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## TOXIC TORTS

### PARASITES

Contrary to conventional wisdom, scientific literature has identified a viable mechanism by which bed bugs may transmit disease, according to medical authorities, and infestations that are allowed to thrive unabated present health and liability issues that dwarf the misery inflicted by itchy bites, says attorney Daniel W. Whitney in this BNA Insight. The author offers litigators a primer on disease transmission issues related to bedbugs. Whitney co-authored a BNA Insight in 2010 on the prosecution and defense of bed bug lawsuits (25 TXLR 37, 1/14/10).

## Bed Bug Disease Transmission: A Primer for Litigators



BY DANIEL W. WHITNEY

**B**ed bugs are recognized as presenting a significant public health hazard.

For example, as acknowledged by the Baltimore City Health Department:

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The rise of bed bugs in Baltimore presents a significant public health challenge. Medical conditions associated with bed bugs include multiple itchy bites and inflammation, secondary skin infection, a minor potential for anemia from blood loss, minor risk of anaphylaxis, stress, anxiety, and sleeplessness. In some cases patients have developed more serious reactions. Those most vulnerable to adverse health effects from bed bug bites include the elderly, disabled, and young children. There is also potential for overexposure to pesticides used to control bed bugs. Residents exposed to bed bugs may suffer emotional distress, exacerbated by the financial burdens of discarding belongings, buying products to control bed bugs, and contracting professional pest control services.<sup>1</sup>

Moreover, bed bug infestation has been recognized by managers of large apartment communities as presenting “a clear and imminent danger” of harm to tenants and the landlord’s property.<sup>2</sup> Although intense localized itching (with or without secondary skin infection), and systemic reactions (generalized urticaria, anaphylaxis and asthma) accompanied by emotional

<sup>1</sup> Baltimore City Health Department, Healthy Homes Division, Lead, Asthma & Injury Prevention Bureau, Bed Bug Response Plan, April 20, 2009, p. 3 (footnotes omitted).

<sup>2</sup> Letter on file from Hirschfeld Properties (major owner and manager of apartment home communities throughout the eastern United States) to tenant dated October 13, 2010.

distress, can be seriously debilitating, transmission of potentially fatal disease is altogether another matter.

Conventional wisdom holds that bed bugs are not known to transmit disease.<sup>3</sup> This “wisdom” is sometimes twisted into a more positive and confident assertion that “bed bugs don’t spread disease.” Scientists understand, however, that the absence of proof is not proof. Moreover, although largely ignored, the scientific literature has highlighted a viable mechanism by which bed bugs can in fact transmit disease such as Chagas, hepatitis B (HBV), methicillin-resistant *Staphylococcus aureus* (MRSA) and other blood-borne pathogens. The discussion which follows will focus on pathogens in three separate categories: Chagas (protozoan parasites), HBV (virus) and MRSA (bacteria) as valid candidate pathogens for bed bug-borne transmission.

## Chagas

The transmission of Chagas disease by kissing bugs has direct parallels to bed bugs and is a model for understanding bed bug disease transmission. Entomologists researching the transmission of the potentially fatal Chagas disease have established that the kissing bug (family *Reduviidae*, subfamily *Triatominae*) is a carrier of a protozoan parasite known as *Trypanosoma Cruzi* (TC) which causes the disease. Chagas disease, after a long latency period, is manifested in potentially fatal digestive and cardiac disorders, and is often undiagnosed.<sup>4</sup>

Kissing bugs feed at night on human blood and often bite their hosts around the eyes and lips.<sup>5</sup> The itchy bites are inevitably scratched. The kissing bug defecates where it eats (termed “reflexive feces excretion”), and its feces contains the parasite.<sup>6</sup> The insect bite can be the source of infection by parasite-infested feces entering raw skin lesions or muscosal surfaces.<sup>7</sup>

Like kissing bugs, bed bugs feed at night on human blood. Bed bugs will search out its victim’s exposed

flesh. If arms, legs, neck and torso are covered, they will bite in and around the face. Bed bugs leave itchy welts in many of its victims, and those subjected to chronic attacks often have abraded lesions and raw, open skin wounds from uncontrollable scratching. Bed bugs are also known to defecate immediately upon drawing its blood meal as well as regurgitate in place upon eating. Both kissing bugs and bed bugs are at risk of being squished and their bodily contents emptied onto the flesh that crushes it while the human host is tossing and turning during sleep.

The literature recognizes that kissing bugs and bed bugs share common traits pertinent to the transmission of disease:

*Trypanosoma cruzi*. *T. cruzi*, which causes Chagas disease, is transmitted by kissing bugs. Bedbugs and kissing bugs have many similarities: both have reflexive feces excretion after a blood meal, which is an important behavioral feature responsible for transcutaneous *T. cruzi* transmission from kissing bugs. Indeed, scratching pruritic bites facilitates mechanical entry of parasites contained in bedbug feces into bite sites. . . . Pertinently, *T. cruzi* has been detected in wild bedbugs. Moreover, in experimental laboratory studies, after eating an infectious meal, the bedbug had acquired the parasite, which replicated and was detected in feces. Transstadial transmission has also been proven, and Azevedo et al. studied bedbug salivary glands to precisely describe their ultrastructure, as *T. cruzi* stored therein might be transmitted during a blood meal. Thus, arguments supporting vectorial competence and capacity exist in the literature, and bedbug transmission to humans would not be unlikely. To date, *T. cruzi* is among the most studied candidates for transmission via feces or saliva, and ongoing experimental and epidemiological studies are trying to determine whether transmission is fact or fiction.<sup>8</sup>

The reference to “transstadial transmission” is significant. Transstadial transmission of an infectious agent means passage of an infectious agent “from one stage of life cycle to another, as nymph to adult. Transmission may be by injection of salivary gland fluid during biting, or by regurgitation or deposition on the skin of feces or other material capable of penetrating through the bite wound or through an area of trauma from scratching or rubbing. This transmission is by an infected nonvertebrate host and not simple mechanical carriage by a vector as a vehicle.”<sup>9</sup>

fed with triatomines, of which 56% tested positive for TC. *Id.*

<sup>8</sup> Delaunay, P., et al. “Bed Bugs and Infectious Diseases,” *Clin. Infect. Dis.*, 52:200-210 (2011) at p. 207 (footnotes omitted) (emphasis added). According to one entomologist, “[a]lthough North American *Triatoma* species have tested positive for *T. cruzi*, Chagas’ disease is much less of a concern in the U.S. because [for unexplained reasons] the North American *Triatoma* delay defecation until 20-30 minutes post-feeding. By this time, they are usually no longer in contact with the sleeping human.” Vetter, R., “Kissing bugs (*Triatoma*) and the skin,” *Dermatology Online Journal* 7(1):6 (2001) (footnote omitted) p. 5. Even if North American kissing bugs are “house trained” to defecate away from their host, bed bugs are not known to share this trait. Instead, bed bugs share the same impolite habit as South American kissing bugs. As recognized by entomologist L.J. Pinto, “[a] drop of blood is often extruded out the anus as the bug completes its blood meal.” Pinto, L.J., et al., “Bed Bug Handbook,” Pinto & Associates Inc. (Dec. 2007) p. 51.

<sup>9</sup> Definition available at [http://www.ph.ucla.edu/epi/bioter/anthapha\\_def\\_a.html](http://www.ph.ucla.edu/epi/bioter/anthapha_def_a.html). Pinto references research interest in

<sup>3</sup> For example, the New York City Department of Health and Mental Hygiene’s Advisory on “STOP BED BUGS IN HOTELS SAFELY” states, “[a]lthough bed bugs are a nuisance, they are not known to spread disease.” (available at <http://www.nyc.gov/html/doh/downloads/pdf/vector/bed-bug-hotel-eng.pdf>; Joint Statement on Bed Bug Control in the United States from the U.S. Centers for Disease Control and Prevention (CDC), and the U.S. Environmental Protection Agency (EPA) (CDC Joint Statement) (“Although bed bugs are not known to transmit disease, they are a pest of significant public health importance.”) (Page last updated 2/17/11; available at [http://www.cdc.gov/nceh/ehs/Docs/Joint\\_Statement\\_on\\_Bed\\_Bug\\_Control\\_in\\_the\\_US.pdf](http://www.cdc.gov/nceh/ehs/Docs/Joint_Statement_on_Bed_Bug_Control_in_the_US.pdf)).

<sup>4</sup> Bern, C., et al., “Evaluation and Treatment of Chagas Disease in the United States,” *JAMA*, 2007: 298 (18): 2171-2181 (11/14/07); Hagar, J., Rahimtoola, S., “Chagas’ Heart Disease in the United States,” *NEJM*, 1991 325:763-768 (9/12/91).

<sup>5</sup> Berenbaum, M., “Kiss and Telmophage,” *American Entomologist*, Vol. 55, No. 2 (Summer 2009) at p. 68 (“It’s actually quite true that any of a number of South American kissing bugs, and, for that matter, kissing bugs from other continents, will indeed climb on your face while you’re sleeping, eat (or at least bite) your lips, and defecate on your face.”).

<sup>6</sup> *Id.*

<sup>7</sup> Dorn, P., Perniciaro, L. “Autochthonous Transmission of *Trypanosoma cruzi*, Louisiana,” *Emerging Infectious Diseases*. [www.cdc.gov/eid](http://www.cdc.gov/eid). Vol. 13, No. 4, April 2007, p. 605. Autochthonous (i.e., originating where found) transmission of Chagas disease has been reported. One such case involved an insect-bitten woman in Louisiana whose household was in-

Given common feeding and excretory habits, the remaining question is whether bed bugs can acquire and transmit Chagas disease. Entomologists speak in terms of “vector competence.”<sup>10</sup> Vector competence is “the ability to acquire, maintain, and transmit an infectious disease to another animal.”<sup>11</sup> There is evidence that bed bugs can acquire, maintain and transmit the *TC* parasite. An animal study involving mice and bed bugs showed that bed bugs acquired, maintained and transmitted the parasite. One hundred twenty five bed bugs acquired the infection after feeding on an infected wild mouse. The infected bed bugs were then allowed to feed on a group of 30 laboratory mice that had previously been free of the *TC* parasite. Thereafter, 15 days after bed bug bites, nearly all of the exposed mice (96.6%) acquired the *TC* infection. Just as troubling, the infection was maintained in the bed bugs for 320 days, which constitutes nearly the entire life span of a bed bug.<sup>12</sup> Laboratory studies and investigation have not only confirmed vectorial competence, but have observed *TC* in wild bed bugs.<sup>13</sup>

If Chagas disease were a rare malady perhaps there would be no pause for concern that bed bugs would have the opportunity to obtain the parasite by biting someone with the disease. Actually, there are worrying population trends that may place the issue in a different light:

Chagas disease is endemic throughout Mexico and Central and South America, with 7.7 million persons infected, 108.6 million persons considered at risk, 3-3.3 million symptomatic cases, an annual incidence of 42,500 cases (through vectorial transmission), and 21,000 deaths. This disease is caused by the protozoan parasite *Trypanosoma cruzi*, which is transmitted to humans by blood-sucking insects of the family *Reduviidae* (*Triatominae*).

Although historically Chagas disease has been considered restricted to Latin America, the disease is becoming a serious health issue in the United States because of the presence of a notable number of blood donors seropositive for *T. cruzi*.<sup>14</sup>

The U.S. Centers for Disease Control and Prevention (CDC) estimates about 300,000 immigrants with *TC* liv-

ing in the United States come from areas of widespread infection.<sup>15</sup> Even assuming that such persons were not accompanied by hitchhiking bed bugs, such persons may end up staying in a hotel with a high turnover of guests or residing in a multi-unit apartment where bed bugs may draw their infected blood. Feeding opportunities exist in a multitude of other high turnover, crowded public places such as homeless shelters, hospitals, dormitories, movie theaters, trains, etc. As demonstrated in the laboratory, the *TC* parasite can be maintained within the bed bug for about 320 days. Thereafter the resident infected bed bug, known to feed at least once a week,<sup>16</sup> can potentially transmit the disease to its successive human hosts for the vast majority of its life span.<sup>17</sup>

## Hepatitis B

Recently, the possibility of hepatitis B virus (HBV) transmission by bed bugs has attracted attention. HBV is considered “[t]he best candidate for human disease transmission by bed bugs.”<sup>18</sup> As noted in Goddard’s JAMA article, studies have repeatedly demonstrated that bed bugs collected from living quarters in HBV endemic areas in various locations were hepatitis B surface antigen positive.<sup>19</sup> Hepatitis B surface antigen (HBsAg) has also been shown to survive in bed bugs for more than 7 weeks after an infected blood meal.<sup>20</sup> HBV DNA has been detected in bed bugs and their feces up to 6 weeks after feeding on infected blood.<sup>21</sup> As re-

<sup>15</sup> CDC, Chagas Disease, *Epidemiology & Risk Factors* (available at <http://www.cdc.gov/parasites/Chagas/epi.html>).

<sup>16</sup> Pinto, *supra*, p. 48.

<sup>17</sup> But see Goddard, J., “Bed bugs and Transmission of *Trypanosoma cruzi*,” *Clin. Infect. Dis.* 53(2):210 (7/15/11) (“Although it is possible that bed bugs may indeed be involved in transmission of *T. cruzi*, convincing proof is lacking thus far.”).

<sup>18</sup> Goddard JAMA, *supra*, at p. 1361.

<sup>19</sup> See Jupp, P., *et al.*, “Infection of the common bed bug (*Cimex lectularius* L) with hepatitis B virus in South Africa,” *S. Afr. Med. J.* 1978; 53(15):598-600 (30.6/1000 bed bugs collected from huts in HBV endemic areas in Africa were HBsAg positive); Wills, W., *et al.*, “Hepatitis-B virus in bed bugs (*Cimex hemipterus*) from Senegal,” *Lancet*, 1977; 2(8031): 217-219 (14% of bed bugs collected from bedding in huts in Senegal, West Africa, were HBsAg-positive); El-Masry, S., Kotkat, A., “Hepatitis B surface antigen in *Cimex lectularius*,” *J. Egypt Public Health Assoc.* 1990; 55:230-236 (33.5%; and for HBsAg unknown status (n=229 bugs), 24.4%) (10/276 military recruits (3.6%) were HBsAg-positive; 300/1800 bed bugs (16%) collected from barracks were HBsAg-positive); Brotman, B., *et al.*, “Role of arthropods in transmission of hepatitis-B virus in the tropics,” *Lancet*, 1973; 323:1305-1308.

<sup>20</sup> Goddard JAMA, *supra*, p. 1361 (citing Ogston, C., *et al.*, “Persistence of hepatitis B surface antigen in the bed bug *Cimex hemipterus* (Fabr.),” *J. Infect. Dis.* 1979; 140(3):411-414 (HBsAg found in most bed bugs 4 weeks after infected blood meal; one bug was HBsAg-positive 6 weeks after initial feeding); Jupp, P., McElligott, S., “Transmission experiments with hepatitis B surface antigen and the common bed bug (*Cimex lectularius* L),” *S. Afr. Med. J.* 1979; 56(2):54-57 (HBsAg persisted in bed bugs for >7 weeks after experimental feeding but no viral replication)).

<sup>21</sup> Goddard JAMA, *supra*, p. 1361 (citing Blow, J., *et al.*, “Stercorarial shedding and transtadial transmission of hepatitis B virus by common bed bugs (Hemiptera: Cimicidae),” *J. Med. Entomol.*, 2001; 38(5):694-700 (HBV nucleic acids in bed bugs and their excrement up to 35 days after feeding on in-

transmission of infection via three routes: bed bug feces, regurgitation or interrupted feeding. Pinto, *supra*, p. 66.

<sup>10</sup> Goddard J., de Shazo R., “Bed Bugs (*Cimex lectularius*) and Clinical Consequences of Their Bites,” *JAMA*, Vol. 301, No. 13 (4/1/09), p. 1361 (“Goddard JAMA”).

<sup>11</sup> *Id.*

<sup>12</sup> *Id.*, p. 1362, Table 2. (citing Jorg, M.E., “*Cimex lectularius* L. (the common bed bug), the vector of *Trypanosoma cruzi*,” *Rev. Soc. Bras. Med. Trop.*, 1992; 25(4): 277-278.

<sup>13</sup> Delaunay, *supra*, p. 206, Table 1 (citing Burton, G., “Bed-bugs in relation to transmission of human diseases,” *Public Health Rep.* 1963; 78: 513-24; Villagrán, M., *et al.*, “Natural infection and distribution of triatomines (Hemiptera: Reduviidae) in the State of Querétaro, Mexico,” *Trans. R. Soc. Trop. Med. Hyg.* 2008; 102: 833-8; Azevedo D., *et al.*,” “Notes on midgut ultrastructure of *Cimex hemipterus* (Hemiptera: Cimicidae),” *J. Med. Entomology* 2009; 43: 435-41.

<sup>14</sup> Reisenman, C., *et al.*, “Infection of Kissing Bugs with *Trypanosoma cruzi*, Tucson, Arizona, USA,” *Emerging Infectious Diseases*, <http://wwwnc.cdc.gov/eid/article/16/3/09-0648.htm>, Vol. 16, No. 3, March 2010 at p. 400 (footnotes omitted). In southern Arizona, kissing bugs and white-throated wood rats infected with *TC* are common, and a recent study of 22 sites or houses where insects were collected in Tucson found that 63% had at least one bug infected with *TC*. *Id.* p. 404.

searchers have recently concluded, HBV may be transmitted by a bed bug's infectious feces: "After feeding on an infectious blood meal, bed bugs excrete hepatitis B surface antigen in their feces and could be a possible source of HBV infection by contamination of skin lesions or mucosal surfaces, or by inhalation of dust."<sup>22</sup> This startling conclusion is followed by the agnostic reassurance that "their transmission of a human disease is yet to be firmly established."<sup>23</sup>

This "reassurance" resembles that of pest-control technicians who, following multiple treatments, see no visible evidence of active infestation and advise residents that they will know the treatments were successful if the bed bugs stop biting. While it is bad enough to serve as human bait and sustain additional localized or systemic skin reactions, it is orders of magnitude worse to involuntarily participate in a "human experiment" to see if any pathogen-infected bed bugs on the premises transmit HBV, Chagas disease or other blood-borne pathogen.

## MRSA

A study published online in a journal of the CDC suggests that bed bugs could play a role in transmitting MRSA.<sup>24</sup> A sample of bed bugs, collected from three patients was found to be infected with MRSA and vancomycin-resistant *Enterococcus faecium* (VRE). The researchers at a Vancouver, British Columbia, hospital tested three patients from an impoverished community who were infested with bed bugs. Researchers collected five bed bugs and determined that the insects carried two types of drug-resistant bacteria. Three bed bugs from one patient contained methicillin-resistant *Staphylococcus aureus* (MRSA), and the two from the other patients each contained VRE.

The study did not address whether the patients were infected with the bacteria detected in each bed bug, but noted "[t]he phenotype of the MRSA recovered from the bed bugs was consistent with community-associated MRSA and identical to that found on antibiograms from patients with MRSA infection who reside in this community."<sup>25</sup>

Given the high prevalence of MRSA in residents of the hotels and rooming houses the researchers concluded:

Bed bugs may become colonized with community-associated MRSA. Consequently, these insects may act as a

infected blood meal; HBV DNA detected in bed bugs 21 and 28 days after infectious blood meal); Silverman, A., *et al.*, "Assessment of hepatitis B virus DNA and hepatitis C virus RNA in the common bed bug (*Cimex lectularius* L.) and kissing bug (*Rodnius prolixus*)," *Am. J. Gastroenterol.* 2001; 96(7): 2194-2198.

<sup>22</sup> Goodard *JAMA*, *supra*, p. 1365. See also Jupp, P., "The mechanical transmission of hepatitis B virus by the common bedbug (*Cimex lectularius* L.) in South Africa," *S. Afr. Med. J.* 1983; 63(3):77-81 (finding no biological multiplication of HBsAg, but mechanical transmission of virus from bed bugs to man could occur via infected feces, regurgitation, interrupted feeding or crushing infected bugs).

<sup>23</sup> *Id.*

<sup>24</sup> Lowe, C., Romney, M., "Bed Bugs as Vectors for Drug-Resistant Bacteria," Vol. 17, No. 6, June 2001 (available at [http://wwwnc.cdc.gov/eid/article/17/6/10-1978\\_article.html](http://wwwnc.cdc.gov/eid/article/17/6/10-1978_article.html)).

<sup>25</sup> *Id.* p. 2

hidden environmental reservoir for MRSA and may promote the spread of MRSA in impoverished and overcrowded communities.

Bed bugs carrying MRSA and/or VRE may have the potential to act as vectors for transmission. Further studies are needed to characterize the association between *S. aureus* and bed bugs. Bed bug carriage of MRSA, and the portal of entry provided through feeding, suggests a plausible potential mechanism for passive transmission of bacteria during a blood meal. Because of the insect's ability to compromise the skin integrity of its host, and the propensity for *S. aureus* to invade damaged skin, bed bugs may serve to amplify MRSA infections in impoverished urban communities.<sup>26</sup>

The study did not clarify whether the patients acquired the bacteria from the bed bugs or vice-versa. The study further did not elucidate whether the bacteria from the bed bugs was internal or external to the bugs. Even if the bugs were carrying the bacteria on their exteriors, the Vancouver study is significant. Bed bugs could spread the bacteria from person-to-person, especially in crowded places with high turn-over such as homeless shelters. The bacteria have the ability to survive for days, and possibly months, under the right conditions.<sup>27</sup> As noted by the CDC, "[e]ven if surfaces have MRSA on them, this does not mean that you will definitely get an infection if you touch those surfaces. MRSA is most likely to cause problems when you have a cut or scrape that is not covered."<sup>28</sup> Besides open wounds, MRSA "can also get into small openings in the skin, like the openings of hair follicles."<sup>29</sup> Bed bugs obviously penetrate human skin to draw blood. As noted by one entomologist:

Once a bed bug has found a preferred feeding site on a host, it hooks the claws on its forelegs into the host's skin in order to gain the leverage needed to penetrate to a blood source. The beak is placed at right angles to the skin and the bug flexes its body and rocks back and forth as its mouthparts are inserted. The cutting parts of the beak move and slice, probing and forging a path through tissue, seeking a suitable-sized blood vessel. . . . Once a proper blood vessel is located, the blood is sucked up through the beak and into the digestive system.<sup>30</sup>

If the beak is contaminated with MRSA, the bacteria's portal of entry is obvious. Furthermore, the potential risk posed by a MRSA-laden bed bug is clear to one with skin scratched raw due to itchy bed bug bites.

## Conclusion

For over 100 years bed bugs have been suspected of transmitting human disease. Research and interest on this topic dropped following the largely successful eradication of bed bugs worldwide after World War II. In recent years, the major resurgence of bed bugs as a public health threat has renewed interest in the question of bed bug disease transmission. Even as we enter a time of reduced funding of public health research, the

<sup>26</sup> *Id.*

<sup>27</sup> Neely, A., Maley, M., "Survival of Enterococci and Staphylococci on Hospital Fabrics and Plastic," *J. Clin. Microbiol.* 2000 Feb. 38(2): 724-726.

<sup>28</sup> CDC-MRSA Causes/MRSA Infections (available at <http://www.cdc.gov/mrsa/causes/index.html>).

<sup>29</sup> *Id.*

<sup>30</sup> Pinto, *supra*, p. 51.

urgent call for continued research must be heeded: “[T]he pathogens carried by wild bed bugs have to be investigated and updated with modern tools and parallel studies in bed bug and human samples, with blinded clinical assessment to detect the same pathogens independently.”<sup>31</sup> Especially given the similarities between bed bugs and kissing bugs and vectorial competence of bed bugs to transmit Chagas disease, public health officials and pest control managers would be well advised to refrain from saying “bed bugs don’t transmit disease.” Instead, a candid response demands admitting that a plausible mechanism exists, and more research is needed to confirm or refute the extent of the threat. In

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<sup>31</sup> Delaunay, *supra*, p. 208. See also CDC Joint Statement, *supra*, p. 5 (“CDC recognizes that very limited research has been conducted on bed bugs during the past several decades and encourages increased bed bug research to determine . . . the potential for bed bugs to transmit disease.”).

other words, “we’re not sure; but it looks like under the right circumstances, bed bugs can transmit disease.” How many entomologists or public health officials would risk sleeping in a bed bug-infested homeless shelter whose residents, including both humans and bed bugs, were infected with Chagas disease? We’re guessing not one.

Owners and operators of premises having a duty to exercise reasonable care towards their guests and occupants will ignore this danger at their peril. Laboratory testing is available to detect the presence of blood-borne pathogens, and sophisticated molecular techniques may be used to identify and match the DNA of organisms harbored by resident bed bugs. As noted at the outset of this article, bed bugs may present a “clear and imminent” danger, and infestations that are allowed to thrive unabated may present health and liability issues that dwarf the misery inflicted by itchy bites.