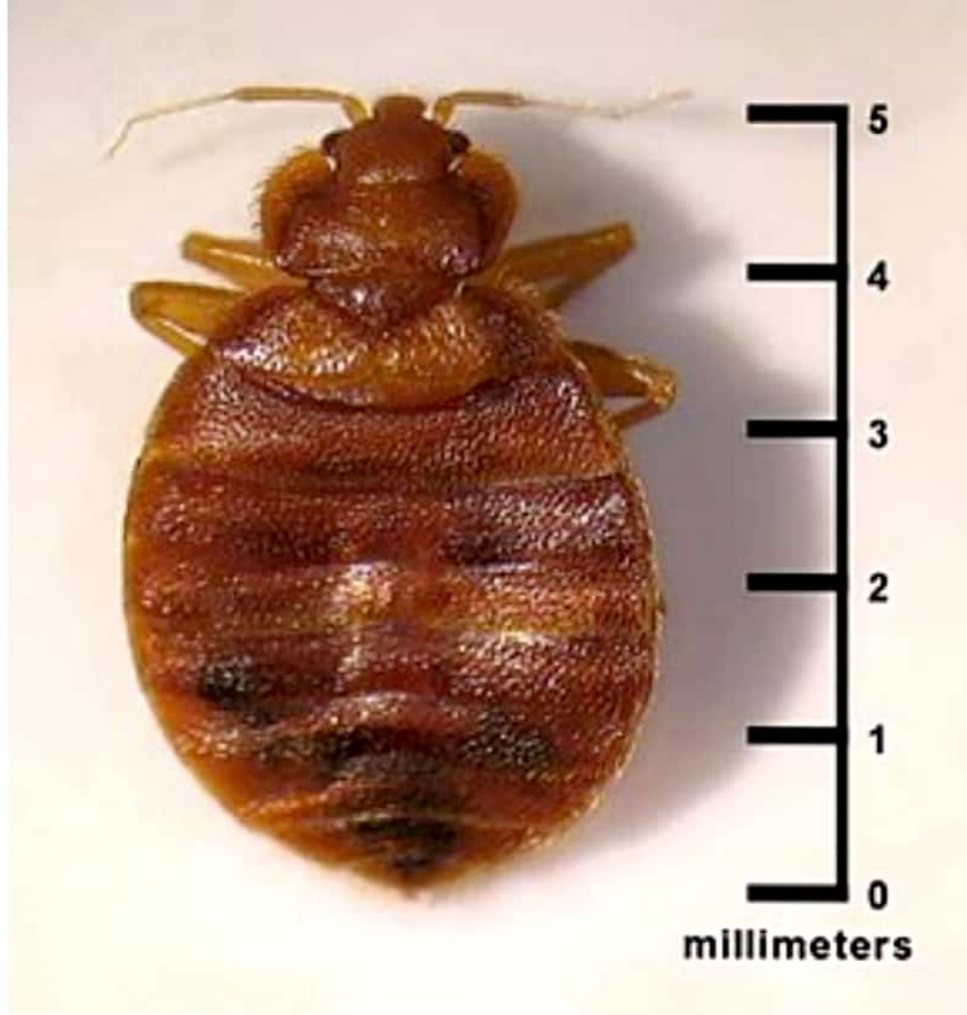


BUG cimex



An adult bed bug (*Cimex lectularius*)

Adult *Cimex* are light brown to reddish-brown, flat and oval. The mouthparts are beak-like, and adapted for piercing and sucking. Following a blood meal the abdomen is plump and darker in colour. The front wings are **vestigial** and reduced to pad-like structures and there are no hind wings. *Cimex* have segmented abdomens with microscopic hairs that give them a banded appearance. Adults grow to 3 to 9 mm (0.12 to 0.35 in) long. The different species are very similar in **morphology** and can only be separated by microscopic examination.^{[1][3]} **Sexual dimorphism**

occurs in *C. lectularius*, with the females larger in size than the males on average. The abdomens of the sexes differ in that the males appear to have "pointed" abdomens, which are actually their copulatory organs, while females have more rounded abdomens.^[4]

Newly hatched nymphs are translucent, light in color at first, becoming browner as they moult and approach maturity. A *Cimex* nymph of any age that has just consumed a blood meal has a bright red, translucent abdomen, fading to brown over the next several hours, and to opaque black within two days as the insect digests its meal.^[3] *Cimex* may be mistaken for other insects, such as booklice, small cockroaches, or carpet beetles; however, when warm and active, their movements are more ant-like, and like most other true bugs, they emit a characteristic disagreeable odor when crushed.

Cimex use pheromones and kairomones to communicate regarding nesting locations, feeding, and reproduction.

The lifespan of *Cimex* varies by species and is also dependent on feeding.

^ Feeding habits



Scanning electron micrograph (SEM) digitally colorized with skin-piercing mouthparts highlighted in purple and red

Cimex are obligatory **hematophagous** (bloodsucking) insects. Most species feed on humans only when other prey are unavailable.^{[16][17][18]} They obtain all the additional moisture they need from water vapor in the surrounding air.^[19] *Cimex* are attracted to their hosts primarily by carbon dioxide, secondarily by warmth, and also by certain chemicals.^{[20][21][22]} Bed bugs prefer exposed skin, preferably the face, neck, and arms of a sleeping person.

Bed bugs have mouth parts that saw through the skin, and inject saliva with [anticoagulants](#) and painkillers. Sensitivity of humans varies from extreme allergic reaction to no reaction at all (about 20%). The bite usually produces a swelling with no red spot, but when many bugs feed on a small area, reddish spots may appear after the swelling subsides.^[12] The bite marks may appear in a straight line.^[23]

Although under certain cool conditions adult *Cimex* can live for over a year without feeding,^[24] under typically warm conditions they try to feed at five- to ten-day intervals, and adults can survive for about five months without food.^[25] Younger [instars](#) cannot survive nearly as long, though even the vulnerable newly hatched first instars can survive for weeks without taking a blood meal.

At the 57th annual meeting of the [Entomological Society of America](#) in 2009, newer generations of pesticide-resistant *C. lectularius* in [Virginia](#) were reported to survive only two months without feeding.^[26]

[DNA](#) from human blood meals can be recovered from *Cimex* for up to 90 days, which means they can be used for [forensic](#) purposes in identifying on whom the bed bugs have fed.^{[27][28]}

^ Reproduction



Male bed bug [traumatically inseminating](#) a female

Since males are attracted to large body size, any *Cimex* with a recent blood meal can be seen as a potential mate. However, males will mount unfed, flat females on occasion. The female is able to curl her abdomen forward and underneath toward the head to deter the male if she does not wish to mate. Males are generally unable to discriminate between the sexes until after mounting, but can do so before insemination.^[4][North Carolina State University](#) found that bed bugs in contrast to most other insects tolerate [incest](#) and are able to genetically withstand the effects of [inbreeding](#) quite well.^[31] Male bed bugs sometimes attempt to mate with other males and pierce their abdomens.^[32] This behaviour occurs because

sexual attraction in bed bugs is based primarily on size, and males mount any freshly fed partner regardless of sex.^[33]

All *Cimex* mate by traumatic insemination.^{[34][35]} Female *Cimex* possess a reproductive tract that functions during oviposition, but the male does not use this tract for sperm insemination.^[34] Instead, the male pierces the female's abdomen with his hypodermic penis and ejaculates into the body cavity. In all bed bug species except *Primicimex cavernis*, sperm are injected into the mesospermae, ^[34] a component of the spermae, ^[34] a secondary genital structure that reduces the wounding and immunological costs of traumatic insemination.^{[36][37][38]} Injected sperm travel via the haemolymph (blood) to sperm storage structures called seminal receptacles, with fertilisation eventually taking place at the ovaries.^[37]

The "*Cimex* alarm pheromone" consists of (*E*)-2-octenal and (*E*)-2-hexenal. It is released when the insect is disturbed, as during an attack by a predator. A 2009 study demonstrated the alarm pheromone is also released by male *Cimex* to repel other males that attempt to mate with them.^{[38][39]}

^ Life stages



Bed bugs have five immature nymph life stages and a final sexually mature adult stage.^[47] They shed their skins through **ecdysis** at each stage, discarding their outer exoskeleton, which is somewhat clear, empty **exoskeletons** of the bugs themselves. *Cimex* must molt six times before becoming fertile adults, and must consume at least one blood meal to complete each **molt**.^[48]

Each of the immature stages lasts about a week, depending on temperature and the availability of food, and the complete lifecycle can be completed in as little as two months (rather long compared to other **ectoparasites**). Fertilized females with enough food lay three to four eggs each day continually until the end of their lifespans (about nine months under warm conditions), possibly generating as many as 500 eggs in this time.^[48]

Genetic analysis has shown that a single pregnant *Cimex*, possibly a single survivor of eradication, can be responsible for an entire infestation over a matter of weeks, rapidly producing generations of offspring.^[49]

^ Host searching



Cimex lectularius only feeds every five to seven days, which suggests that it does not spend the majority of its life searching for a host. When a *Cimex* is starved, it leaves its shelter and searches for a host. If it successfully feeds, it returns to its shelter; otherwise, it continues to search for a host. After searching—regardless of whether or not it has eaten—the *Cimex* returns to the shelter to aggregate before the photophase (period of light during a day-night cycle). Reis argues that two reasons explain why *C. lectularius* would return to its shelter and aggregate after feeding. One is to find a mate and the other is to find shelter to avoid getting smashed after eating.^[50]

^ Aggregation and dispersal behavior



Cimex lectularius aggregates under all life stages and mating conditions. *Cimex* may choose to aggregate because of predation, resistance to desiccation, and more opportunities to find a mate. Airborne pheromones are responsible for aggregations. Another source of aggregation could be the recognition of other *C. lectularius* bugs through mechanoreceptors located on their antennae. Aggregations are formed and disbanded based on the associated cost and benefits.

Females are more often found separate from the aggregation than males. Females are more likely to expand the population range and find new sites. Active female dispersal can account for treatment failures. Males, when found in areas with few females, abandon an aggregation to find a new mate. The males excrete an aggregation pheromone into the air that attracts virgin females and arrests other males. ^[51]

Cimex lectularius Control Method

Integrated Pest Management (IPM) takes advantage of all appropriate pest management options, including the judicious use of pesticides. Although bed bugs may sometimes be controlled by non-chemical means alone, this approach is often very difficult, potentially less effective, and usually more resource intensive. A comprehensive IPM program to control bed bugs may include a number of non-chemical and chemical methods. Non-chemical methods include: Put bedding and clothing in the dryer at high temperatures for 30 minutes to kill bed bugs (just washing will generally not kill bed bugs). Heat infested articles (e.g., furniture, luggage, other items that can't go in a clothes dryer) and/or areas (i.e., a room in a house or apartment, or a whole house) to at least 120 °F (approx. 49 °C) for 90 minutes to ensure that eggs are killed. Cold treatments (below 0 °F (-19 °C) for at least 4 days) can eliminate some infestations. If needed, use pesticides carefully according to the label directions or hire a pest management professional.

Bed bugs, or **Cimicidae**, are small **parasitic** insects. The term usually refers to species that prefer to feed on human blood.

Early detection and treatment are critical to successful control. According to a survey, the most commonly infested places are the **mattress** (98.2%), boxspring (93.6%), as well as nearby carpets and **baseboards** (94.1%).^[1] In fact, bed bugs thrive in areas where there is an adequate supply of available hosts, and plenty of cracks and harborages within 1.5 metres (4.9 ft) of the host.^[2]

Because treatments are required in sleeping areas and other sensitive locations, methods other than chemical **pesticides** are in demand. Treatments can be costly, laborious, time consuming, repetitive, and embarrassing, and may entail **health risks**.

Inorganic materials such as [diatomaceous earth](#) or [amorphous silica gel](#) may be used in conjunction with other methods to manage a bed bug infestation, provided they are used in a dry environment. Upon contact with such dust-like materials, the waxy outer layer of the insect's exoskeleton is disrupted, which causes them to dehydrate.^[23]

Bean leaves



A traditional [Balkan](#) method of trapping bed bugs is to spread bean leaves in infested areas. The [trichomes](#) (microscopic hooked hairs) on the leaves trap the bugs by piercing the [tarsi](#) joints of the bed bug's [arthropod legs](#). As a bug struggles to get free, it impales itself further on the bean leaf's trichomes. The bed bugs and leaves then can be collected and destroyed. [\[27\]\[28\]\[29\]](#) Researchers are examining ways to reproduce this capability with artificial materials. [\[27\]\[29\]](#)

Essential oils



Many claims have been made about essential oils killing bed bugs. However, they are unproven. The FTC is now filing a suit against companies making these claims about these oils, specifically about cedar, cinnamon, lemongrass, peppermint, and clove oils. [\[30\]](#)

Steam



Steam treatment can effectively kill all stages of bed bugs. To be effective, steam treatment must reach 150–170 degrees Fahrenheit (65 - 75 degrees C) for a sustained period. Unfortunately, bed bugs hide in a diversity of places, making steam treatment very tedious, labour-intensive and time consuming. There is also the risk of the steam not penetrating materials enough to kill hidden bed bugs. The steam may also damage materials such as varnished wood, or cause mold from the moisture left behind. Effective treatment requires repeated and very thorough steaming of the mattress, box spring, bed frame, bed covers, pillows, not to mention other materials and objects within the infested room, such as carpets and curtains.

Infested clothes can be effectively treated by a high-temperature ironing with vapor. If performed meticulously, this method yields faster disinfection compared to high-temperature washing in a washing machine. However, attention should be paid in order to avoid bedbug escape from the ironed clothes.

^ Freezing



Bed bugs can be killed by a direct one-hour exposure to temperatures of $-16\text{ }^{\circ}\text{C}$ ($3\text{ }^{\circ}\text{F}$), however, bed bugs have the capacity for rapid cold hardening, i.e. an hour-long exposure to $0\text{ }^{\circ}\text{C}$ ($32\text{ }^{\circ}\text{F}$) improved their subsequent tolerance of -14 to $-16\text{ }^{\circ}\text{C}$ (7 to $3\text{ }^{\circ}\text{F}$),^[34] so this may need to be maintained for longer. Freezer temperatures at or below $-16\text{ }^{\circ}\text{C}$ ($3\text{ }^{\circ}\text{F}$) should be sufficient to eliminate bed bugs and can be used to decontaminate household objects. This temperature range should be effective at killing eggs as well as all stages of bugs.^[35] Higher temperatures however are not effective, and survival is estimated for temperatures above $-12\text{ }^{\circ}\text{C}$ ($10\text{ }^{\circ}\text{F}$) even after 1 week of continuous exposure.^[35]

This method requires a freezer capable of maintaining, and set to, a temperature below $-16\text{ }^{\circ}\text{C}$ ($3\text{ }^{\circ}\text{F}$). Most home freezers are capable of maintaining this temperature.