
BED BUG INFESTATIONS: A CASE REPORT IN AN URBAN ENVIRONMENT OF CENTRAL ITALY AND EFFECTIVENESS OF STEAM TREATMENT AGAINST *CIMEX LECTULARIUS* (HEMIPTERA: CIMICIDAE)

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ABSTRACT

There has been resurgence in interest in infestations from the common bed bugs (*Cimex lectularius*), as they have become more prevalent in well-developed countries. This paper reports the case of a 50-year-old woman whose bedroom was infested by bed bugs. The woman presented in our laboratory with insect specimens that she had caught in her bedroom. She reported bites on shoulders, back, belly, and thighs associated with sleep disturbance. Based on an examination of the morphological characteristics, the insects were identified as *Cimex lectularius*. As the apartment had been rented for several years before the woman moved in, it was suspected that the bed bugs had been introduced by some of the tenants, including some from overseas, who may have inadvertently brought the bugs with them in their luggage/belongings and who had previously lived in the apartment. After two unsuccessful insecticide applications, a thorough weekly decontamination using a steam cleaner completely resolved the infestation within about two months. Knowledge of the epidemiology, life cycle, clinical signs, medical treatment and environmental management of bed bugs by physicians, dermatologists, and entomologists may contribute to the better dissemination of information needed for effective prevention and control as well as to a more accurate diagnosis of the bite marks caused by these insects.

Keywords: Bed bugs, *Cimex lectularius*, infestation, central Italy

REZUMAT

A existat o creștere a interesului pentru infestările de la ploșnițele comune (*Cimex lectularius*), deoarece acestea au devenit mai răspândite în țările bine dezvoltate. Acest articol relatează cazul unei femei în vârstă de 50 de ani al cărei dormitor era infestat de ploșnițe.

Femeia a prezentat în laboratorul nostru specimene de insecte pe care le prinsese în dormitorul ei. Ea a raportat mușcături pe umeri, spate, abdomen și coapse asociate cu tulburări de somn. Pe baza unei examinări a caracteristicilor morfologice, insectele au fost identificate ca *Cimex lectularius*. Întrucât apartamentul fusese închiriat cu câțiva ani înainte ca femeia să se mute, s-a bănuit că ploșnițele au fost introduse de unii dintre chiriași, inclusiv unii din străinătate, care s-ar putea să fi adus din neatenție ploșnițele cu ei în bagaj/bunurile lor, și care locuiseră anterior în apartament.

După două aplicații nereușite cu insecticid, o decontaminare săptămânală amănunțită cu un aparat de curățat cu abur a rezolvat complet infestarea în aproximativ două luni.

Cunoașterea epidemiologiei, a ciclului de viață, a semnelor clinice, a tratamentului medical și a managementului de mediu al ploșnițelor către medici, dermatologi și entomologi pot contribui la o mai bună diseminare a informațiilor necesare pentru prevenirea și controlul eficient, precum și la un diagnostic mai precis al urmelor de mușcătură cauzate de aceste insecte.

Cuvinte-cheie: ploșnițe, *Cimex lectularius*, infestare, Italia centrală

1. INTRODUCTION

The bed bug is the common name for *Cimex lectularius* (Hemiptera: Cimicidae), a species of strictly hematophagous and synanthropic insects with a worldwide distribution [1]. All adult and immature stages of *C. lectularius*

feed on humans, but they also feed on bats and occasionally on other warm-blooded animals (birds, dogs, cats, rodents) when the preferred human host is not present [1]. Bed bugs generally live in close proximity to areas where humans sleep and are temporary ectoparasites

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because their life cycle entirely occurs in the environment with the exception of the feeding behavior [1-2].

Each adult female lays about 2-4 eggs each day and can lay 200-500 eggs over her lifetime. The eggs are hidden within solid surfaces and hatch within 6-10 days at room temperature. The life cycle is composed of five nymphal stages followed by the adult stage. Each juvenile stage requires a blood meal to molt and the adults require an additional blood meal to reproduce. Overall, the nymph stages last about 6-8 weeks if a host is available and the adults can typically live for 6-12 months [2]. This explains how, in a newly infested site, bed bugs can rapidly multiply exponentially [3].

C. lectularius was a common problem all over the world up during World War II. Subsequently, the wide scale use of pesticides, such as DDT and malathion, and improved hygienic conditions has meant that bed bugs virtually disappeared in many countries from the 1950s to almost the start of the 21st century [1, 4], while infestations in poor countries have never decreased [3].

In the last few years, bed bugs have begun to re-emerge as pests in a number of countries around the world. These include Australia [4], Canada [5], France [6], Israel [7], Italy [8-9], Korea [10], Kuwait [11], Nigeria [12], and the United States [1]. Prevalences of infestation of 53.8% have been reported in Israel [7], 11-63% in Canada [5], 14.3-66.7% in Nigeria [12], and 68.2% in Pennsylvania [13]. Here, a case is reported of the resolution of a severe bed bug infestation affecting an adult woman's bedroom in an urban area in central Italy.

2. CASE PRESENTATION

In late January 2019, a 50-year-old woman, living alone, got in touch with our laboratory. She complained that she had first found bed bugs in her apartment about three months previously. She brought some of the insects with her in a glass jar, which she had collected in her bedroom (Fig. 1). Information on the case was collected. The woman was living in an apartment that she had inherited from her grandmother in 2018. The apartment was

located in a central area of the city of Pisa (43°43'N 10°24'E, Tuscany, central Italy). The apartment had remained uninhabited for a few months after the grandmother had died but an unspecified number of tenants, including overseas visitors, had rented it for many years previously.



Fig. 1 – Unfed specimens of *Cimex lectularius*:
1) adult and nymphal stages (scale bar = 5 mm);
2) nymphal stage, dorsal view (scale bar = 1 mm);
3) adult stage, dorsal view (scale bar = 1 mm);
4) adult stage, ventral view (scale bar = 1 mm).

Before moving into the apartment herself, the woman painted the walls. As she was doing so, she noticed that there were many crushed insects or live ones crawling on the walls and that all the electrical outlets had been sealed with tape. At the time, she did not pay much attention to the insects, as it seemed that they disappeared spontaneously as she thoroughly cleaned the house.

In early November 2018, the woman moved into the apartment. Immediately after settling in, when she woke up in the morning, she started to find many bite marks on different parts of her body such as shoulders, back, belly, and thighs (Fig. 2). As the number of bite marks increased every day, she turned to a pest control company for assistance. In mid-November 2018, pest control operators carried out an inspection and found evidence of a bed bug infestation. They treated the bedroom with insecticides, using both a spray product (Baygon®) and a fumigation device; however, the woman was unable to provide more detailed information regarding the two

treatment methods. After treatments were performed, for about a month and a half, she no longer found new bite marks.



Fig. 2 – Bite marks caused by *Cimex lectularius* on shoulder and back of an adult woman whose bedroom was found to be infested by bed bugs.

At the end of December 2018, she found a bed bug in her bedroom and crushed it. From that day onwards, she began to suffer from insomnia due to the fear of being bitten while sleeping. In mid-January 2019, she woke up one morning and saw bite marks on her arm again. Due to financial constraints, she preferred not to contact the pest control company again, but to carry out an environmental treatment herself using a commercial spray product (Baygon®). However, only five days after this treatment, upon awakening she found new bites on her arms and legs. At the end of January 2019, she therefore decided to collect some of the bed bugs and to bring the specimens to our laboratory asking for advice on an inexpensive but effective treatment. The woman also reported that she had been reluctant all this time to consult a doctor or dermatologist regarding a bite treatment, because the skin lesions disappeared spontaneously within a few days and also because she was very embarrassed by the situation.

After collecting the woman's history, the

specimens were microscopically examined. Small brownish, wingless insects with an oval, flattened, segmented body, approximately 4-5 mm in length, were observed (Fig. 1). On the basis of their morphological characteristics and following the identification keys provided by Mathison and Pritt [14], the insects were identified as belonging to the *C. lectularius* species. Because the woman asked for help regarding an effective and inexpensive method of disinfestation, we strongly recommended the use of a steam cleaner, with a temperature of at least 70-80 °C [1]. A thorough and rigorous environmental treatment of her bedroom at least once a week was also strongly recommended. The woman was clearly informed that persistence and perseverance regarding the steam treatment were essential for the complete removal of the infestation, as both a long period of time and a high number of treatments were inevitably required. She was also advised to monitor the effectiveness of the steam treatment by checking for the appearance of new bite marks and the presence of live bed bugs. Finally, at the end of the consultation, in order to gather the clearest and most complete documentation of the case, the woman was asked if it was possible for her to provide a photo of the bite marks. She agreed and later in the day she emailed a photo of the most recently affected skin areas (Fig. 2).

At the end of February 2019, we contacted the woman by telephone for follow-up of the bed bug steam treatment. She reported having found several web pages with demonstration videos on how to kill bed bugs using steam. Based on our advice and information gleaned from the web, she had performed four weekly treatments of her bedroom with a steam cleaner, the last of which was that morning. She had not had any new bites. During the first treatment, she found many bed bugs in the folds of the mattress, near the bed and on the floor, including one under a wall mirror. The following week (second treatment), she only saw three bed bugs while she was using the steam cleaner and two more, crawling up the wall to escape the steam, right after she finished. A week later (third treatment), she found only

three bed bugs, one of them crawling on the ceiling. None of the bed bugs appeared to be blood-filled after being crushed. During the final week (fourth treatment), for the first time she found no bed bugs. We advised the woman to continue the thorough and frequent cleaning procedures of the bedroom with the steam cleaner, as before.

In early March 2019, the woman contacted us, complaining that she had seen a live bedbug near an electrical outlet during the latest treatment and another on the dresser the day before. Despite this, she also stated that she had not had any new bites and that neither of the bed bugs appeared to be blood-filled after being squashed. We advised her not to be discouraged and to continue the steam cleaner treatment, as previously indicated.

In mid-April 2019, we contacted the woman again for further follow-up of the bed bug steam treatment. She stated that she was continuing the treatment as before, that she had not seen bed bugs since early March, and that she had not had any new bites until then. Since no bedbugs had been found in the environment and no new bite marks had appeared for about five weeks, we felt that the problem was most likely resolved and therefore suggested that the woman stopped the steam treatment. About eight months later, the woman confirmed that the problem had been definitively resolved.

3. DISCUSSION

The finding of *C. lectularius* was not unusual, given that this bed bug species is predominantly seen in temperate regions and has previously been reported in Italy, including Tuscany [8-9]. Another *Cimex* species, i.e. *Cimex hemipterus* (commonly known as the tropical bed bug), can also cause human infestations. However, as its common name suggests, its geographical distribution is limited to tropical or warmer regions of the world especially Australia [4], Brazil [15], and South-east Asian countries [16-17]. Although *C. hemipterus* has been found in four poultry houses and was also detected a few times in houses of people who worked in the infested poultry houses [18], there is no indication that it has become established in

areas of Mediterranean countries.

Bed bugs do not typically spread from person-to-person. They can be spread from home to home, from a hotel to home and so forth by hitchhiking on luggage, furniture, boxes, suitcases, or other goods when these are moved [3]. Bedbugs can also hide in clothing from infested homes and may be spread by a person unknowingly wearing infested clothing [3]. In addition to apartments, these insects can be spread to an extremely wide range of indoor areas such as homeless shelters and rooming houses [5], hotels, trains and dormitories [3], or residences, prisons and industrial buildings [7]. Other infested settings include hospitals, fire stations, shopping stores, office buildings, cinemas, colleges, aircrafts, and churches [1], hostels [12], laboratories, airports, cruise ships, and schools [2]. Briefly, they can infest almost any site where people sleep or sit [1]. International travellers are known to contribute to the spread of parasites in new areas [19-20]. In this case, it is suspected that some of the tenants (including overseas visitors), who had lived in the apartment for many years before the woman, were responsible for introducing bed bugs into the home environment.

It is not known whether the tenants had not taken steps to get rid of the infestation due to financial hardship, lack of adequate information or other reasons. It is plausible that they were aware of the infestation and tried to get rid of the bed bugs with empirical methods, as shown by the presence of crushed bed bugs and electrical outlets sealed with tape. Bed bugs can typically live up to a year or more without a blood meal [3]. They were therefore able to survive without feeding for many months as long as the apartment remained uninhabited. It has been reported that a rapid turnover of residents is a risk factor for bed bug infestation, while overcrowding and deprived conditions facilitate the bed bug burden [3].

This case report shows that a bed bug infestation can persist after it is no longer associated with poor, crowded and unsanitary conditions, as the removal of old furniture, wall paintings, house cleaning and sanitation improvements were all insufficient to eliminate

the bed bug population established in the home environment.

Bed bugs are inactive and stay hidden in habitual dark places during the day. At night, they become active and search for a host for a blood meal [1-2]. Only in cases of severe infestation, they are found on individuals or in their clothes during the day [2]. This suggests that a high level of infestation initially occurred in the household environment in this case, as bed bugs were seen crawling on walls in several rooms in the daytime. *C. lectularius* is attracted to hosts by carbon dioxide, heat, and various compounds emitted across the skin [1]. Bed bugs usually feed about every 3-5 days for 4-10 minutes [2]. They inject salivary proteins with vasodilator, anticoagulant, and anaesthetic properties [1-2]. These latter most likely prevent people from realizing they are being bitten. After feeding, they return to their hiding places [2] where they digest the blood meal and excrete it as a faecal deposit [1]. For these reasons, in the present case report, the woman did not suspect the presence of insects in the apartment until the bite marks appeared. The diagnosis of bed bug infestation was based on the demonstrated presence of insects, which required an inspection of the woman's bedroom by authorized pest control professionals.

We did not attempt to examine the woman's skin lesions (Fig. 2) as this was beyond our scientific expertise. The signs, location, and evolution of the bites associated with anxiety were consistent with data reported in the literature. Bed bug bites can occur not only on the shoulders, back, belly, and thighs as in this case, but also on the face, neck, hands, and toes i.e. on any other body parts that are likely to be exposed during sleep [2, 21].

As confirmed in this case study, bed bug bites themselves are not generally painful [3, 21] and are not felt until several hours later [3], or they are not noticed until the appearance of a clinical reaction, which can occur some days later [2]. Typical bed bug bites are similar to those of other arthropods: i.e., small indistinct erythematous maculopapules with a central hemorrhagic crust or vesicle at the bite site [3] which may later develop into wheals

accompanied by itching and inflammation [1-3]. As in our case, these skin lesions usually resolve spontaneously within 1-6 weeks without treatment [2-3].

Bed bug bites affect each person differently, leading to a range of skin manifestations [1,2]. Some people may have no reaction and will not develop any visible signs of bites, although this may depend on previous exposure [1-2]. Sometimes the intense itching due to numerous bites can lead to excessive scratching with skin excoriations and secondary bacterial infections [1, 21]. Other people may develop allergic reactions, hypersensitivity, and anaphylaxis [1-2].

In the present case report, the number, distribution, and size of the bites could not be determined. Lesion numbers range from several to many, depending on the habitat-infestation intensity [3]. The bite distribution frequently follows a line or curve [3] and has been described as "breakfast, dinner, and lunch" when it appears in a linear array of three bites [2]. The reported size of the maculopapules and wheals varies from less than 5 mm to 2 cm [1, 3] and from 2 to 6 cm [1] in diameter, respectively.

In addition to the present case, some cases of bedbug infestations have been linked to mental health effects, including shame, nervousness, stress, anxiety, exhaustion, sleep disturbance, severe psychiatric symptoms [1-2, 22], and even suicide [23]. Although bed bugs harbour at least 45 human pathogens, there have been no reported cases of transmission to humans to date [3].

Chemical products and non-chemical methods can control bed bug infestations [1, 21]. The former are insecticides such as pyrethroids, silicates, and insect growth regulators as well as carbamates and some organophosphates or, more recently, neonicotinoids and arylpyrroles [1]. The latter include the disposal of infested items, vacuuming, heat, and cold temperatures [1]. In general, insecticide application is the first choice treatment, though an integrated approach combining chemical and non-chemical means may be advisable [1].

In line with this, in the present case the

professionals immediately used insecticides to treat the infestation, including a registered brand of insecticide spray and an unspecified fumigant product. It is possible that the pest control company would not reveal the name and/or components of the latter because it was a product registered for use only by specially trained professionals.

Bed bug infestations are difficult to eradicate [1]. In fact, insecticides kill bed bugs when applied carefully and directly to the insects and their hiding places. However, because of their ability to hide in little cracks and crevices (see below) where it is difficult for insecticides to penetrate, the treatment mainly kills insects that are exposed and not in their hiding places and only to a limited extent those that are hidden in isolated and protected shelters [1]. Many of the most commonly used products do not have very long residual activity and/or ovicidal effects and, thus, nymphs will newly hatch from the eggs despite the insecticide application [1].

Certain populations of bed bugs have developed resistance to widely used insecticides [1-4, 21]. Moreover, the harmful use of insecticides for bed bug control has caused acute kidney injury [24], dry cough with dyspnea and chest tightness [25], and acute illnesses in 111 individuals, including one fatal case [26]. For these reasons, safe and complete bed bug eradication is difficult to achieve without the help of professionals [21] and very often requires multiple treatments [27], as in this case.

Unfortunately, each intervention on the part of a licensed pest control company is very expensive and many people cannot afford the fees [1], as in our case. It is possible that the woman was unable to perform a second application of insecticides with the correct treatment strategies on her own, thus increasing the amount of time needed for the complete removal of the bed bugs and making it harder to eliminate them.

In the daytime, bed bugs tend to aggregate especially under mattresses, in seams, folds and box springs of mattresses, bed sheets, bed frames, headboards, inside cracks or crevices

of walls and floors, behind wallpaper, and in and near any other furniture (nightstands, dresser tables) around beds [1-3, 21]. This is in line with the finding of bed bugs in a variety of hiding places reported here. This also implies that adult males and females, eggs, nymphs, exuviae, and excrements can be searched for by thoroughly inspecting all the suitable places within a given environment [28].

Because treatments are required in sleeping areas and other sensitive locations, methods other than insecticides are in demand. As previously mentioned, chemical treatments can be costly and may entail health risks. Steam cleaning systems transform ordinary tap water into a super-hot steam, under pressure, which can kill bacteria, yeasts and moulds [29] as well as dust mites [30] and bed bugs [21, 31]. The high temperature of steam (near 100 °C = 212 °F) will kill bed bugs and their eggs instantly without leaving behind any residues [21, 31]. Steam cleaners therefore offer those who oppose the use of potentially toxic insecticides, as well as people with multiple chemical sensitivities, a very effective chemical-free alternative for eliminating bed bugs and also with the benefit of being environmentally safe.

Steam has the additional advantage of penetrating cloth surfaces and can be used on large cleanable items such as carpets, furniture, suitcases, and so forth without danger [21, 30]. This makes steam cleaners safe for use on mattresses and box springs, crevices and corners on bed frames, sofa seams, chairs, rugs, and drapes in addition to any other surface and corner in a home where bed bugs may hide [31]. Nonetheless, steam may damage some finished furniture surfaces and some fabrics such as microfibers [31] if they are unable to resist a core temperature ≥ 55 °C [21].

A small steam cleaner is affordable for most people. If the frequent use or treatment of large areas is needed, a high capacity steamer with higher cost is recommended [31]. In the present case report, the woman followed our advice along with website suggestions with the result that steam alone was all she needed to eradicate the bed bugs. Unfortunately, steam treatment is laborious, time consuming, and

repetitive. She religiously reapplied the steam every seven days for about two months and half until no bed bugs or bites were seen for a 5-week period.

4. CONCLUSIONS

When moving to a new home, it is very important to know whether the people who previously lived in the house adequately prevented the introduction of household pests. In terms of bed bugs, it is essential to perform a thorough inspection for signs of infestation, even if the house has been empty and unoccupied for several months because these insects can live more than a year without feeding. If a bed bug infestation is detected, it is essential to ask a licensed pest control company for adequate environmental treatment before moving there permanently.

Our report suggests that a combination of insecticides and steam treatment can play an important role in an integrated plan for bed bug removal. Steam is very successful and safe to kill any surviving or hatched bed bugs after an insecticide application.

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