

Cases of bed bug (*Cimex lectularius*) infestations in Northwest Italy

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Summary

Bed bugs (*Cimex lectularius*) have been a common problem for humans for at least 3,500 years and in Europe their presence was endemic until the end of World War II, when infestations began to decrease. However, since the beginning of the 21st century new cases of infestations have been reported in developed countries. Many theories have been put forward to explain this change of direction, but none has been scientifically proven. The aim of this study is to provide some reports of bed bug infestations in Northern Italy (Liguria, Piedmont and Aosta valley regions) and a brief summary about their identification, clinical significance, bioecology and control. From 2008 to date, 17 bed bug infestations were identified in Northwest Italy. Knowledge about the presence and distribution of bed bugs in Italy is scanty, prior to this work only 2 studies reported the comeback of these arthropods in the Italian territory; further investigations would be necessary to better understand the current situation.

Casi di infestazione da cimici dei letti (*Cimex lectularius*) in Italia Nord-occidentale

Parole chiave

Cimici dei letti,
Cimex lectularius,
Controllo degli
infestanti,
Epidemiologia,
Identificazione,
Infestazione,
Italia Nord-occidentale.

Riassunto

Le cimici dei letti (*Cimex lectularius*) sono un problema comune per l'umanità da almeno 3.500 anni. In Europa la loro presenza è stata endemica fino al termine della II Guerra Mondiale, quando è stata osservata una diminuzione del numero di infestazioni. Tuttavia, dai primi anni 2000, nei paesi sviluppati è stata riscontrata una nuova recrudescenza. Sono state prese in considerazione numerose teorie per fornire una spiegazione a tale inversione di tendenza, ma nessuna è stata scientificamente provata. L'obiettivo di questo lavoro è di riportare diversi casi d'infestazione da cimici dei letti in Italia Nord-occidentale (Liguria, Piemonte e Valle d'Aosta) e offrire informazioni riguardo alla loro identificazione, al loro significato clinico, alla bioecologia e al controllo. Dal 2008 sono stati identificati 17 casi d'infestazione nell'area di studio. Ad oggi, i dati sulla reale presenza e distribuzione delle cimici dei letti in Italia sono limitati; prima del presente lavoro 2 soli studi avevano documentato il ritorno di questi insetti sul territorio italiano. Ulteriori indagini sarebbero necessarie per comprendere meglio l'epidemiologia attuale.

Introduction

Bed bugs are nocturnal haematophagous arthropods belonging to the family *Cimicidae*, order *Hemiptera*. The family includes 6 subfamilies, 23 genera and 91 species. Three species are considered ectoparasites of humans: *Cimex lectularius*, the common bed bug, is a cosmopolitan species associated with humans, bats and chickens; *Cimex hemipterus*, the tropical bed bug, is a parasite of humans and chickens (15), and *Leptocimex boueti* belongs to the *Cacodminae* subfamily and affects bats and people in West Africa (46).

Recent findings of bed bugs specimens in tombs in Egypt prove the relationship between humans and cimicids for at least 3,500 years (33) and both the ancient Greek and Latin literature testifies the existence of *C. lectularius* (43). The parasite has been recorded through history in Greece in 400 BC, in Italy in AD 77, in Germany in the 11th century, in France in the 13th century and in England in 1583, although the wide dissemination of this insect throughout the world probably did not begin until the 16th century (22).

Until 1945 bed bugs presence was endemic worldwide; documents report that in 1930 one third of the London population was infested (24). After the World War II a decrease of bed bugs incidence in developed nations was observed (24), due to social and economic progress and possibly to the development of new insecticides (e.g. diclodifeniltricloetano-DDT), while their presence remained widespread in poor countries (19, 21). Since the late 90's there has been a global resurgence of the number of infestations (15, 37). In Europe cases have been reported in the UK (5, 17, 48), Germany (26) and Spain (18). The distribution of bed bugs in Italy is scarcely known; to the authors' knowledge, prior to this study only reports from North-Eastern and Central Italy were available (28, 29).

The aim of this article is to provide a documented evidence of the presence of bed bug infestations in Northwest Italy and a brief summary about their identification, clinical significance, biology and control. Furthermore we want to direct the reader to a policy of non-chemical control.

Materials and methods

Since 2001, the section of Imperia of Istituto Zooprofilattico Sperimentale del Piemonte, Liguria e Valle d'Aosta (IZS) has conducted a national entomological surveillance plan and has established a provincial office of Veterinary Public Health Services accredited for the identification of arthropods. The study area covers 34,085 km² (corresponding to the regions of Piemonte, Liguria and Valle d'Aosta).

From 2008 to date the Institute received 17 samples of 'potential' bed bugs, delivered directly by private citizens who had found them in their own homes. The specific identification of arthropods was conducted through direct observation with a stereoscope (Nikon model SMZ800, Tokio, Japan), following the identification keys of Usinger (46) and Tremblay (45). The order *Hemiptera* or *Rhynchotha* includes species of insects that range in size from 1 mm to around 1 cm and are characterized by a stiliform mouthpart in which mandibles and maxillae are sheathed in a modified *labium* forming a 'beak' or 'rostrum' [from the greek *ρύγχος* = (rhynchos)], which is capable to penetrate plant or animal tissues to suck out the liquids. The suborder *Heteroptera* is characterized by a 'rostrum' in the anterior region of the head. Wings, when present, are generally constituted by a pair of forewings, or hemelytra, generally more sclerificate, and a pair of membranous hind wings. Insects of the family *Cimicidae* are apterous and brown, while the genus *Cimex* can be identified by anatomical details, as a second antennal segment subequal to the interocular space and the pronotum 1 ½ or more times as wide as head. The bat bug *L. boueti* is smaller than *C. lectularius* and *C. hemipterus* and differs from *C. lectularius* in having a narrower pronotum, only slightly wider than the head, and very long legs. *C. lectularius* and *C. hemipterus* are morphologically similar; the distinction is based on an upturned lateral flange on the margin of the pronotum which makes this structure wider in the common bed bug compared to that of the second species (46).

In order to understand the methods of control used in Italy, in addition to a scientific bibliographic research (6, 13, 16, 11, 25, 28, 29, 31, 41, 49) the following sources were examined:

- catalogs and guidelines of the companies for the production of equipment and insecticides for pest control (4, 9, 10, 30);
- technical manuals and seminars organized by the National Association of Pest Control Companies (2, 3, 6, 7, 8, 20, 27, 34, 42);
- pest control journals (16, 20).

Results

Results are given in details in Table I, of the 17 samples received, all specimens were identified as belonging to the species *C. lectularius* (Figure 1): 3 infestations occurred in 2008 (Liguria), 5 in 2009 (Liguria), 2 in 2010 (Liguria), 3 in 2011 (2 in Piemonte and 1 in Liguria), 3 in 2012 (of which 2 in Liguria and 1 in Piemonte), and 1 in 2013 (Piemonte). Interestingly, no cases had been registered between 2001 and 2008. All infestations involved adult specimens, with the exception of 3

cases, which also included nymphs (in 2011 and 2012). The samples were collected mainly during spring and summer: 14 infestations occurred from April to September and only 3 in the remaining months (1 in November, 1 in February and 1 in March). All those who brought the specimens for identification were private citizens and reported bites and dermatological reactions. Bed bugs were found in most of the cases in the bedroom; in 1 case the sofa was infested. In 2 cases the source of infestation was second hand furniture, in particular some furniture for the bedroom and a sofa that had

been recently bought from a shop and an antique market, respectively.

Discussion

Our results are a contribution to the epidemiology of bed bugs in Italy and suggest a diffusion of such infestations, in agreement with data from other countries (15). Bed bugs' epidemiology in Italy is poorly characterized: 2 human infestations have been reported in Pisa in 2003, other 2 in Italian trains in 2005 (28) and more recently a study identified 23 cases of *C. lectularius* infestations between 2006 and 2011 in the North-East of the country (29). However, the presence of *C. lectularius* is probably underestimated due to several reasons among which the scarce public awareness, the reticence of people to inform physicians (15), the reluctance of accommodation industry's to declare the pest presence and a certain lack of exchange of epidemiological data between pest control companies and scientific research institutes. Also in the case of our study a possible underestimation of the actual number of cases should be taken into account, due to the fact that data from pest control companies were not included. Interestingly, the information gathered from the examined technical sources reveal that bed bugs start to become a relevant topic in the industry of pest management in Italy since 2002 (2, 9, 10).

Furthermore, it has to be mentioned that the identification of bed bugs is not straightforward. *C. lectularius* is 4/5 x 3 mm, dorso-ventrally flattened and females are larger than males. Adult bed bugs are reddish-brown to dark-brown depending on climatic conditions and feeding status. The nymphal stages are translucent and cream in color during the first instar and their internal structure turns reddish

Table 1. Bed bugs specimens identified in the study area, with the area of origin and collection dates.

Year	Collection date	Geographical origin (region, province)	Stage of identified specimens	
1	2008	10/07	Liguria, Imperia	Adults
2	2008	14/07	Liguria, Savona	Adults
3	2008	05/08	Liguria, Genoa	Adults
4	2009	06/05	Liguria, Imperia	Adults
5	2009	17/6	Liguria, Imperia	Adults
6	2009	21/08	Liguria, Imperia	Adults
7	2009	07/09	Liguria, La Spezia	Adults
8	2009	18/11	Liguria, Imperia	Adults
9	2010	15/07	Liguria, Imperia	Adults
10	2010	22/09	Liguria, Savona	Adults
11	2011	07/04	Liguria, Imperia	Adults
12	2011	07/09	Piedmont, Cuneo	Adults
13	2011	13/09	Piedmont, Asti	Juveniles
14	2012	02/02	Liguria, Imperia	Adults
15	2012	21/08	Liguria, Genoa	Juveniles
16	2012	28/09	Piedmont, Cuneo	Adults and juveniles
17	2013	07/03	Piedmont, Verbania	Adults

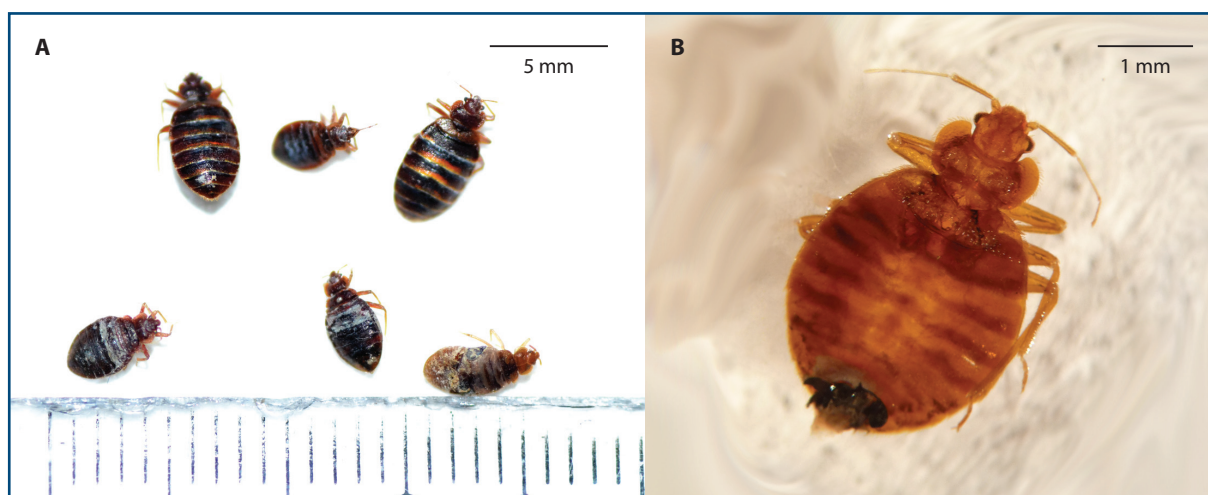


Figure 1. Adults of *Cimex lectularius*. (A) Adult specimens observed by stereomicroscopy. (B) Optical microscopy of an adult female.

after a blood meal. Instars and adults are both haematofagous. The life cycle includes 5 nymphal stages, lasting 2.5-10 days each. The nymphs become progressively dark as they move along the 5 stages. Nymphs are morphologically very similar to adults but smaller (1-4 mm vs 5-6 mm) and sexually immature. Feeding generally occurs within 24 hrs after hatching or molting (15). The duration of the life cycle depends on the temperature, and varies from 24 days at 30°C to 128 days at 18°C. In cold conditions insects can live up to 1.5-2 years without feeding (37). In average temperature conditions of 23°C, it takes approximately 9 days for an egg to hatch (14). Eggs have an elongated aspect, pearly white colour and are about 1mm long. They are laid singly and are coated with transparent adhesive cement (22). Bed bugs favourite hosts are humans, but they can feed also on pets, bats and birds; in all cases the only moment of contact with the host is during the blood meal (14). The carbon dioxide and the body heat attract bed bugs to their hosts (37). Bed bugs are active in the dark and hide under mattresses, curtains, carpets, up-holstered furniture and crevices of walls during the day. Other common sites of infestations include public facilities such as theatres, office waiting rooms, upholstery seats in buses and trains. Heavily infested areas by this insect may be identified by a characteristic sweet smell (22).

In case of suspicion of bed bug presence, monitoring and accurate searches over a full day are required to discover and identify the insects (28).

In case of a proven infestation, eradication is a challenge (15). Nowadays, bed bugs can be eradicated both with the use of insecticides and with physical methods such as thermic disinfection and cryogenic treatment with liquid nitrogen.

The worldwide most commonly used insecticides against *C. lectularius* are pyrethroids, carbamates, silicates and insect growth regulators (IGRs) (38). In Italy, while there is a fair number of registered pyrethroids, there is only 1 authorized carbamate (bendiocarb) (11). Among pyrethroids, deltamethrin is the most widely used molecule; however, a general resistance of bed bugs to this principle is well documented (38) and pyrethroids are extremely toxic for bees and many aquatic organism (35).

The use of silicates and IGRs is generally not practiced because they are slow to react (2, 3, 9, 10, 40, 41). In this respect, the study conducted by Romero *et al.* is noteworthy (39), as it showed that up to 6 days are necessary to achieve 100% of mortality in adult bed bugs with silicates. The class of IGRs presents the same drawback as silicates: after being dosed they lead bed bugs to die just after numerous molts. Organophosphates are the most effective group of insecticide, but their use to contrast bed bugs is forbidden in all Europe. To be effective all insecticides

should be applied directly on the bed bug's body: for this reason the formulation of the insecticide can seriously interfere with its success (15).

In Italy, as well as in other countries (27), non-toxic techniques and monitoring of post-treatment actions are preferred to the use of insecticides (7, 20, 31).

Scientific publications (25, 31, 41, 49), together with seminars, brochures and catalogues edited by the Associazione Nazionale delle Imprese di Disinfestazione (ANID) (2, 3, 4, 6, 7, 8, 9, 10, 13, 16, 11, 20, 27, 30, 32, 34, 40, 42) reveal that the topic 'bed bugs and control strategies' is of fundamental interest to the pest control sector.

Bed bugs can cause unpleasant bite reactions and significant blood loss in chronic infestations (36, 47). The feeding in itself does not produce any pain, while sensitivity reactions are the results of substances injected during feeding (28). Approximately 20 human pathogens have been shown to survive for varying lengths of time in *C. lectularius*. However, there is little or no evidence that the insect is a vector of these agents (12). People are most often bitten on the limbs, trunk and face and individual reactions vary from no response to anaphylactic reaction. The cutaneous reaction can be localized or systemic. The sign of the bite can often be visible in the middle of the lesion. The local reaction can be similar to an uncomplicated mosquito bite or, in some individuals, can cause large fluid-filled blisters. Erythema is uncommon, but may occur as a result of multiple feedings that cause extensive subcutaneous hemorrhaging (43). Severe infestations are usually accompanied by typical sweet and sickly smell. The severity of the cutaneous reaction depends on the immunologic status of the host, however the exact immune basis of the cutaneous reaction is not known. According to some authors (1), antigens in bed bugs' saliva stimulate the production of IgG antibodies, while another study (23) showed the presence of IgE antibodies. During the first exposure bed bugs' bites can be totally asymptomatic; cutaneous reactions can develop up to 11 days after the bite. In most of the cases, however, the reaction occurs within 24 or 48 hrs, and within minutes in hypersensitive individuals. Secondary infections, as folliculitis, cellulitis and impetigo, that can result from a bite are also well documented (15).

Several theories have been provided to explain the recent rise in bed bug infection rate worldwide, although none has been scientifically demonstrated (15). The increase of international travels is considered as the primary reason, since bed bugs can be passively transported over long distances by clothing and luggage (12). Some authors (38) also report that the trade of second-hand furniture can be an easy way to transfer bed bugs, as it has also been shown by the results of this study. The widespread use of air

conditioning, which uniformes the temperature and avoids extreme variations (14) creates ideal conditions for the bugs' development and may contribute to the infestation rise. In general, overcrowding and poverty stricken conditions predispose to the onset of disease (12). Furthermore, as already mentioned, other factors such as uncertainty on the control methods, the fact that it is not a notifiable disease, the resistance to insecticides, the absence of interest in researching new active principles, can influence the pest rise. There are no studies on the resistance to pesticides in Italy, suggesting that the subject is currently neglected.

Bed bugs resurgence should be considered as an emerging public health problem and direct cooperation between specialists in the National Health Service is necessary both for diagnosis and management. Further investigations would be necessary to better understand the epidemiology in Italy and Europe and to assess the real public health risk.

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