed Bug Product Search Tool" at <http://cfpub.epa.gov/oppref/bedbug/> for finding products labeled in different treatment areas (mattress, whole room, whole home and crack/surface/void).

An insecticide treatment may not provide 100 percent control of bed bugs for a number of reasons. Reinfestations may occur due to difficulties in locating all of the hiding places, or bed bugs may migrate from adjacent rooms or nearby apartments in a multidwelling housing. Treatment areas may be prepared inadequately by not removing clutter, and not sealing cracks and crevices also may result in ineffective control. Many insecticides do not kill eggs, and a second treatment may be necessary after egg hatch. Research has found that at least two applications are necessary for successful eradication of bed bugs, but some infestations may require up to four or more applications. If a reduced rate of insecticide is used instead of the labeled rate, it may not kill bed bugs, and it could encourage the development of insecticide resistance.

Bed bugs already have developed insecticide resistance to the pyrethroid class of insecticides, and, unfortunately, most insecticides used in our homes for bed bug control belong to this class. To reduce the potential for resistance, used different classes of insecticides if available, or used alternative chemicals, such as diatomaceous earth or insect growth regulators (interferes with insect molting and reproduction). A combination of nonchemical and chemical strategies is the best control strategy. After treatment, continue to monitor for bed bugs for at least two weeks, and avoid vacuuming because it may remove the insecticide residue, which is important for long-term control of bed bugs.

If you have a bed bug infestation, we strongly recommend you seek the services of a professional exterminator or pest control operator as soon as possible to prevent further infestation. Controlling an infestation requires thorough inspection and often disassembly of beds, furniture, and possibly carpeting and flooring. Any potential hiding place must be identified and carefully treated. Specialized equipment often is needed to reach bed bug hiding spots. For tips on how to choose a pest control company, visit the EPA's Citizens Guide to Pest Control and Pesticide Safety at www.epa.gov/pesticides/bedbugs/#hiring.

For more information on bed bugs, see the following websites:

EPA Bed Bugs – www.epa.gov/pesticides/bedbugs/

Let's Beat the Bed Bug! (University of Minnesota)
<https://www.bedbugs.umn.edu/>

Bed Bugs (University of Kentucky)
<http://entomology.ca.uky.edu/files/efpdf3/ef636.pdf>

Bed Bugs are Back! An IPM Answer (Cornell University)
<https://ecommons.cornell.edu/handle/1813/43824>

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