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The following list contains some common preparations made prior to bed bug treatment. This is not an all inclusive list.

- Remove all sheets, pillows and bedding material. Seal them in a plastic bag until they can be cleaned to prevent the infestation from spreading.
- Wash sheets and bedding in soap and hot water. Items that cannot be washed, such as bedspreads and draperies, should be dried at high temperatures for one hour (only high heat eliminates eggs in these items). This will also be necessary for clothing or bedding stored beneath beds or in dressers where bed bugs are discovered.
- Everything that can be laundered *should* be laundered before treatment and placed in plastic bags. This would include stuffed animals and other soft articles.
- Place the clean items in new, unused plastic bags and tie closed. Do not bring bags of clean laundry into the home until after the service is performed.
- Clear all floors of loose items such as toys, change, trash, etc... including floors in closets and interior storage. Place all items in sealed plastic bags for laundering or disposal.
- Don't move items to another home or room during treatment. You may spread bed bugs to the other areas and may reintroduce bed bugs to your newly treated home later, when you retrieve your belongings.
- Ensure all items are removed from dresser tops and within dressers, nightstands, bookshelves, coffee tables, etc.
- All wood furniture, CD and tape stands must be turned over and inspected for bed bugs and their eggs.
- Move all furniture and bed frames at least 18" from the wall so you can inspect and treat the carpet edge and baseboards where bed bugs prefer to hide.
- Lean mattresses and box springs against the wall for inspection and treatment in small crevices and tufts. Upholstered furniture (couches and chairs) will need to be inspected and treated. Remove and bag throws, pillows and slip covers, and dry at high temperatures. Vacuum deep into crevices with a crevice attachment.
- Aquariums: disconnect the air pump and cover the top with a plastic bag or sheet.
- Birds, dogs, cats and other pets must be completely removed from the residence.
- All furniture containing potential hiding crevices, such as bookshelves and desks, should be emptied.
- Remove all clutter, boxes, bags, etc.
- Vacuum the entire carpet with a crevice attachment, especially the edges.
- Vacuum floors, furniture and inside closets, dresser drawers and bed stands. Also vacuum mattresses and box springs. Dispose of vacuum bag.
- Seal the vacuum bag in a plastic bag and discard in an outside trash bin.
- Purchase mattress covers for mattress and box springs.

UK COOPERATIVE EXTENSION SERVICE
UNIVERSITY OF KENTUCKY — COLLEGE OF AGRICULTURE
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BED BUGS

By Michael F. Potter, Professor & Urban Entomologist

Most householders of this generation have never seen a bed bug. Until recently, they also were a rarity among pest control professionals. Bed bug infestations were common in the United States before World War II. But with improvements in hygiene, and especially the widespread use of DDT during the 1940s and '50s, the bugs all but vanished. The pests remained fairly prevalent, however, in other regions of the world including Asia, Africa, and Eastern Europe. In recent years, bed bugs have also made a comeback in the U.S. They are increasingly being encountered in homes, apartments, hotels, motels, health care facilities, dormitories, shelters, schools, and modes of transport. Other places where bed bugs sometimes appear include movie theaters, laundries/dry cleaners, furniture rental outlets and office buildings. Immigration and international travel have undoubtedly contributed to the resurgence of bed bugs in the U.S. Changes in modern pest control practice — and less effective bed bug pesticides — are other factors suspected for the recurrence.

DESCRIPTION AND HABITS.

Adult bed bug feeding on human

Bed bugs are small, brownish, flattened insects that feed solely on the blood of animals. The common bed bug, *Cimex lectularius*, is the species most adapted to living with humans. It has done so since ancient times. Bed bugs are mentioned in medieval European texts and in classical Greek writings back to the time of Aristotle. Other bed bug species prefer to feed on wild hosts, especially bats and birds.

Adult bed bugs are about 3/16-inch long and reddish-brown, with oval, flattened bodies. They are sometimes mistaken for ticks or cockroaches. The immatures (nymphs) resemble the adults, but are smaller and lighter in color. Bed bugs do not fly, but can move rapidly over floors, walls, ceilings and other surfaces. Female bed bugs lay their eggs in secluded areas, depositing 1, 2 or more eggs per day and hundreds during a lifetime. The eggs are tiny, whitish, and hard to see on most surfaces without magnification (individual eggs are about the size of a dust speck). When first laid, the eggs are sticky, causing them to adhere to surfaces. Newly hatched nymphs are straw-colored and no bigger than a pinhead. As they grow, they molt (shed their skin) five times before reaching maturity. A blood meal is needed between each successive molt. Under favorable conditions (70-80°F), the bugs can complete development in as little as a month, producing three or more generations per year. Cooler temperatures or limited access to blood extends the development time. Bed bugs are resilient. Nymphs can survive months without feeding and the adults for more than a year. Infestations therefore are unlikely to diminish by leaving premises unoccupied. Although *C. lectularius* prefers feeding on humans, it will also bite other warm-blooded animals, including dogs, cats, birds and rodents.

Dark spots of bed bug excrement on a mattress

Bed bugs are active mainly at night. During the daytime, they prefer to hide close to where people sleep. Their flattened bodies enable them to fit into tiny crevices — especially those associated with mattresses, box springs, bed frames and headboards. Bed bugs do not have nests like ants or bees, but do tend to congregate in habitual hiding places. Characteristically, these areas are marked by dark spotting and staining, which is the dried excrement of the bugs. Also present will be eggs and eggshells, the brownish molted skins of maturing nymphs and the bugs themselves. Another telltale though less frequent sign is rusty or reddish blood smears on bed sheets or mattresses from crushing an engorged bed bug. Heavy infestations

Bed bugs often congregate along seams of mattresses and box springs. Blackish spots are excrement.

may have a "buggy" smell, but the odor is seldom apparent and should not be relied upon for detection.

Bed bugs prefer to hide close to where they feed. However, if necessary, they will crawl several feet to obtain a blood meal. Initial infestations tend to be around beds, but the bugs eventually may become scattered throughout the bedroom, occupying any crevice or protected location. They also may spread to adjacent rooms or apartments.

BITES & CONCERNS.

Bed bugs usually bite people at night while they are sleeping. They feed by piercing the skin with an elongated beak through which they withdraw blood. Engorgement takes about three to 10 minutes, yet the person seldom knows they are being bitten. Bed bugs normally do not reside on people like head or body lice —immediately after feeding they crawl off and reside elsewhere to digest their meal. Symptoms after being bitten vary with the individual. Many develop an itchy red welt or localized swelling within a day or so of the bite. Others have little or no reaction, and in some people the reaction is delayed. Unlike flea bites that occur mainly around the ankles, bed bugs feed on any skin exposed while sleeping (face, neck, shoulders, back, arms, legs, etc.). The welts and itching are often wrongly attributed to other causes, such as mosquitoes. For these reasons, infestations may go a long time unnoticed, and can become quite large before being detected. The likelihood of bed bugs increases if the affected individual has been traveling, or had acquired used beds or furnishings before symptoms started to appear. Bed bugs also are suspect if you wake up with itchy bites you did not have when you went to sleep. Conversely, it is important to recognize that not all bites or bite-like reactions are due to bed bugs. Confirmation requires finding and identifying the bugs themselves, which often requires the help of a professional. (Other possible sources of irritation are discussed in University of Kentucky entomology fact sheet ENT-58; *Invisible Itches: Insect and Non-Insect Causes*).

A common concern with bed bugs is whether they transmit diseases. Although bed bugs can harbor pathogens in and on their bodies, transmission to humans is considered unlikely. Their medical significance is chiefly limited to the itching and inflammation from their bites. Antihistamines and corticosteroids may be prescribed to reduce allergic reactions, and antiseptic or antibiotic ointments to prevent infection. Though not known to carry diseases, bed bugs can severely reduce quality of life by causing discomfort, sleeplessness, anxiety, and embarrassment.

Conventional insect repellents, like those used to deter ticks and mosquitoes, do not appear to be effective against bed bugs. Attempting to avoid being bitten by applying insect repellent at bedtime is not recommended. Sleeping with the lights on is not likely to deter hungry bed bugs either.

HOW INFESTATIONS BEGIN.

It often seems that bed bugs arise from nowhere. The bugs are efficient hitchhikers and are usually transported in on luggage, clothing, beds, furniture, and other items. This is a particular problem for hotels, motels and apartments, where turnover of occupants is constant. Bed bugs are small, cryptic and agile, escaping detection after crawling into suitcases, boxes and belongings. The eggs are especially tiny and are usually overlooked. Acquiring secondhand beds, couches and furniture is another way that the bugs are transported into previously non-infested dwellings. Bed bugs also can be carried in on a person's clothing or shoes, resulting in an infestation.

Once bed bugs are introduced, they often spread throughout a building. The bugs can travel from room to room or floor to floor either by crawling or via a person. Unlike cockroaches that feed on filth, the level of cleanliness has little to do with most bed bug infestations. Pristine homes, hotels and apartments have plenty of hiding places and an abundance of warm-blooded hosts. Thus, they are almost as vulnerable to infestation as are places of squalor.

When bed bug-like insects are found, it's important to consider whether bats, swallows, chimney swifts, pigeons or other wild hosts are involved. Although similar in appearance, species of bed bugs that normally feed on bats and birds can be differentiated from those that prefer humans. Entomologists and knowledgeable pest control firms can make this determination.

Bed bugs often congregate along seams of mattresses and box springs. Blackish spots are excrement.

WHERE THEY HIDE.

Bed bugs can live in almost any crevice or protected location. The most common place to find them is the bed. Bed bugs often hide within seams, tufts and crevices of the mattress, box spring, bed frame and headboard. A thorough inspection requires dismantling the bed, and standing the components on edge so that upper and lower surfaces can be examined. Things to look for are the bugs themselves, and the light-brown, molted skins of the nymphs. Dark spots of dried bed bug excrement are often present along mattress seams or wherever the bugs have resided. Box springs afford many places for bed bugs to hide, especially underneath where the fabric is stapled to the wooden frame. Oftentimes the underlying gauze dust cover must be removed to gain access for inspection and possible treatment. Successful treatment of mattresses and box

springs is difficult, however, and infested ones may need to be discarded or encased in a protective cover. Cracks and crevices of bed frames should be examined, especially if the frame is wood. (Bed bugs have an affinity for wood and fabric more so than metal or plastic). Headboards secured to walls should also be removed and inspected. In hotels and motels, the area behind the headboard is often the first place that the bugs become established. Bed bugs also hide among items stored under beds.

Bed bugs are frequently found on the undersides of box springs.

During the early stages of a bed bug problem, the pests tend to congregate mostly in beds and other sleeping areas. As infestations grow larger, they tend to move beyond beds into other locations making control more difficult. Upholstered chairs and sofas should be examined above and beneath, especially seams, tufts, skirts and crevices. Sofas can be major bed bug hotspots, especially when used for sleeping. Like beds, they can be difficult to treat and may need to be discarded. Nightstands and dressers should be emptied and examined inside and out, then tipped over to inspect the woodwork underneath. Oftentimes the bugs will be hiding in cracks, corners, and recesses. Other common places to find bed bugs include: along and under the edge of wall-to-wall carpeting (especially behind beds and furniture); cracks in wood molding; ceiling-wall junctures; behind wall-mounted picture frames, mirrors, switch plates and outlets; under loose wallpaper; amongst clothing and clutter stored in closets; and inside clocks, phones, televisions and smoke detectors.

Bed bugs tend to congregate in certain areas, but it is common to find a single bug or some eggs scattered here and there. Persistence and a bright flashlight are requisites for success. A thorough inspection and treatment may take up to several hours. Some companies are beginning to use canines for detecting hard-to-find infestations. When properly trained, the dogs can be very effective. However at this time very few companies are using them due to the expense of training and maintaining such animals.

CONTROLLING INFESTATIONS.

Bed bugs are challenging pests to control. Since they can hide in so many places, treatments must be thorough and elimination is not always a certainty. In most cases, it will be prudent to enlist the services of a professional. Experienced pest control firms know where to look for bed bugs, and have an assortment of management tools at their disposal.

Bed Bugs hidden beside a recessed screw under a nightstand.

Owners and occupants have an important role and will need to assist the professional. Affording access for inspection and treatment is crucial, and excess clutter will have to be removed. Belongings strewn about rooms afford many places for bed bugs to hide, and impedes inspection and treatment. Some pest control firms want furniture moved away from walls and mattresses and box springs stood on edge before they arrive; others prefer to inspect first and move these items themselves. Since bed bugs can disperse throughout a building, it often will be necessary to inspect adjoining rooms and apartments.

Treatment Procedures.

Inspections and treatments must be very thorough

Infested and infestation-prone bedding and garments will need to be bagged and laundered (120°F minimum) since these items cannot be treated with insecticides. Another effective and efficient option is to place clothing, toys, shoes, backpacks, etc., in a clothes dryer set at medium to high heat for 10 to 20 minutes. This will kill all bed bug life stages and can be done alone or in conjunction with laundering. According to textile experts at the Drycleaning & Laundry Institute (Laurel, MD), most garments designated as 'dry-clean only' (e.g., cotton, wool, silk, linen, rayon, nylon, poly blends) will not be harmed provided they are dry before being placed in a clothes dryer at moderate (less than 160°F) settings. While dry cleaning procedures also kill bed bugs, there is risk of infesting the establishment when buggy items are de-bagged, tagged and sorted.

Items which cannot be put in a washer or dryer can sometimes be de-infested by wrapping in plastic and placing them outdoors in a hot, sunny location, closed vehicle, etc. for at least a day. If this method is attempted, packing fewer items per bag makes it harder for the bugs to find cooler places to hide. Monitoring with a thermometer is prudent, with a target internal temperature of at least 120°F. Bed bugs also will succumb to cold temperatures below 32°F, but the freezing temperatures must be maintained for several days. Consequently, throughout much of the country, heating tends to be a faster, more reliable option than chilling. Attempts to rid an entire dwelling of bed bugs by raising or lowering the thermostat will be unsuccessful, although some companies are having success using supplemental heaters.

Bed bugs often reside along baseboards. Photo show eggs, nymphs, and adults beneath carpet edge.

General housecleaning measures, such as vacuuming floors and surfaces, seldom reaches the places where bed bugs hide. Targeted vacuuming of infested harborages, however, can help remove some of the bugs before treatment with insecticides. Bed bugs and especially the eggs can be difficult to dislodge. Optimum results will be achieved by moving and scraping the end of the suction wand along infested areas such as seams and fabric folds of beds and sofas, and the perimeter edge of wall-to-wall carpets. Afterward, dispose of the vacuum contents in a sealed trash bag. Some pest control firms also employ commercial steamers or rapid freezing equipment to treat areas where bed bugs are found or suspected. Used correctly, they kill both bugs and eggs on contact. Neither method, however, affords residual protection against bed bugs which may have been missed.

At times it may be necessary to throw out infested items, especially beds and upholstered furniture. Knowledgeable pest control firms are able to advise clients on what can stay and what should go. When infested items are discarded, bagging or wrapping them prevents dislodgement of bugs en route to the Dumpster®.

While the aforementioned measures are helpful, insecticides are important for bed bug elimination. Professionals treat using a variety of low-odor sprays, dusts and aerosols. Baits designed to control ants and cockroaches are ineffective. Application entails treating all areas where the bugs are discovered or tend to crawl or hide. This may take hours of effort and follow-up visits are usually required.

Some bed bug species are parasites of bats or birds, and may bite people if the wild hosts are no longer available. If bat bugs or bird bugs are involved, roosting and nesting sites should be the primary focus of treatment and the animals excluded from the building.

Do I Have to Throw Out the Bed? Eliminating bed bugs from beds can be challenging. If there are holes or tears in the fabric, the bugs and eggs may be inside, as well as outside. There also are restrictions on how beds can be treated with pesticides. For these reasons, companies sometimes recommend that beds be discarded, especially when heavily infested or in poor condition. Another option is to encase both the mattress and box spring in a protective cover like those used for allergy relief. Encasements specifically designed to help protect against bed bugs are available through retail outlets or pest control firms. Once the cover is installed and zipped shut, any bugs which happen to be inside are entombed and eventually will die. Encasements also help protect newly purchased beds, and make it easier to spot and destroy any bugs residing on the outer surface during subsequent examination. Encasements will not, however, keep bed bugs from crawling onto a bed and biting a sleeping person.

Some companies treat seams, tufts, and crevices of bed components with insecticides, but they usually will not spray the entire mattress surface. They also should not spray bed sheets, blankets or clothing, which should be laundered. Vacuuming and steaming further help to eliminate bugs and eggs from beds, but afford no residual protection and may not kill bed bugs hidden inside the box spring or mattress. Fumigation is another way to de-infest beds and hard-to-treat items, but the procedure is not always available. In extreme cases, entire buildings have been fumigated for bed bugs. The service can be quite costly though, and involves covering the building in a tarp and injecting a lethal gas. Some companies also de-infest such items with specialized heating equipment.

PREVENTING INFESTATIONS. As difficult as it can be to eradicate bed bugs, it makes great sense to take precautions to avoid them in the first place. Householders should be vigilant when acquiring used furnishings, especially beds and couches. Curbside items should be avoided, and secondhand articles should be examined closely before being brought into the home, and perhaps laundered or placed in a dryer. Avoiding problems with bed bugs is most challenging in apartments, hotels and other places where there are ongoing opportunities for the bugs to be introduced. Preventative inspection by tenants, housekeeping staff, or pest control firms is the best way to uncover infestations in their initial stages when they are easiest to control.

Discarded beds and couches might be infested and should be left alone.

Concerned travelers may want to get in the habit of checking their bed for signs of bed bugs, a common practice in the past. This would entail examining the bed sheets and upper and lower seams of the mattress and box spring, especially along the head of the bed. Some professionals also suggest removal and examination behind the headboard, a frequent hiding place for the bugs in hotel rooms. Headboards are heavy and cumbersome, however, and untrained persons should not attempt removal themselves. If bed bugs are discovered, travelers can request another room, preferably in another area of the building. Vigilant travelers may also want to elevate suitcases off the floor on a luggage stand, tabletop or other hard surface. Should travelers experience itchy welts suggestive of bed bug bites during their stay, it would be prudent upon returning home (before unpacking) to place all clothing in disposable plastic bags and directly into the washer and/or dryer. Inspecting or vacuuming luggage upon arrival home is less useful since it's hard to spot bed bugs inside a suitcase. The suitcase itself can either be treated or discarded.

The incidence of bed bugs in the United States is increasing to the point where vigilance by all is a prudent practice. Familiarity can help to avoid infestation, or at least prompt earlier intervention by a professional.

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Killing Them Softly: Battling Bed Bugs in Sensitive Accounts

Bed bugs are well-adapted to living with humans. Like other successful parasites, they prefer to live near their next meal. In the case of the nocturnal bed bug, this usually means close to where people sleep or lounge. In recent surveys of bed bug-infested apartments, for example, more than 90 percent of the insects were found living in beds, sofas and recliners (see "**Battling Bed Bugs in Apartments**," PCT August 2006). Ironically, these are the places many firms are uncomfortable spraying due to client concerns about pesticides. This article examines non-chemical options for battling bed bugs when pesticides may not be an option.

DISPOSAL. The fastest way to reduce bed bug numbers is to throw out infested items. Bed bugs can be hard to eradicate from beds and upholstered furniture because so many may be present and well concealed. Box springs, sofas and recliners are especially challenging, affording unlimited hidden harborage within inches of the host. Heavily infested or damaged mattresses, frames and headboards also may warrant disposal. Nonetheless, throwing out infested items isn't an option for some customers and often may not be necessary. One misdirected homeowner we know threw out $50,000 worth of furniture following advice posted on the Internet. Another discarded almost everything they owned including their entire wardrobe, kitchen utensils, children's toys and an infant potty seat. Knowledgeable pest managers are better able to advise clients on what can stay and what should go. When infested items are discarded, bagging or wrapping them prevents dislodgement of bugs en route to the dumpster.

ENCASEMENT. One good way to limit bed bug habitation of beds is encasement. Encasing both the mattress and box spring denies them access to inner, hard-to-treat areas. Once the cover is installed, any bed bugs which happen to be inside are entombed and eventually will die. A tight-fitting smooth outer cover also makes it easier to spot and destroy any bugs reappearing on subsequent visits. Encasement makes a lot of sense if the old infested bed is to be kept. They also help protect new bed components until the current infestation is eliminated. Some pest control firms supply and install the bed covers themselves to ensure that they will be used and installed properly.zippered bed encasements of various qualities are available at bedding supply stores. Bed bugs trapped inside will not bite through the fabric, but cheaper covers are more likely to tear during installation and use. One high quality encasement developed specifically for bed bugs was recently introduced by Protect-A-Bed (Chicago). No encasement product, however well constructed, will keep bed bugs from crawling onto a bed and biting a sleeping person.

VACUUMS. Vacuums can remove many types of pests ranging from cockroaches to ladybugs. Routine vacuuming by clients is seldom of much benefit against bed bugs because they hide in places where normal house cleaning efforts do not reach. Targeted vacuuming of infested harborages, however, can be useful if performed properly and limits of the procedure are understood. Bed bugs are harder than cockroaches to dislodge with a vacuum. Adults and nymphs cling more tightly to surfaces and each tiny translucent egg is affixed with a cement-like substance. When vacuuming bed bugs, better results are achieved by scraping the end of the suction wand repeatedly over the harborage area. While many bed bugs will be dislodged, some individuals — and especially eggs — will be left behind. Removal becomes difficult if not impossible when bugs and eggs are located deep within crevices of wood, fabric or upholstery. Another potential concern when vacuuming bed bugs is the chance they will be spread. Perhaps more so than with cockroaches, we have noticed some bugs and plenty of eggs surviving the high-speed ride down the vacuum hose into the collection bag. If vacuum bags are not discarded, bed bugs could be transported to other clients or back to the office. Brush attachments enhance the potential for spread by allowing bugs and eggs to adhere to the bristles

STEAMERS. If bed bugs have a weakness, it's elevated temperature. Temperatures of about 120°F are lethal to most insects provided they cannot escape to a cooler location. The advantage of steam is that heating is intense and immediate, killing both bugs and eggs on contact. The types of steamers used for bed bug treatment are like those used for sanitizing floor drains. When targeting bed bugs though, the less moisture emitted the better, especially when treating mattresses and other slow-drying materials where mold growth is a possibility. Low-moisture steamers are available from such companies as AmeriVap Systems, Atlanta, Ga., 800/763-7687; and Hi-Tech Cleaning Systems, Columbus, Ohio, 866/606-1355. It is important to have a commercial-grade steamer with a water tank large enough to accommodate extended use between fill-ups. Most machines come with variable steam outputs and multiple attachments. Larger brush heads usually work best. Small diameter tips are less efficient and frequently emit too much pressure, causing bugs and eggs to be blown off the substrate. While some of the dislodged bed bugs may die, others could survive and be scattered here and there. When using steam, it is important that the bed bugs be exposed to lethal temperatures. Ideally the steamer head should be moved directly over the surface being treated. Holding the steam head farther away might only give the bugs a warm moist bath. A good way to confirm that lethal temperatures are being achieved is to use a digital infrared thermometer. Instantaneous temperature readings can be had by pointing the device at the area just treated. Alternatively, one can hold their hand several inches from the steam head and slowly and carefully move it closer. Vapor too hot to touch is what's needed to kill bed bugs and eggs on contact. An effective way to further elevate the temperature of emitted vapor is to wrap the brush head of the steamer in a towel. A small tea towel works well and can be secured to the steam head using the spring-mounted clips. This technique produces vapor so hot that the steam head can now be moved quickly and efficaciously over infested and suspect areas. Using the towel method, lethal temperatures can be achieved several inches from the steam head, which can be useful when treating hard-to-reach areas (e.g., between cushions of upholstery or the framework of sofas and box springs). Towels that become overly moist can be replaced. Steam can be used to treat almost any area where bed bugs are found or suspected. Logical places include beds, couches and recliners, baseboards and carpet

edges, beneath and within nightstands and dressers and floor areas (especially under and around beds). Avoid treating finished wood surfaces or delicate items that might be damaged by high heat. Vacuums and especially steamers are useful when battling bed bugs. Neither, though, affords residual protection against bugs or eggs which may have been missed.

LAUNDERING/DRYING. Bed bugs often infest bedding, clothing and other personal belongings which cannot be treated with insecticides. An oft-mentioned way to de-bug such items is laundering — yet to our knowledge, no testing has been done to verify effectiveness. A simple experiment was conducted to study this question. Three groups of live bed bug adults, nymphs and eggs were placed in small nylon mesh pouches which were then placed inside cotton socks. The bed bug-provisioned socks (along with a full load of clothing) were then run through a standard wash cycle using hot water. A second trial was run with similarly infested socks placed only in a clothes dryer. The bed bug-laden socks were accompanied by a load of unwashed clothing and subjected to high heat (greater than 175° F) for five minutes. No bed bugs or eggs survived the washing or drying cycles, suggesting that either regimen, alone or in combination, is effective. Clothing, footwear, area rugs, toys, stuffed animals, backpacks and other non-launderable items can conveniently be de-infested by heating them for a period of time in a dryer at most settings. For reference, a typical clothes dryer run for five minutes at low, medium or high heat produced temperatures of about 140, 150 and 180°F, respectively, amongst a bundle of dry clothing — plenty hot to kill bed bugs. While certain items may require professional dry-cleaning, utilizing conventional washers and dryers may help limit the spread of bed bugs to these establishments.

SEASONAL TEMPERATURES. Lethal outdoor temperatures have long been employed in the battle against bed bugs. In the tropics, infested bedding is often left out in the sun and such methods can also be used during warm seasons in this country. It's risky, however, to rely on ambient heating to achieve lethal temperatures in all harborage locations. Wrapping items in plastic before placing them outdoors in a sunny location (preferably on pavement), produces higher internal temperatures. It also pays not to over pack — more trash bags with fewer items make it harder for bed bugs to find cooler places to hide. Monitoring with a thermometer is also prudent, with a target internal temperature of at least 120° F. In colder climates, freezing might be a way to de-infest furniture and other belongings. Bed bugs and their eggs can be killed by very low temperatures, but it is difficult to achieve them without using a deep freezer. Temperatures below 0°F for one to two weeks are generally believed to be needed to reliably kill all life stages. Fluctuating winter temperatures which often extend above this level are probably less effective and are currently being studied by Dr. Steven Kells at the University of Minnesota. Overall and throughout much of the country, heating tends to be a faster, more reliable option than chilling.

STRUCTURAL HEATING. Elevating the temperature within buildings has been used to eradicate pests ranging from grain insects to termites. Structural and containerized heat treatments are also being developed for bed bugs. Companies such as TempAir (Burnsville, Minn., 888/838-4035) have begun licensing the patented technology to interested pest control firms. Portable heaters and fans are used to gradually heat the air within rooms to about 125 to 130°F while monitoring with strategically placed sensors. A licensing and royalty fee is typically required along with the initial equipment purchase. While heat treatments hold promise, eliminating infestations by raising the temperature within a building may not be so easy. As observed with cockroaches, bed bugs may seek out cooler areas as the temperature within rooms builds. Whether some bugs will be able to survive by moving to cooler locations (including adjacent units) still needs further study.

STERIFAB/BEDLAM. Sterifab and Bedlam are often used to treat bed bug-infested beds and upholstered furniture. Although both products are technically pesticides, some companies choose to use them because of their comparatively short residual when treating human contact surfaces. Sterifab and Bedlam contain mainly alcohol and the relatively short-lived pyrethroid d-phenothrin. There is uncertainty whether either product has sufficient residual activity to kill bed bug nymphs emerging from eggs. To study this question, groups of adult bed bugs were sprayed directly with each product. In another experiment, adults and newly emerged nymphs were confined on filter paper discs that were treated one hour, two days or seven days earlier. Three different bed bug populations were evaluated: two previously shown to be susceptible to pyrethroid insecticides, and a third population known to be resistant. When adult bed bugs were sprayed directly with Sterifab or Bedlam, all (100 percent) died including those from the pyrethroid-resistant population. Efficacy against resistant bugs presumably was related to the alcohol present in both formulations which itself is lethal to bed bugs as a contact (wet) spray. When newly emerged nymphs were confined on surfaces treated with Sterifab or Bedlam one hour, two days, or seven days before, almost all (95% to 98%) of the pyrethroid-susceptible nymphs were killed, but nearly none (2%) succumbed from the resistant population. These preliminary findings suggest that both products provide excellent contact kill as a direct spray against adults and nymphs. Whether they'll also afford residual protection against emerging bed bug eggs depends on the (pyrethroid) susceptibility of the population and perhaps other factors still being investigated.

CLOSING THOUGHTS. Several useful non-chemical tools are available for managing bed bugs. These tools will become even more important when battling pesticide-resistant populations. It should be noted, however, that none of these tactics afford extended residual protection against reinfestation. Any bugs or eggs managing to escape treatment will live to bite another day. So will any other bed bugs which happen to appear later on. Residual insecticides still will be needed — a conclusion also reached in the 1930s and '40s after all manner of pesticide-free approaches were devised and tried. Barring the discovery of an incredibly effective product with a similarly permissible label, programs incorporating chemical and non-chemical tactics will probably be most effective. If necessity is the mother of invention, we should be in for an interesting ride.

All photos are courtesy of M.F. Potter

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