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

Spraying springs of bed with 5% DDT in kerosene for bed bugs. USDA photograph by Madeleine Osborne

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^{o} 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

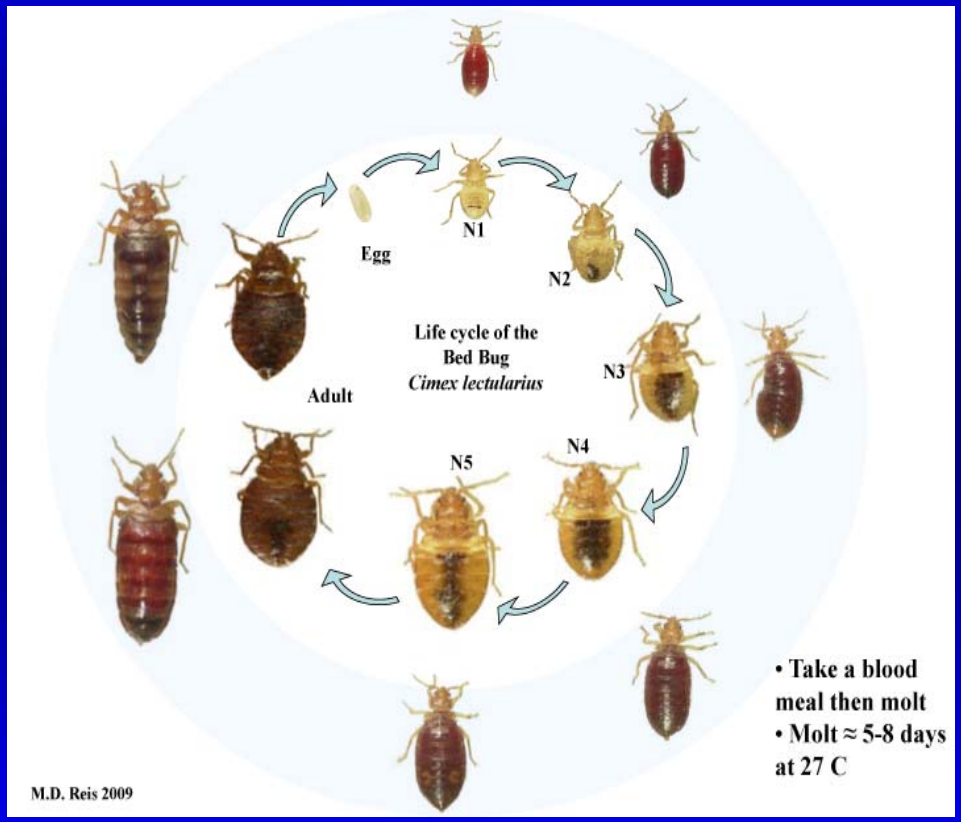
Hatching bed bug nymphs

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 >70º 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 be bugs

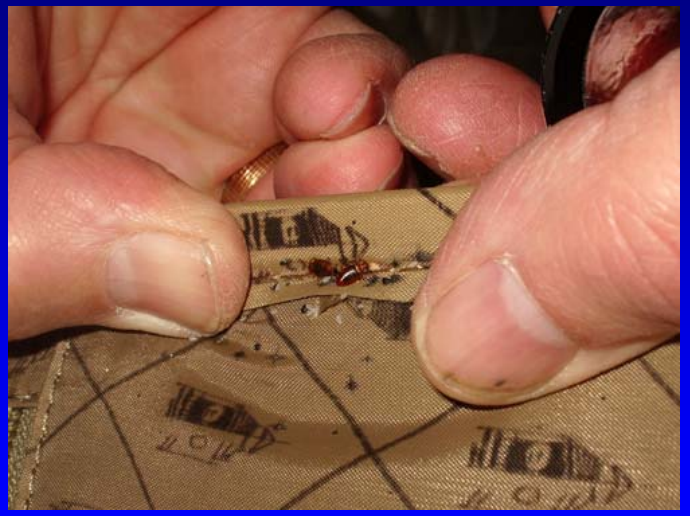
Bed Bug Evidence

- **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.

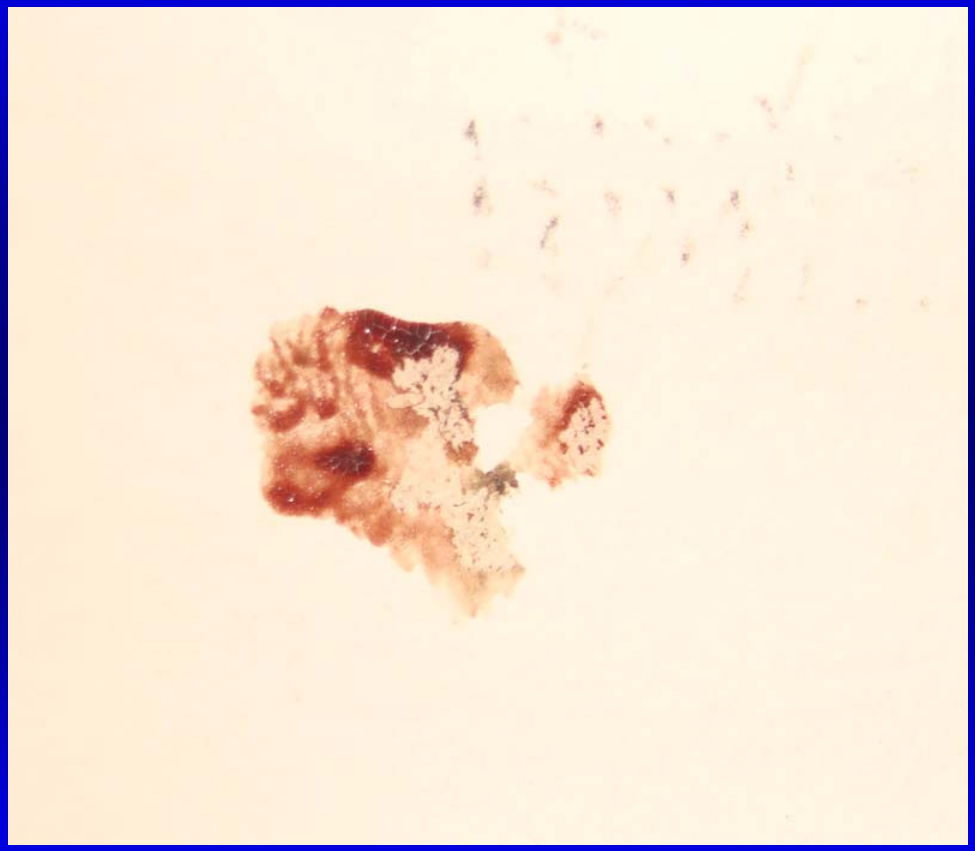
Hard to Find but Obvious

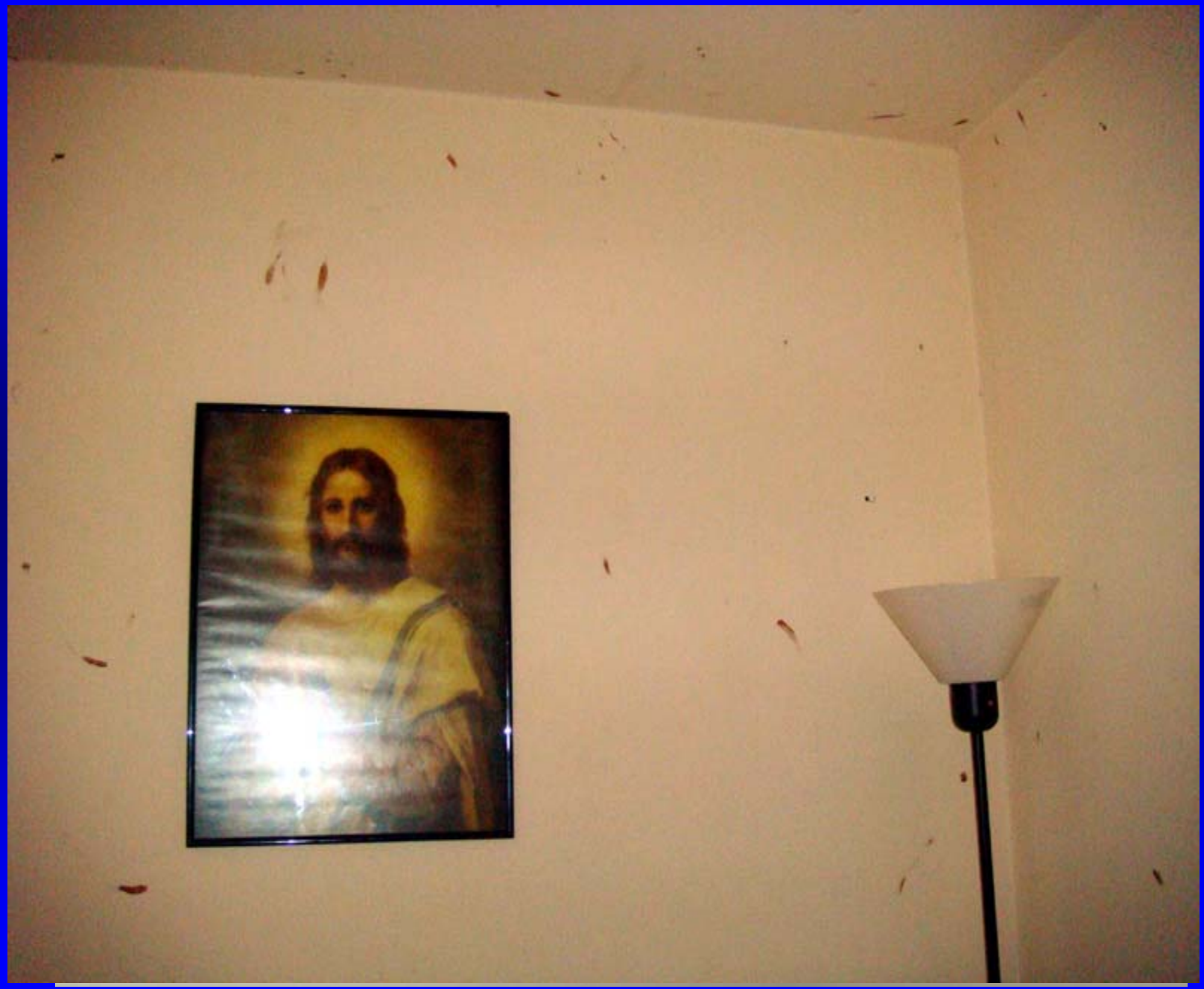


Less Obvious Unless You Know

- 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

What is this?





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 kills 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?