
BED BUGS

Integrated Pest Management In and Around the Home

Bed bugs are blood-sucking insects in the family *Cimicidae*. Both nymphs and adults feed on humans mostly at night, a time when it is difficult to detect their stealthy habits.

Cimex lectularius is a cosmopolitan, or widely distributed, species, most frequently found in the northern temperate climates of North America, Europe, and Central Asia. It occurs more sporadically in southern temperate regions. In tropical regions, *C. hemipterus* is the dominant species, but this species does not occur in California. The most common species found in California is *C. lectularius*.

The growth and development of *C. lectularius* is optimal when it feeds on humans; however this insect also feeds on other species of mammals and birds found near the home including chickens, mice, rats, and rabbits.

Until recently, bed bug infestations were thought to be associated primarily with crowded and dilapidated housing. However, such infestations have undergone a resurgence and can be found even in the finest hotel and living accommodations. The reasons for the resurgence are not totally understood but appear to involve increased human travel, ease of movement of infested luggage and items, and changes in the pesticides available to control this pest.

IDENTIFICATION AND LIFE CYCLE

Adult bed bugs (Fig. 1) are oval, wingless, about $\frac{1}{5}$ inch long, and rusty red or mahogany. Their bodies are flattened, they have well-developed antennae, their compound eyes are small, and the area behind the head (the prothorax) expands forward on either side of the head. The immatures appear

identical to the adults except for their smaller size, thinner outer skeleton (cuticle), and lighter, yellowish-white color.

Bed bugs are readily distinguished from another common blood-sucking species, conenose bugs (see *Pest Notes: Conenose Bugs* listed in References), by their smaller size, more rounded shape, and lack of wings as adults. Conenose, or kissing, bugs may be up to $\frac{3}{4}$ inch long.

Female bed bugs lay 200 to 500 tiny, white eggs in batches of 10 to 50 on rough surfaces such as wood or paper. Glue-like material covers the eggs, which hatch in about 10 days. After hatching occurs, the eggshells frequently remain stuck in place.

There are five progressively larger nymphal stages, each requiring a single blood meal before molting to the next stage. The entire life cycle (Fig. 2) from egg to adult requires anywhere from 5 weeks to 4 months, depending on temperature and availability of food (blood). When temperatures are in the range of 70° to 82°F, development occurs most rapidly.

Nymphs and adults generally feed at night and hide in crevices during the day. Common hiding places include seams in mattresses and box springs, cracks in bed frames, under loose wallpaper, behind picture frames, and inside furniture and upholstery. Occasionally people pick up bed bugs in theaters or on buses and trains. They also can bring them into their home on clothing, bedding, luggage, or firewood.

Bed bugs can go without feeding for 80 to 140 days. Older stages of nymphs can survive longer without feeding than younger ones, and adults have survived without food for as long as

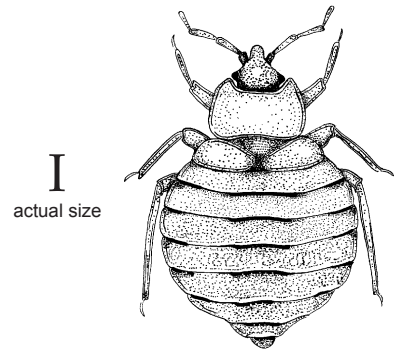


Figure 1. Adult bed bug.

550 days. A bed bug can take six times its weight in blood, and feeding can take 3 to 10 minutes. Adults live about 10 months, and there can be up to 3 to 4 generations of bed bugs per year.

DAMAGE

Bed bugs feed on humans, usually at night when they are asleep. They feed by piercing the skin with their elongated mouthparts, which consist of two stylets that normally fold under their body when at rest but fully extend during blood-meal feeding. One stylet has a groove that carries saliva into the wound, while the other has a groove through which body fluids from the host are taken in.

A single feeding may take up to 10 minutes, and feels like a pin prick, but because feeding usually occurs at night when people are asleep they are not aware they have been bitten until afterwards. However, saliva injected during the feeding can later produce large swellings on the skin that itch and may become irritated and infected when scratched. Swelling may not develop until a day or more after feeding, and some people do not show symptoms. Bed bugs currently are not considered to be disease carriers.

PEST NOTES

Publication 7454

University of California
Statewide Integrated Pest Management Program
Agriculture and Natural Resources

May 2009

Distinguishing bed bug bites from the bites of other arthropods such as mosquitoes, fleas, and spiders is difficult. People often confuse itching bed bug welts for mosquito bites. The only way you really can confirm bed bugs are the cause is to find the bugs in your bed or bedroom. Often people are bitten when traveling, making diagnosis even more difficult.

In addition to the direct injury to humans, bed bugs have stink glands that leave odors. They also leave unsightly fecal spots on bed sheets and around their hiding places. These spots are darkish red in color, roughly round, and can be very small.

MANAGEMENT

Managing a bed bug infestation is a difficult task that requires removal or treatment of all infested material and follow-up monitoring to ensure the infestation has been eliminated and does not return. Management will require employing several nonchemical methods such as vacuuming, washing bedding at a high temperature, using steam or heat treatment, and sealing up hiding places.

Insecticides may be required to eliminate serious infestations; however few active ingredients are federally registered for bed bugs for over-the-counter use. At the professional control level, there are more registered products; however, resistance among bed bug populations is common, and low-level infestations are difficult to detect. There has been some success combining chemical and nonchemical products with increased sanitation and habitat modification.

Monitoring and Detection. You can detect a bed bug infestation by searching for the pests or their fecal spots, egg cases, and shed skins (exuviae). Current research reports more than 85% of bed bugs are found in or near the bed, so inspections for infestations should focus on the mattress, bed frame, and headboard areas. Lift the mattress and inspect all seams and surfaces as well as the box springs. You may need to dismantle the bed. Use a flashlight to aid the inspection process.

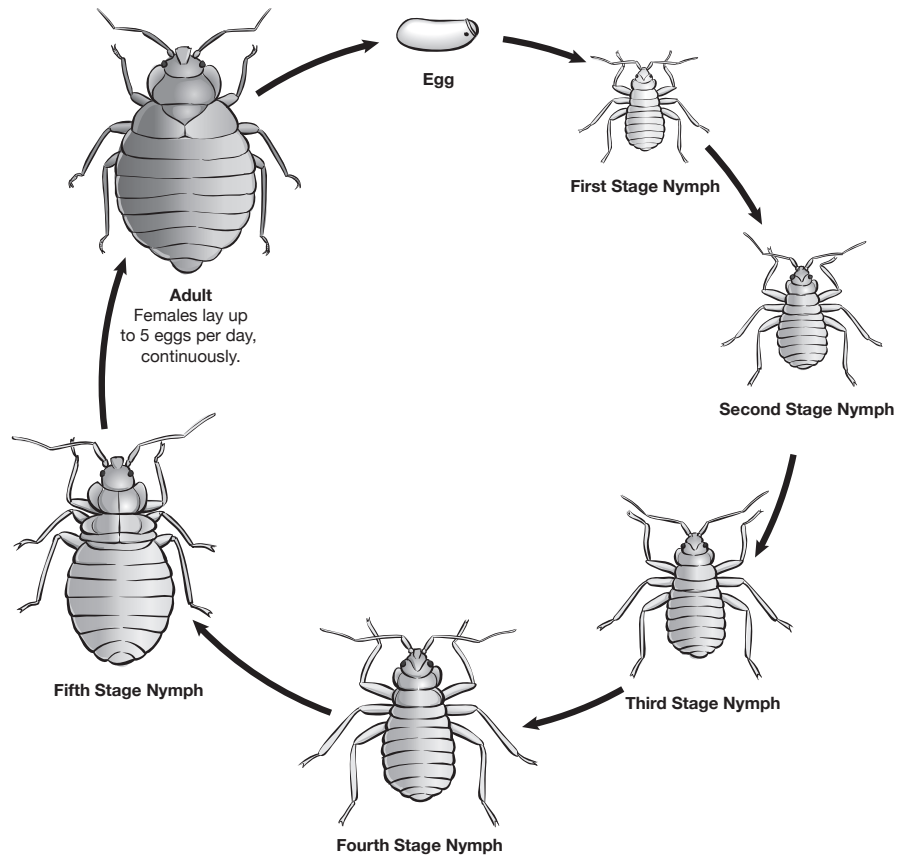


Figure 2. Bed bug life cycle. There are 5 nymphal stages, each requiring a blood meal before molting to the next stage.

Remember, these nocturnal insects are small. Although you can see adults and aggregations of nymphs with the unaided eye, seeing the eggs requires a hand-magnifying lens. It may be easier to detect dark spots of dried bed bug excrement or the insects' light-colored shed skins. A foul, rotting, bloody-meat smell might be present in heavily infested areas.

In addition to the bed area, the remaining 15% of infestations usually are in upholstered furniture other than beds, in bedroom cabinets, along baseboards, under wallpaper, and in carpets, wall hangings and similar hiding spots. Bed bugs prefer fabric or wood surfaces to metal or plastic. For heavy infestations, adjoining rooms, filing areas, and clutter can be out-of-way shelters. It takes patience and perseverance to find low-level infestations of such a persistent, nagging problem.

Recent research has shown searching with dogs can be an effective method for finding bed bug infestations. Under laboratory and simulated-field conditions, using dogs to search for bed bugs was 97% effective. Other recent research indicates using small, double-cupped monitors that are easily installed on the leg ends of beds trapped six times more bed bugs than were found from human visual searches alone. This trap, Interceptor, is commercially available.

A new university study indicates an airborne aggregation pheromone, a behavior-modifying chemical, might help control infestation levels. With this new research, hopefully traps attractive to bed bugs soon will be commercially available.

Prevention. People usually bring bed bugs into their homes, in luggage or on clothes, after visiting an infested dwelling or hotel. If you travel frequently,

watch for signs of bed bugs in your hotel room by checking under sheets and inspecting mattresses, especially if you have been bitten. If you suspect bed bugs, check your luggage before leaving and wash all your clothes as soon as you get home.

You also can bring bed bugs into your home on bedding or furniture. If you purchase second-hand furniture, especially beds or mattresses, thoroughly inspect the item before bringing it into your home. If you remove infested mattresses or furniture from your home, do not leave it on the curb or porch. Take it immediately to the dump.

Managers of hotels, furnished apartments, dormitories, homeless shelters, and other facilities that house transient populations need to train staff to recognize signs of bed bug activity and take action as soon as they find an infestation. One proactive step a manager can take is to regularly replace beds, mattress, and bedding materials. Frequent laundering of bedding and placing items that could be infested in walk-in freezers during tenant change and turnover can help prevent the spread of bed bugs.

It is much easier to control a population when the infestation is small. Keep clutter down, so it is easier to inspect and bed bugs have fewer hiding places. Also, seal up cracks, crevices, and holes in bedding or furniture and other potential hiding sites.

Nonchemical Management. In addition to preventing the introduction of bed bugs, a number of other nonchemical control methods can help manage this pest. These methods are directed at killing or removing bugs or restricting access to beds or bedding materials.

You can remove bed bugs and eggs with the suction wand of a strong vacuum; however, you must target the vacuum on the seams of mattresses and box springs, along perimeters of carpets, under baseboards, and in other areas where bed bugs live. A single vacuuming rarely gets all bugs and eggs and, therefore, should be repeated. Portable

steam cleaners can also be used to clean mattresses and furniture.

Commercial heating services are available to treat entire rooms in homes for bed bug infestations. The current label use for commercial heating services is 140°F for two hours or 130°F for three hours, which will kill most bed bugs and eggs. In California, providers of heat services must be licensed and bonded by the Structural Pest Control Board when treating for wood destroying pests. Chilling to a temperature of 32°F or lower and maintaining this temperature for several days also will kill bed bugs.

For suspected infestations in clothing or bedding, a home laundry drier is very good at killing bed bugs; only 10 to 15 minutes exposure is needed.

Mattress encasements specifically designed to keep out bed bugs are commercially available. Encasements are particularly useful for hotels or other facilities with many beds; however, their effectiveness at excluding bed bugs has not been thoroughly researched. In many cases, the best approach may be to throw out the mattress, clean the area thoroughly, and install a new mattress—with or without an encasement.

Other management practices include sealing up hiding places such as cracks and crevices in walls and around windows and doors where bed bugs can hide. As a temporary measure, you can exclude bed bugs from clean beds by coating bed legs with petroleum jelly or placing them inside glass jars or metal cans, which are too slippery for bed bugs to climb.

Insecticides. Insecticides alone won't control bed bug infestations. Their use must be combined with a program of removing and cleaning infested beds, bedding, and other harborage sites then following up with a regular detection program to ensure treatment was effective.

The most effective bed bug pesticides are available to commercial pesticide

applicators only. Professionals also have the equipment and expertise that allow a more effective application of insecticides than residents could do themselves. In addition, professionals have the training to detect and isolate infestations, which often allows for more effective control.

Insecticides may be applied as *liquids* directly to cracks, crevices, bed frames, baseboards, or similar sites, or they may be applied as *dusts* in cracks and crevices. Pesticides generally are not applied to mattresses or bedding because of risk to people.

Liquid insecticide formulations include:

- Products containing the botanical insecticide pyrethrin, which gives quick knockdown but little long-term control;
- Various synthetic pyrethroid products (cyhalothrin, bifenthrin, deltamethrin, and permethrin); and
- Newer types of products including the pyrrole insecticide chlorfenapyr (Phantom) and the insect growth regulator hydroprene (Gentrol), which cause sterility in adults.

There is growing interest in the last two products, because some bed bug populations have developed resistance to pyrethroid insecticides and no longer can be effectively controlled by them. However, both newer products take up to several days to be effective.

Insecticides applied as dusts cling to the pest's cuticle, wearing away the insect's protective wax covering or poisoning the insect when it grooms itself. Several dust products used in bed bug management include boric acid, diatomaceous earth, fumed silica, and formulations of pyrethroids. These materials can provide long-term control as part of an integrated program if they are placed in out-of-the-way places—such as under baseboards or in wall voids—that don't get wet.

Do-It-Yourself Treatments. Although over-the-counter pesticide products that have "bed bug control" written on the label can be found on store shelves, they generally are not recommended. Performance of these products under actual field conditions is not known. If you need to use a pesticide, you are better off hiring a licensed, professional pesticide applicator with experience in treating bed bugs (see *Pest Notes: Hiring A Pest Control Company* listed in the References).

Residents do have an important role to play when their homes are infested with bed bugs. Once professional treatment has occurred, you should continue to monitor for bed bugs daily. Also, keep down clutter and vacuum previously infested areas regularly.

REFERENCES

- Ebeling, W. 1975. *Urban Entomology*. Oakland: Univ. Calif. Agric. Sci. pp. 463-475.
- Getty, M. M., R. L. Taylor, and V. R. Lewis. 2008. Hot house. *Pest Control Technol.* 36 (2): 97-100.
- Greenberg, L., and J. H. Klotz. May 1998. *Pest Notes: Conenose Bugs*. Oakland: Univ. Calif. Agric. Nat. Res. Publ. 7455. Also available online at <http://www.ipm.ucdavis.edu/PMG/PESTNOTES/pn7455.html>
- Moore, D. J., and D. M. Miller. 2006. Laboratory evaluations of insecticide product efficacy for control of *Cimex lectularius*. *J. Econ. Entomol.* 99 (6): 2080-2086.
- Moore, D. J., and D. M. Miller. 2008. Field evaluation of insecticide treatment regimens for control of the common bed bug, *Cimex lectularius* (L.). *Pest Manag. Sci.* 65:332-338.
- Pfiester, M., P. G. Koehler, and R. M. Pereira. 2008. Ability of bed bug-detecting canines to locate live bed bugs and viable bed bug eggs. *J. Econ. Entomol.* 101 (4):1389-1396.
- Potter, M. F. 2008. Bed Bugs. University of Kentucky ENTFACT-636.
- Romero, A., M. F. Potter, D. A. Potter, and K. F. Haynes. Insecticide resistance in the bed bug: a factor in the pest's sudden resurgence? *J. Med. Entomol.* 44 (2):175-178.
- Siljander, E., R. Gries, G. Khaskin, and G. Gries. Identification of the airborne pheromone of the common bed bug, *Cimex lectularius*. *J. Chem. Ecol.* 34:708-718.
- Ter Poorten, M. C., and N. S. Prose. 2005. The return of the common bed bug. *Pediatr. Dermatol.* 22:183-187.
- Thomas, I., G. G. Kihiczak, and R. A. Schwartz. 2004. Bed bug bites: a review. *Int. J. Dermatol.* 43:430-433.
- Wang, C., M., A. El-Nour, and G. W. Bennett. 2007. Controlling bed bugs in apartments—a case study. *Pest Control Technol.* 35(11): 64, 66, 68, 70.
- Wilens, C., D. L. Haver, M. L. Flint, P. M. Geisel, and C. L. Unruh. 2006. *Pest Notes: Hiring A Pest Control Company*. Oakland: Univ. Calif. Agric. Nat. Res. Publ. 74125. Also available online at <http://www.ipm.ucdavis.edu/PMG/PESTNOTES/pn74125.html> ❖

AUTHORS: V. R. Lewis, Dept. of Environmental Science, Policy, and Management, UC Berkeley; L. Greenberg, Dept. of Entomology, UC Riverside; and J. H. Klotz, Dept. of Entomology, UC Riverside.

TECHNICAL EDITOR: M. L. Flint

EDITOR: M. L. Fayard

ILLUSTRATIONS: Fig. 1: S. A. Klotz; and Fig. 2: W. Suckow adapted from S. Charlesworth, Purdue University.

This and other Pest Notes are available at www.ipm.ucdavis.edu.

For more information, contact the University of California Cooperative Extension office in your county. See your telephone directory for addresses and phone numbers, or visit <http://ucanr.org/ce.cfm>.

University of California scientists and other qualified professionals have anonymously peer reviewed this publication for technical accuracy. The ANR Associate Editor for Urban Pest Management managed this review process.

To simplify information, trade names of products have been used. No endorsement of named products is intended, nor is criticism implied of similar products that are not mentioned.

This material is partially based upon work supported by the Extension Service, U.S. Department of Agriculture, under special project Section 3(d), Integrated Pest Management.

Produced by **UC Statewide Integrated Pest Management Program**
University of California, Davis, CA 95616



**University of California
Agriculture and Natural Resources Program**

WARNING ON THE USE OF CHEMICALS

Pesticides are poisonous. Always read and carefully follow all precautions and safety recommendations given on the container label. Store all chemicals in the original, labeled containers in a locked cabinet or shed, away from food or feeds, and out of the reach of children, unauthorized persons, pets, and livestock.

Pesticides applied in your home and landscape can move and contaminate creeks, rivers, and oceans. Confine chemicals to the property being treated. Avoid drift onto neighboring properties, especially gardens containing fruits or vegetables ready to be picked.

Do not place containers containing pesticide in the trash or pour pesticides down the sink or toilet. Either use the pesticide according to the label, or take unwanted pesticides to a Household Hazardous Waste Collection site. Contact your county agricultural commissioner for additional information on safe container disposal and for the location of the Household Hazardous Waste Collection site nearest you. Dispose of empty containers by following label directions. Never reuse or burn the containers or dispose of them in such a manner that they may contaminate water supplies or natural waterways.

NONDISCRIMINATION STATEMENT

The University of California prohibits discrimination or harassment of any person on the basis of race, color, national origin, religion, sex, gender identity, pregnancy (including childbirth and medical conditions related to pregnancy or childbirth), physical or mental disability, medical condition (cancer-related or genetic characteristics), ancestry, marital status, age, sexual orientation, citizenship, or service in the uniformed services (as defined by the Uniformed Services Employment and Reemployment Rights Act of 1994: service in the uniformed services includes membership, application for membership, performance of service, application for service, or obligation for service in the uniformed services) in any of its programs or activities.

University policy also prohibits reprisal or retaliation against any person in any of its programs or activities for making a complaint of discrimination or sexual harassment or for using or participating in the investigation or resolution process of any such complaint.

University policy is intended to be consistent with the provisions of applicable State and Federal laws. Inquiries regarding the University's nondiscrimination policies may be directed to the Affirmative Action/Equal Opportunity Director, University of California, Agriculture and Natural Resources, 1111 Franklin Street, 6th Floor, Oakland, CA 94607, (510) 987-0096.