

Bed Bugs Uncovered: Identifying, Preventing, and Protecting

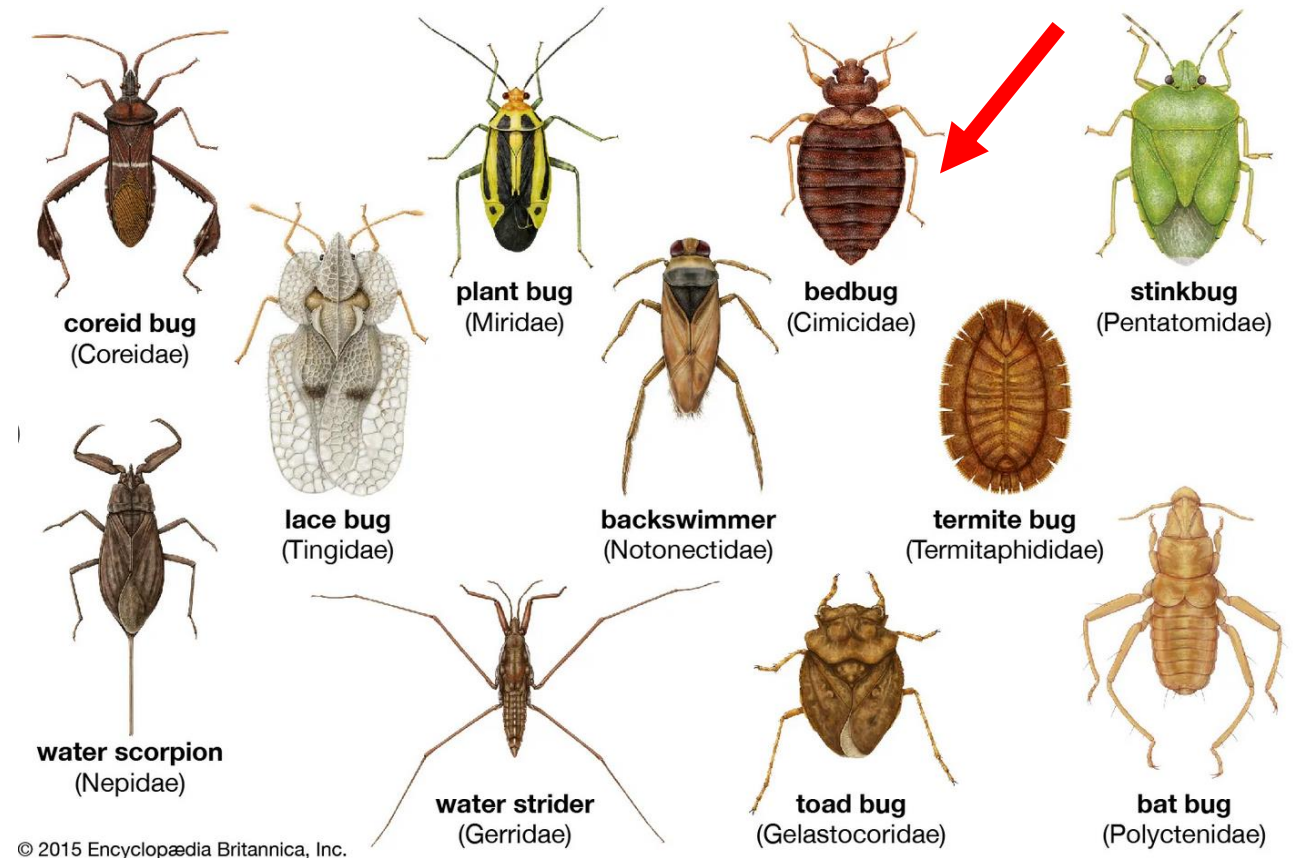
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Entomology

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Order Hemiptera – Bed bugs are True Bugs!

- True bugs
- “Half-wing”
- Cicadas, aphids, bed bugs, leafhoppers and planthoppers, assassin bugs, kissing bugs, shield bugs, stink bugs, etc.,
- >80k species worldwide



Hemipteran Families - Cimicidae

Bed Bugs (*Cimex lectularius*)

- Latin “bug, of bedroom”
- Small, oval, flattened body
- Wingless
- Beak is 3-segmented
- Reddish brown, about the size of an apple seed as an adult

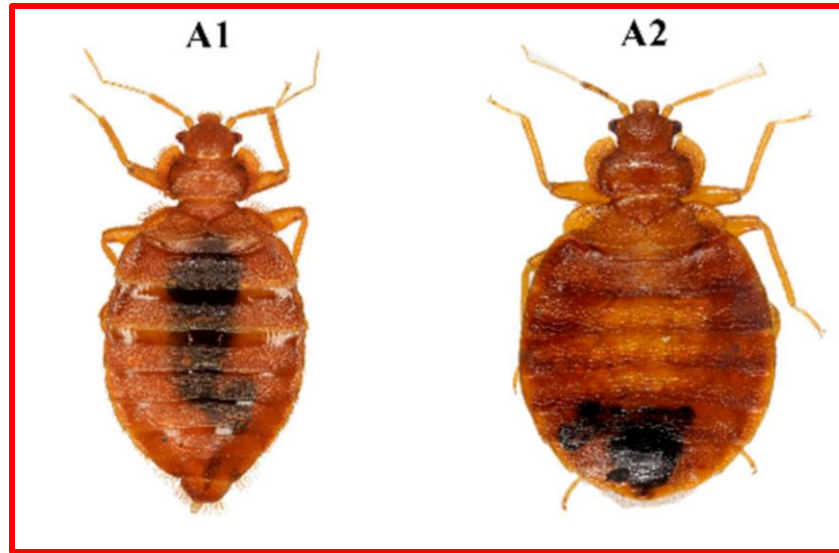


Credit: Dong-Hwan Choe

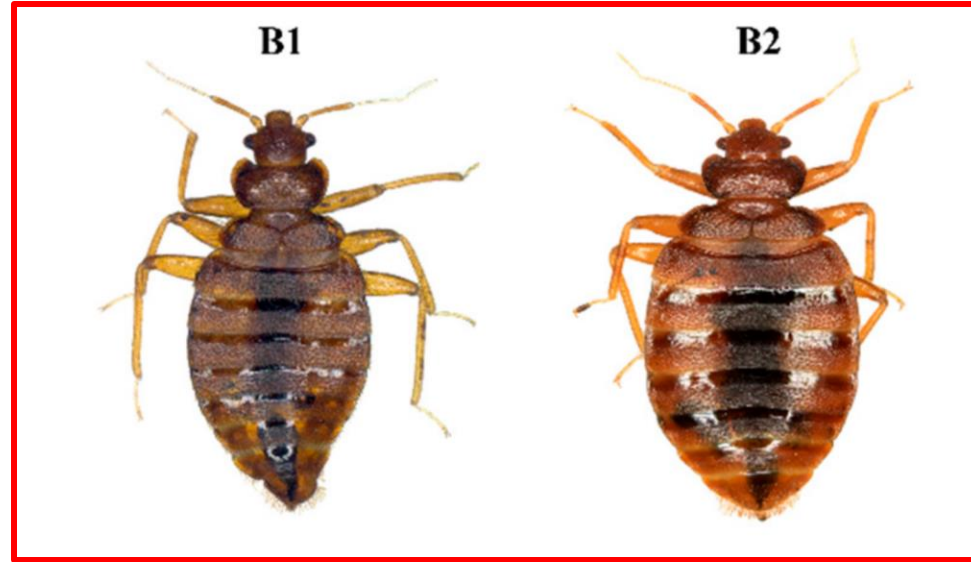
Cimicids are Exclusively Parasitic Hemipterans



Common Bed Bugs



Tropical Bed Bugs



Swallow Bugs

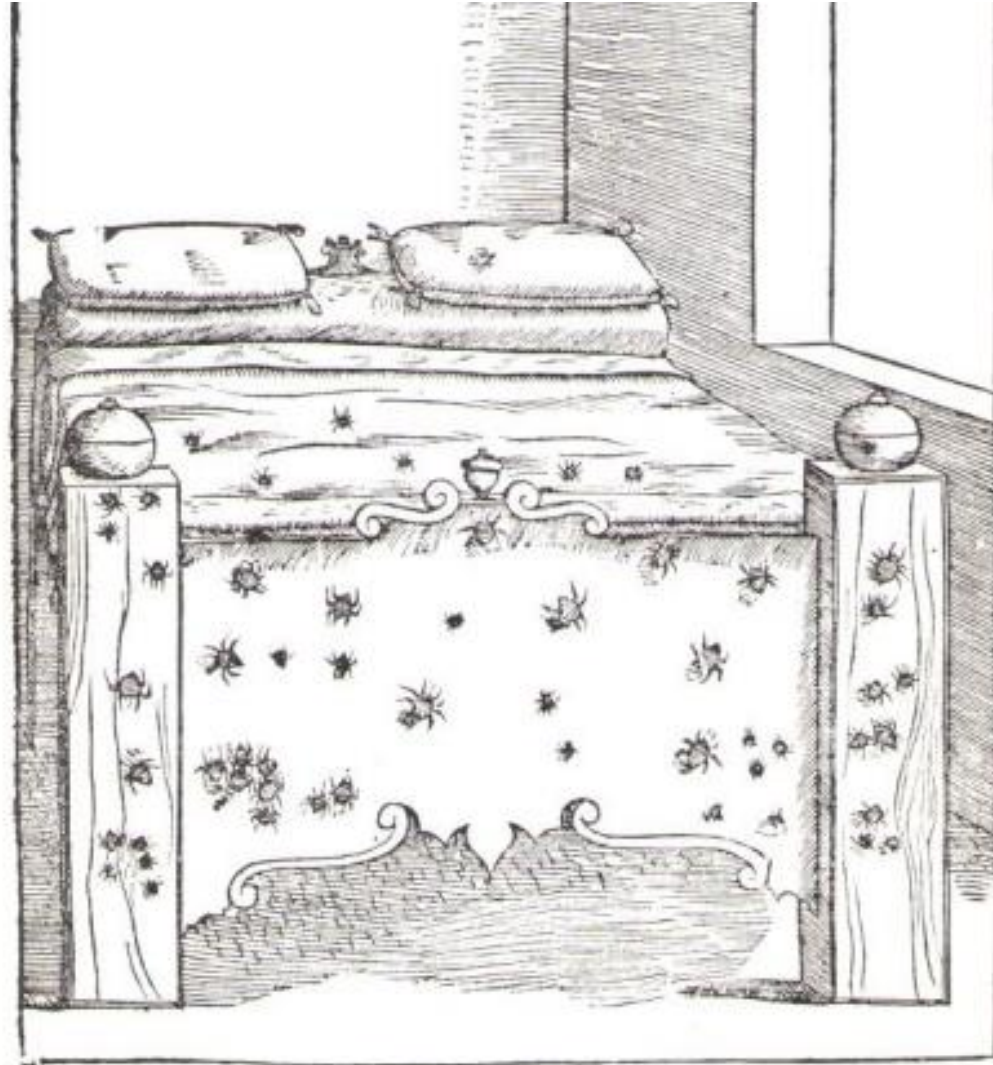


Eastern Bat Bugs



Bed Bugs Have Been Pest of Humans for Centuries

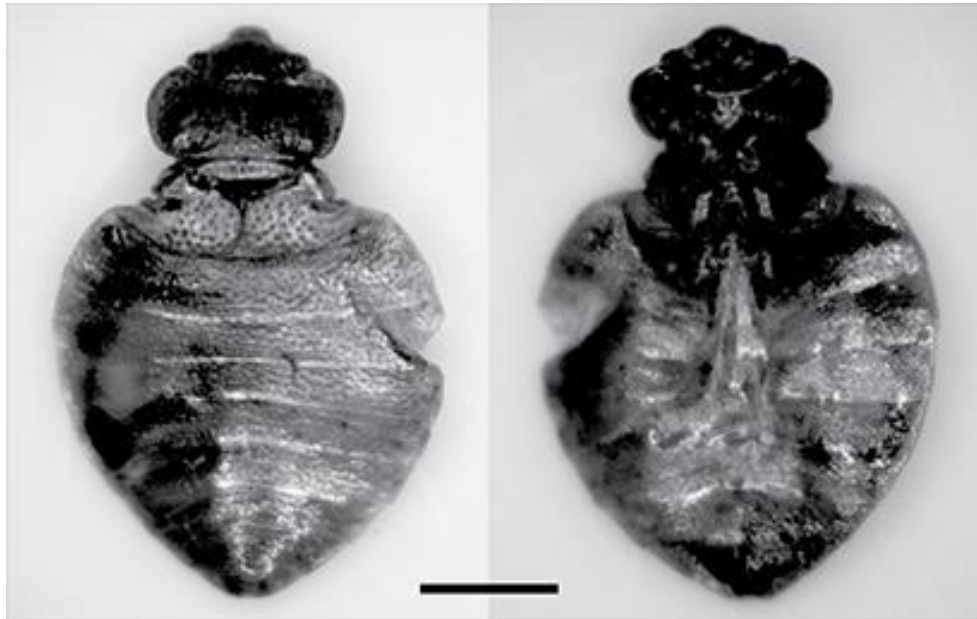
Woodcarving of a
bed bug infestation,
from Matthioli 1568



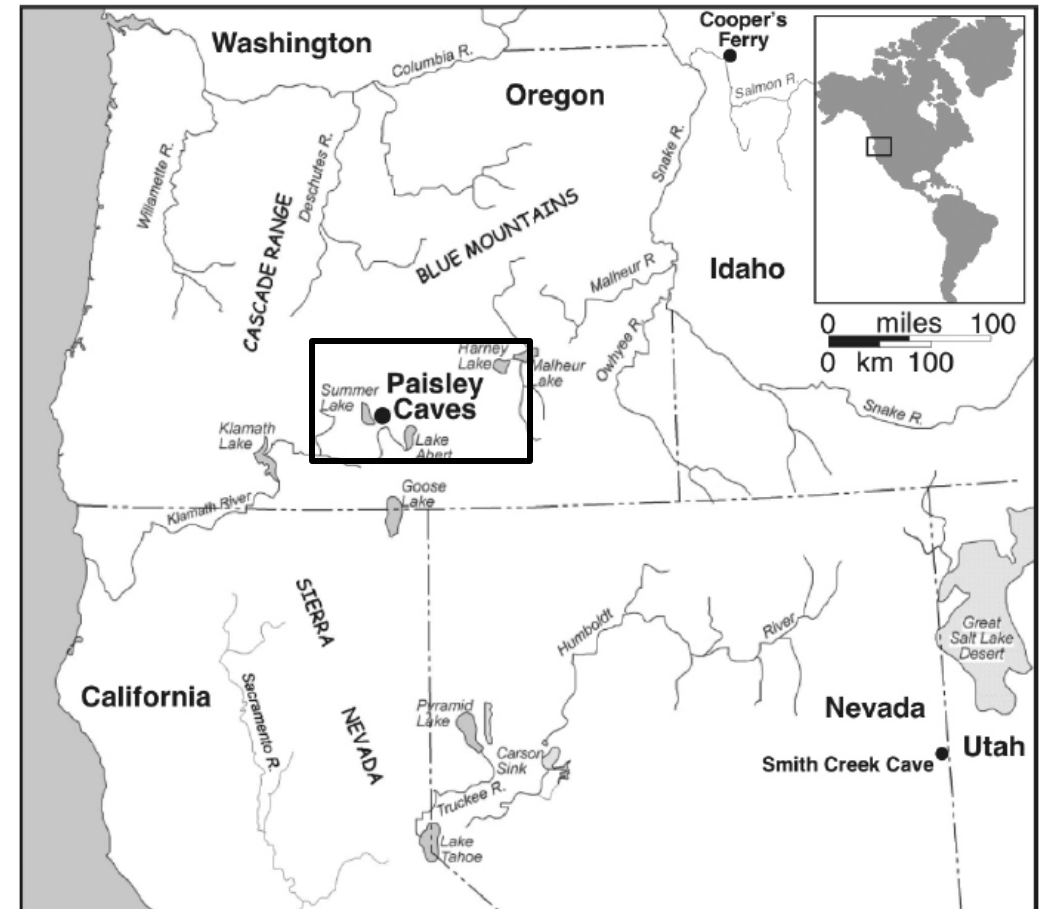
Bed Bugs Have Been Pest of Humans for Centuries

An Early Holocene Record of *Cimex* (Hemiptera: Cimicidae) From Western North America

Martin E. Adams^{1,2} and Dennis L. Jenkins³



3 species found, including modern bat bug



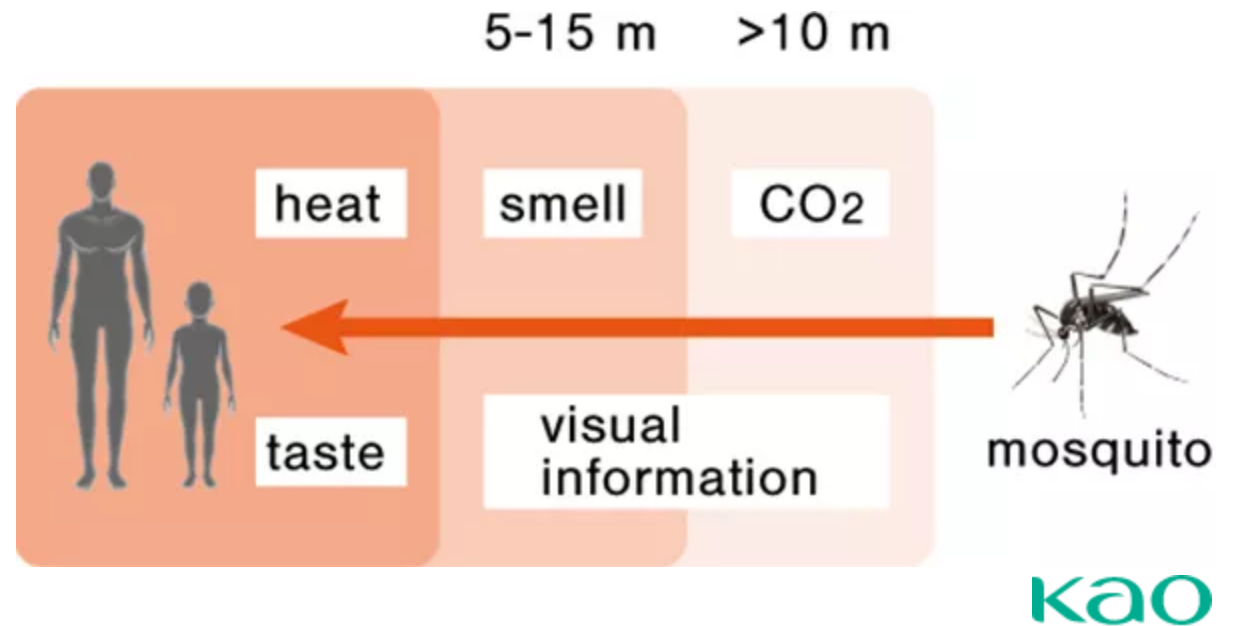
What are conducive conditions for bed bugs?

- People or another suitable vertebrate host (chickens, rodents, bats)
- High turnover locations
- Bed bugs do not care about filthy conditions!
- Food, warmth, and a place to rest/hide



Bed bugs come from people! (but they didn't send them to you)

- Passive acquisition of bed bugs (hitch hiking)
- Acquired an infested item
- Your neighbor has them and they spread
- Use typical blood feeding insect stimuli to locate a host



How do we know that humans share their bed bugs?



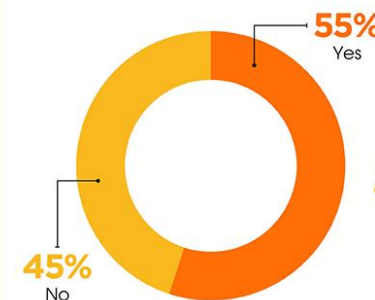
- Insecticide resistance is widespread in bed bugs associated with humans
- Can use resistance genes (*kdr*) to track the spread of bed bugs
- Collected bed bugs from human and bat populations, looked for gene flow

Host association drives genetic divergence in the bed bug, *Cimex lectularius*

WARREN BOOTH,^{*1} ONDŘEJ BALVÍN,^{†‡1} EDWARD L. VARGO,^{§¶} JITKA VILÍMOVÁ[†] and COBY SCHAL[§]

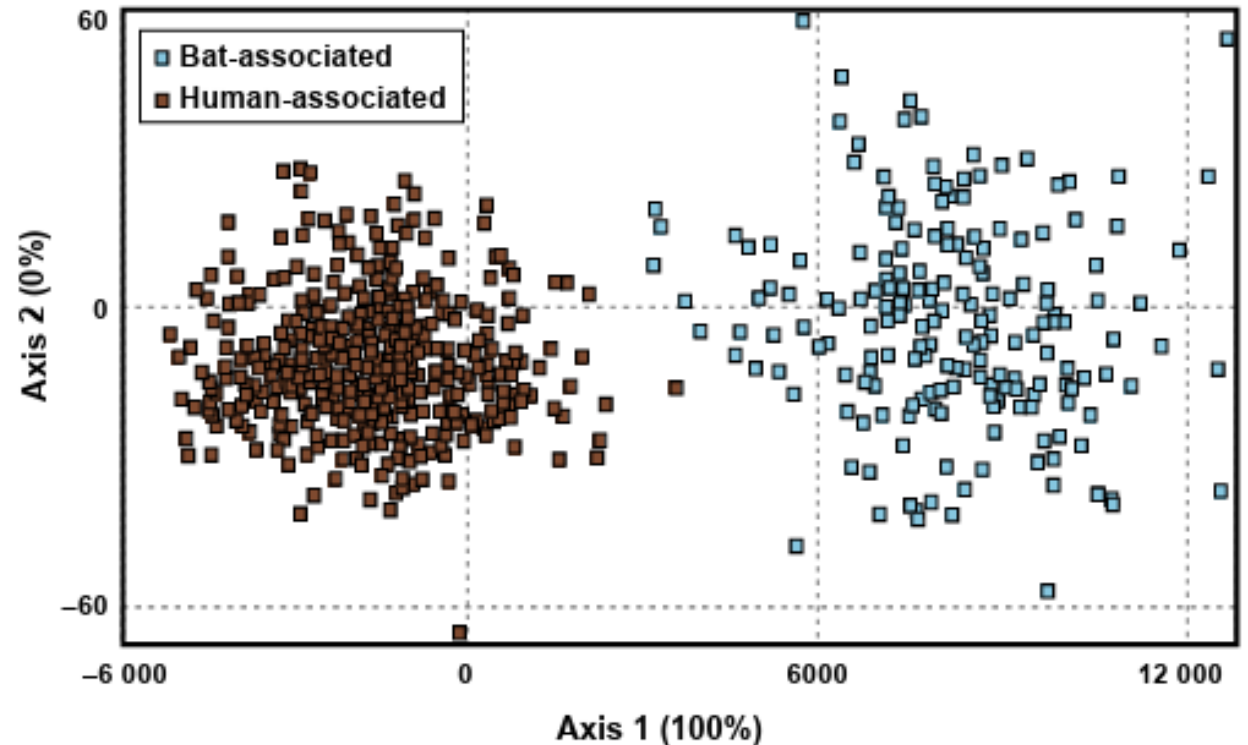
HAVE YOU EVER OBSERVED BED BUGS RESISTANT TO PESTICIDES?

Source: PCT Reader Poll, July 2023



How do we know that humans share their bed bugs?

- Limited gene flow between bat and human populations of bed bugs
- Suggests divergence between two host associated populations
- Reinforces that bats were the ancestral host of bed bugs



Host association drives genetic divergence in the bed bug, *Cimex lectularius*

WARREN BOOTH,^{*,†} ONDŘEJ BALVÍN,^{†,‡} EDWARD L. VARGO,^{§¶} JITKA VILÍMOVÁ[†] and COBY SCHAL[§]

Dispersal - Passive Movement of Bed Bugs



PMP
Pest Management
Professional

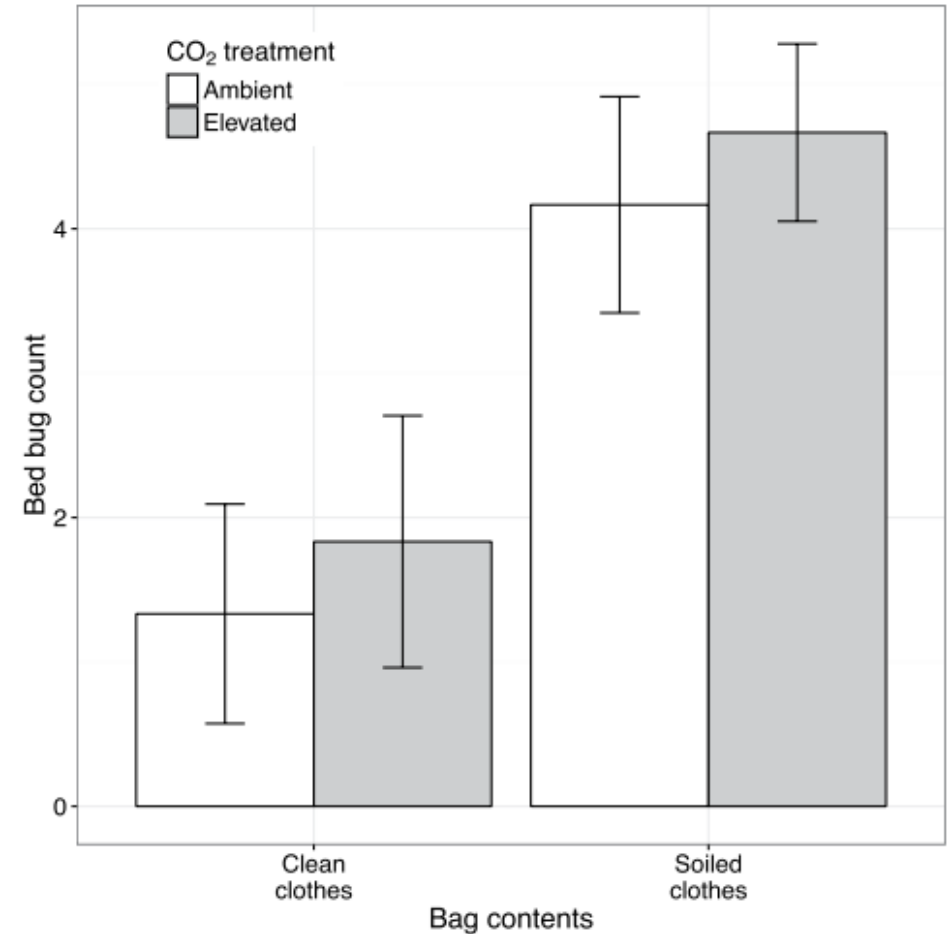


Bed bug aggregation on dirty laundry: a mechanism for passive dispersal

William T. Hentley , Ben Webster, Sophie E. F. Evison & Michael T. Siva-Jothy

Dispersal - Passive Movement of Bed Bugs

- 4 volunteers wore clean clothes for 3 hours
- Placed clothes in a bag, then a room, with or without CO₂
 - Bed bugs aggregated on luggage with dirty clothes
- Provides a mechanism for how bed bugs are passively moved



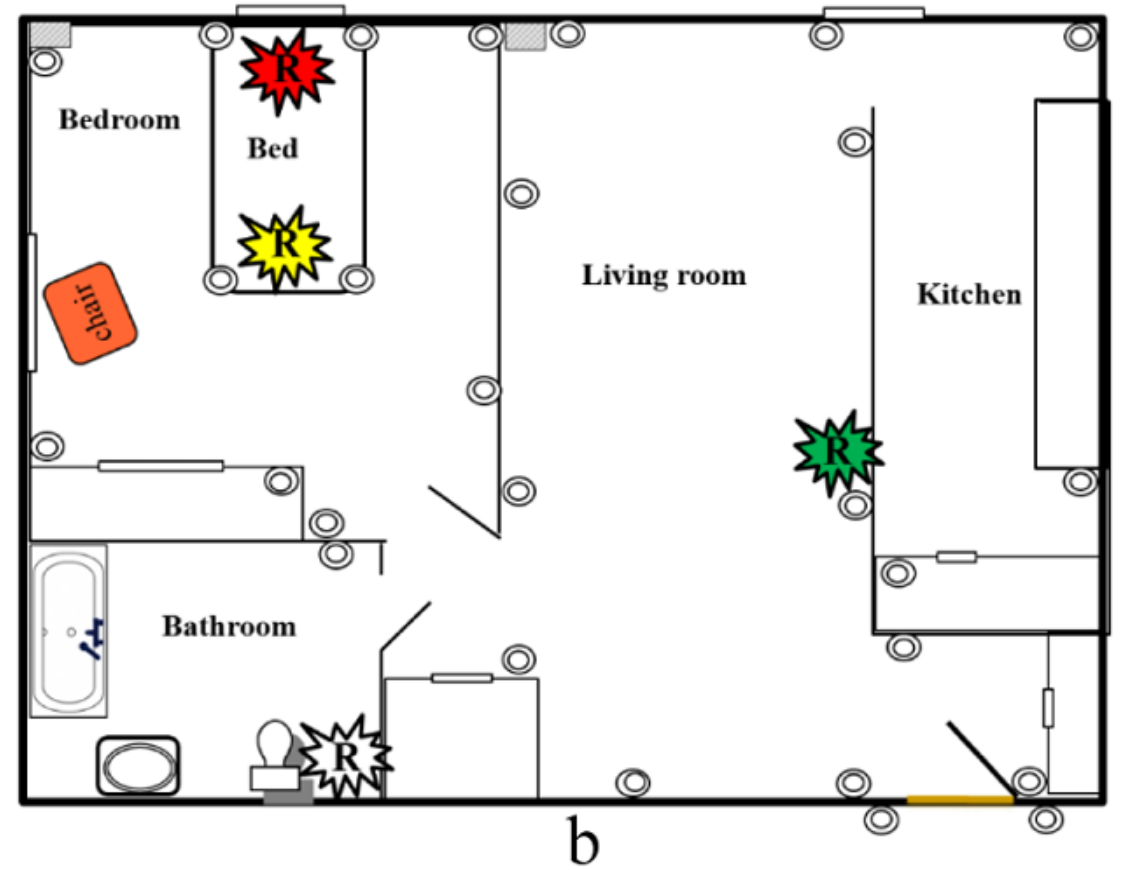
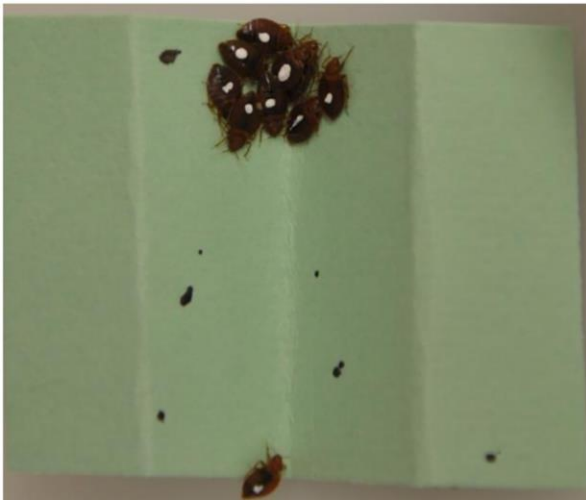
Bed bug aggregation on dirty laundry: a mechanism for passive dispersal

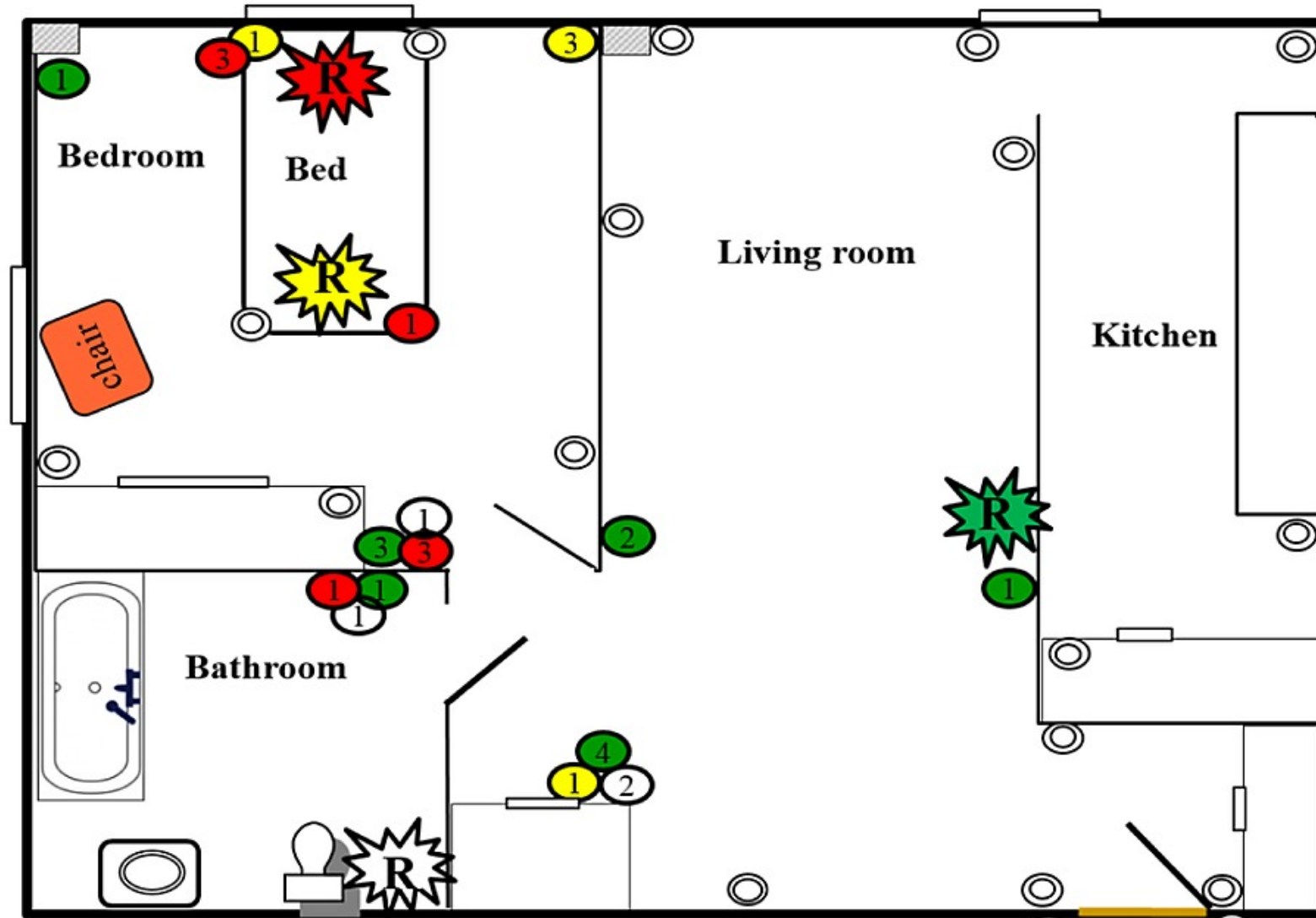
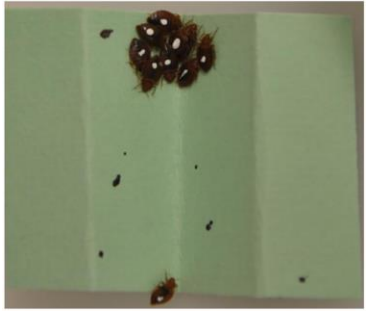
William T. Hentley, Ben Webster, Sophie E. F. Evison & Michael T. Siva-Jothy

Dispersal - Bed Bugs Actively Move Also!

Mark-Release-Recapture Reveals Extensive Movement of Bed Bugs (*Cimex lectularius* L.) within and between Apartments

Richard Cooper*, Changlu Wang, Narinderpal Singh

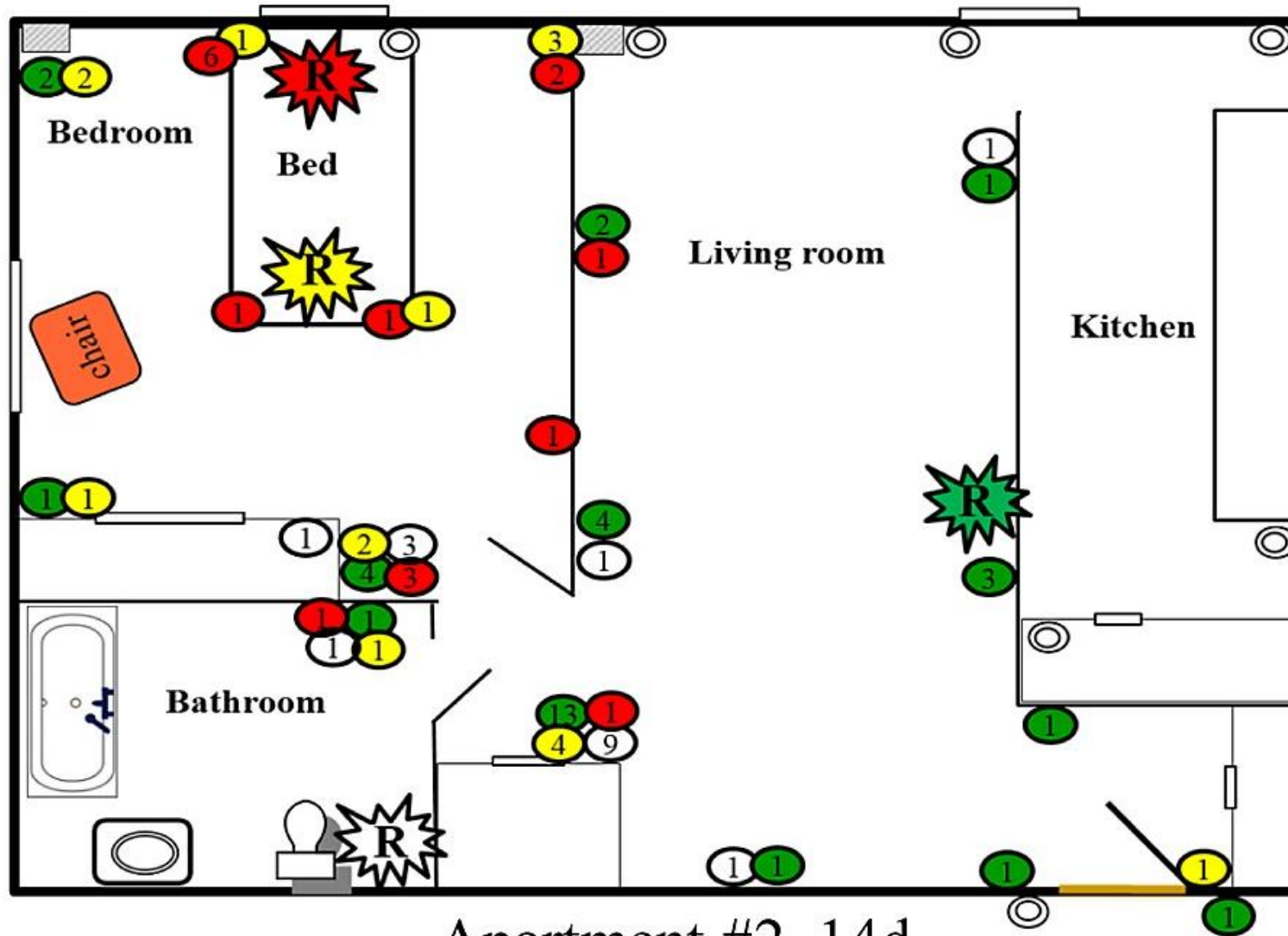




Apartment #2, 24 h.

Mark-Release-Recapture Reveals Extensive Movement of Bed Bugs (*Cimex lectularius* L.) within and between Apartments

Richard Cooper*, Changlu Wang, Narinderpal Singh



Apartment #2, 14d.

Mark-Release-Recapture Reveals Extensive Movement of Bed Bugs (*Cimex lectularius* L.) within and between Apartments

Richard Cooper*, Changlu Wang, Narinderpal Singh

Commercial Properties

How did they get here?

- Likely introduced by guest, or employee depending on setting
- Neighboring areas for bed bugs to spread to or be reintroduced from
- Potentially more areas to inspect
- Public scrutiny/ privacy, financial losses
- Consider treating off-site locations

Movie Theaters



Hotels/Resorts/Casinos



Poultry Production



Medical/ other offices



Residential Properties

How did they get here?

- Single family home
 - Yourself, family member, guest, or infested item
 - Did you travel recently?
- Apartment
 - Introduction from a neighboring unit, the same explanations as above

House



Apartment



Signs of a Bed Bug Infestation

- Cast skins or molts



Photo credit: Dong-Hwan Choe

Signs of a Bed Bug Infestation

- Cast skins or molts
- Fecal stains (run brownish red when wetted)



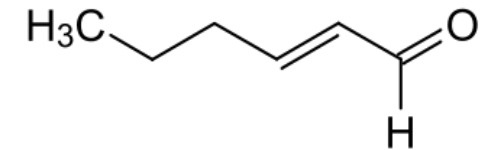
Signs of a Bed Bug Infestation

- Cast skins or molts
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- Live and dead bugs
- Eggs

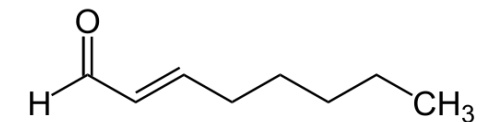


Signs of a Bed Bug Infestation

- Cast skins or molts
- Fecal stains (run brownish red when wetted)
- Live and dead bugs
- Eggs
- Bed bugs have a distinct odor (alarm pheromones)



E-2-Hexenal



E-2-Octenal

Signs of a Bed Bug Infestation

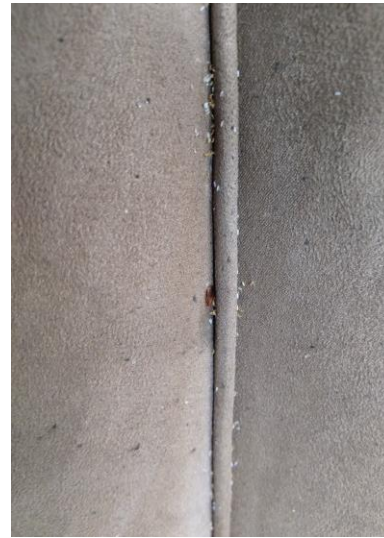
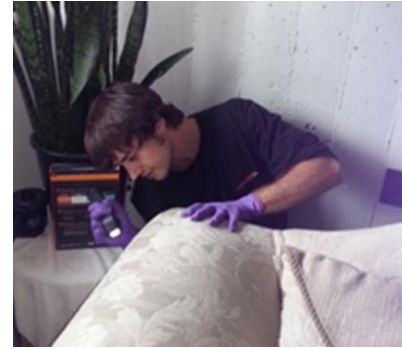
- Cast skins or molts
- Fecal stains (run brownish red when wetted)
- Live and dead bugs
- Eggs
- Bed bugs have a distinct odor (alarm pheromones)
- Human made signs



Signs of a Bed Bug Infestation



Inspections



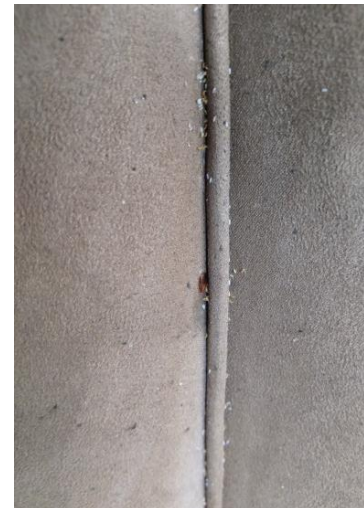
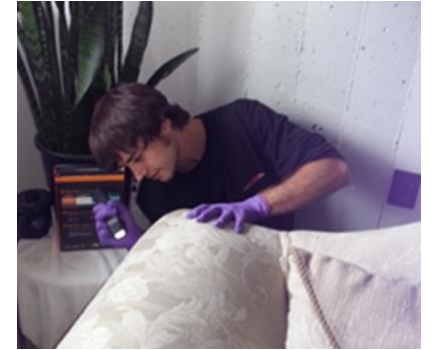
Bed Bug Control: Visual Inspection

Tools

- Strong flashlight
- Headlight
- Gloves
- Screwdriver



Photo credit: Ryan Davis



Bed Bug Control: Visual Inspection

- Talking with resident is critical
 - Where do you sleep?
 - Locations people spend a lot of time at
 - Complete inspection
 - Record keeping

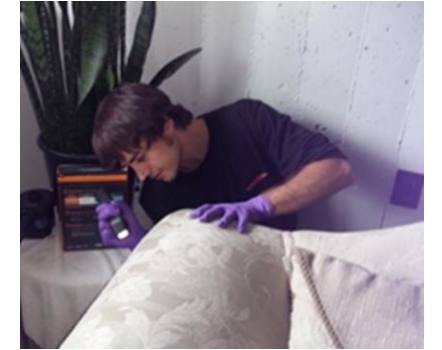
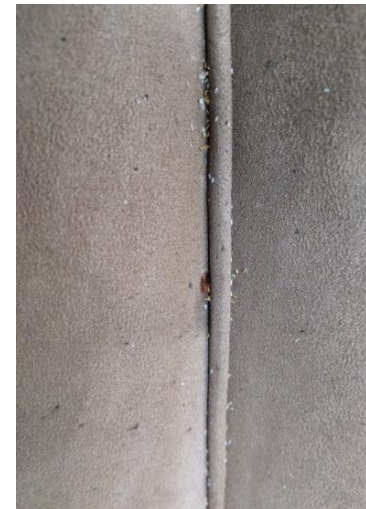


Photo credit: Ryan Davis



Bed Bug Cryptic Behaviors

Prefers contact with tight spaces

Nocturnal, but not always

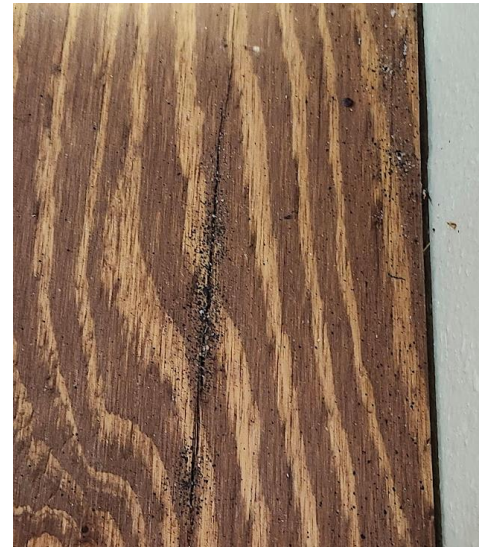


Bed Bugs Orient to Tall Objects



Bed Bug Visual Inspections

- Initial inspection



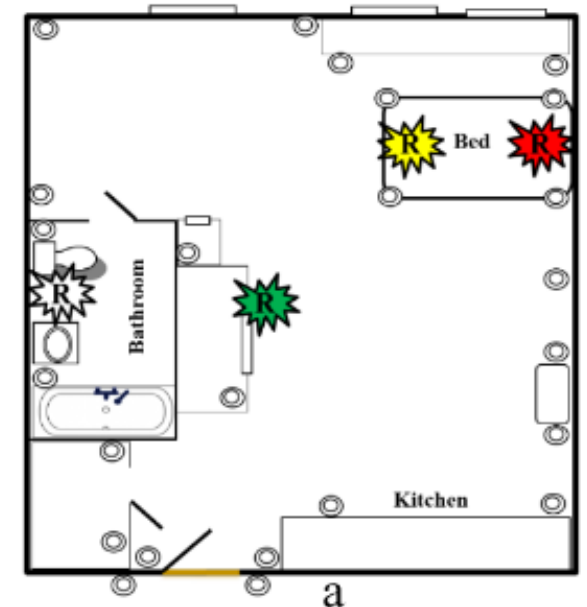
PPE for a Bed Bug Inspection

- Booties (anti-slip)
- Tyvek suit
- Gloves
- Change your clothes, shoes after the inspection/ visit, bag them, and freeze them
 - Wash clothes later



Bed Bug Monitoring Tools

- Pitfall style traps
 - Traps allow for low-level detection
 - Evaluate control program
 - Furniture should be off walls



Cooper et al. 2015

Bed Bug Monitoring Tools: K-9 Inspection



MMPC 

Bed Bug IPM Program Summary

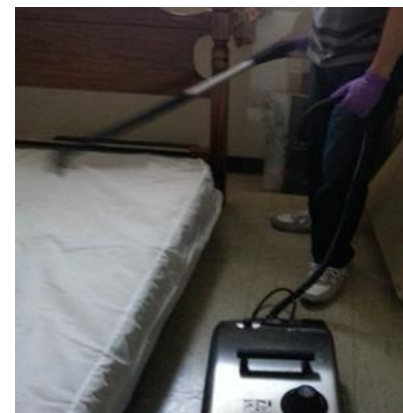
- Initial inspection
- Non-chemical tools
- Insecticide application
- Wait 10 to 14 days (eggs hatch, bugs move)
- Follow-up inspection/ treatment
- Monthly product rotation



Photo by Richard Cooper from the Bed Bug Handbook

Bed Bug IPM Program

- Initial inspection
- Non-chemical tools
 - Mattress encasements
 - Vacuuming
 - Heat
 - Cold (Cryonite®)



Non-Chemical Control Tools: Mattress Encasements

- Contains bugs on mattress
- Easier to treat/find after
- Need to be used with pitfall traps
- Don't remove cover



Vacuuming for Bed Bugs is Critical

Handheld



Backpack

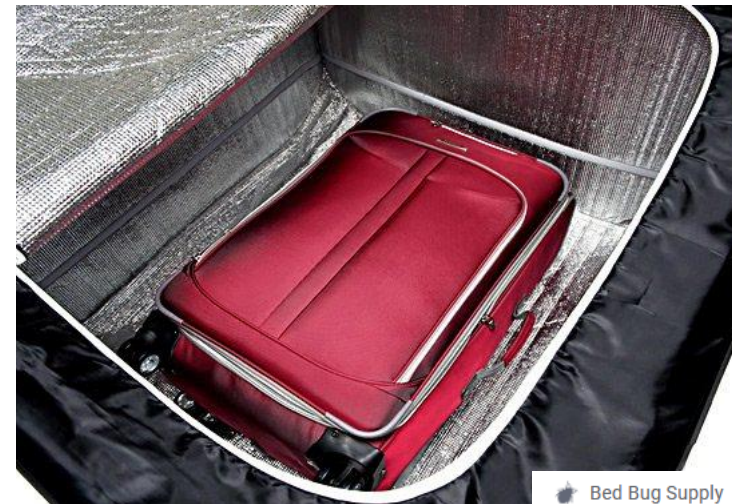
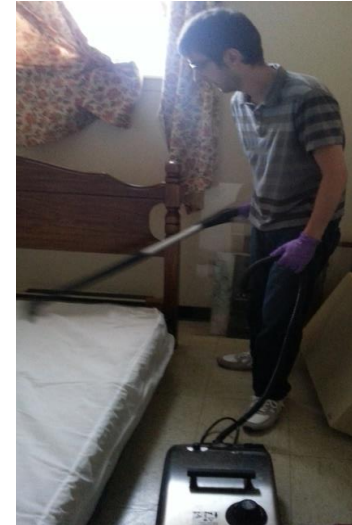


ATRIX



Heat for Bed Bug Management

- Heat methods
 - Topical use of steam (~212 °F)
 - Heated containers (>122 °F)
 - Whole unit heating (>122 °F), 6 to 8 hours
 - Temperature/time combination is critical



Cold for Bed Bugs

- Cryonite® system
- Bag sensitive items and place in freezer for ~2 days



Bed Bug IPM Program

- Initial inspection
- Non-chemical tools
- Insecticide application
 - Follow label directions
 - Directly to insects
 - Cracks and crevices
 - Bed frame
 - Baseboards
 - Mattress folds
 - Between mattress and boxspring



Photo by Richard Cooper from the Bed Bug Handbook

Bed Bug IPM - Insecticides

Pyrethroids



Neonicotinoids



Pyrrole - Chlorfenapyr



Combo-Products and Aerosols, *Foams*



Synergists

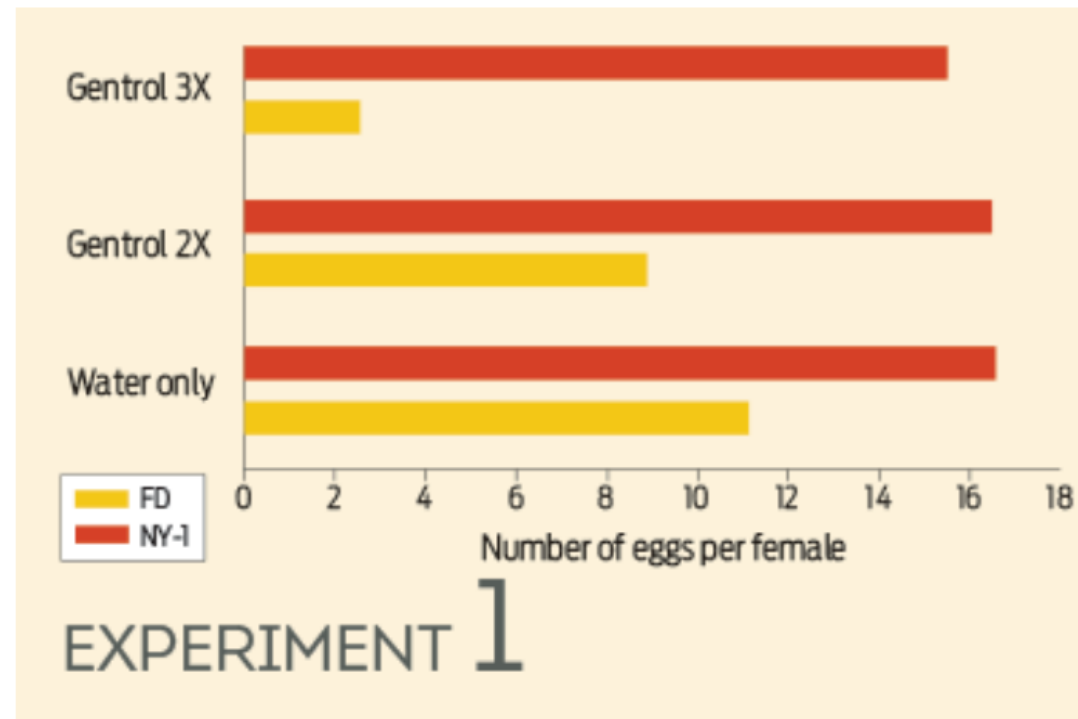


Not a product endorsement



GULF SOUTH VECTOR

Do Not Use Insect Growth Regulators for Bed Bugs

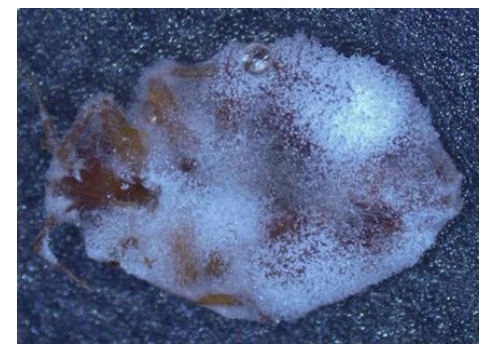


PCT 2012

Bed Bug IPM - Insecticides - Foams



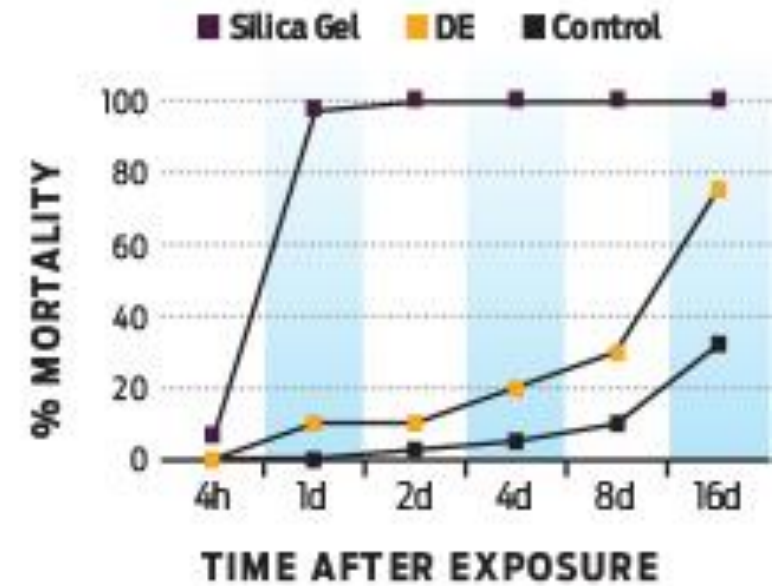
Biopesticide - Aprehend® for Bed Bugs



Silicates Work Great for Bed Bugs!



Doggett et al. 2008



PCT 2014

- Use silica gels or dusts, not diatomaceous earth
- Gaps in floorboards, baseboards
- Thin layers



Bed Bug IPM Program Summary

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- Non-chemical tools
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Photo by Richard Cooper from the Bed Bug Handbook

Thank You! Questions?

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