Bed Bug Basics

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Order Heteroptera (True bugs)

- Family Cimicidae
- Originally cave dwellers (Middle East) that were ecto-parasites of bats
- Humans moved into the caves so bed bugs started to feed on humans
- Humans have transported bed bugs all over the world

Piercing-sucking mouthparts
US History of the Bed Bug

- Common pest in the US at the turn of the century
- Essentially eradicated in 1940-50 due to DDT
- Resistance documented to DDT, malathion, carbamates and pyrethroids
Why are Bed bugs back?

- International travel?
- Reduced baseboard spraying?
- Misidentification?
- We don’t know how to treat?
- Wartime pest?
- Increased pressure of resistant populations?

World-wide resurgence: Pest control operators report a 100-500% increase in bed bug jobs in US, Europe, and Singapore
So What Are They Doing?

- Aggregate in cracks and crevices all day
- If hungry they become active between midnight and 5:00 am
- Stimulated by and increase of CO$_2$ in the room
- Will travel many yards to get to a host
- We still don’t know exactly how a bed bug finds the host
Bed Bug Feeding

- Probe the skin to find a capillary space that allows the blood to flow rapidly
- May probe the skin several times before feeding.
- Feeds for 5-10 minutes
- After feeding, leaves the host to aggregate
- Bed bugs usually feed every 3-7 days
Feeding Behavior

• Most of the time, the majority of the population is in the digesting state.

• Old literature claims that adults live for a 1 year without feeding.

• However, recent research indicates that all life stages live only ~70 days without feeding.

• However, they can live longer at cool temperatures <40°F.

May void part of previous meal while feeding.
Right After Feeding?

- Right after adults take a blood meal they become very interested in mating, particularly the males.
- They engage in traumatic insemination.
- The male stabs his paramere through the female wall into a specialized organ on her right side, called the Organ of Berlese.
- The male sperm is released into the female’s body cavity, where over the next several hours it will migrate to her ovaries and fertilize her eggs.
- Females may be mated with as many as 5 different males.
- We have seen females begin to produce eggs within one day of mating.
Consequences of Mating

- The female’s body must heal from this wound.
- Females are known to leave aggregations after being mated several times.
- The process of healing from mating has an impact on the female’s ability to produce eggs.
- Females that mate only once will produce 25% more eggs than females that are mated repeatedly.

Will mate when skinny as well.
Why do you care?

- A single mated female brought into a home can cause an infestation without having a male present.
- Must have regular blood meals.
- The female will eventually run out of sperm, and will have to mate again to fertilize her eggs.
- She can mate with her own offspring after they become adults.
Egg Production

- The total number of eggs a female can produce is dependent on feeding frequency not the number of matings.

- After taking a blood meal the females produce 5-20 eggs over the course of 10 days.

- She will not reproduce again without feeding.

- However, she can reproduce without mating again and even up to 25% more offspring!!!!!!

These eggs are about to hatch (~5 days old). You can see the eye spots of the developing nymphs.
Population Growth

- Eggs can be laid singly or in groups
- About 97% of all eggs will hatch successfully
- Females in the laboratory begin to die after about 9 feedings
- Average females produces \(~113\) eggs in her lifetime
- Under optimal conditions the population can double in \(~16\) days
Egg Hatch Time

• Our lab observations indicate that about 64% of the eggs hatch between days 6 and 7.
• Greater than 90% are hatched between days 8-9.
• Temperature will influence hatch time

Hatching bed bug nymphs
Nymph Survivorship

• The *first instars* (newly hatched nymphs) will need a blood meal within ~3 days before they start to die.
• The early death is most likely due to dehydration (moisture loss) rather than starvation.
• Many first instars probably die because their egg was laid too far from a host.
What is the bed bug lifecycle?

- Bed bugs go through 5 nymphal instars before they become adults
- Each instar must have a blood meal to molt to the next stage (5-8 days)
- If no host present it does not molt
- First instar to adult in ~37 days
Fed and Unfed Nymphs

Incomplete blood meals and starvation will prolong development.
Adult Life Span

• An adult bed bug at >70° F will live between 99 and 300 days (laboratory).
• We do not know how long a bed bug will live in someone’s apartment (several months).
• Conditions are tough in human dwellings (finding food, temperature and humidity, insecticides, being crushed etc.)
• Resistant bed bugs have shorter life spans and reproduce less than non-resistant bugs
The Signs of Bed Bug Presence

• Bed bugs have to be brought in
  – Traveling
  – Used furniture
• First indicator is unexplained itching red welts
• Bites suggest bed bugs but are not definitive
• Medical doctors are terrible about diagnosing bites!
Bite Reactions (the first indicator)

- My technician’s arm one week after feeding 1000s of bed bugs.
- My arm one week after feeding 60 2-3rd instar bed bugs.
- My student’s arm 1 year after feeding mixed stage bed bugs.
• **Bites**
  
  – One study found only 30% had a reaction when bitten by a bed bug.
  
  – Another study indicated that 96% (of refugees in Sierra Leone) had reactions.
  
  – Reaction will vary depending on your immune system and Number of bites
  
  – More evidence is needed than bites to confirm bed bugs
Bed Bug Evidence

• Fecal spots (bed bug poop)
  – Mattress seams and on the tag
  – Wood frame of the box springs
  – Behind the head board
  – Along the tops of baseboards or the edge of carpeting
  – Ceiling/wall junctions and behind pictures on the wall
  – At electrical outlets
  – In curtain seams

• This is blood that has gone through the gut of the bed bug.

• Looks like cockroach feces but *feels* very different
Bed Bug Evidence

- Molted skins (exuvia)
- The molted skins can be found in bed bug aggregations or by themselves
- In a new infestation, bed bug evidence may be very hard to find. Yet, because a large percentage of any bed bug population is immature, there is always potential to find molted skins.
Hard to Find but Obvious
Less Obvious Unless You Know

• What does this look like to the untrained eye?
• Is it a moisture leak upstairs?
• Mildew that is getting out of control?
• Look closer and see what is really there.
• Bed bug aggregations
Last One,
What is this?
Bed Bug Basics: Social Issues

- Bed bugs still have a stigma
- Everyone wants to blame or have someone else pay for the problem
- Residents worry about neighbors or management finding out
- Hotels worry about the internet reviews
- It has been slow trying to get community-wide bed bug programs started
- Other people are obsessing about bed bugs
Health Issue: Stress

• Stress (after an infestation)
  – Sleeplessness
  – Medical bills
  – Destruction of self-image
  – Throwing out all belongings
  – Moving
  – Legal action

• Stress (no infestation)
  – Waking family members in the middle of the night or pulling out the furnace
  – Moving, and moving and moving!
Social Issues: Lawsuits

- NYC >2000 summonses in 2006
- The questions:
  - Did the hotel know they had an infestation?
  - Should they have known?
  - Was there a prevention program in place?
  - Can a landlord charge tenants for bed bug control?
- Claims:
  - Damage
  - Injury (bites)
  - Emotional stress

Leslie Fox: lawsuit for 21 million
Legislation

• San Francisco passed “Directors Rules and Regulations on how to Control Bed bug infestation” Article 11, Sec. 581 of Public Health Code on Sept. 1, 2006
  – Property Owners and Operators “shall not have a public nuisance on the property”
  – Tenants must clean and cooperate with owners and PCOs or be cited
  – PCOs have guidelines for inspection and treatment procedures

• 2009 Virginia HB 2080- Landlord is to maintain fit premises. Tenant shall prepare the dwelling for pesticide application according to management instructions. If insects are found...
Other Social Issues

- Rise in low-income infestations where people cannot afford control
- Language barriers, hiding, denial, lack of literacy are contributing to the spread
- Resident using and misusing their own insecticides
- EPA is particularly concerned about non-registered insecticides being purchased over the internet
Why We Don’t have “the Answer”

• Most products will kill some bed bugs if you apply them directly.
• Sprays have low residual efficacy
• Consumers do not realize that killing bed bugs we can see is not the problem.
• Our problem is stopping the infestations.

Why not just hit each bug with a hammer?
Bed Bug Basics Summary

• Bed bugs biology and behavior contributes to their success as a pest
• We must be able to recognize the signs of an infestation early on to deal with bed bugs effectively
• We must understand the social issues regarding bed bugs, and be able to work with those issues
• We must be in acceptance that (right now) there is not single insecticide product that capable of eliminating bed bugs
• All treatment is time consuming and expensive
• There is no pest management company that can work a miracle overnight
Questions?