BUG BIZ
Pest Management and Insect Identification Series
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Cimex lectularius, Bed Bug

(Hemiptera: Cimicidae)

Aaron R. Ashbrook, Joseph McCarthy, Forest Huval, Thomas E. Reagan, Christopher E. Carlton

Description

Adult bed bugs (*Cimex lectularius*) are dark brown in color and have been described as looking similar to apple seeds. They are oval in shape, range from 0.2 to 0.3 inches (5 to 7 mm) in length, and are flattened from the top and bottom, allowing them into small cracks and crevices. The bed bug proboscis is held horizontally between the front legs and is pivoted downward to feed. Bed bugs have six legs and are excellent climbers. They do not have wings, but wing pads are present in adults. The compound eyes are located near the base of the four segmented antennae. Bed bugs have short bristles or hairs, called setae, on their bodies, but are not as extensively covered in setae as related species such as the bat bug or swallow bug. Bed bug adults are sexually dimorphic, meaning that the males and females look different from each other. The abdomens of adult males taper to a point, whereas those of females are slightly larger and more rounded. Females have a V-shaped groove on the right underside of the abdomen called an ectospermalege. The 11 abdominal segments on adult bed bugs are distinct and visible.

Immature bed bugs, known as nymphs, are similar to adults in body shape and are translucent to light brown in color. Nymphs that have fed have a visible dark spot in the center of their abdomen that indicates the blood meal. Bed bug nymphs range from 0.06 to 0.18 inches (1.5 to 4.5 mm), depending on age and food supply. The eggs are small, less than 1/25 of an inch (1 mm), elongate and white.

When bed bugs feed, they substantially increase in size to accommodate the blood meal and their abdomens become red. After feeding, bed bugs defecate to remove excess liquid and iron, leaving telltale fecal stains. Bed bug fecal material is dark brown or black in color and can be used as a sign of an infestation. The cast molts of bed bugs are also signs of a potential infestation.

Several similar species of the family Cimicidae that occur in Louisiana may be mistaken for bed bugs. Bat bugs (*Cimex* spp.) and swallow bugs (*Oeciacus vicarius*) may occasionally enter buildings and homes in the absence of their bat and bird hosts but do not establish infestations like bed bugs. Differences are subtle and require detailed study of specimens. If any doubt occurs about the identity of the insects, a qualified insect diagnostician should be consulted.



An adult male bed bug next to fresh fecal stains. The abdomen comes to a point at the end, thus indicating it is a male (John Obermeyer).

Life Cycle

Bed bugs have an incomplete life cycle (hemimetabolous). First stage immatures hatch about seven to 10 days after being laid. Immature bed bugs go through five growth stages (instars) before reaching adulthood, which takes more than one month. However, development time can change depending on temperature, frequency and size of meals. Warmer or cooler temperatures can speed or slow development, respectively, and infrequent or small blood meals resulting from absence or movement of the host can slow development. Bed bug adults live for several months. After obtaining a blood meal from a host, adult bed bugs mate via a process called traumatic insemination. When engorged, adult male bed bugs mount other

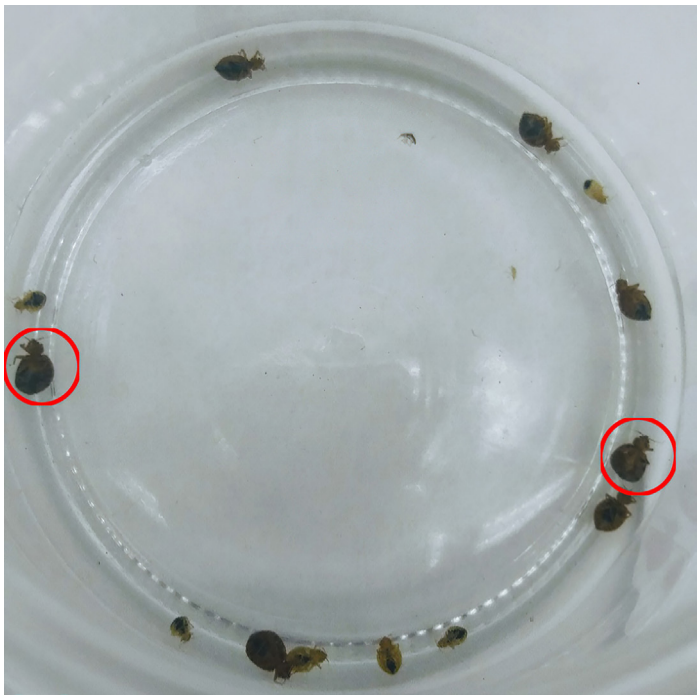
large bed bugs in an attempt to mate. If it is a female, the male uses a sharp part of his genitalia (paramere) to penetrate a specialized region on the female's abdomen, the mesospermalege, which is the tissue behind the ectospermalege, and is adapted to tolerate the wound and is the route for fertilization. If the male mounts an adult male or a large nymph, they emit alarm pheromones to alert the mounting male of their identity. After mating, females lay between one to five eggs a day. In order for bed bugs to develop through each life stage, as well as for the females to lay eggs, they must obtain a blood meal and will feed once a week if possible. First stage nymphs die in a few days if they are not able to feed. However, adult and late-stage bed bug nymphs can live for several weeks or months without feeding. Bed bugs are secretive, avoid light and remain hidden during the day, when they are mostly stationary. Late at night or early morning, bed bugs become active to feed and use carbon dioxide, heat and pheromones to locate a host. After feeding, bed bugs return to their hiding places or harborage, forming dense aggregations until the next feeding. This behavior often allows bed bugs to go undetected until the infestation is large, making them more difficult to eliminate than in early stages of an infestation.

Ecological Significance and Pest Status

Cimex lectularius is a blood-feeding insect of the hemipteran family Cimicidae, all of which are parasites that feed on birds, bats and rodents. The bed bug, *Cimex lectularius*, and the tropical bed bug, *Cimex hemipterus*, both feed on humans. The tropical bed bug has not been reported in Louisiana but has been found in Florida. Bed bugs have been a pest of humans for centuries. They had been eradicated from many parts of the world by the mid-20th century due to the use of DDT. However, bed bugs reemerged on a global scale as a serious pest during the early 2000s due to resistance to pyrethroid insecticides, which work similar to DDT. The pest status of bed bugs comes from their feeding style, which is to obtain a blood meal from a host. Bed bugs use their proboscis to penetrate the skin of a host and will feed on their blood for approximately 10 to 20 minutes. Bed bug saliva contains anti-coagulants, which human skin reacts to by developing raised, red and itchy welts. People have different sensitivities to bed bug bites and may not feel the bite or have a skin reaction. If a bite is scratched too much, they can become an open wound that is vulnerable to infection. In some cases, elderly people have suffered anemia from large bed bug infestations. Bed bugs can cause anxiety, lack of sleep, paranoia and can worsen the mental health state of individuals. Fortunately, based on current knowledge, bed bugs do not transmit disease to humans or pets. Bed bugs will also feed on chickens and infestations can grow to high numbers on poultry farms.



Engorged adult bed bug, side view (Gary Alpert, Harvard University, Bugwood.org).



Mixed life stages of bed bugs in a glass jar. Females, circled in red, have round abdomens, and are larger in size. Tan colored bed bug nymphs of different ages are also present and have a dark spot in the center of their abdomen (John Obermeyer).

Social stigma is often associated with those that have bed bugs, which can result in their infestations going unreported, allowing infestations to grow and spread. Bed bugs hide in furniture that their hosts often spend time resting in, such as chairs, sofas, bed frames, mattresses and box springs. When bed bug infestations are large, they start to harbor in areas nearby, such as carpet, baseboards, electrical sockets, headboards, dressers, paintings, electronics, clothes, etc. Bed bugs will hitchhike on people's clothes, shoes or different possessions to move to new locations. They are most common in places with a high turnover of people, especially hotels, hostels and bed-and-breakfast establishments. They are typically spread when people unknowingly carry individual

bed bugs from infested locations. In multifamily home settings, they also actively disperse to other apartments in order to find a host or to avoid damage from traumatic insemination. Bed bugs are also known to spread through the sale of used furniture from infested locations. When traveling or purchasing used furniture, it is best to conduct an inspection of any bedding and seams to ensure there are no bed bug hitchhikers. A common misconception holds that bed bugs are associated with poor hygiene, but this is not necessarily the case. Even five-star resorts and high-end hotels can suffer from infestations.

Control

Bed bug control can be difficult because they are often hidden in protected areas where insecticides may not be applied, or they avoid exposure to treatments because of their secretive behavior. To further complicate control efforts, many bed bug populations are resistant to insecticides, making this method less effective. Therefore, combining chemical and non-chemical control methods or integrated pest management strategies is recommended and often used for more effective bed bug elimination. It may be possible for individuals to eliminate bed bug infestations. However, it may be in their best interest to contact a local professional pest management company to ensure safe and proper bed bug elimination. Cooperating with your pest control company is critical for their management plan. Often a bed bug treatment will consist of preparation, inspection, application of different treatments, a follow-up inspection in about a week and a half and subsequent treatment. Follow-up treatments are recommended to manage newly hatched bed bugs or those that avoided treatment the first time. Proper bed bug elimination takes time and patience to adequately prepare the domicile, find all infested areas, and ensure thorough treatment. Many of the tools discussed below are only available to pest management professionals, but this guide can help explain treatment options. Products used must be approved for bed bug control and label directions must be followed. Additionally, sufficient time must be allowed for treatment measures to work. Preventative measures, such as inspection of beds and furniture while traveling and inspection of used furniture after purchase, can help reduce the chance of bed bug infestations.

Detection of bed bugs. The use of pitfall-style traps is a critical step to bed bug detection, preventing their spread to other furniture, and gauging the success of management programs. Pitfall traps for bed bugs are double-walled — rough walls on the outside so that they can enter but smooth walls on the inside. Traps for bed bugs are placed on legs of furniture or bed frames. When a bed bug climbs down from the furniture



Bed bug eggs, nymphs and an adult on the exterior seams of a couch. Bed bugs are positively thigmotactic, meaning they have a preference to be in contact with different objects or other bed bugs (needs photo credit).

or up the side of the trap, they fall in and become stuck because they cannot climb the smooth interior surfaces. The use of traps for bed bug management is critical. Sticky traps are not as effective against bed bugs because sometimes they pull themselves free from the adhesive. Active traps that produce stimuli that attract bed bugs, such as heat or carbon dioxide, are also effective but can be costly. Dogs are sometimes used to help detect the presence of bed bugs using their keen sense of smell. They are typically used when a high number of domiciles need to be inspected. Properly trained dogs can distinguish between active and old infestations. However, some dogs may give false positives, so a second dog and handler may be necessary for additional confirmation.

Non-chemical control options. One simple non-chemical method of bed bug control is to collect them using forceps and place the insects in soapy water. This is impractical if the infestation is large. A vacuum with sufficient suction can remove bed bugs from infested furniture. Vacuum attachments with bristles should not be used because bed bugs can get stuck in them. Once a vacuum is used to collect bed bugs, the vacuum bag should be removed and the hole taped over so that the bed bugs cannot escape. In cases

where disposal of infested items is being considered, treatment may be more cost effective as opposed to replacement. Replacement items can be subsequently infested by bed bugs if they have not been eliminated.

Mattress encasements are also used for protection against bed bugs. Special bite-proof cloth is used for the fabric of the encasement and is put on the exterior of infested mattresses and box springs, capturing the bed bugs inside. The encasement is then zipped shut and the bed bugs inside will starve to death after several months. It is important that the encasement does not get torn or opened to prevent bed bugs from escaping. The exterior of mattress encasements can be reinfested by bed bugs, but they will be exposed due to the lack of hiding places in the fabric and are more vulnerable to other control methods. Pitfall traps are often used with encasements so that bed bugs are less likely to reinfest the mattress.

Heat is lethal to bed bugs at sufficient temperatures and exposure times. Lethal heat is used for bed bugs when the infestation is large or when they are in areas where insecticides cannot be safely or legally applied. No residual protection is provided by a heat treatment. When adult bed bugs and nymphs are exposed to temperatures of 113 F (45 C) for more than 60 minutes, complete mortality will occur. Bed bug eggs require exposure to 122 F (50 C) for a similar period of time to cause mortality. Just like cooking food, it takes time to properly heat furniture and other bed bug infested items to temperatures that are lethal to the insects. Therefore, reaching the necessary temperatures required to cause bed bug mortality requires proper equipment, training and movement of infested items when heating. Heat can be used to control bed bugs in several ways. Clothing and bedding with bed bugs can be laundered on the high temperature setting in a washer and dryer. Industrial carpet steamers can be used to treat bed bugs on the exterior of furniture. However, steamers are not as effective against bed bugs on leather surfaces. A third option is to place infested items in a heated compartment or tent to heat for several hours. The final option for using heat is to put in large heat generators and fans into a domicile and heat it until temperatures that are lethal to bed bugs are reached and can be maintained. For the success of a heat treatment, temperatures lethal to bed bugs must be reached and maintained for enough time to eliminate all life stages. Items that are sensitive to heat exposure should be removed from areas that are being heated for bed bug elimination.

Low temperatures are also used for bed bug control, but the options are more limited on its usage. When only a small number of items are infested with bed bugs, the items may be placed in a freezer for two to four days depending on the temperature of the freezer (-16 to -20 F). Another way that cold is used for bed bugs is the Cryonite system, where dry ice (-110 F) is expelled from the end of tube apparatus, instantly freezing exposed bed bugs on contact. The Cryonite system is used in a similar way that a steamer is used for bed bug control. If the temperature and humidity of the room is high where Cryonite is being used, it will reduce the efficacy of the control option.

Chemical insecticides and other control options. A variety of chemical insecticide options are available for use on bed bugs. Many products used for bed bug management are only available to licensed pest management professionals. Insecticides are often used for bed bug management because of their low cost and efficiency. However, bed bugs that are associated with humans may be resistant to insecticides, which reduces their efficacy. Label directions must be followed when using an insecticide for bed bug control, and only certain areas in a home can be treated. Total release foggers should not be used for bed bug control and are not an effective option. Several classes of insecticides are used for bed bug control. One of the most common insecticides used for bed bugs are pyrethroids, such as deltamethrin, but many bed bug populations are resistant to chemicals from this class. Some bed bug formulations contain other pyrethroids to enhance efficacy or piperonyl butoxide (PBO), which can synergize a pyrethroid by interfering with a bed bug's ability to detoxify the insecticide. Neonicotinoids are another class of insecticides that are used for bed bug control. They have a different mode of action than pyrethroids. Dichlorvos is the one organophosphate is approved for bed bugs and is applied as a pest strip for use in small, contained environments. Organophosphates can also affect humans and other mammals and should be used with caution. One pyrrole insecticide, chlorfenapyr, is another effective option for bed bugs but has a slower mode of action. Fumigation chambers with sulfuryl fluoride can be used when a vehicle is infested with bed bugs. Whole building fumigation with sulfuryl fluoride is also highly effective but is used when infestations are very difficult to eliminate and is used less due to high cost.

Bed bugs are highly susceptible to drying out, therefore desiccant dusts are effective against them. Desiccants abrade the insect cuticle and remove the waxy outer layer, or epicuticle, causing water loss from the insect. Diatomaceous earth is commonly used for bed bugs and other crawling insects. Silica dusts, such as CimeXa, are incredibly effective against bed bugs and can cause high mortality in only one day. Dusts can be difficult to use properly because of inhalation hazards

and should be avoided in humid areas that reduce efficacy. However, silicate dusts are highly effective when properly used as part of a bed bug management program.

Two alternative products are used for bed bug control that have different modes of action than traditional insecticides. The first is a fungal microbial pesticide called Aprehend, which is an oil-based spray that contains *Beauveria bassiana*, a fungus that only infects insects. Aprehend is applied as a barrier using specialized equipment and the fungal spores are picked up by the bed bugs when they walk over it. The fungus then infects the bed bug and can subsequently spread to other bed bugs once the original insect has died. The other alternative products are neem oil sprays or other essential oil products used for bed bug control. Essential oil products have been shown to have efficacy against bed bug adults, nymphs and eggs. Essential oil sprays have minimal residual activity and do not remain active for long when applied. However, many essential oils have known insecticidal activity and are an additional control tool for bed bugs.

Mention of trade names or commercial products in this article is for informational purposes only and does not constitute endorsement by LSU AgCenter.

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Matt Lee, Interim LSU Vice President for Agriculture
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