

Bed Bugs

Making a Comeback in Tennessee, Too!

Karen Vail, Associate Professor, Entomology & Plant Pathology



Introduction

“Red coats,” “wall louse,” “bed louse” and “mahogany flat” – do you recognize any of these terms? These are just some of the many common names given to the bed bug, a not-so-common bug making a comeback. Bed bugs take shelter in or near the cracks and crevices of beds and in bedrooms. They feed on human blood at night, often leaving an itching lump as a result of a bite.

Some scientists theorize that bed bugs were associated with bats living in caves. When humans started



Figure 1: Bed bug male (on top) and female adults with young nymphs (Credit: UT E&PP).

sharing caves, these bugs started feeding on humans also. Closer associations with humans most likely occurred when humans moved from caves to constructed homes. While we can't determine the exact date when bed bugs started living with and feeding predominantly on humans, Greek writings as early as 423 B.C. indicate problems with bed bugs.

Bed bugs were more common in the U.S. prior to World War II, but populations declined soon after the widespread use of DDT and other synthetic insecticides began. Bed bug populations remained steady in parts of

Europe, South and Central America, Africa and Asia. In the 1970s and 80s, bed bugs were practically unheard of in the U.S., but the slow comeback started in the 90s. Their prevalence was reflected in the attention given to them in U.S. trade journals. The two major pest management trade journals published only two bed bug articles between 1991 and 1996, but 11 articles appeared between 1997 and 2002.

More recently, a national survey of Orkin pest control branches indicated a 500 percent increase in service calls for bed bugs in 2003 and another 20 percent in 2004. The number of states where Orkin provided bed bug treatments increased from 35 in 2003 to 43 in 2004. Bed bugs have been found in places that house large numbers of people, such as apartments, hotels, motels, dormitories, shelters, cruise ships and other modes of transport, as well as single-family homes. One pest management professional in a large U.S. city received 125 bed bug calls in one week during 2005.

Prompted by the number of bed bug calls received in spring 2005, the author asked Tennessee county Extension agents to report the number of bed bug cases they were

Reasons for Bed Bug Re-establishment in the United States

Some reasons suggested for the resurgence of these pests include the following, although some are more plausible than others:

- Banning of DDT (probably the least valid because some bed bug resistance to DDT was reported before it was banned).
- Travel (people returning from bed-bug-infested areas such as Asia, Africa, Central/South America and Europe).
- Less spraying of residual insecticides indoors (cockroaches and ants have been controlled with baits rather than sprays).
- Pest management professionals (PMPs) missing infestations because they were unfamiliar with bed bugs.
- Less-than-effective treatments.

aware of in their counties for each year from 2000 to the present. Taking into account reports from county agents and identifications made in the Extension Urban IPM Lab in Knoxville and the UT Plant and Pest Diagnostic Center in Nashville, 26 percent (17/65 counties) had bed bugs in the last five years. Thus far we have no information from 30 counties. Assuming those counties not reporting lacked bed bugs, the percentage of counties with reported cases of bed bugs could be as low as 18 percent. Bed bugs were reported in all three Grand Divisions of Tennessee (East, Middle and West). From the reports, it seems safe to assume that Tennesseans are NOT being left out of the current national bed bug resurgence.

Identification

The adult bed bug, *Cimex lectularius* L., is 1/4-inch long, 1/8-inch wide and reddish brown (Figure 1). It is flattened from top to bottom (Figure 2), with an oval body that is well adapted for hiding in narrow crevices. The body may become greatly enlarged and blood-red during a blood meal (Figure 3), but it subsequently turns a dirty brown. Bed bugs lack wings and cannot fly, but they are very mobile. We timed one moving 16 centimeters in 4.17 seconds (7.55 ft/min.). Newly hatched nymphs are clear to lightly-colored with red eyes. Both nymphs and adults are covered with short, golden hairs. The male's abdominal tip is more pointed than the female's rounded tip.

In Tennessee, we could also encounter a relative of the bed bug called the bat bug or *Cimex adjunctus* Barber. Bats typically nest in caves but on occasion may roost in the dark spaces of an attic, where bat bugs may feed on the flightless young. When bat pups start to fly or when a colony is discovered and excluded, bat bugs may seek humans as an alternate food source. Humans, bats and poultry can serve as hosts for bed bugs and bat bugs, but



Figure 2: Bed bugs are vertically flattened, allowing them access to small cracks. Some say that a bed bug can fit into any crack wide enough to admit a sheet of paper.

humans are the preferred host of bed bugs. These two species share certain characteristics: the beak (or sucking mouthpart) does not reach the base of the second leg and the fourth antennal segment is shorter than the third. Distinguishing characteristics include the length of the fringe hairs on the pronotum, which are shorter than the width of the bed bug eye and longer than or equal to the width of the bat bug eye (Figure 4).

Biology

Bed bugs tend to aggregate in cracks and crevices and usually seek out a blood meal at night. They typically walk undetected across human skin; although when intentionally placed on a human, the observed movements may be more noticeable across hairier areas. Feeding generally occurs without the host's notice, but there may be a very

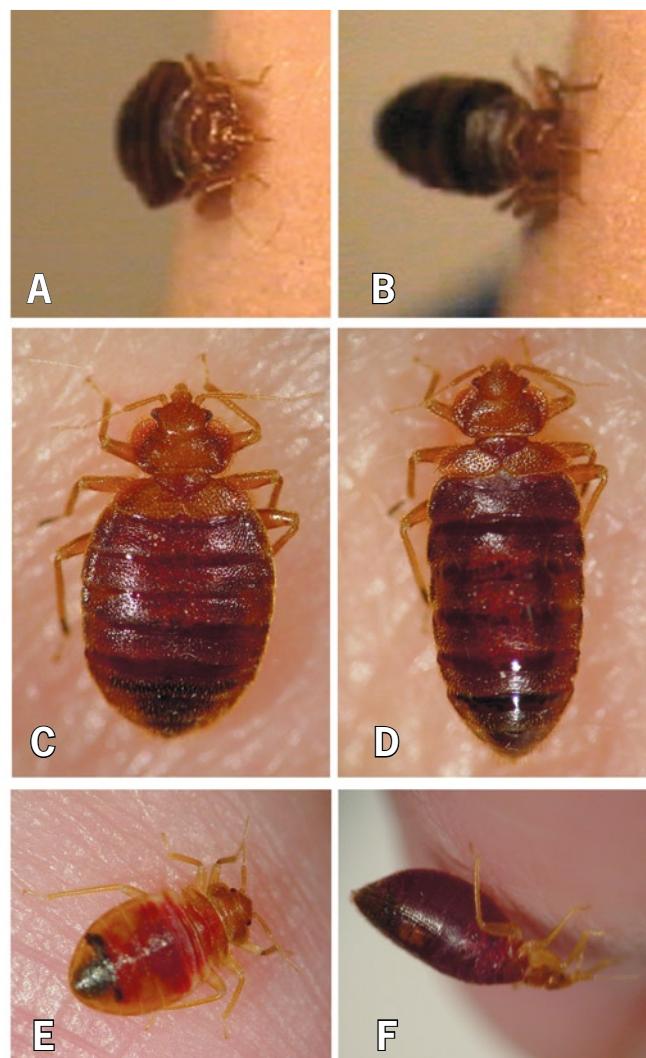


Figure 3. Bed bug adults get deeper (A then B) and longer (C then D) after feeding. This is more obvious in the nymphs (E and F). (Credit: UT E&PP)

slight twinge of pain that quickly dissipates upon initial insertion of the mouthparts. Because the human hosts are usually asleep when bed bugs are feeding, it is unusual for the host to be aware of them. The ensuing lump that develops or the tarry substances left behind (Figure 5) are often the first clues to the pest's presence.

Bed bug mating, called traumatic insemination, is an unusual process. The male "stabs" the female's abdomen with a specially modified organ and shoots sperm into the body cavity. The sperm then move to the female reproductive tract. In a suitable environment, the female will deposit elongate, white eggs about 1 mm long (Figure 6), which stick to surfaces. Typically a female will deposit up to five eggs a day and may lay as many as 200 to 500 eggs during her life. About six to 10 days later, a nymph will emerge from the egg. The nymph, after taking at least one blood meal between molts, will go through five immature stages called instars before becoming an adult. An adult female must mate and take at least one blood meal before producing eggs.

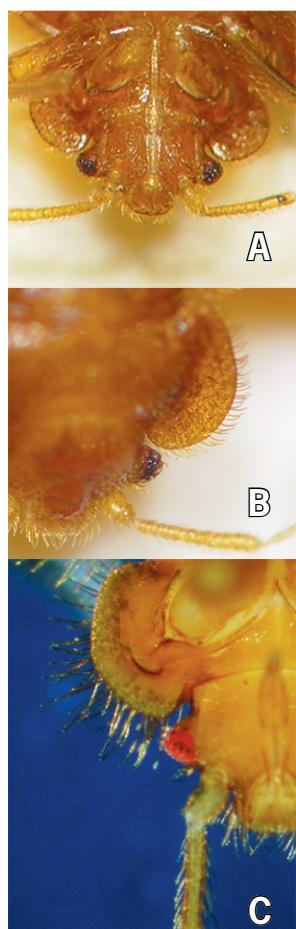
To go from egg through adult and egg again under ideal conditions (75 to 80 percent relative humidity, 83 to 90 degrees F) may take four to five weeks. Under less optimal conditions such as lower temperature and/or with fewer blood meals, development time may be longer. Adults can live several months (some say for more than a year)

and nymphs for three months without feeding. Under typical conditions with a host (food supply), a bed bug may be able to live more than 300 days.

Bites and Fears

When bed bugs are growing, they may feed as often as once a day with meals lasting from a few to a dozen minutes or longer. Bed bugs insert their

Figure 4. Bed bugs and bat bugs both have a beak that does not reach the base of the second pair of legs (A) and the fourth antennal segment is shorter than the third. Bat bugs and bed bugs can be distinguished by the length of the fringe hairs on the pronotum, which are shorter than the width of the bed bug eye (B) and longer than or equal to the width of the bat bug eye (C). (Credit: UT E&PP K. Vail (A&B), E. Bernard (C))



mouthparts into the skin and search for a blood vessel from which to withdraw blood. When a person is bitten, a large oval lump or wheal may arise followed by itching and more inflammation, or no reaction or a delayed reaction may be experienced. The bite may be mistaken for a mosquito bite or even a flea bite. Flea bites usually occur around the ankles, but bed bug bites are found on areas of the skin that are exposed during sleep, such as arms, legs, face, neck and shoulders. Because the bite reaction is similar to that caused by other insects, bed bug infestations are difficult to diagnose correctly when bites are first experienced. This allows the bed bug population to increase and possibly disperse before the culprit is identified. It is very difficult to identify a bug by its bite, so it is important to bring the bug when seeking diagnostic services. Other causes of itching are described in UT Extension PB 1673, General Rodent and Pest Control Licensing Manual, found at <http://eppserver.ag.utk.edu/psep/secondlevel/thirdlevel/GRC/GRCindex.htm>, pages 77-79.

Bed bug bites may cause complications. Asthmatic symptoms have been reported as a result of a bed bug bite, and one person bitten near the eye experienced a swollen eye lid. It is estimated that 30,000 to 40,000 bed bug bites would be needed to result in an 8 ounce loss of blood. This population range is unlikely in a bedroom.

Can Bed Bugs Transmit Disease Organisms to Humans?

At least 27 human disease organisms have been isolated from bed bugs, but biological transmission of a disease organism to a human has never been documented. Thus they are not considered a serious health threat. The major medical concern is the itching caused by the bites. As with other bites or wounds in the skin, antibiotic or antiseptic applications are usually prescribed to prevent infection.



Figure 5. The tarry residue deposited after feeding is often a clue that bed bugs are present. (Credit: UT E&PP)

Where Did My Bed Bugs Come From?

Bed bugs are often accidentally transported in luggage, clothing, beds, furniture and other items. Travelers visiting areas where bed bugs are common, such as Asia, Africa, Europe, the Caribbean, Central and South America (or even the U.S., although bed bugs are not that common yet), may unintentionally return with the pests. Because of their thin shape, their ability to stay hidden in tight spots and their quickness, bed bugs often move into suitcases, boxes and other containers without being seen. They are also transported into new living spaces when infested, previously owned mattresses, box springs or furniture items are bought or rented. Introduction of bed bugs is more likely in hotels, motels and apartments because of the frequent occupant turnover.



Figure 6. The white eggs are about 1 mm long and stick to surfaces. Newly hatched nymphs are light-colored with red eyes. (Credit: UT E&PP)

Because initial symptoms of bed bugs are ignored or other causes are blamed, the bed bugs may spread away from the bedroom before they are detected. Bed bugs feed on warm-blooded animals (humans, bats, poultry, lab mammals, pigeons), so poor sanitation, i.e., leaving food around and not cleaning spills, will not directly affect bed bug populations. Because bed bugs hide in cracks and crevices, even very clean dwellings can have bed bugs.

Other animals can introduce bed bugs or their relatives to a structure. Check attics and other locations for alternate hosts, such as bats and birds. An entomologist should be able to distinguish bed bugs from their relatives. University of Tennessee Extension has a Plant and Pest Diagnostic Center in Nashville and entomologists in Nashville, Knoxville and Jackson. Distance Diagnostics (<http://web.utk.edu/%7Eextepp/ddtrain/equipped-counties-web.jpg>) are available in many county Extension

offices (http://www.agriculture.utk.edu/personnel/districts_counties/default.asp) should you need to seek identification of a suspected bed bug.

Steps to Managing Bed Bugs

- 1. Identify**
- 2. Cooperate and educate**
- 3. Inspect thoroughly**
- 4. Control nonchemically & chemically**
- 5. Follow up & re-treat**

What to do About a Bed Bug Infestation

Bed bug elimination can be very difficult because the bugs can hide in cracks and crevices. A pest management professional (PMP) should be considered for management of this pest as PMPs have the tools needed for crack-and-crevice applications as well as access to a greater variety of insecticides. Most PMPs will have a separate contract for bed bugs, which clearly explains their responsibilities and their client's responsibilities. If a building is used for the temporary or permanent lodging of others, etc. (TDA 62-21-124), pesticides must be applied by someone under the direct supervision of a person licensed to apply pesticides. This means pest management in hotels and motels must be performed by a PMP.

In addition to hiring a pest management professional, a resident will need to help if bed bugs are to be successfully controlled. Excess clutter needs to be removed,



Figure 7. Remove excess clutter including items stored under bed. Note bed bug on packing material. (Credit: UT E&PP)

including items stored under beds (Figure 7). PMPs must be given access to areas in rooms where cracks and crevices occur. In some instances, infested mattresses and box springs will need to be discarded. These should not be left by the curb or dumpster but taken directly to the dump so others don't acquire your bed bug population. If removal to the dump is not an option, mattresses can be shredded or otherwise mutilated so they can no longer be used for bedding.

Finding the Bed Bugs

A heavily infested house may have a distinctive odor similar to "fresh, red raspberries," so odor may help detect areas of infestation. Many PMPs indicate this odor is not present unless the infestation is extensive. Some people are very sensitive to bed bug bites, while others are hardly aware of them, so complaints should not be relied upon to delimit infestations. Immediately after feeding, bed bugs defecate the semisolid sticky remains of their last meal. Look for tarry or "rusty" spots on bedding, along mattress seams and other places bed bugs feed and hide.

Because they prefer to live close to their host, bed bugs are often found in bedrooms or sleeping areas in the cracks and crevices of headboards, bed frames and mattresses. They prefer rough, dry surfaces such as wood or fabric. Smooth, metal surfaces are less likely to be infested. Bed bugs are commonly found in the seams of mattresses; under plastic boxspring corner covers (Figure 8); inside mattress coils; in cracks in bed frames, bedside furniture and dressers, wall boards and wood paneling; in clutter under the bed; under door and window frames; behind pictures; under loose wallpaper; under the edges of wall-to-wall carpeting, baseboards and other wood molding; in ceiling-wall junctures; inside clothing stored in closets and dressers; inside lamps, clocks, phones, televisions and smoke detectors; and in other rooms near the hosts' sleeping areas as well. In hotels/motels, bed bugs are often found in the crevice produced by the headboard support that is screwed into the wall behind the headboard. They are less likely to be found in bedding that is changed on a regular basis. Glue boards, which are excellent trapping devices for brown recluse spiders, are not effective at trapping bed bugs. Bed bugs may move from an attic area to living spaces through light and fan ceiling fixtures or light switches, pipe penetrations or wall outlets.

To be successful, inspection must go beyond the cursory look and furniture must often be turned over or disassembled. Dismantle the bed, stand the components on edge and look for live bed bugs, their cast skins and dried excrement. Experts recommend at least two people help with the bed breakdown because large mattresses are difficult to maneuver (Figure 9). Check under tags and remove tags if allowed. Box spring bottom coverings or dust covers are often stapled to the frame. This lining can be removed to inspect the inner side of the box spring. Fold the liner towards the middle and place it in a 30-gallon plastic trash bag for removal. Or, the staples can be temporarily removed from three sides to allow a thorough inspection of the box spring interior. Electrical appliances



Figure 9. Large mattresses are difficult to maneuver so at least two people should work together. In hotels, check behind the headboard support too. (Credit: UT E&PP)



Figure 8. Bed bugs can be found in tight spots around the bed, including under the plastic corner cover. (Credit: UT E&PP)

may need to be dismantled to some extent, too. Empty dressers and nightstands and inspect them inside and out. When you are finished with that, turn them over to inspect the base. Check the cracks where the legs attach and give special attention to cracks, corners and recessed areas. Sofa beds and even upholstered chairs can harbor bed bugs. Search all seams, tufts, skirts and crevices of upholstered furniture as well as behind and under cushions. Always wear disposable gloves and be careful when flipping a mattress to avoid dislodging bed bugs onto your clothing.

It is imperative to locate and subsequently treat as many cracks and crevices as possible where bed bugs or evidence of them is found. Be thorough. Even though bed bugs usually occur in clusters, single bugs or eggs are sometimes found. Use a bright flashlight. A PMP may even use a flushing agent. Flushed bugs can be vacuumed. Inspection and treatment of a home can and should be lengthy. In one case, a PMP spent four hours in a bed bug inspection of a one-room apartment.

Nonchemical Management

Clutter should be reduced before either inspection or treatment. Clothes and other items scattered around the room can harbor bed bugs, disrupt the inspection and cause bed bugs to disperse as items are moved.

Laundering, heating and chilling

Bag and launder (120 degrees F minimum) bedding and infested clothing. Bedding should be folded into the middle and then bagged to avoid dropping bed bugs. If laundering is not an option, these items may need to be disposed of because they cannot be treated with insecticide. Other options for items that cannot be treated with insecticides include heat or cold treatment, which may sometimes be effective for small items. These pieces can be bagged in plastic and put in a hot, sunny location for a few days. Ensure the innermost portion of the item reaches 120 degrees F by monitoring it with a thermometer. Bed bugs can also be killed by cold temperatures (32 degrees F or below); however, adults and nymphs may require a week or two, and eggs require 30 days at 32 degrees F or lower to be killed making this an impractical option. While thermal or heat fumigation has been successful for other insects, it is not recommended for rooms infested with bed bugs, which will move out before the room reaches a lethal temperature.

Natural Enemies

While there are several species of ants and spiders, a centipede, a pseudoscorpion, as well as a mite that reportedly prey on bed bugs, all of them would also be considered pests inside structures.

Steam and Vacuum Application

Because of the safety risk involved with chemical treatment of mattresses, sofas or other furniture that people touch, some alternative methods have been developed. Orkin Inc. has data indicating steam cleaning, in conjunction with applying an insecticidal dust to suspected crevice and void harborage, can be very effective in managing bed bug populations. A low-vapor, high-temperature (220 degrees F) steam applied to seams, tufts, button-holes, crevices and folds of mattresses, box springs, sofas, love seats, chairs and other similar furniture should kill all eggs, nymphs and adult bed bugs contacted. Be sure to check sofas to see if they are hide-a-beds with mattresses. Vacuuming with a crevice tool along edges of the beds, mattresses, etc. can also help reduce bed bug populations. Don't just use any steam cleaner – it is important to use a low-vapor steam because moisture may lead to mold growth. Steam cleaning will kill only the adults, nymphs and eggs in actual contact with the steam. It is possible that bed bugs deep in a mattress may not be exposed to the steam and thus not affected.

Chemical Management

In the not-so-distant past, bed bug infestations were treated by spraying an entire room, including beds, floors, walls and furniture, with DDT. Although this is no longer permitted, thoroughness is still of the utmost importance. Treatments are now targeted to cracks and crevices.

As bed bugs and their harborage are found during inspection, treat these infested areas with a crack-and-crevice or void application of a dust, spray or aerosol registered for this purpose. Dusts tend to persist in voids longer than sprays because they rest on the surface.

Treat crevices of bed frames, baseboards, under edges of wall-to-wall carpeting, other wall/floor material interfaces, closets, wood paneling, the back side of wall-mounted items, behind mounted lights, ceiling fan fixtures and any other places that may harbor bed bugs (Figure 10). The wall between the bedroom and bathroom will have a higher humidity and may need to be drilled and injected with dust or aerosol. After pesticide applications, caulk cracks and crevices. Avoid spray runoff if applying liquid insecticides onto surfaces and into cracks. Do not apply liquids to electrical components. Multi-dwelling structures and hotels require frequent inspections and perhaps repeated applications. If an infestation in an apartment building or hotel is localized, all units connected to the infested area should also be treated. If wild animal hosts are located and removed, the area they inhabited should be treated for bed bugs and the structure pest-proofed (see UT Extension PB1303, Managing Pests Around the Home) to prevent future animal infestations. Insecticides suggested for bed bug control are listed in our Insect and Disease Control Manual located at <http://eppserver/redbook/sections/structural.htm>.

One treatment may not be sufficient to obtain satisfactory control. A re-inspection will determine whether the infestation is under control. Some pest management firms wait one week after a chemical treatment before allowing a hotel room to be re-occupied. It may be wise to determine whether the pest has been eliminated before re-occupying a room, especially in a hotel or similar building.

What About the Bed?

Do I have to throw out my bed if it is infested with bed bugs? Ideally, if a mattress is intact and has no holes or tears, bed bugs (eggs, nymphs and adults) could be removed with a vacuum and crevice tool or killed by dry steam. If holes or tears are present, bed bugs may be deep inside the mattress and may be unaffected by such treatments. Pest management companies may be hesitant to apply pesticides to mattresses even if this is permitted by the insecticide label. If you choose to keep a mattress, encasing the mattress after a labeled insecticide application may be helpful. Zippered bed encasements promoted for dust mite prevention can be purchased from allergy supply companies. Some pest management companies will treat only the seams, tufts and crevices of bed parts and will not spray the mattress surface or other areas of the bed that the client may contact. Beds and other difficult-to-treat items may be fumigated to remove bed bugs although some PMPs are reporting inconsistencies when fumigating. Entire structures have been fumigated for bed bugs. This, however, is costly; requires much time for preparation, tarping, treatment and voiding of the gas; and would only be recommended in extreme cases where bed bugs have infested an entire structure.

How to Avoid Infestations

Because bed bugs hide very well and are mobile, it is difficult to prevent them from moving from place to place. The following guidelines will help you avoid bringing bed bugs to your home.

1. Be informed about the characteristics of bed bug eggs, nymphs and adults as well as their feces and shed skins. The next time you stay in a hotel, have someone assist you in inspecting behind the headboard, along the mattress seams or other accessible cracks and crevices.
2. Place luggage on the luggage rack in motels, hotels, etc.
3. Inspect luggage for bed bugs before leaving the motel, hotel, etc.
4. When acquiring used or rented beds, bedding, furniture and other items that may harbor bed bugs, inspect them before purchasing or bringing them into your home.



Figure 10. Empty dressers and nightstands and inspect them inside and out. When you are finished with that, turn them over to inspect the base. Check the crack where the legs attach and give special attention to cracks, corners and recessed areas. Can you find all the cracks and crevices that should be inspected and treated as needed?

(Credit: UT E&PP)

Bed bugs are not as common as many other pests in the United States. In Tennessee, about one in five counties has had a single infestation in the last five years. This publication is not meant to cause undue concern, but to prepare you to avoid an infestation and to inform you of treatment options.

Sources

- Anonymous. 2002. Chapter 5: House Frequenting Insect Pests. In Category 8, Public Health Pest Control, Pesticide Applicator Certification Training Manual [K. M. Vail, E. E. Burgess, R. Gerhardt, C. Jones and J. Skinner eds.], The University of Tennessee Agricultural Extension Service, Knoxville, Tennessee.

- Anonymous. 2002. Bed Bugs. Whitmire Microgen Prescription Treatment Brand Pest Management. Volume 2.
- Anonymous. 2005. Bed Bugs Continue Their Comeback, New Orkin Study Finds. Orkin Press Release, Tuesday April 26, 2005 <http://www.pctonline.com/news/news.asp?ID=3397&AdKeyword=bed+bug+survey>
- Cooper, R and H. Harlan. 2004. Chapter 8, Ectoparasites, Part Three: Bed Bugs and Kissing Bugs, pp. 494-529. In (S. Hedges [ed. dir.]), 9th ed. Mallis' Handbook of Pest Control. GIE Publishing, Inc., Cleveland, Ohio
- Jacobs, A. 2005. Just Try to Sleep Tight. The Bed-bugs Are Back. New York Times November 27, 2005 <http://www.nytimes.com/2005/11/27/nyregion/27bugs.html?emc=eta1>
- Meek, F. 2002. Bed Bug Scope of Service. Orkin Technical Services
- NPMA. 2005. Ask the Expert p. 16. In Pest World March/April issue and numerous other fact sheets and news releases
- Potter, M. 2004. Bed bugs. <http://www.uky.edu/Agriculture/Entomology/entfacts/struct/ef636.htm>
- Smith, E. and R. Whitman. 1996. NPCA Field Guide to Structural Pests. NPMA, DunnLoring, Virginia
- Usinger, R. 1966. Monograph of Cimicidae, Thomas Say Foundation Vol. VII, Entomological Society of America, Lanham, Maryland

All photos credited to UT E&PP with no individual listed or where no photo credit was given were taken by J. Morton, A. Toennissen, K.Vail or a Parkman family member.

Precautionary Statement

To protect people and the environment, pesticides should be used safely. This is everyone's responsibility, especially the user. Read and follow label directions carefully before you buy, mix, apply, store or dispose of a pesticide. According to laws regulating pesticides, they must be used only as directed by the label.

Disclaimer

This publication contains pesticide recommendations that are subject to change at any time. The recommendations in this publication are provided only as a guide. It is always the pesticide applicator's responsibility, by law, to read and follow all current label directions for the specific pesticide being used. The label always takes precedence over the recommendations found in this publication.

Use of trade or brand names in this publication is for clarity and information; it does not imply approval of the product to the exclusion of others that may be of similar, suitable composition, nor does it guarantee or warrant the standard of the product. The author(s), the University of Tennessee Institute of Agriculture and University of Tennessee Extension assume no liability resulting from the use of these recommendations.

PB1763-1.5M-9/06 E12-4615-00-001-07 06-0271

Programs in agriculture and natural resources, 4-H youth development, family and consumer sciences, and resource development. University of Tennessee Institute of Agriculture, U.S. Department of Agriculture and county governments cooperating. UT Extension provides equal opportunities in programs and employment.