Bed Bug Basics –Identification, Control and Prevention

Cuyahoga County Bed Bug Task Force, Nov. 1, 2019, 9 am -10 am



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Entomology & Plant Pathology

Bed Bugs

- Biology & Behavior
- Identification
- Management
  - Nonchemical
  - Chemical
  - Prevention

Early recorded history

Greece – 400 B.C.
Italy – 77 A.D.
China – 600 A.D.
Germany – 11th century
France – 13th century
England – 1583
US – arrived with early European settlers (before 1662)

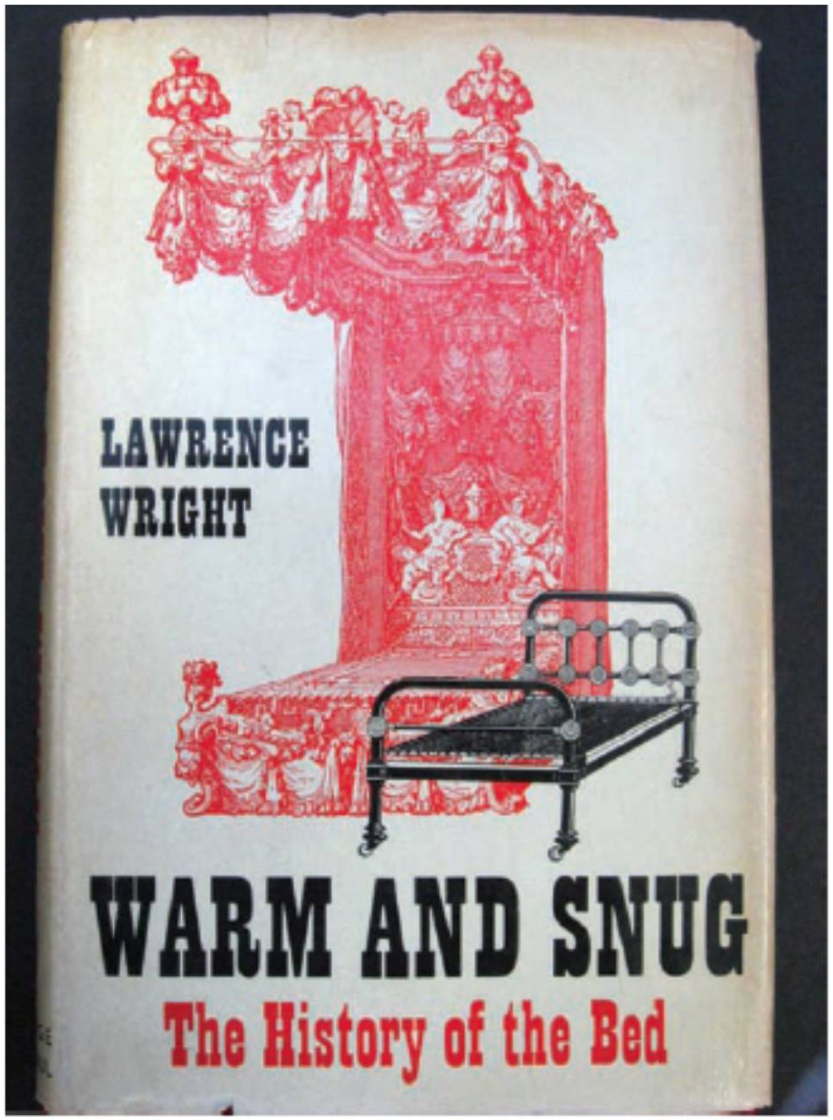

Fig. 14. Bed bugs have played an important role in the evolution of the bed. Today's comfort-oriented beds are once again prime real estate for bed bugs (cover from Wright 1962).

Bed Bug Role in Bed Evolution

- By the mid-18th century, cast iron replacing heavy crack-filled wooden beds
  - less attractive to bed bugs
  - easier to dismantle and inspect
  - alcohol or kerosene over joints and set on fire
- The mid-18th century, cotton mattresses
  - easier to de-infest bedding "could be boiled …without spoiling the fabric" (Wright 1962).
- Mattresses were also redesigned with fewer buttons, folds, and creases

Potter, M. 2011. American Ent. 57: 14-25.

Report

Current Biology

Bedbugs Evolved before Their Bat Hosts and Did Not Co-speciate with Ancient Humans

Highlights

- Bedbugs arose 115 mya, 30+ Ma before their assumed host, bats
- From unknown ancestral hosts, several bat and bird host lineages evolved
- Humans became hosts three times by host extension of specialists, not host switching
- Two urban pests, common and tropical bedbug, split ca. 40 Ma before *Homo* speciation

Authors

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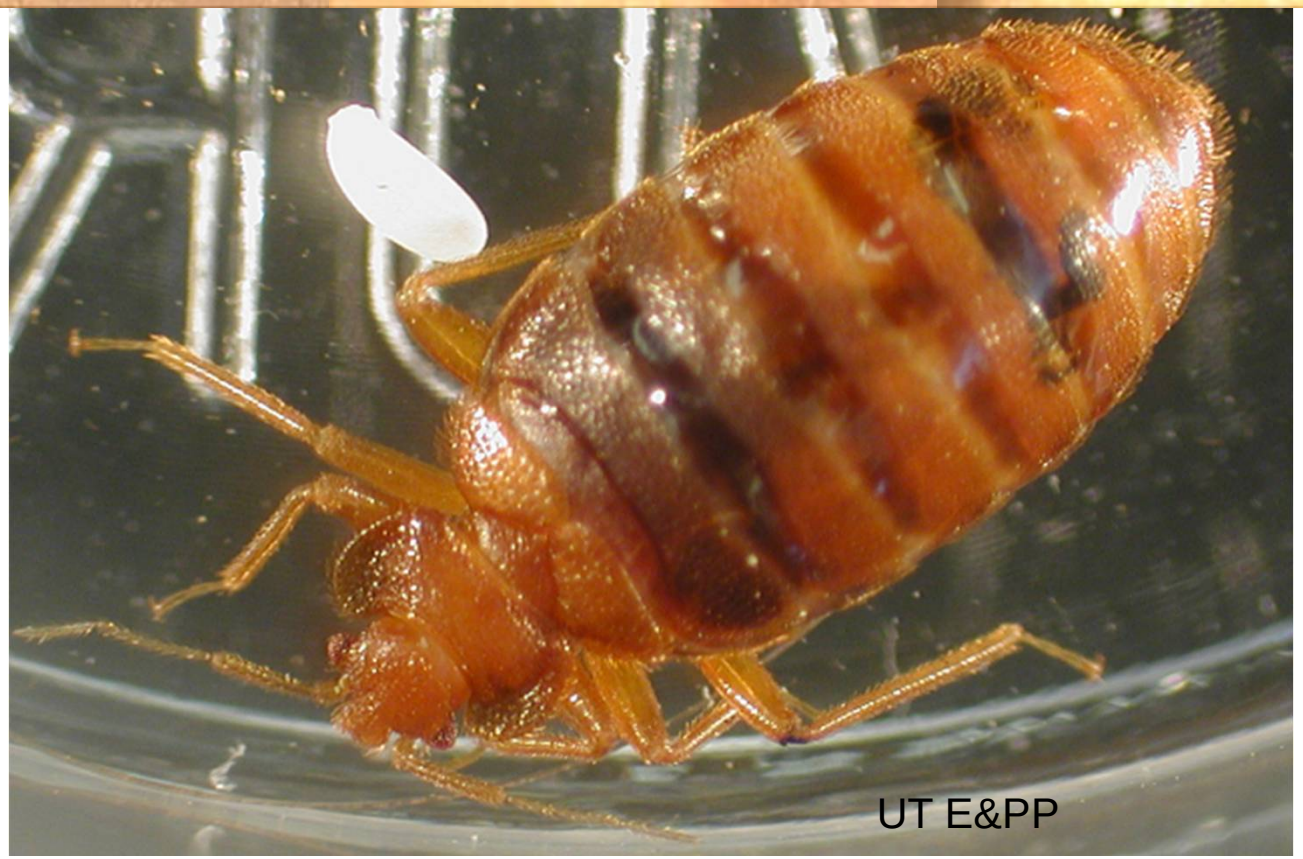
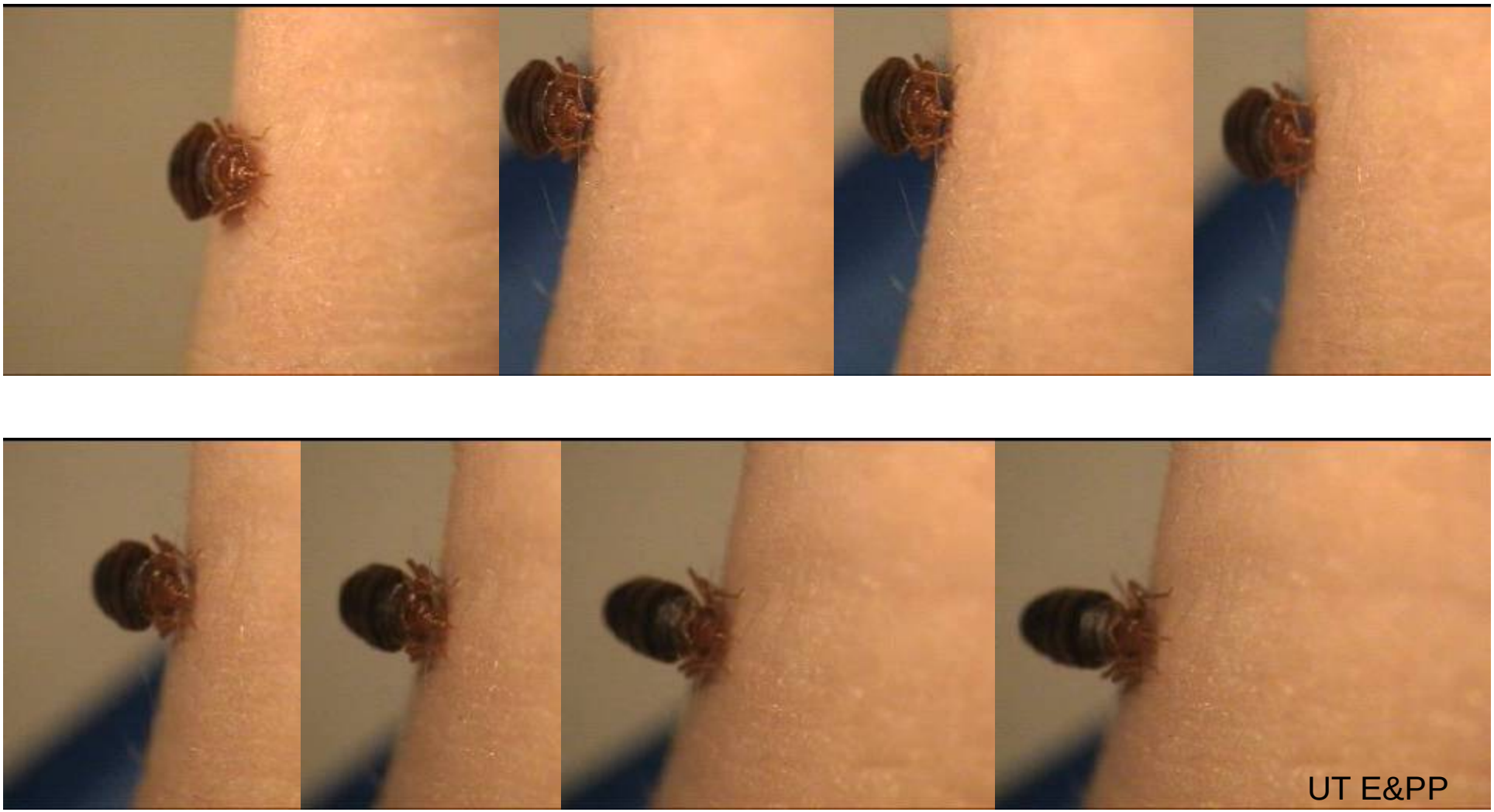
In Brief

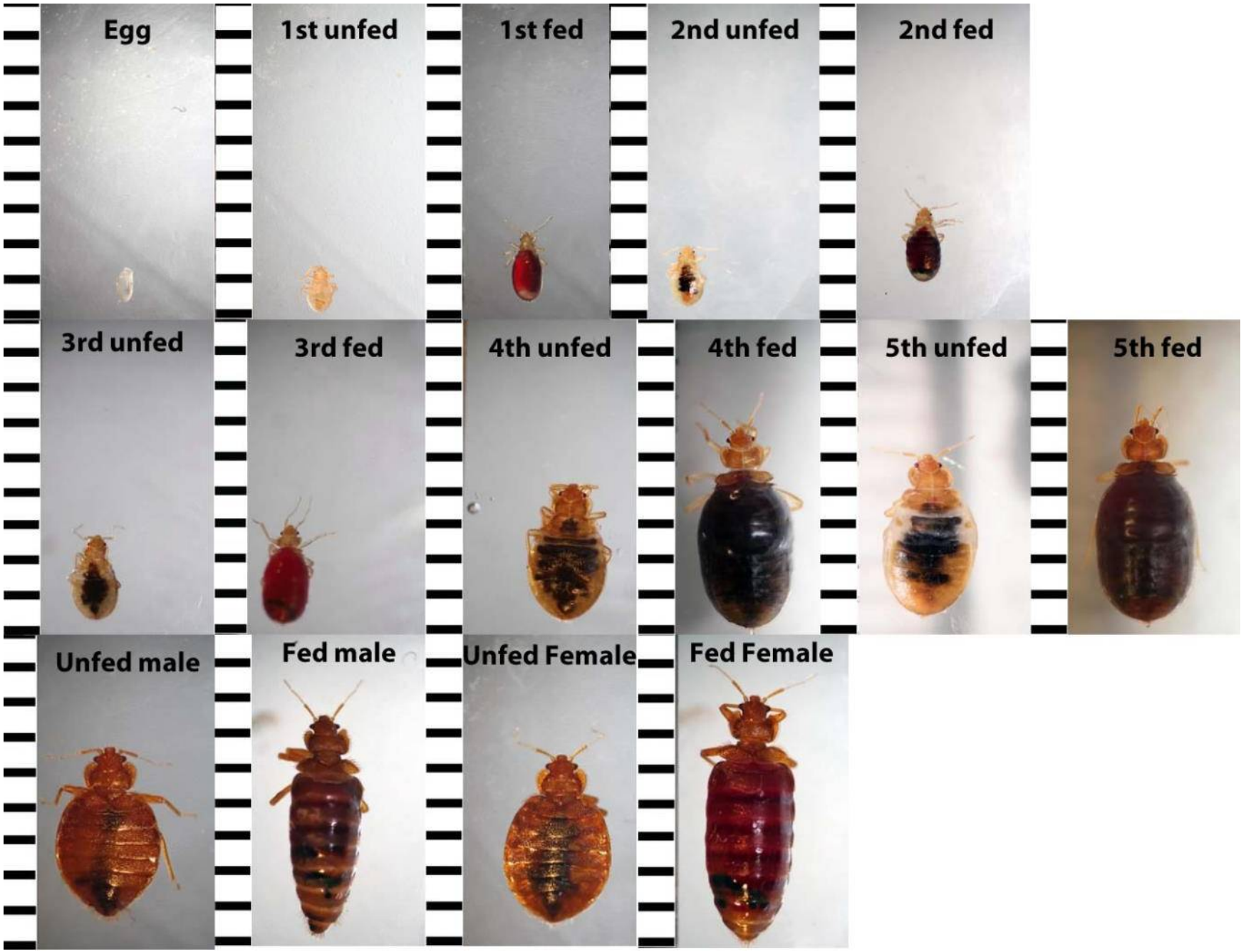
Roth et al., 2019, Current Biology 29, 1847–1853 June 3, https://doi.org/10.1016/j.cub.2019.04.04

Common Bed Bug, *Cimex lectularius*

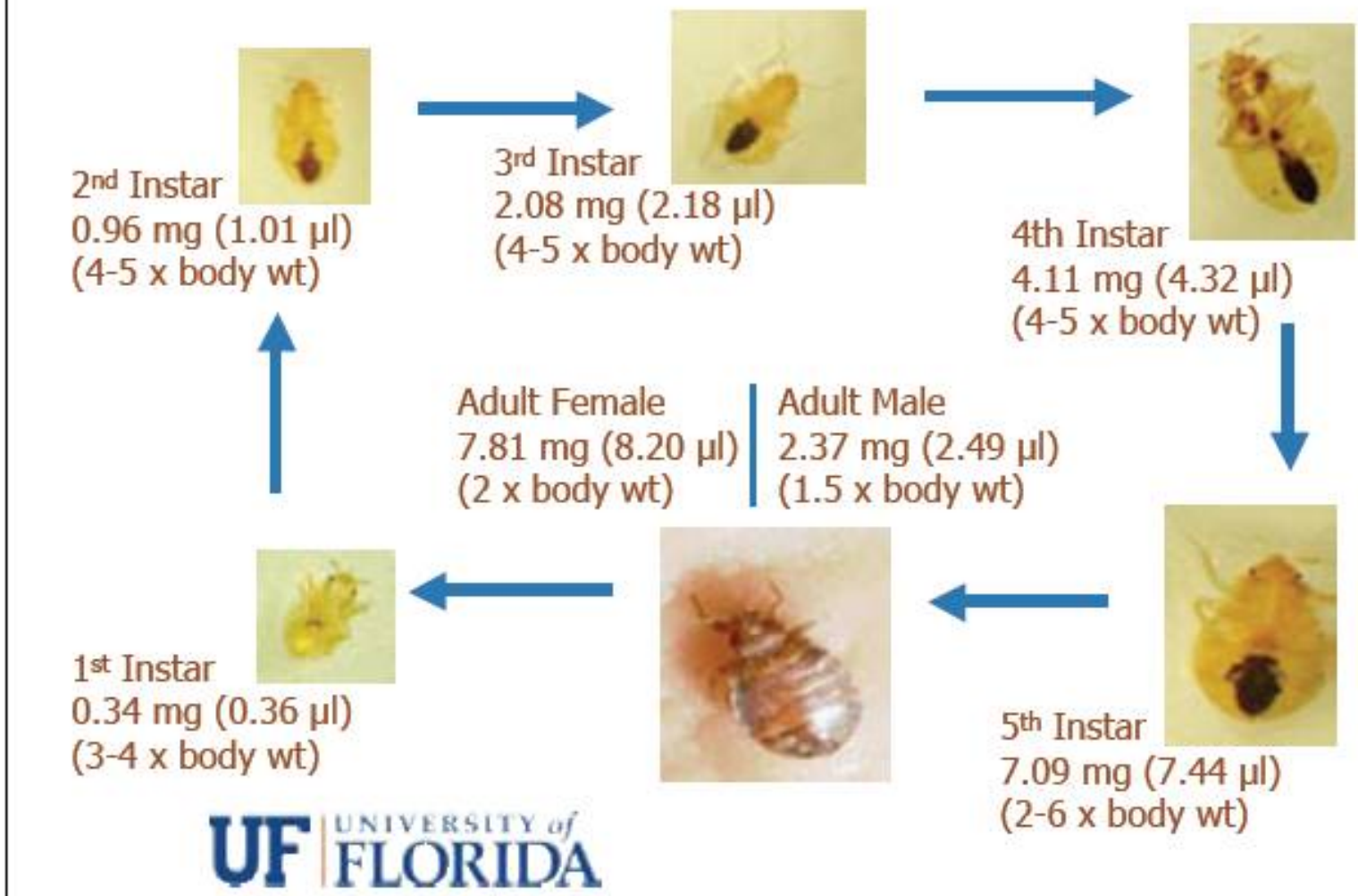




Bed Bug Feeding: 4 minutes 50 sec


Egg
1st unfed
1st fed
2nd unfed
2nd fed
3rd unfed
3rd fed
4th unfed
4th fed
5th unfed
5th fed
Unfed male
Fed male
Unfed Female
Fed Female

How much do they eat?



http://ipm.ifas.ufl.edu/resources/grants_showcase/people_and_communities/bed_bugs_manual.pdf

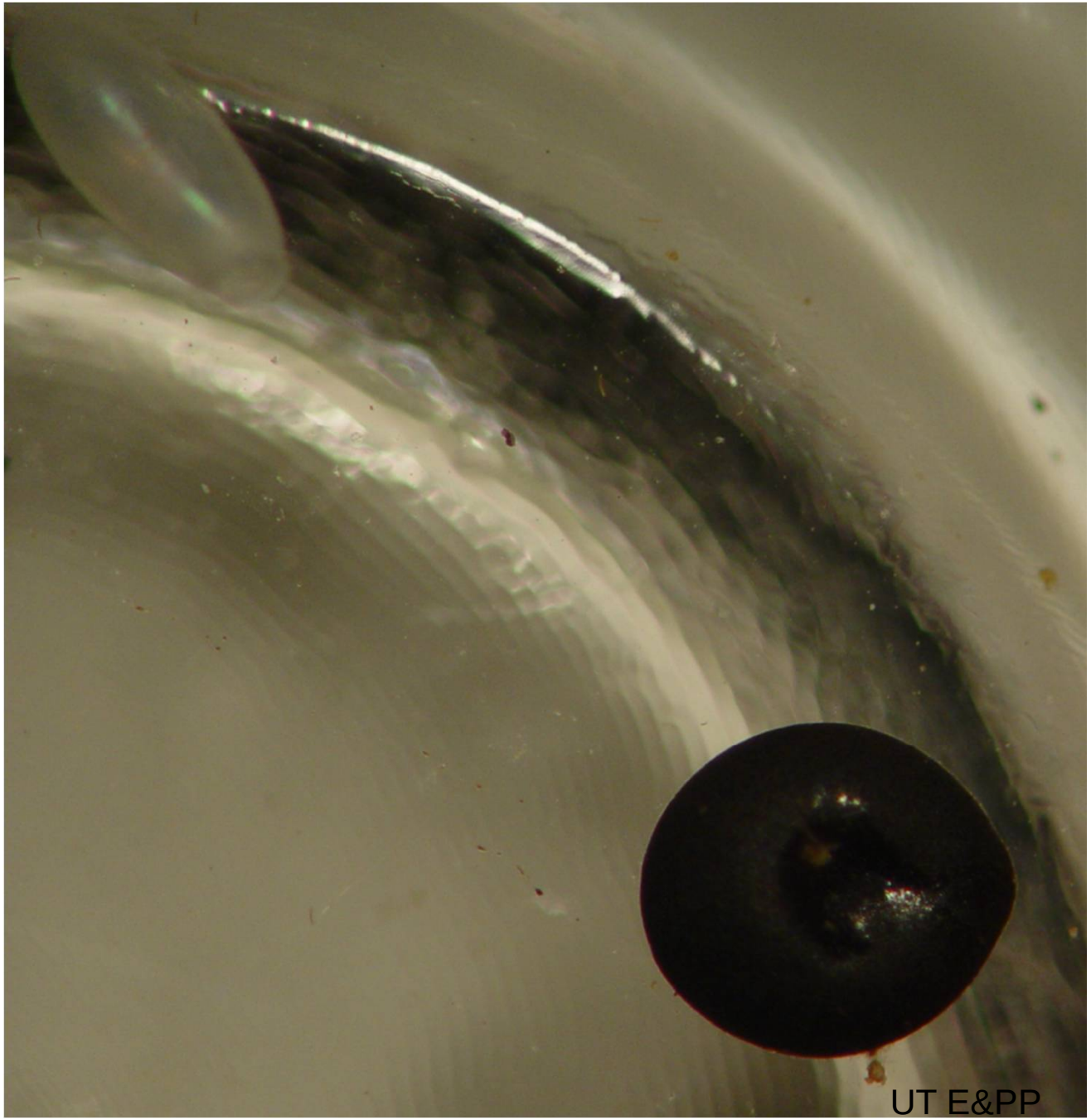
Number of adult females needed to drink a cup and a pint of blood!!!!

28,800
Females

57,600
Females

~10 pts/person = 576,000 bb to exsanguinate

Defecating After Feeding

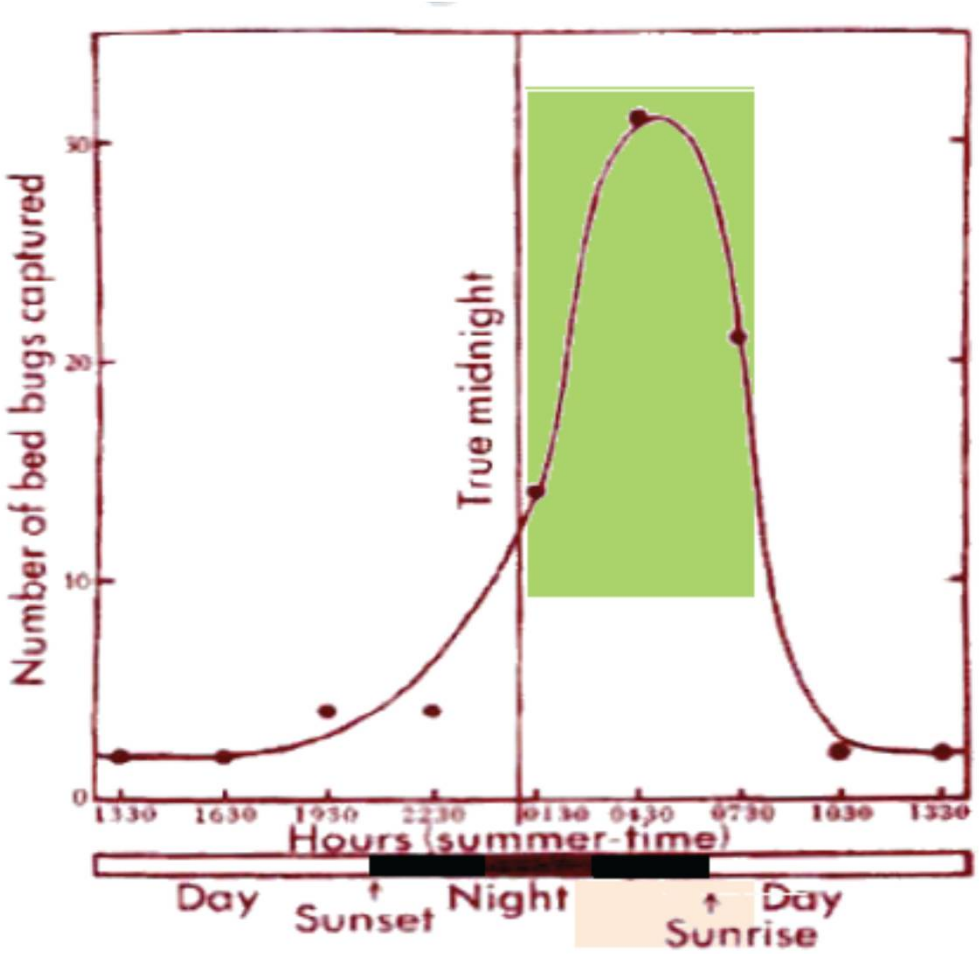

UT E&PP


UT E&PP

Immatures and adults aggregate. Think of as a bloodsucking cockroach.

Activity

When are you more susceptible to bed bugs?



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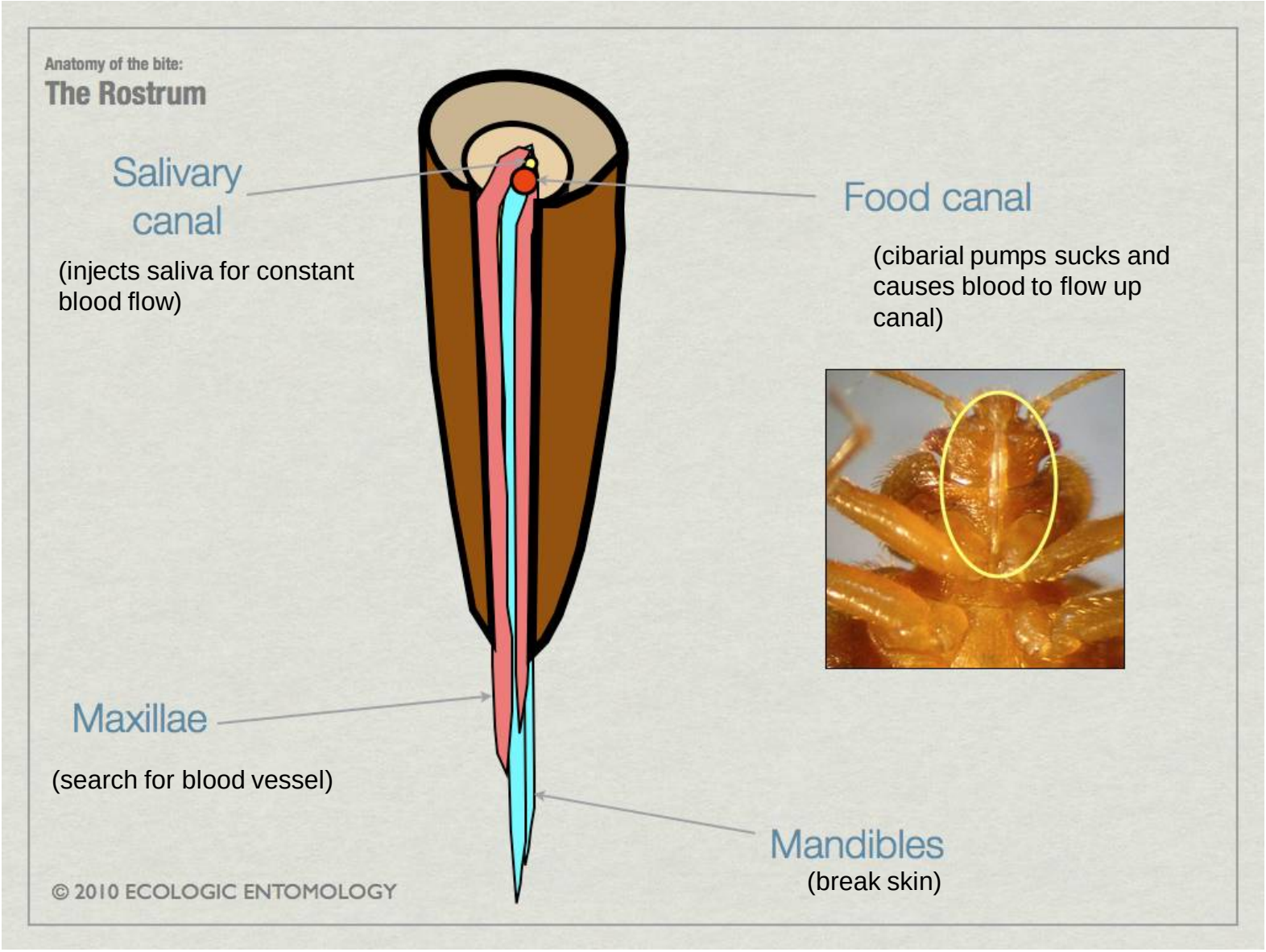
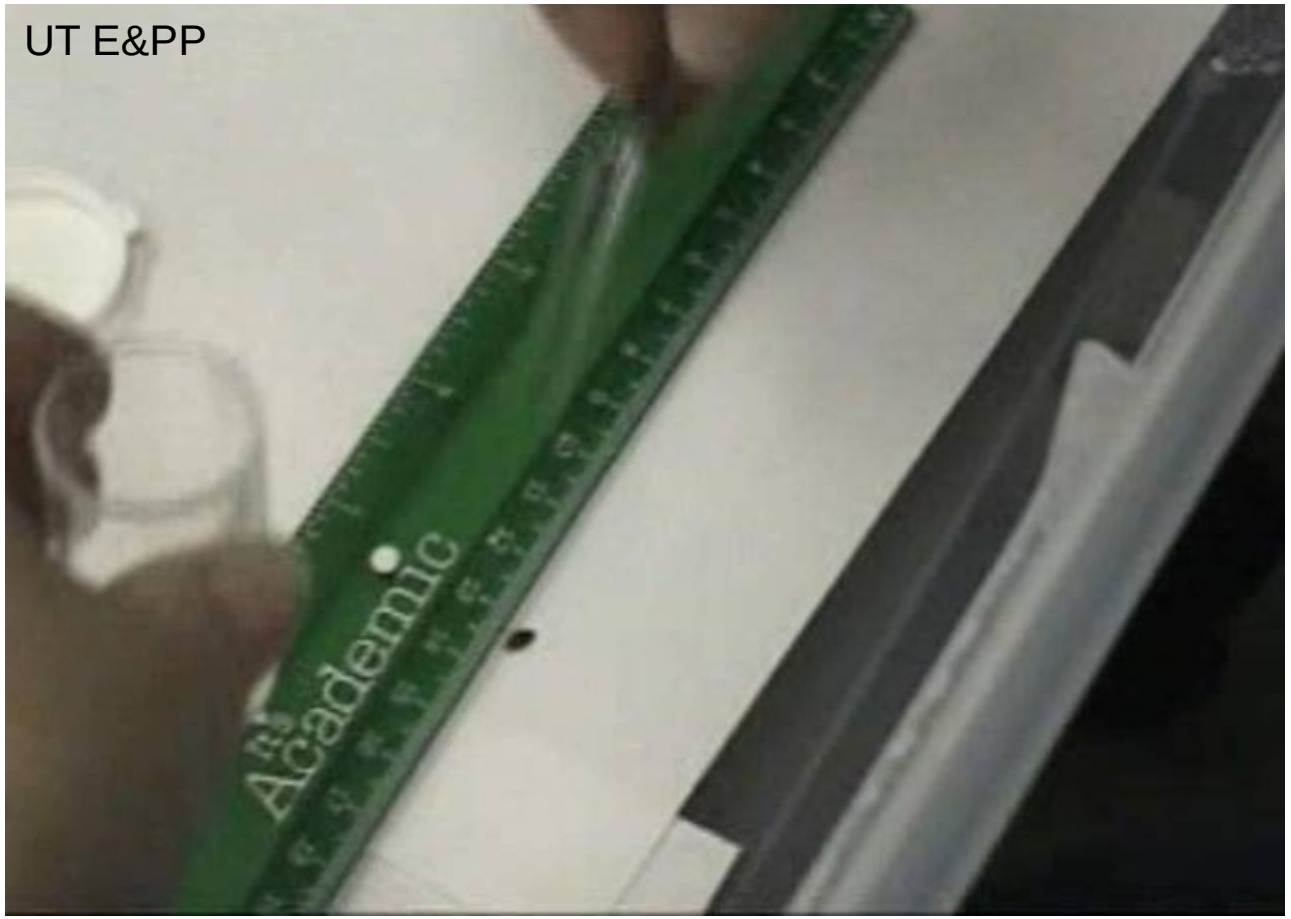
Bed Bug Feeding



Speedy Little Devils

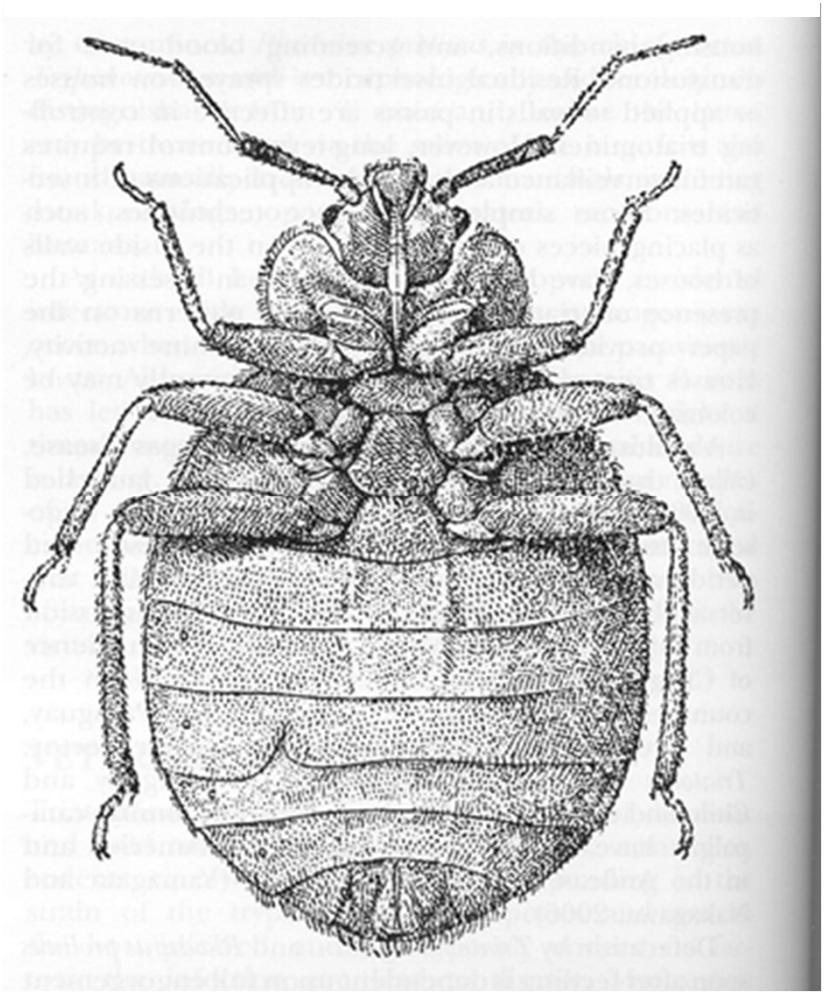


Bed bug speed in video = 16 cm/4.17 sec = 2.3 meters/minute= 7.55 ft/minute

Traumatic Insemination

Male punctures female body wall

Injects sperm into the female's abdomen, outside of the reproductive tract.



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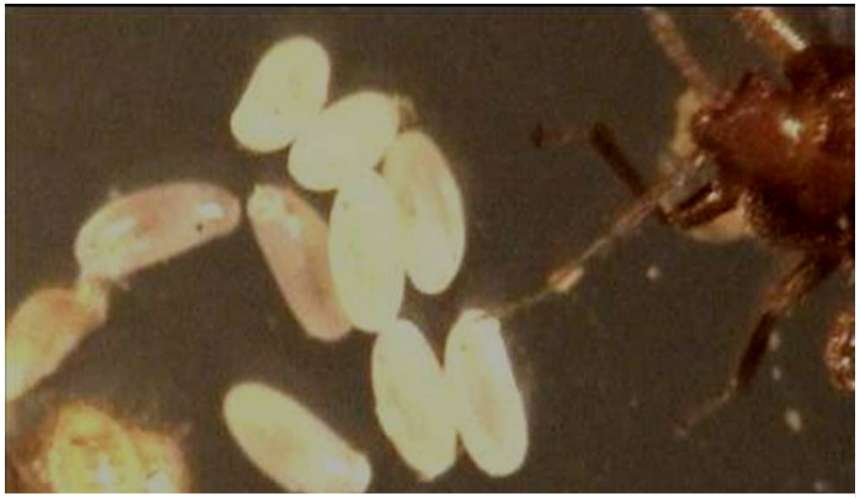
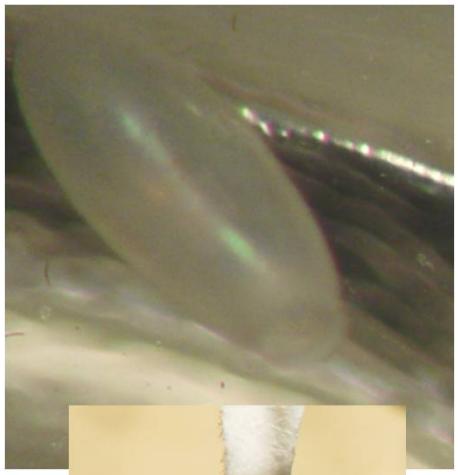
Fecundity

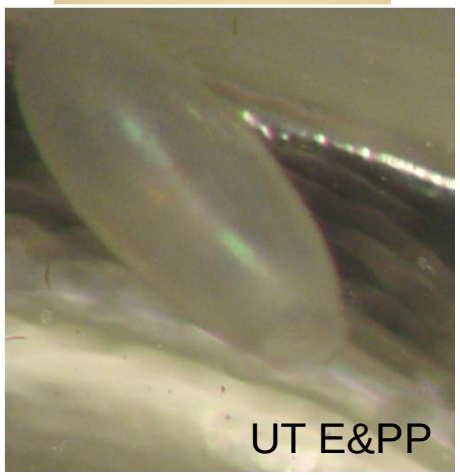


- Interested in mating after bloodmeal, can lay eggs 1 day after mating; can mate with offspring
- 0.5 to 2 eggs a day
- 113 eggs in lifetime (resistance reduces egg #)
- Eggs hatch ~ 9 days (trts at 2 wk intervals)

Development Time & Longevity

- In lab, adult lives between 99 and 300 days at >70F
- Each instar about 5 to 8 days; ~37 days from egg to reproductive adult; need full blood meal to molt
- All life stages live ~ 70 days without feeding (1st=22d, 2nd=48d, 3rd=52d, 4th=54d, 5th=70d, F=64d, M=68d at 70F)





Bed Bug Bite? Response Differs!

"Cutaneous reactions to bedbug bites are characterized by erythematous or urticarial papules. Lesions observed in a linear or cluster formation are typical. **The definitive diagnosis depends on identification of the bedbug."** NEJM Images in Clinical Medicine, Stucki and Ludwig, http://content.nejm.org/cgi/reprint/359/10/1047.pdf, Images from http://www.michigan.gov/documents/emergingdiseases/Bed_Bug_Manual_v1_full_reduce_326605_7.pdf

Bed Bug Bite? Response Differs!

[Bed Bugs] The Sensitivity Spectrum: Human Reactions to Bed Bug Bites (PCT, Potter et al.)
2/11/2010
Seven US City Survey, 474 participants

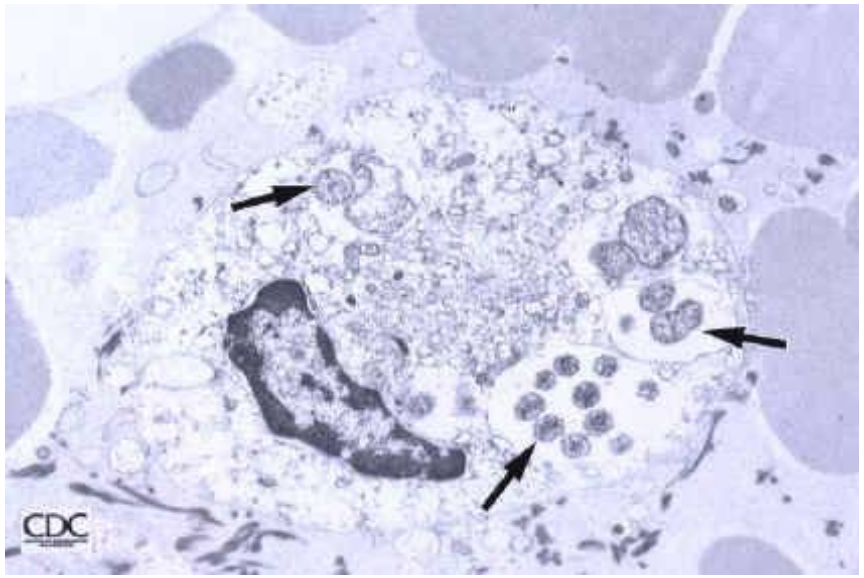
- elderly (>65 yrs), 42% did not react to bbb
- 11-65 yrs, 26% did not react to bbb

Lexington, KY study

- 76% elderly did not react to bbb

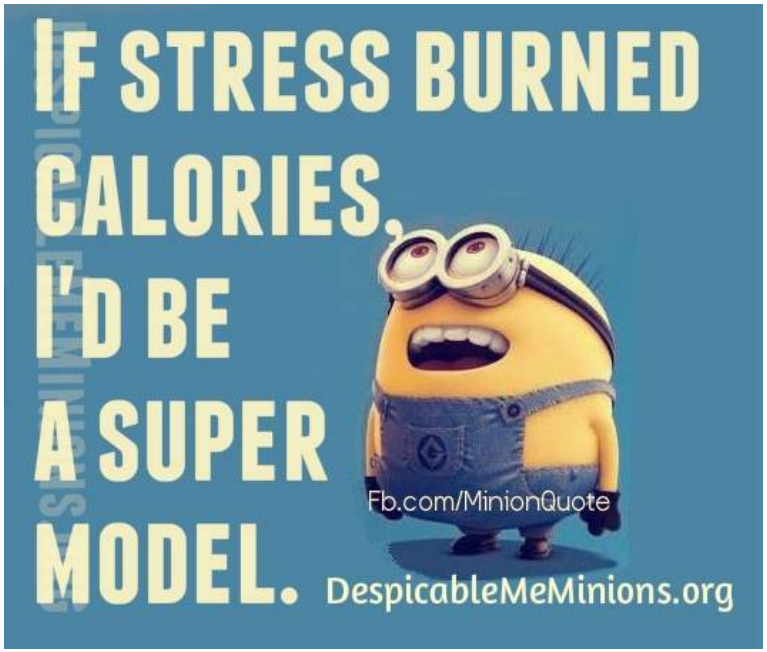
Can Bed Bugs Biologically Transmit Diseases to Humans?

- Over 28 human disease-causing organisms found in bed bugs, but scientists have not been able to document biological transmission to humans.



Other Issues?

- Mental Health – Stress before, during, and after an infestation (Miller 2007)
  - Thought of bug feeding while you sleep is disturbing
- Social ostracism (real and perceived)
- Economic costs (trt, prep, lawsuits)

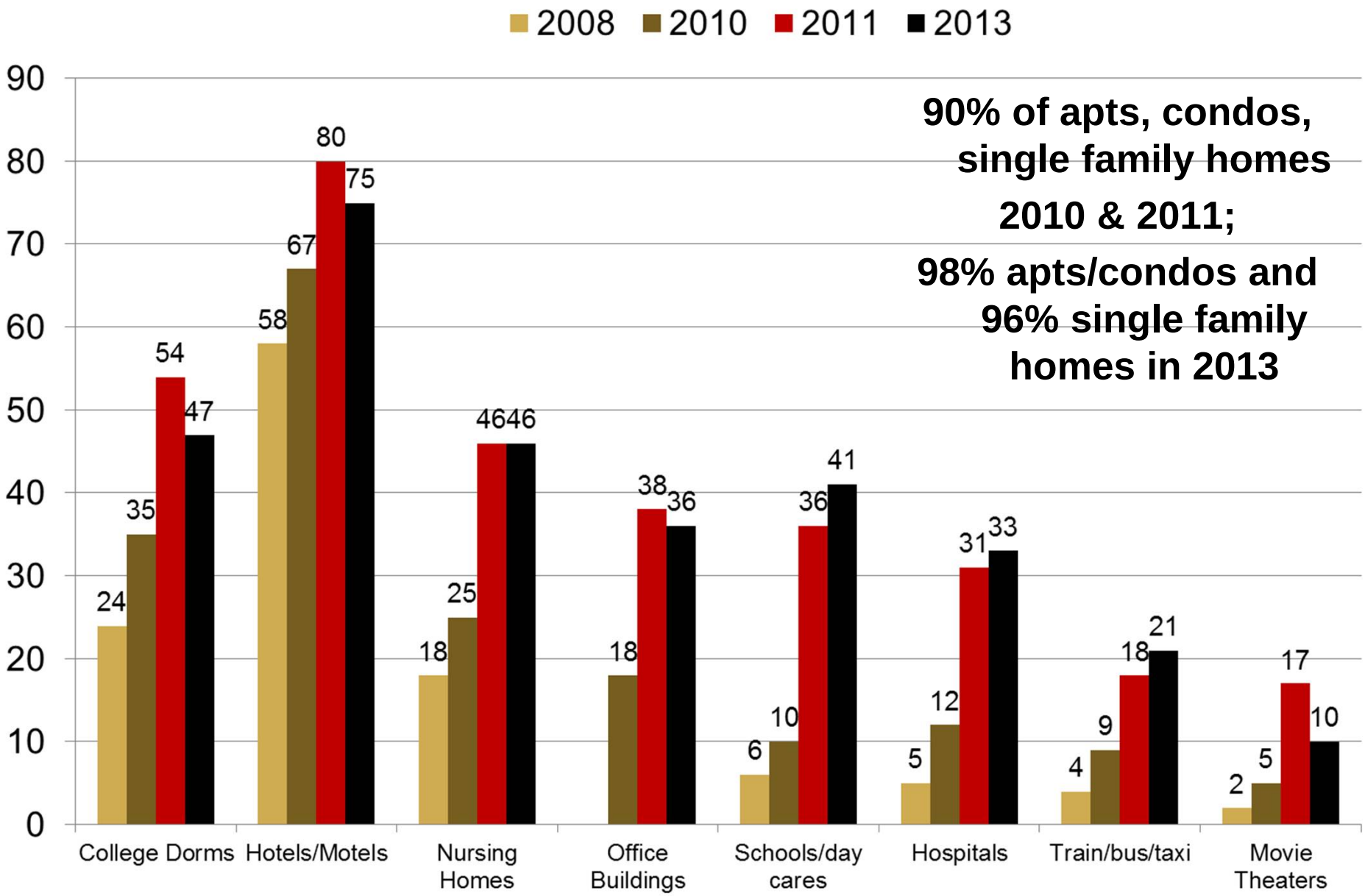


Orkin Releases Top 50 Bed Bug Cities List, Baltimore Remains Front Runner January 14, 2019

https://www.orkin.com/press-room/top-50-bed-bug-cities-list-baltimore-remains-front-runner/

1. Baltimore
2. Washington, D.C.
3. Chicago
4. Los Angeles
5. **Columbus, OH**
6. New York (+2)
7. **Cincinnatti, OH (-1)**
8. Detroit (-1)
9. Atlanta (+4)
10. Philadelphia (+2)
11. **Cleveland-Akron, OH (+3)**
12. San Francisco (-3)
13. Raleigh-Durham, N.C. (+2)
14. Indianapolis (-3)
15. Dallas (-5)
16. Norfolk (+2)
17. Richmond (-1)
18. Greenville (+7)
19. Charlotte, N.C.
20. Grand Rapids, Mich (+3)
21. Buffalo, N.Y. (-1)
22. **Knoxville, Tenn. (-1)**
23. **Nashville, Tenn. (-1)**
24. Champaign (+2)
25. Pittsburgh (-1)
26. Houston (-9)
27. Denver (+1)
28. Milwaukee (+1)
29. Miami
30. St. Louis (+5)
31. Charleston, W.Va.
32. Lansing, Mich (new to list)
33. Syracuse, N.Y.
34. Phoenix (-7)
35. Tampa (+14)
36. Greensboro, N.C. (+10)
37. Omaha, N.E. (+2)
38. Boston (-6)
39. Seattle (-3)
40. Las Vegas (+5)
41. Orlando, FL (new to list)
42. Davenport, Ill. (new to list)
43. Hartford, Conn (-13)
44. Cedar Rapids, Iowa (-4)
45. **Dayton, OH (-11)**
46. Honolulu (-3)
47. Flint, Mich (-9)
48. Wayne, Ind (new to list)
49. San Diego (-8)
50. **Youngstown, OH (new to list)**

% of Accounts PMPs Encountered Bed Bugs



The Business of Bed Bugs, (Potter Jan 2008 PMP); Bugs Without Borders: Defining the Global Bed Bug Resurgence. Potter et al. 2010. NPMA PestWorld Sept/Oct; *The 2011 Bugs Without Borders Survey - Executive Summary* http://www.npmapestworld.org/publicpolicy/documents/2011BBSurveyINDUSTRYFINALExecutiveSummary.pdf. 2013 http://library.constantcontact.com/download/get/file/1102861932245-696/Bed+Bug+Survey.pdf

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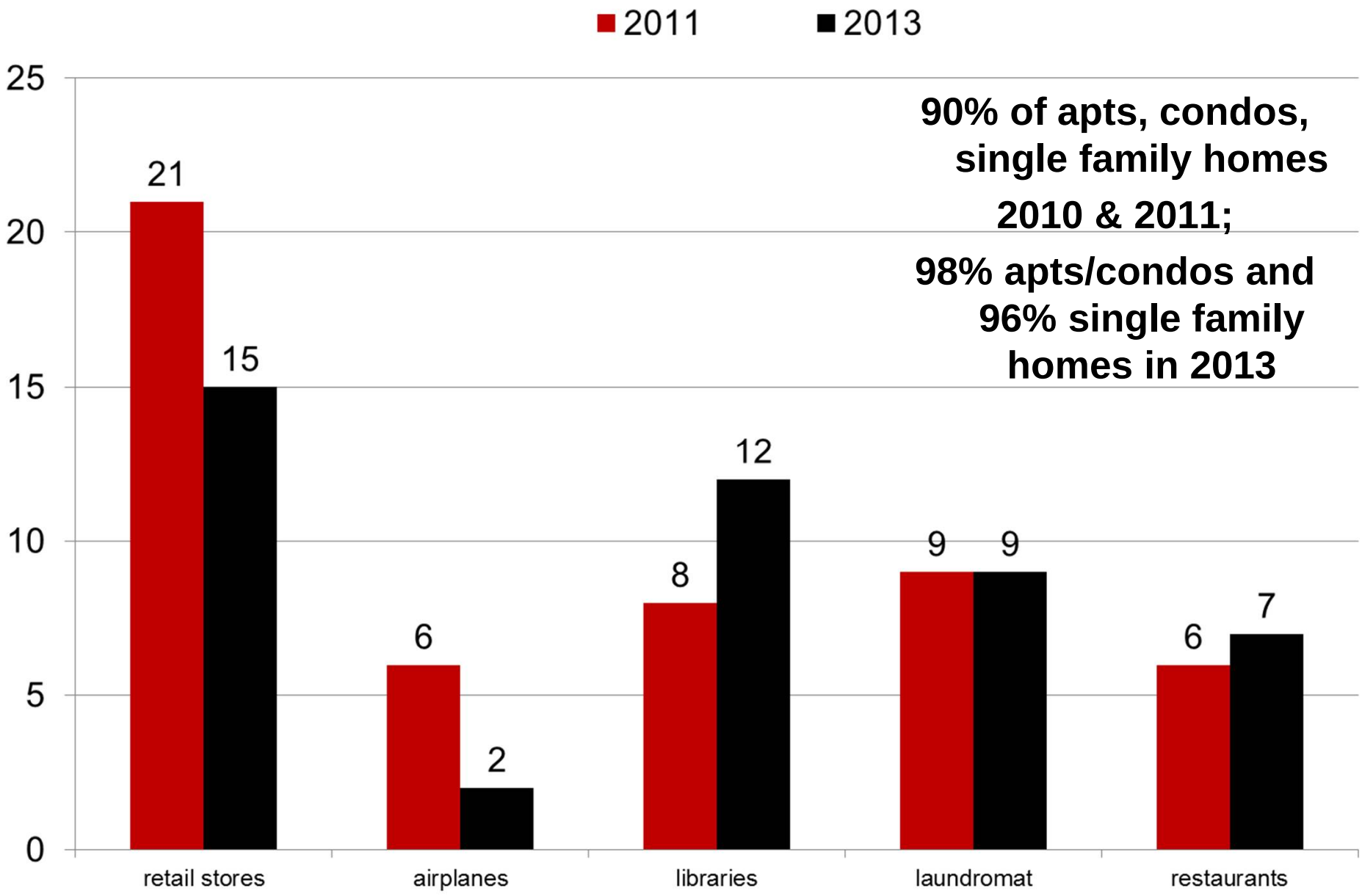

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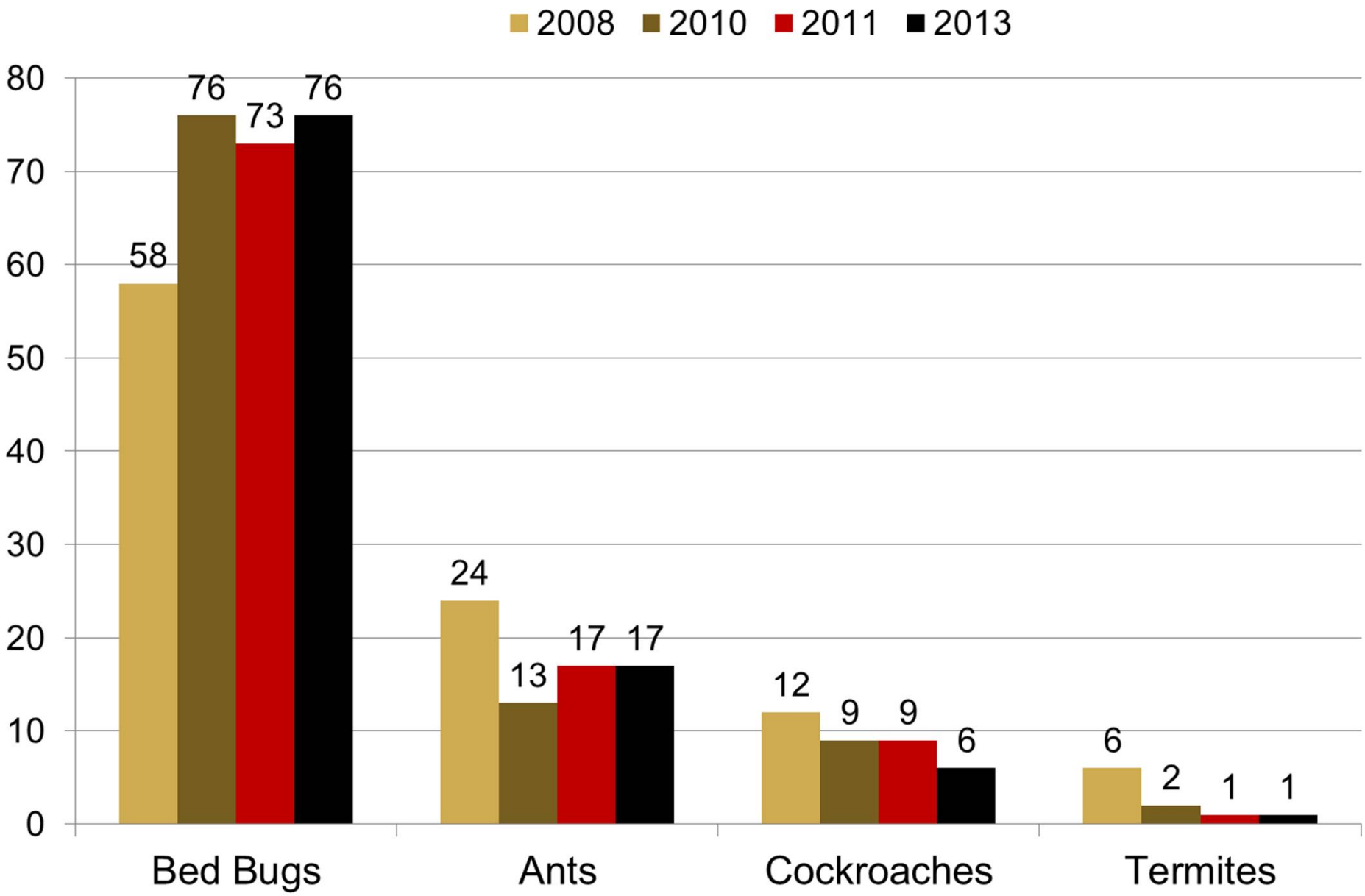
% PMPs Indicate Pest Most Difficult Control



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Global Bed Bug Resurgence Reasons? Potter/NPMA Sept. 2010

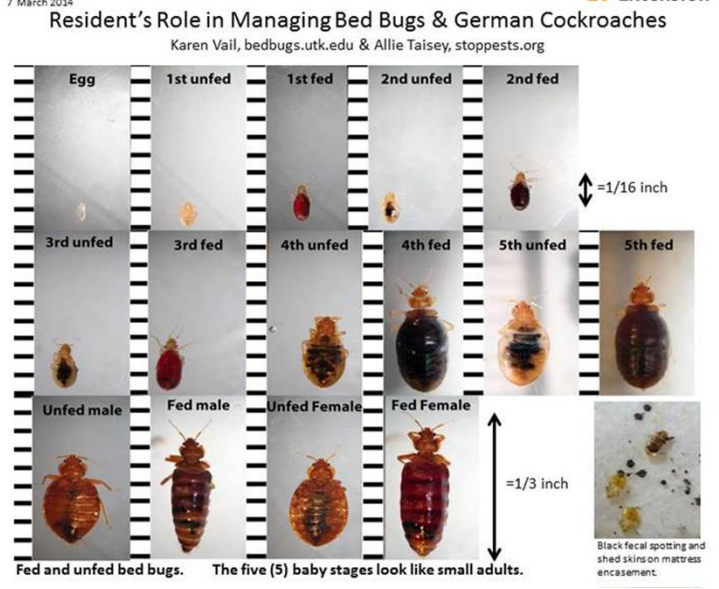
1. Travel (tourists and immigrants returning from bed bug-infested areas)
2. Less spraying of residual insecticides indoors
3. Resistance
4. Lack of societal awareness and precautions
5. More training needed for PMPs
6. Loss of effective insecticides
7. Overcrowding
8. Unregulated sales and smuggling of goods

Global Bed Bug Resurgence Reasons? Potter/NPMA Sept. 2010

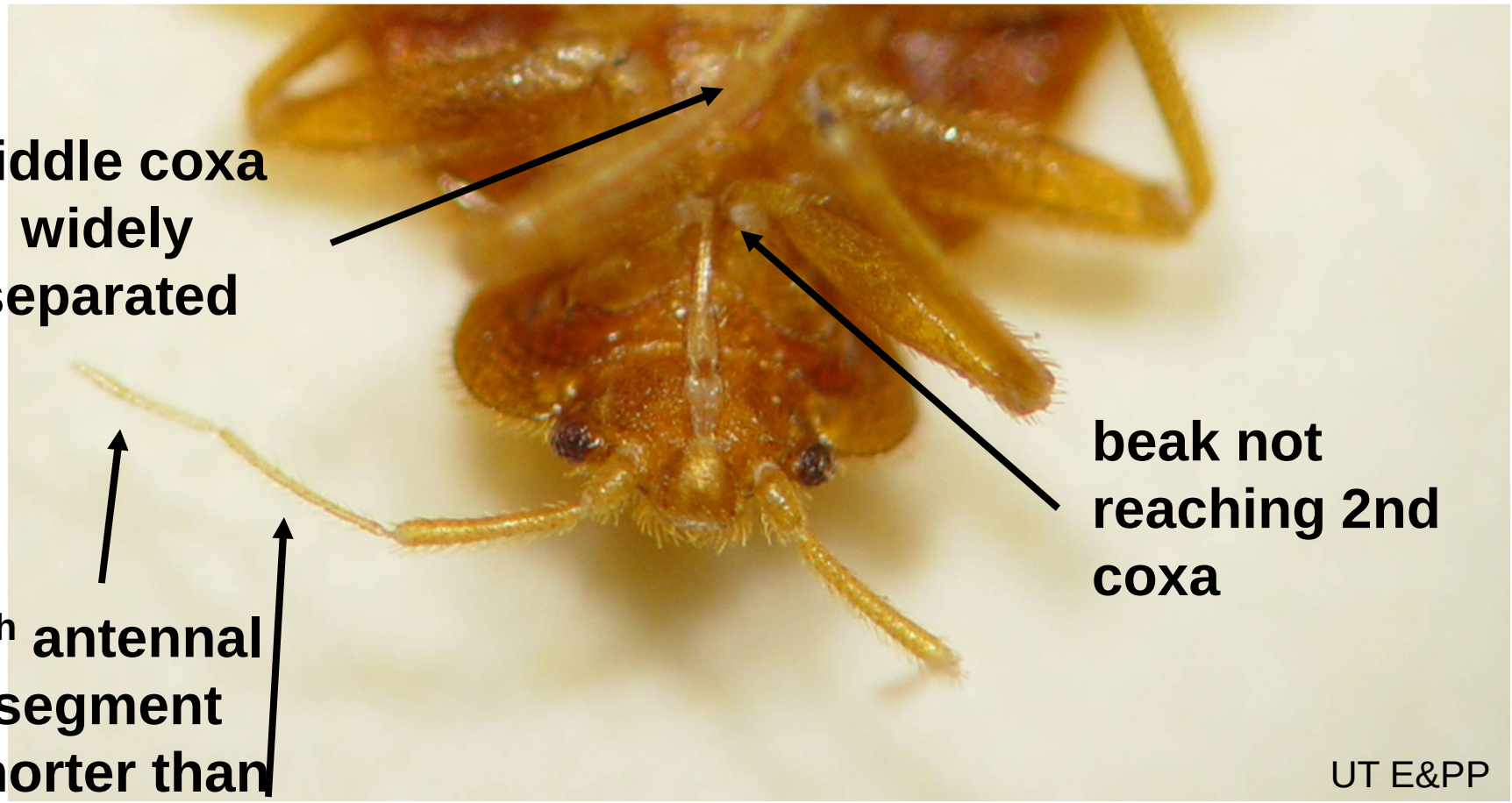
9. More clutter
10. Conducive bldg and decorating practices
11. Transients and occupant turnover
12. Denial/lack of reporting by tenants, workers, landlords, business mgmt., universities
13. Global health officials focused on disease vectors,
14. Worldwide decline in preventive inspections of hotels, apartments
15. etc.

Management

1. Identification
2. Education & Cooperation
3. Thorough Inspection (infested & adjacent)
4. Nonchemical and Chemical Control
5. Follow-up Eval & Add. Measures



Identification



Bat Bug vs. Bed Bug

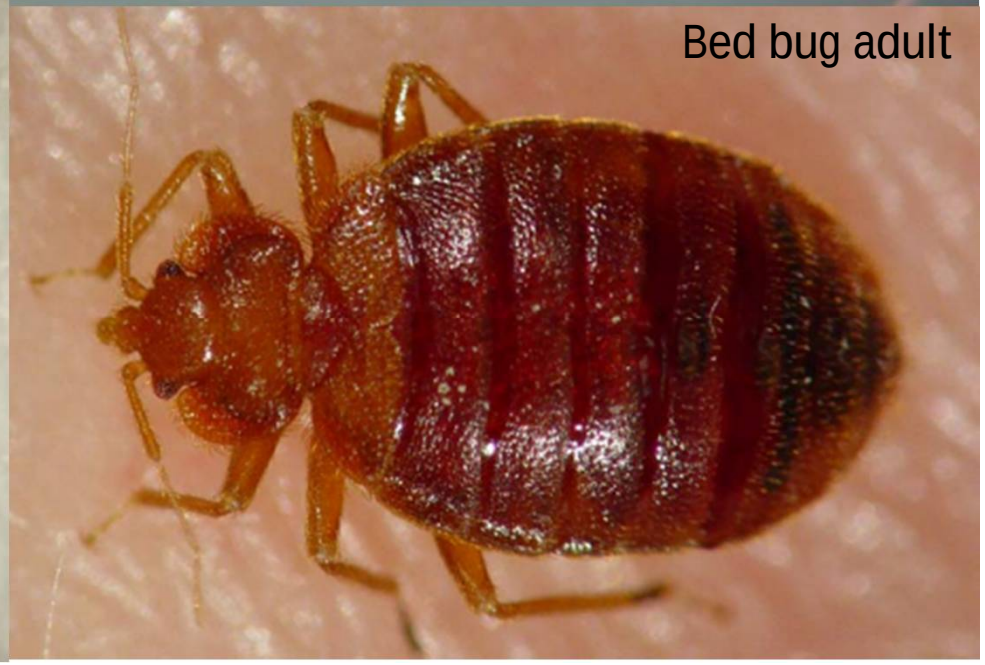
Bat bug – pronotal hair length ≥ eye width

Bed bug – pronotal hair length < eye width


Carpet beetle larva


Cat flea

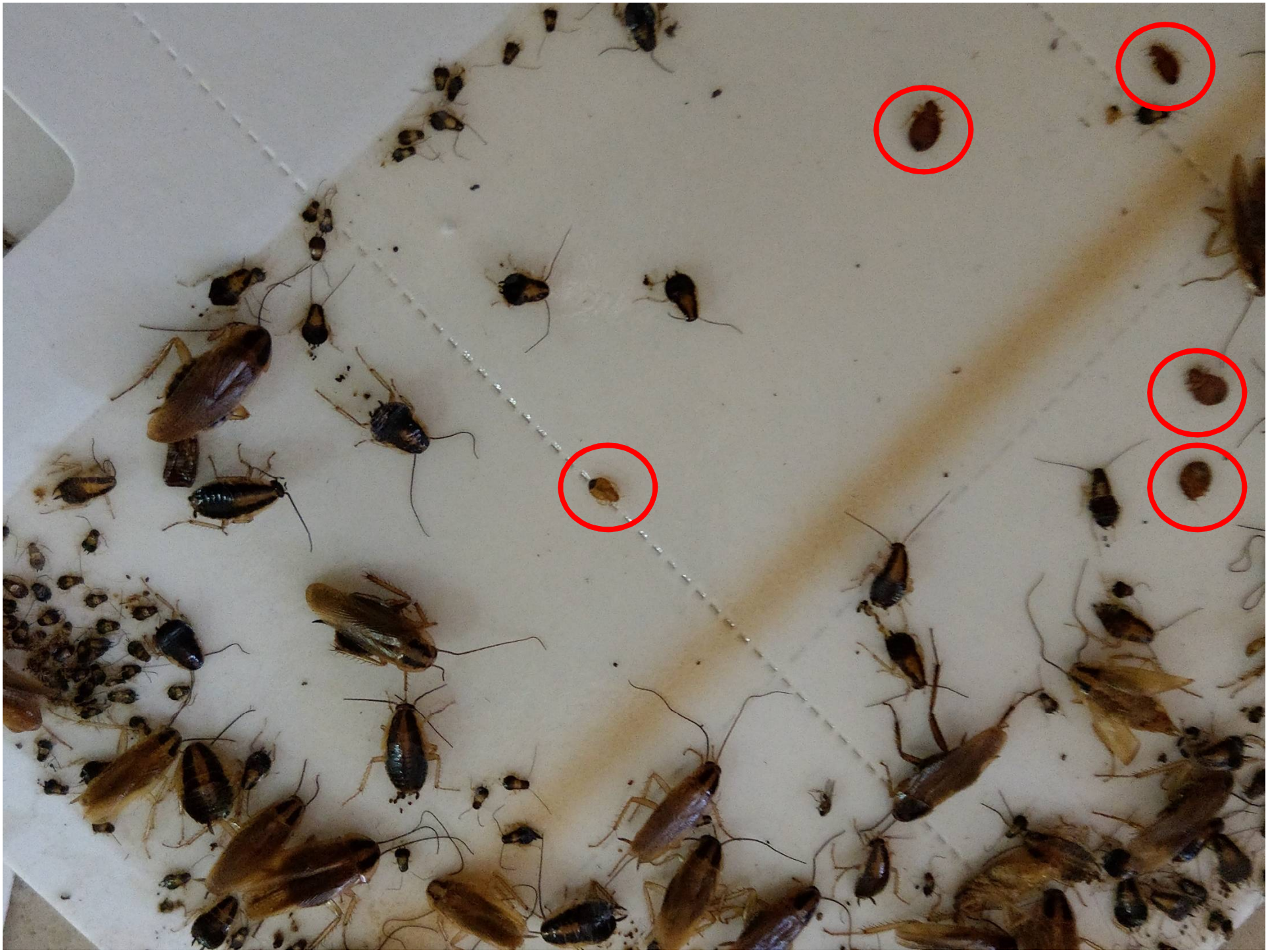

Tick


Bed bug adult

Nymphs

Bed Bug

Cockroach



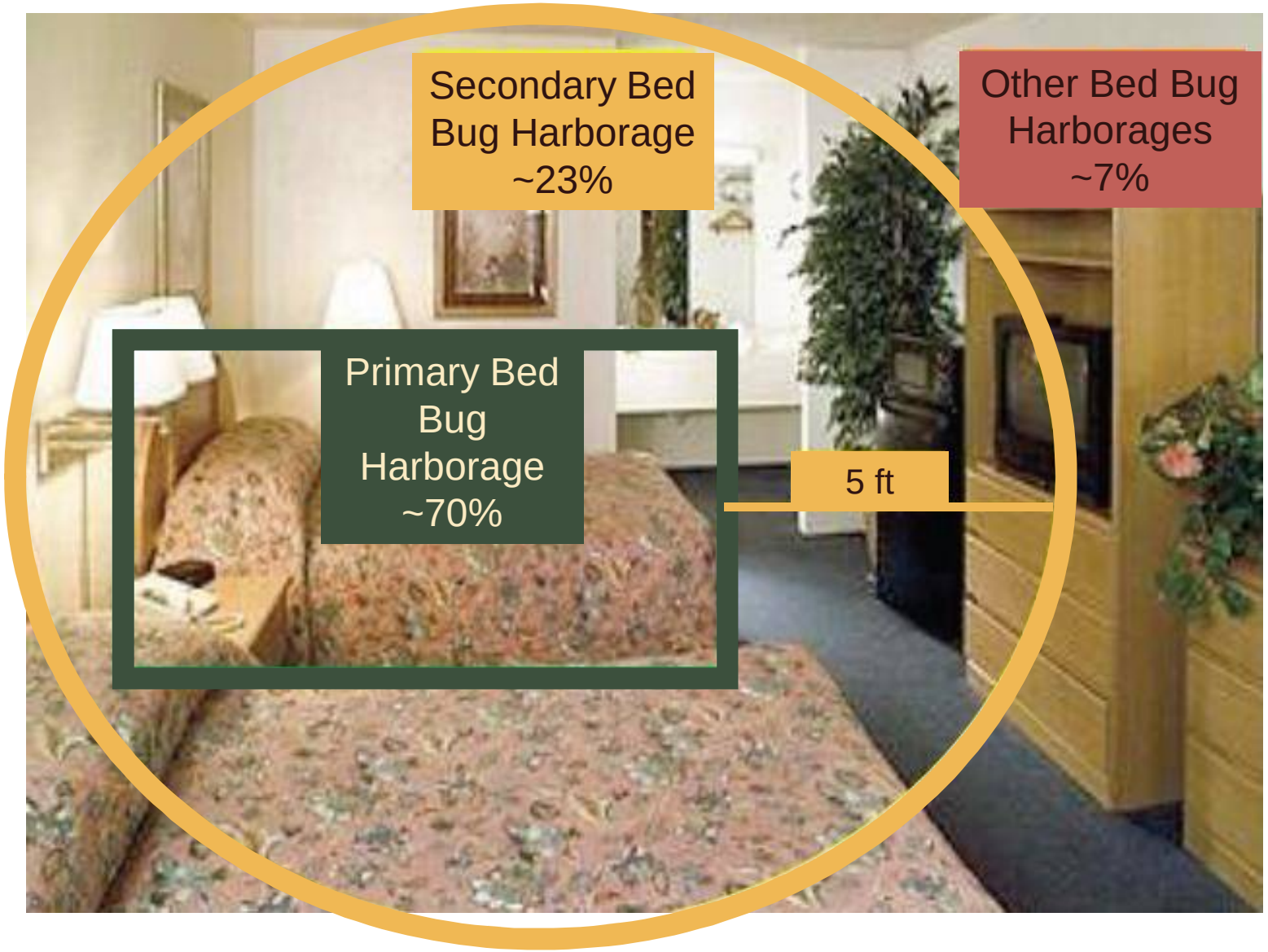
Thorough Inspection

Bed bugs can fit in a crack the thickness of a credit card.

Roll bedding into middle and place in dissolvable bag; launder (>120 F)

Complete Visual Inspection

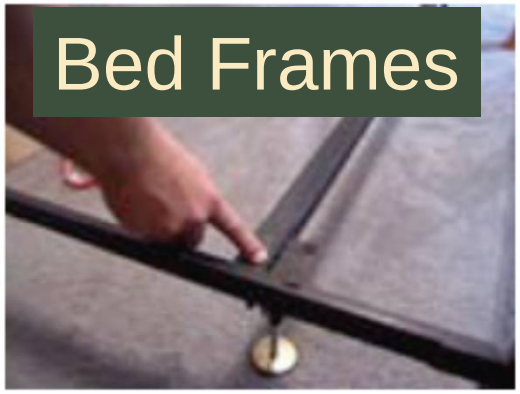
Two people needed for thorough inspection, lifting mattresses and boxsprings.



http://ipm.ifas.ufl.edu/resources/grants_showcase/people_and_communities/bed_bugs_manual.pdf

Possible Primary Harborages

Mattresses



Bed Frames

Box Springs

Linens and Dust Ruffles

Headboards & Wall Mounts

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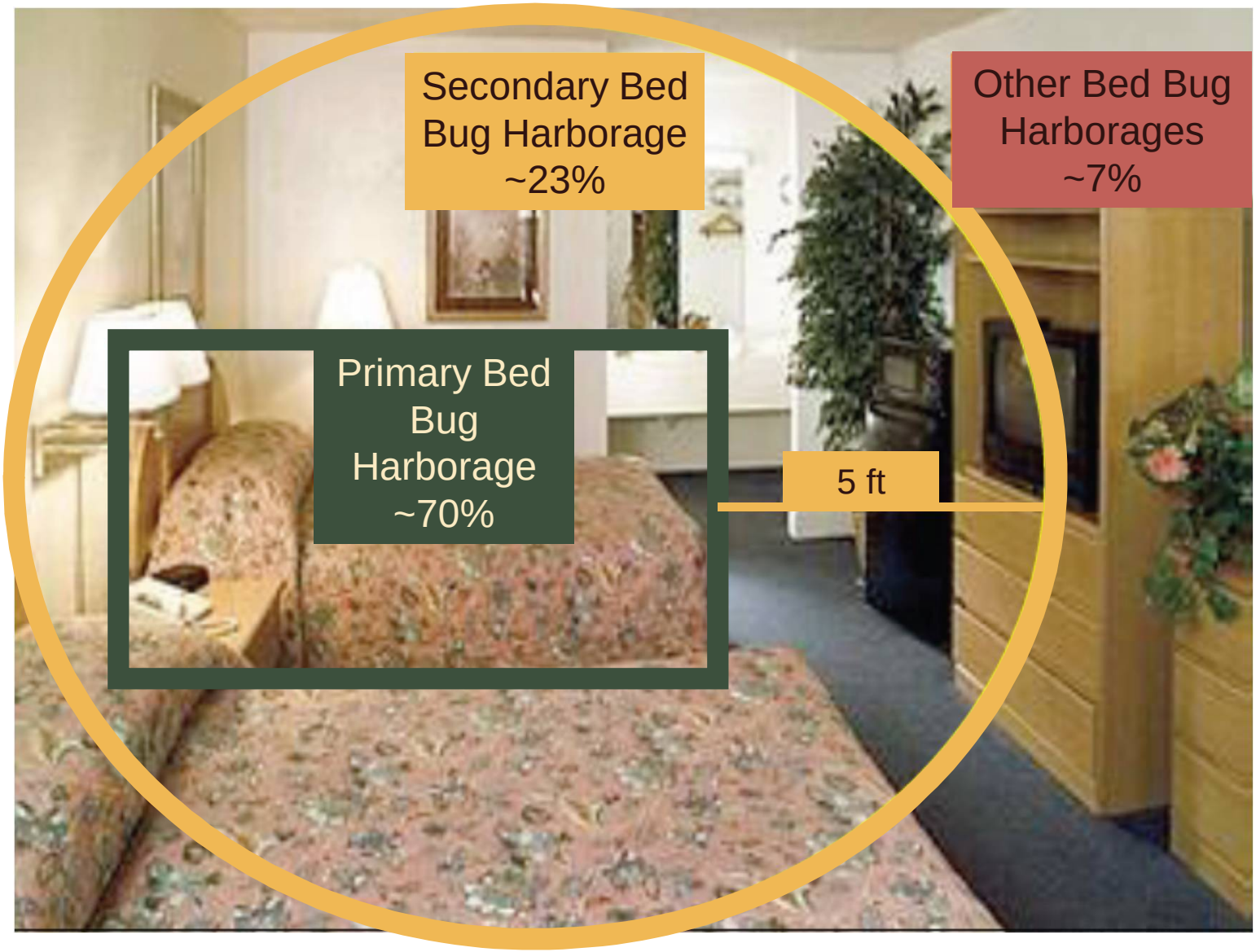

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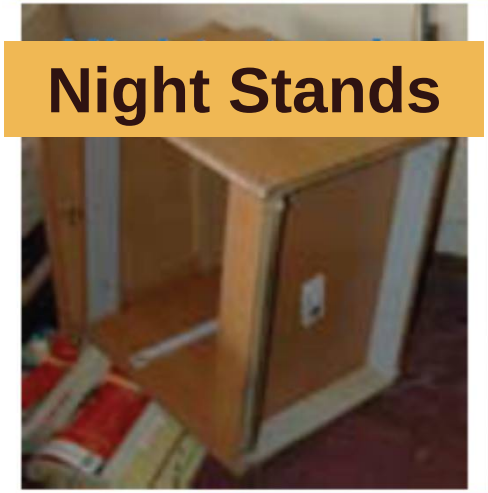
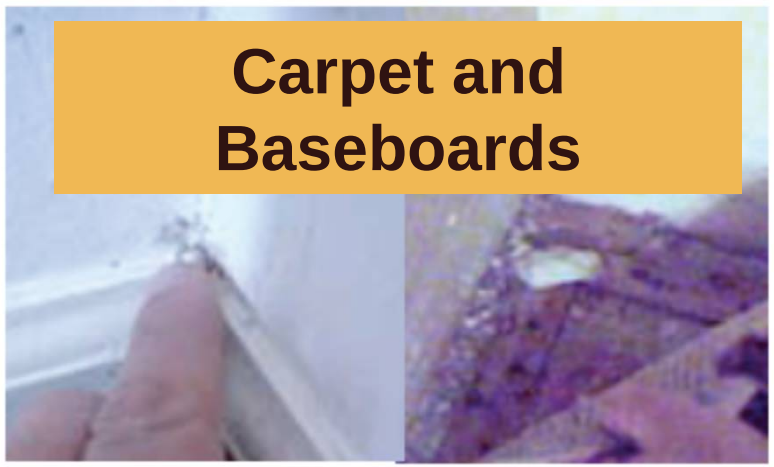
Possible Secondary Harborages





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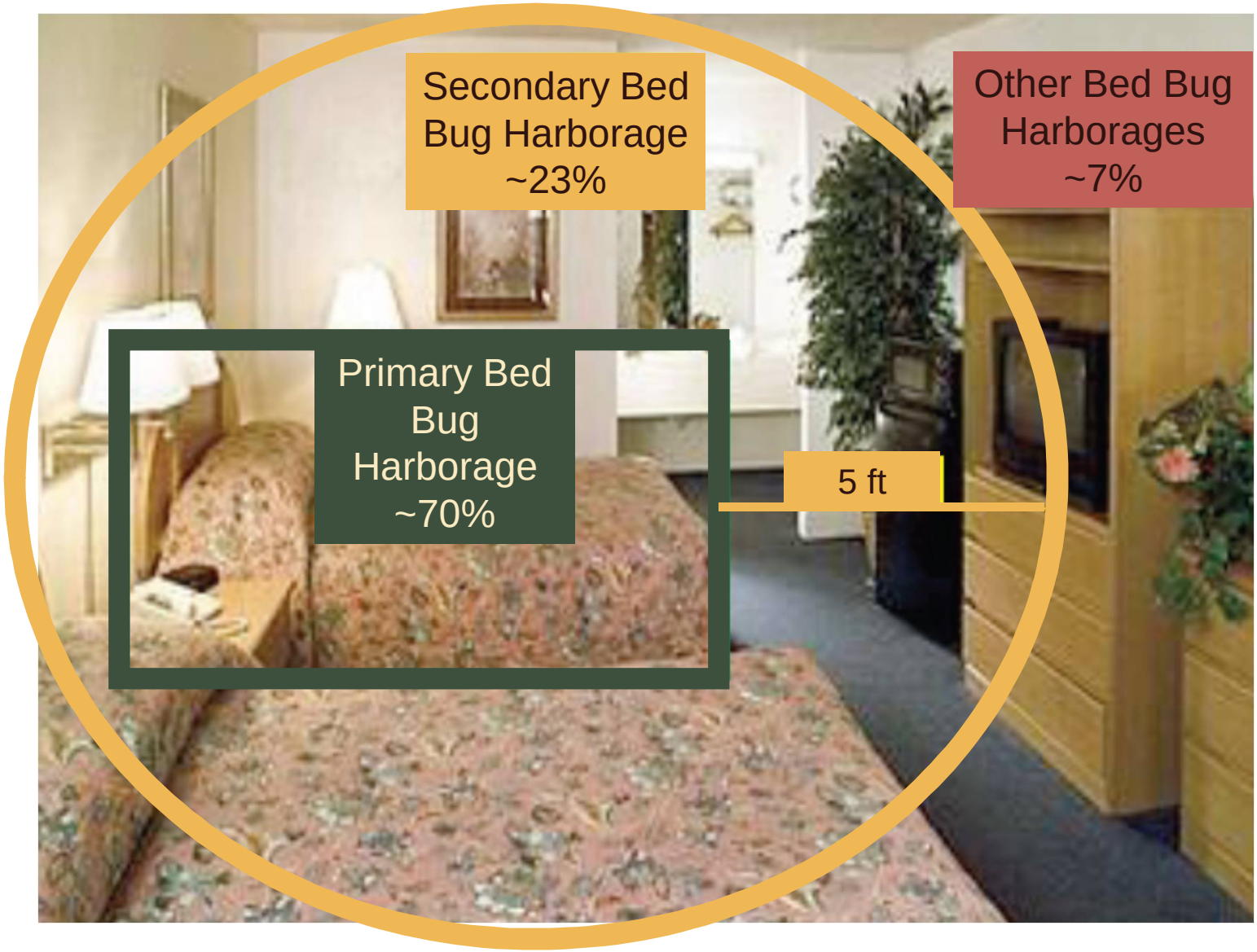

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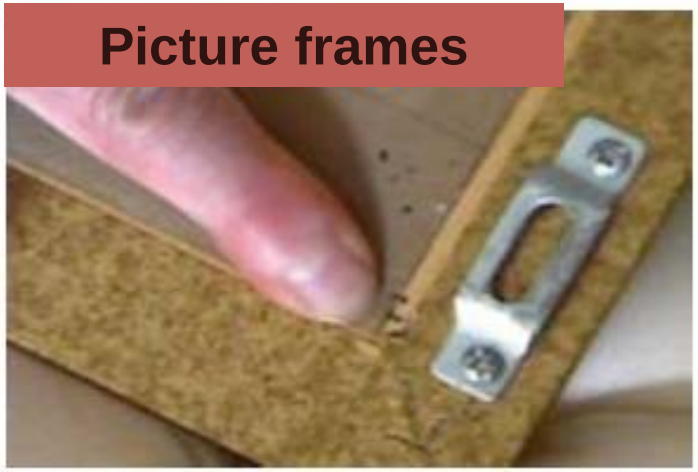
Other Bed Bug Harborages

Smoke detectors

Picture frames

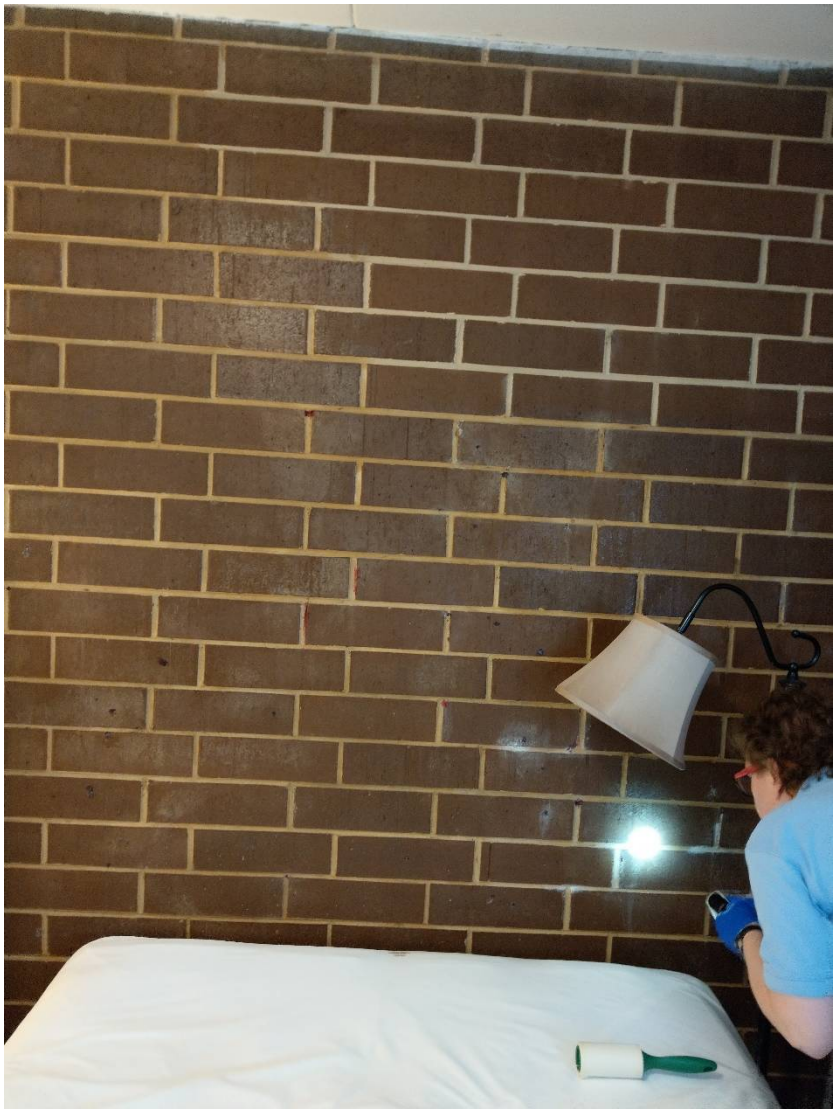


Wall outlets/ switches

Popcorn ceilings

Anywhere!

http://ipm.ifas.ufl.edu/resources/grants_showcase/people_and_communities/bed_bugs_manual.pdf



Early Detection Important

- If less than 10 bed bugs found per apartment, then nonchemical control sufficient
- Furniture in lightly infested can be treated rather than thrown away
- Residents more likely to report an infestation if they are not going to lose their furniture or not need extensive preparation
- Caught early, less likely to spread to neighboring units

Canine Bed Bug Inspection

- Tools
  - Handler
  - Dog
- Advantages
  - Detection by odor rather than vision
  - Can inspect areas not accessible to visual inspection
  - Able to detect hidden infestations (Pinto et al. 2007)

J&K Canine Academy – http://www.jkk9.com/termite.html

http://ipm.ifas.ufl.edu/resources/grants_showcase/people_and_communities/bed_bugs_manual.pdf

Canine Scent Detection Team

Photo credit: Dog Inspectors LLC

Passive Pitfall Monitors

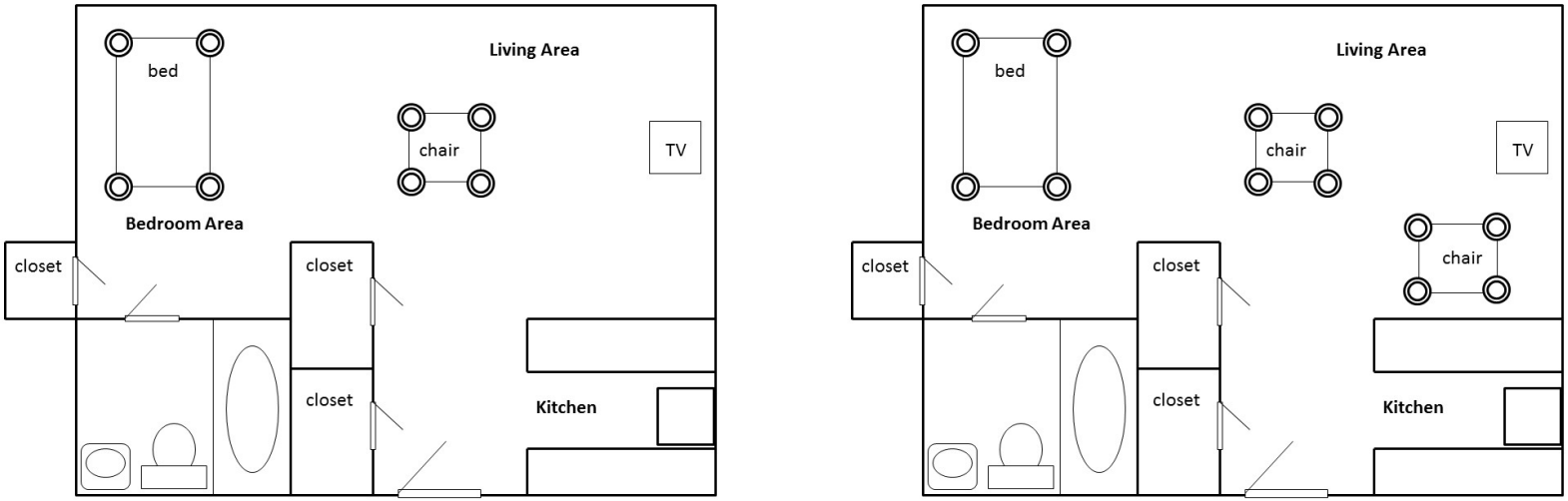
ClimbUp Insect Interceptor BG (black grip)

ClimbUp Insect Interceptor

BlackOut or LightsOut BedBug Detector

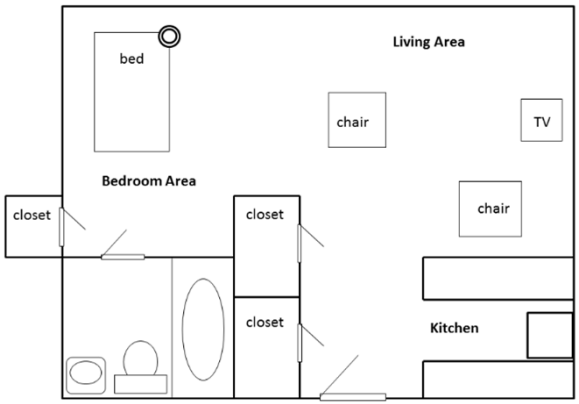
SenSci Volcano

Passive, Pitfall Monitor Traditional Placements

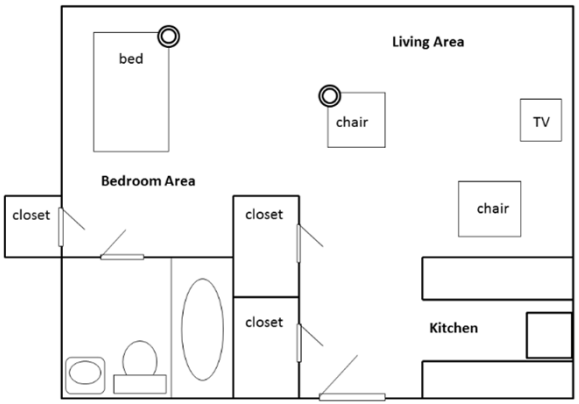


Inspection interval: 2 weeks, 89 to 94% detection

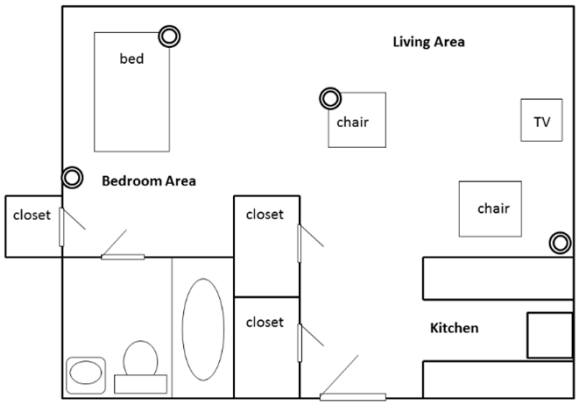
Passive, Pitfall Monitor Placements – Reduced



One



Two



Four

Inspection interval: 3-4 weeks, 80 to 90% detection

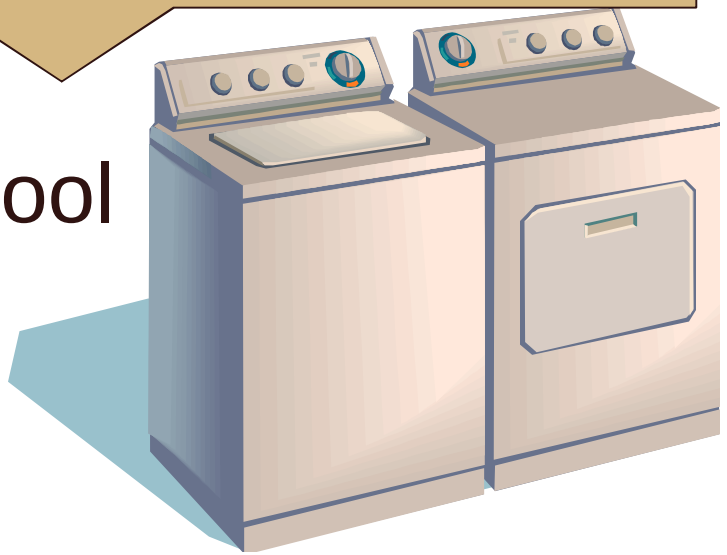
Why Monitor?

- Detect new problems
- Determine extent of problem
- Evaluate effectiveness of control
- Help determine if problem eradicated
- Visual inspections highly inaccurate

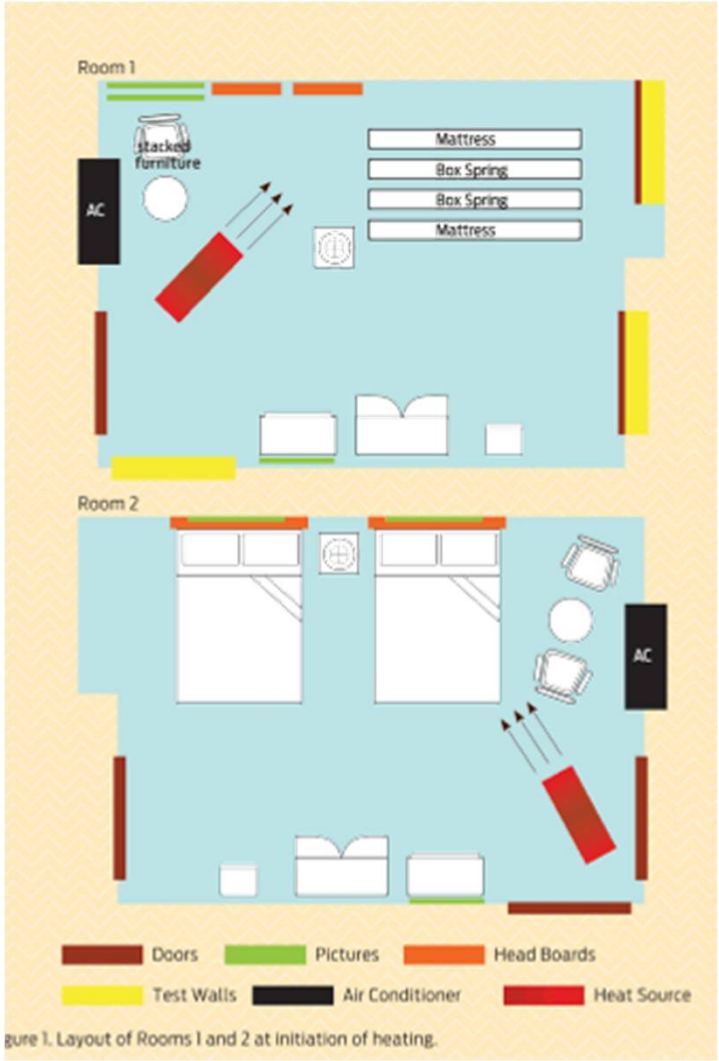
Nonchemical Control - Reactive

- Wash and dry be
  items
- Heat
- Dry steam
- Cold
- Vacuum with crevice tool
- Encasements

10 – 20 minutes on moderate dryer settings should kill all stages of bed bugs. Aiming for all stages to be subjected to 122F or higher.



Room 1 - 7 hrs



gure 1. Layout of Rooms 1 and 2 at initiation of heating.

Room 2 – 4.5 hrs

Whole Room Heating

2 electric forced air heaters
PCT University Research.

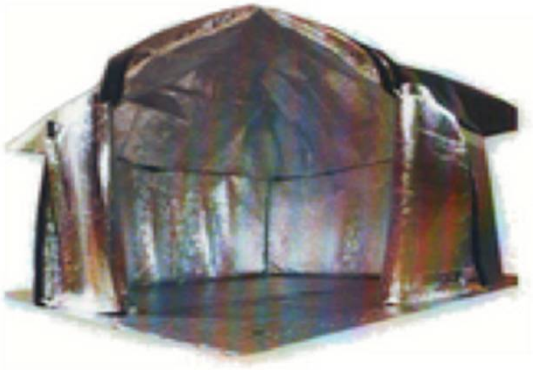
Why You Should Use a Professional

Alcohol not recommended to prevent bed bug infestations because its flammable and has no residual activity.

Heat Chambers

BugStop HotHouse

- **Mobile work horse**



Bed Bug Baker, Lodger Model, Bed Bug Battalion

- **An in-house semi-permanent chamber**

ZappBug Room™
ZappBug

- **Home or personal use. Packs away, transports and stores easily**

D. Miller, VaTech

Smaller Heat Chambers

https://www.zappbug.com/product/zappbug-heater/

Stear

- >1 ga
- 2 unit
- dry st
- •Floor
  Single
  blow b
- •Use in
  monito
  Surfac
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Pest Manag Sci 2018; 74: 2030–2037

Research Article

SCI

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(wileyonlinelibrary.com) DOI 10.1002/ps.4933

Efficacy of three different steamers for control of bed bugs (*Cimex lectularius* L.)

Desen Wang,[a,b] Changlu Wang,[b*] Guohong Wang,[c] Chen Zha,[b] Amanda L Eiden[b] and Richard Cooper[b]

Amazon.com

homedepot.com

Amazon.com

Table 1. Prices and specifications of the three steamers. Except for the prices, the information was obtained from the manufacturers' product instructions. Price information was obtained from http://www.amazon.com

Steamer	Price	Wattage (W)	Water capacity (mL)	Heat-up time (min)	Operating time (min)
HAAN	$75.11	1000	200	<3	15
Steamfast	$101.94	1500	1420	8	45
Steamax	$1259.00	1700	2400	14	90

(a)

Steaming Mattresses

Table 2. Mean (± standard error) treatment duration, temperature during steam treatment, and bed bug control efficacy for the different steamers used to treat bed bugs on mattresses

	Treatment duration (s)	Temperature on the mattress surface during treatment (°C)	% egg mortality	% nymph mortality	% adult mortality
First test†					
HAAN	240.5 ± 26.5	71.9 ± 3.6	100	93 ± 2	95 ± 1
Steamfast	231.3 ± 23.4	72.6 ± 2.8	100	91 ± 3	93 ± 2
Steamax	197.8 ± 20.9	75.4 ± 2.6	100	93 ± 3	91 ± 5
Statistics	$F_{2,15} = 0.9$ $P = 0.429$	$F_{2,15} = 0.4$ $P = 0.696$	–	$F_{2,15} = 0.1$ $P = 0.879$	$F_{2,15} = 0.5$ $P = 0.600$
Second test‡					
HAAN	517.8 ± 29.3	82.7 ± 1.3	100	100	100
Steamfast	462.5 ± 24.6	82.7 ± 0.8	100	100	100
Steamax	428.0 ± 22.8	81.5 ± 1.9	100	100	100
Statistics	$F_{2,15} = 3.1$ $P = 0.074$	$F_{2,15} = 0.2$ $P = 0.803$	–	–	–

† In the first test, only the mattress surface was steamed.
‡In the second test, the mattress surface and the floor of the plastic tray directly under and around the mini mattress were steamed.

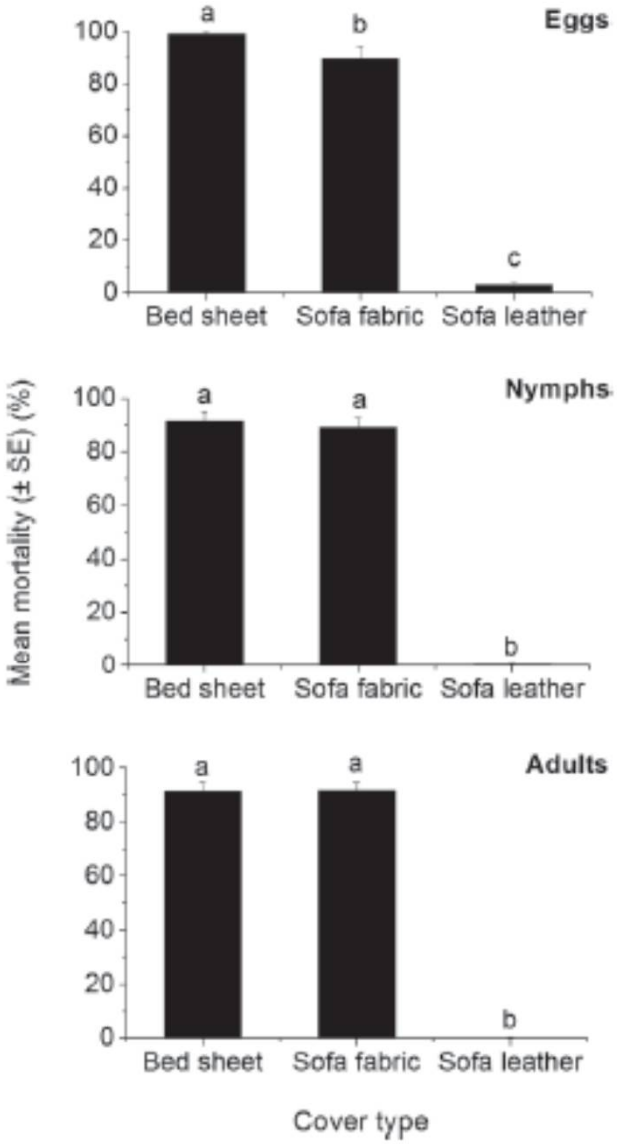
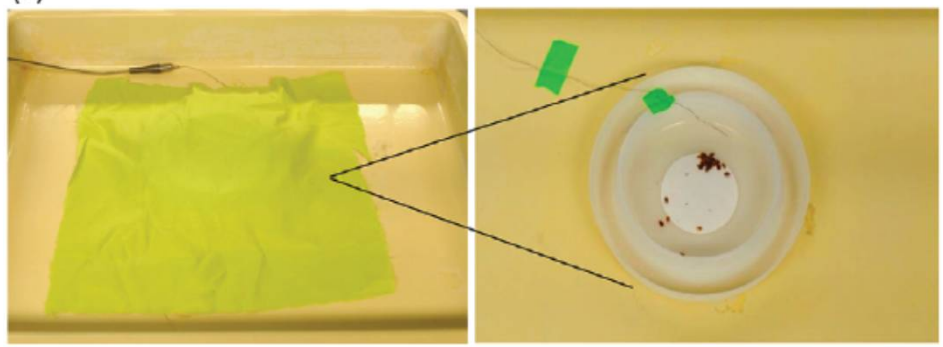


Figure 4. Effect of the cover on the steamer's bed bug control efficacy. Data represent combined results for three steamers and two treatment durations (15 and 30 s). During steam treatment, bed bugs were located under a fabric or leather cover. Different lowercase letters above the bars indicated significant differences between treatments (one-way ANOVA; $P < 0.05$, Tukey's HSD test).

(b)



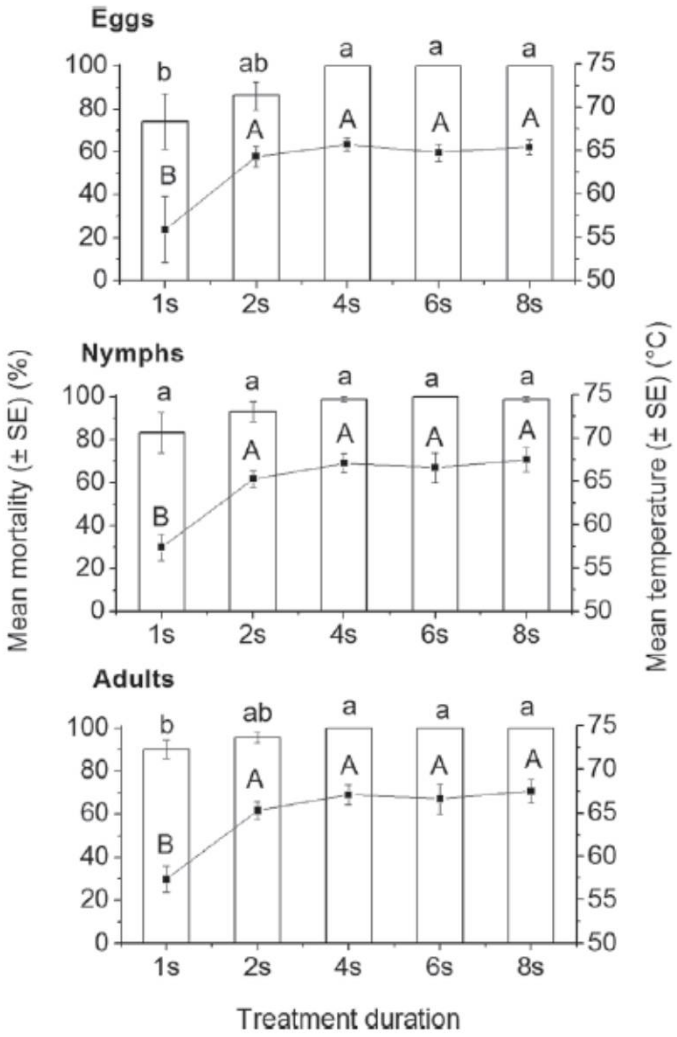
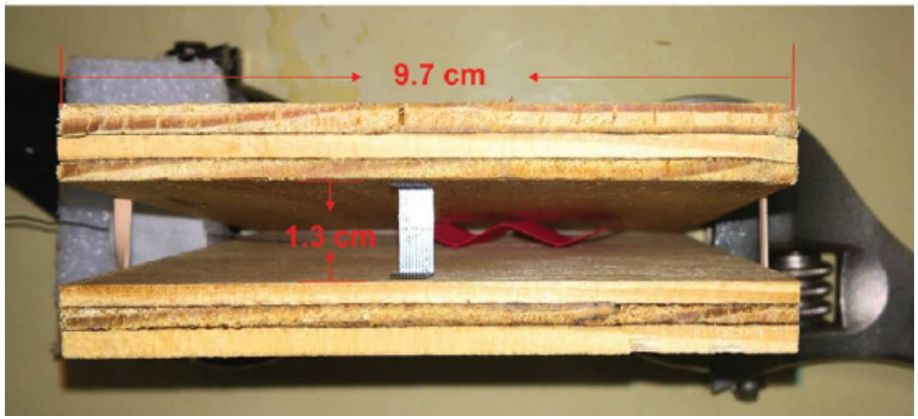


Figure 5. Effect of treatment duration on mean temperature in cracks during steam treatment and steamer's bed bug control efficacy. During steam treatment, bed bugs were hiding in a crack. Bars indicate bed bug control efficacy. The line indicates the temperature in cracks during steam treatment. Data represent combined results for three steamers. Different lowercase letters above the bars indicate significant differences in bed bug control efficacy between treatments; different uppercase letters above the line indicate significant differences in the temperature between treatments (one-way ANOVA; $P < 0.05$, Tukey's HSD test).



Cold

- <32F few days to kill adults & nymphs, 30 days for eggs

•"Bed bugs can tolerate -15C (5F) for short periods and, if acclimated, they can survive at or be for se in Ha

In 2011, Kells recommends 0F for 4 – 10 days

•A minimum of 23 F must be maintained for at least 5 days. As decrease temperature, can shorten time of exposure (Kells 2006). 2011, 0F for 4 – 10 days

•Cryonite?

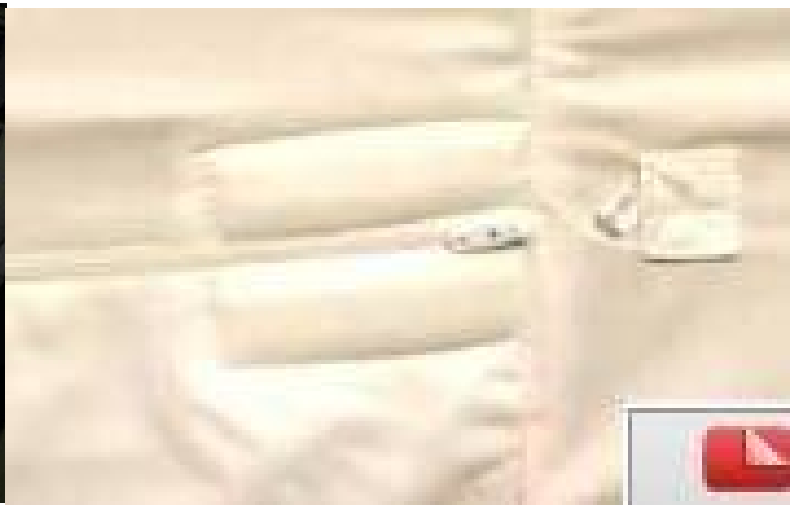
Cold

In 2011, Kells recommended 0F for 4 – 10 days

Bed and Box Spring Encasements

http://www.protectabed.com/, etc.

Protect-a-bed AllerZip
Waterproof Bed Bug Proof
Zippered Bedding Encasement



Sealed BugLock ®
Encasement

Pad corners to prevent tears

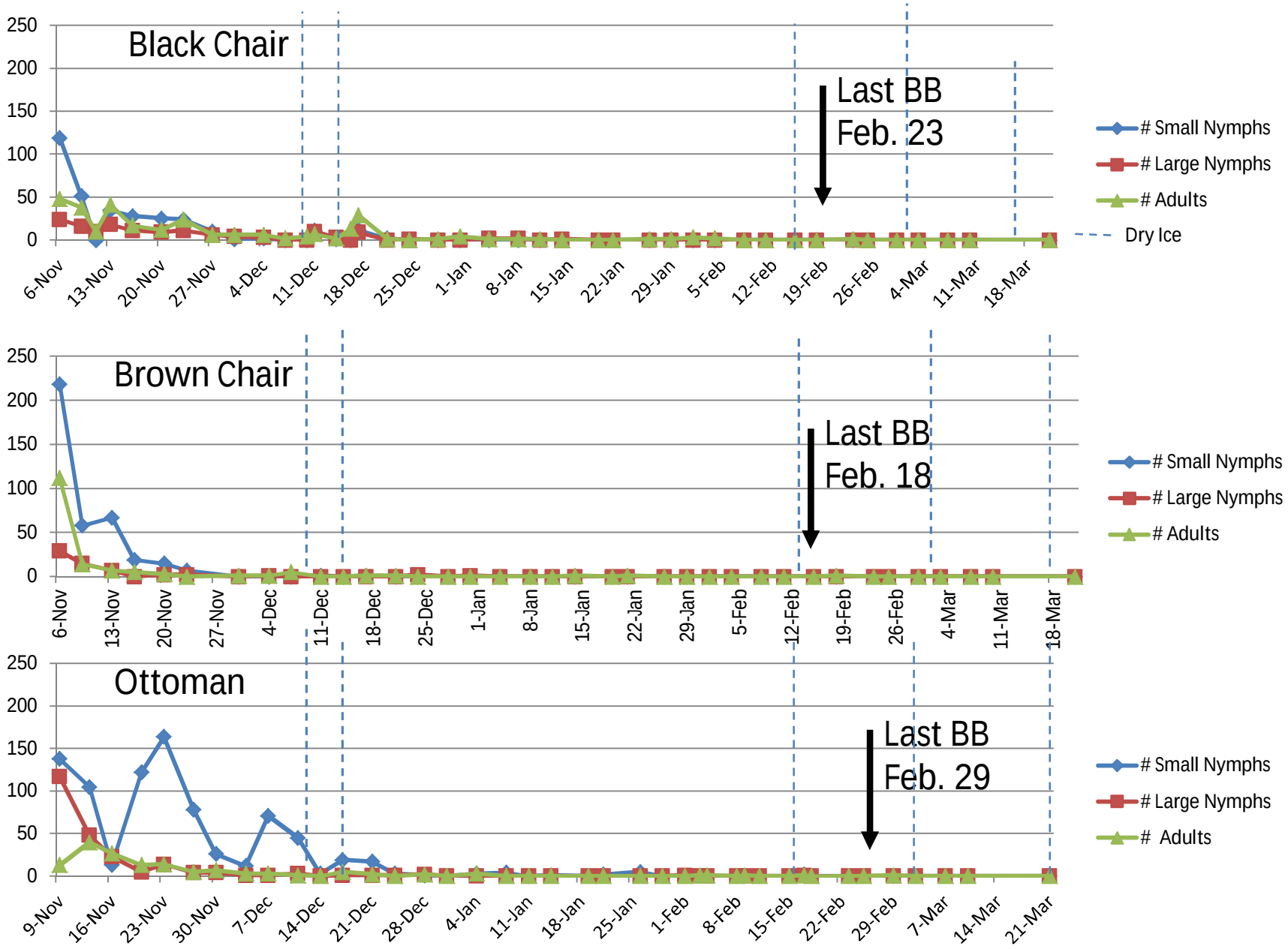
Reasons for Vacuuming

- Vacuum all visible bed bugs during each treatment visit
  - reduces infestation size,
  - removes BB regardless of insecticide resistance or tolerance
  - reduces amount of insecticide needed, important in sensitive environments
  - removes exoskeletons that 1st and 2nd instars to hide in, and
  - removes dead bugs making it easier to find areas where living bed bugs persist.

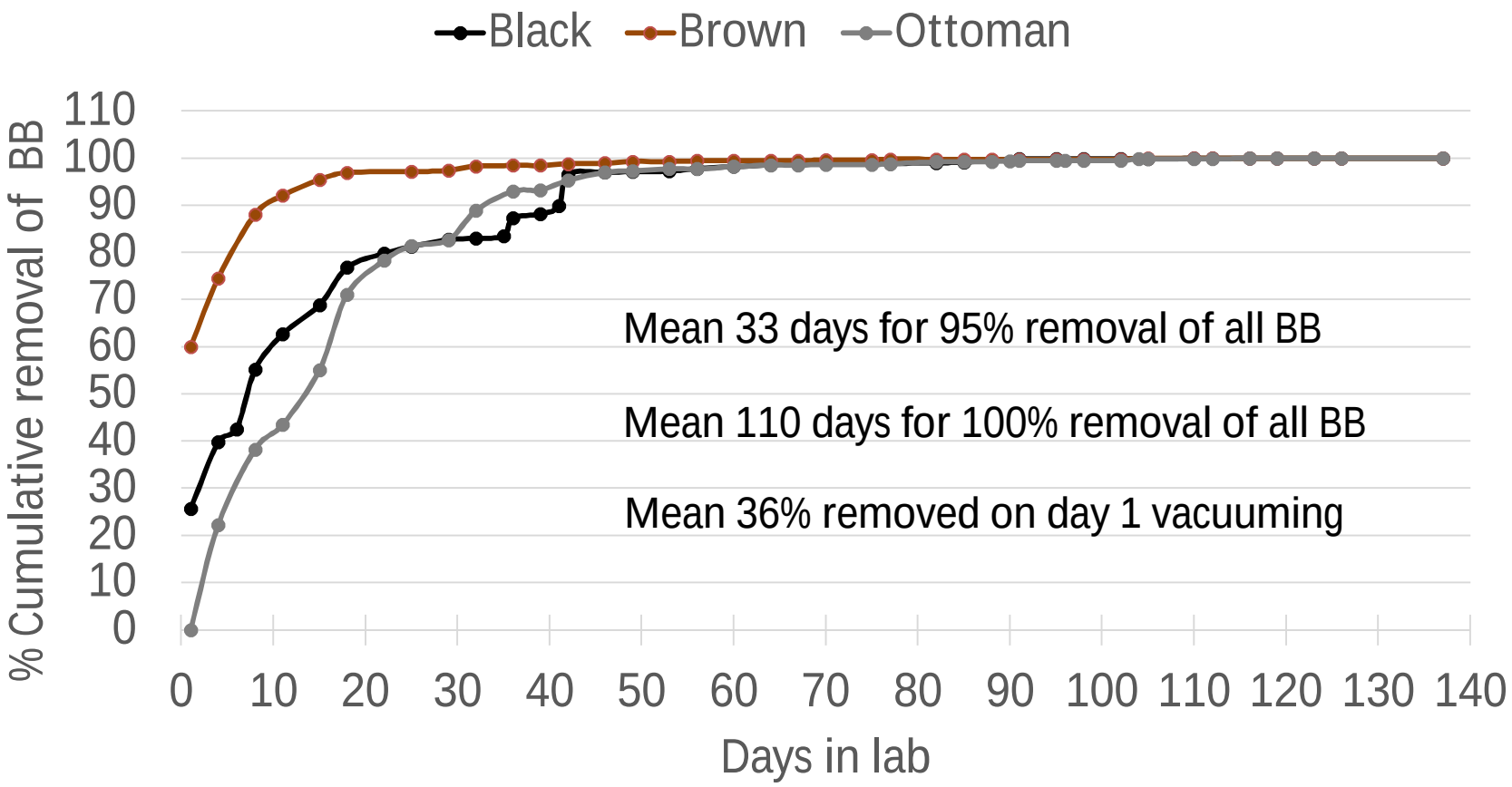
Bed bugs “clingy” – use knee-hi in end of tube

Furniture treated once with nonresidual pesticides (Bedlam and SteriFab)

Immature assassin bug found feeding on bed bug on November 10, 2015


Black Chair
Last BB
Feb. 23
Small Nymphs
Large Nymphs
Adults
Dry Ice
Brown Chair
Last BB
Feb. 18
Small Nymphs
Large Nymphs
Adults
Ottoman
Last BB
Feb. 29
Small Nymphs
Large Nymphs
Adults

% cumulative BB removal by furniture type



Summary

- Furniture treated with nonresiduals once and vacuumed twice a week
  - Mean 848.3 (316.4) bed bugs removed
  - Mean 110 (5.5) days for 100% removal
  - Mean 33 (15.6) days to remove 95%
  - Mean 36% removed on day 1 vacuuming

Conclusion

- Vacuuming isolated, heavily infested furniture 2x a week to rid furniture of bed bugs is a lengthy procedure
- Mean cumulative 5.4 hours vacuuming over 110 days
- Daily vacuuming could require 37 days to eliminate or 23 days to reduce 95%

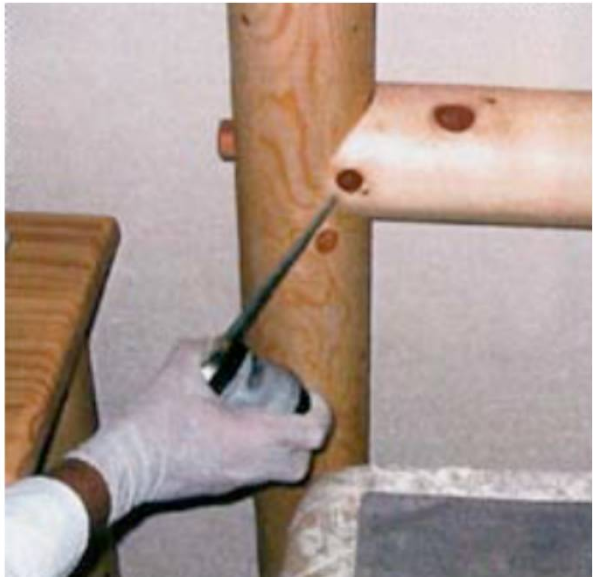
Your new best friend

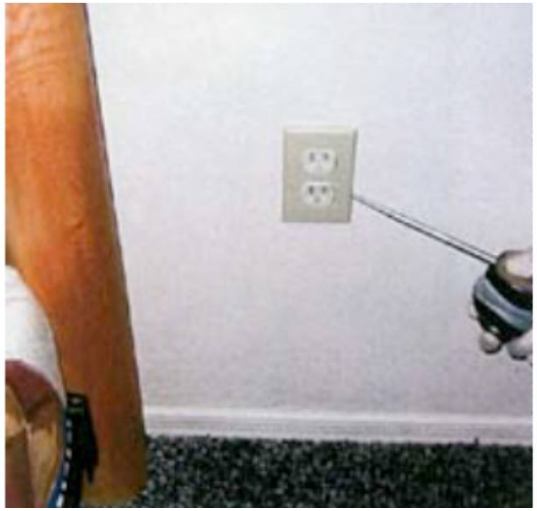
https://pics.drugstore.com/prodimg/412388/450.jpg

Chemical Control

- Treat infested cracks & crevices, voids (dusts) found during inspection
- Treat wall voids of adjoining rooms

Dusting





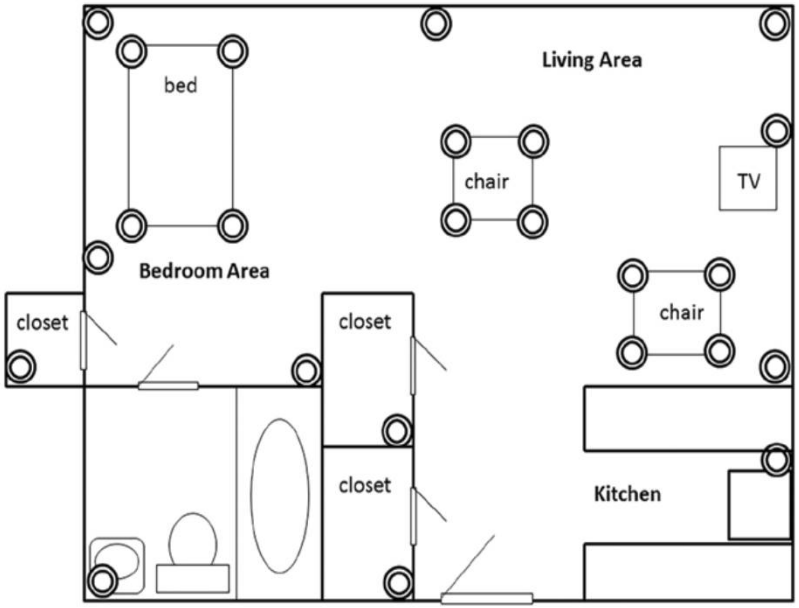
http://ipm.ifas.ufl.edu/resources/grants_showcase/people_and_communities/bed_bugs_manual.pdf

Spraying

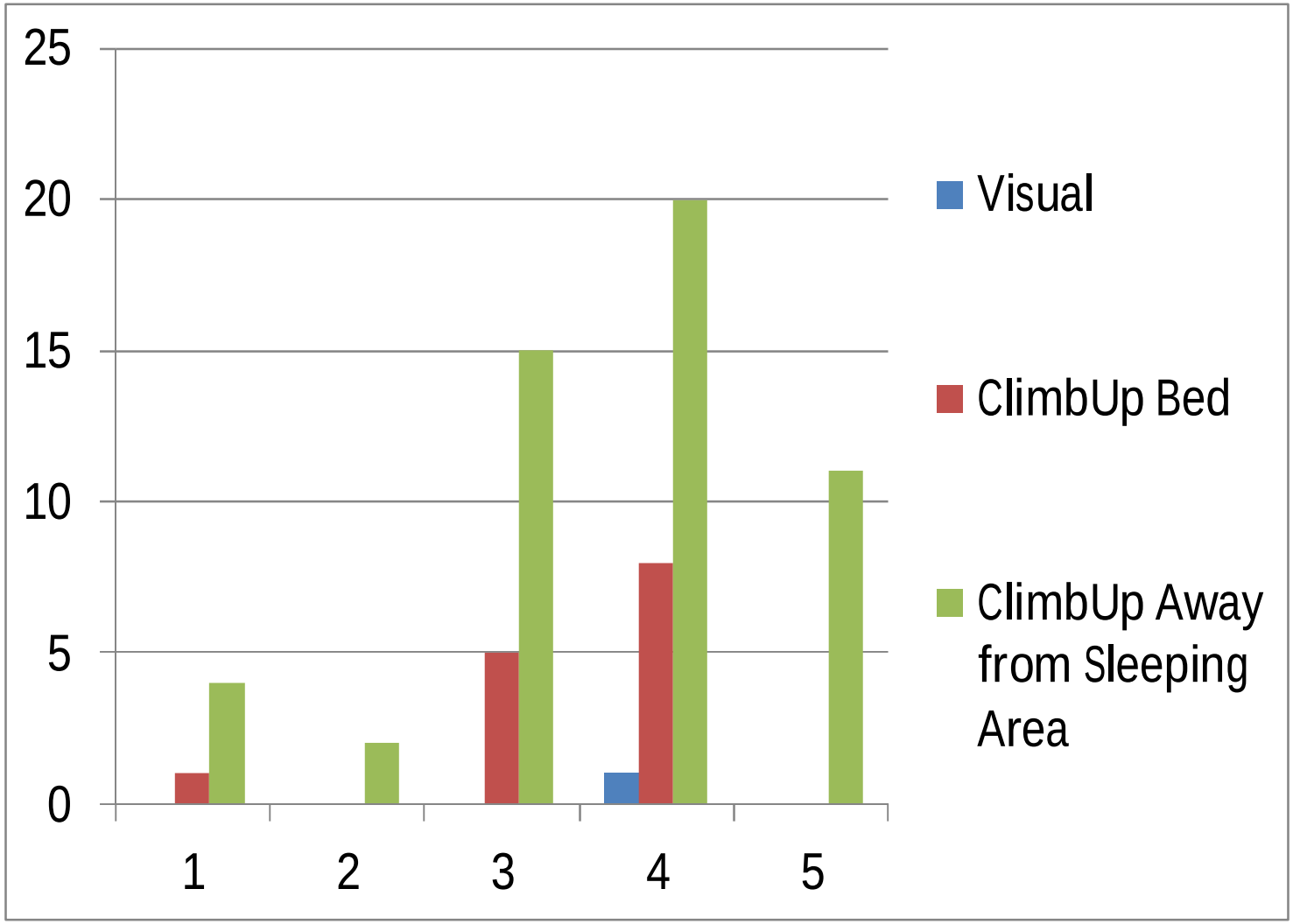
http://ipm.ifas.ufl.edu/resources/grants_showcase/people_and_communities/bed_bugs_manual.pdf

Why Fumigation?

Passive, Pitfall Monitor Placements After Treatment to Determine Bed Bug Elimination



R. Cooper, Case Study #2 NPMA BB Forum Jan. 2011 – to Confirm Efficacy



So your traveling .....

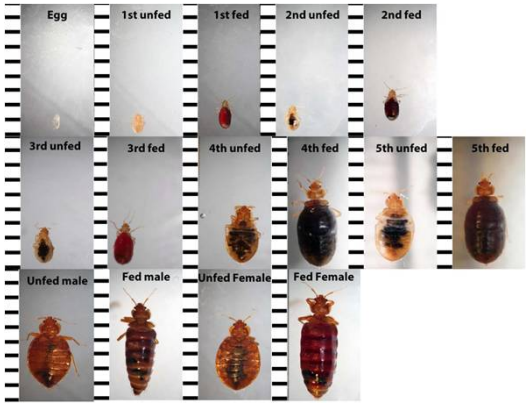
How to prevent picking up bed bugs?

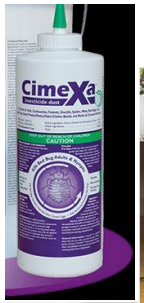
1. Luggage in bathroom or in plastic bag
2. Inspect room (bring gloves, light and lens)
3. Find bug, ask for another room, repeat
4. Return home, clothes into dryer, heat or treat luggage
5. Place monitors in bedroom and elsewhere, inspect regularly

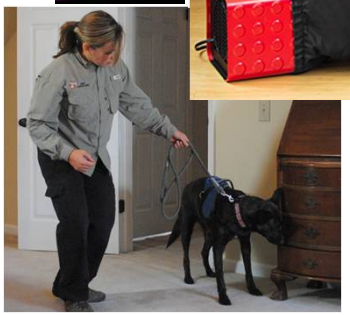
Others Ways To Prevent Bed Bugs From Establishing in Your Home

- Inspect items before purchasing or bringing into home
- Don’t pick up furniture set by the road
- Encase box spring & mattress
- Inspect bed when changing sheets weekly
- Place monitors and check regularly
- If visiting someone with bed bugs, don’t sit on upholstered furniture
- Lint roller to remove bed bugs
- Clothing into dryer

What other techniques would you use as prevention?








Steamer with brush attachment

UT Resources

Bed Bugs in Tennessee Website

http://bedbugs.utk.edu/

UT Insect and Plant Disease Control Manual, Household and Structural

Home Insects (Professional)

http://eppserver.ag.utk.edu/redbook/pdf/professionalinsects.pdf

Affordable Bed Bug Management?

https://utextension.tennessee.edu/publications/Documents/SP761.pdf

Bed Bugs: Prevention and Management

https://extension.tennessee.edu/publications/Documents/PB1763.pdf

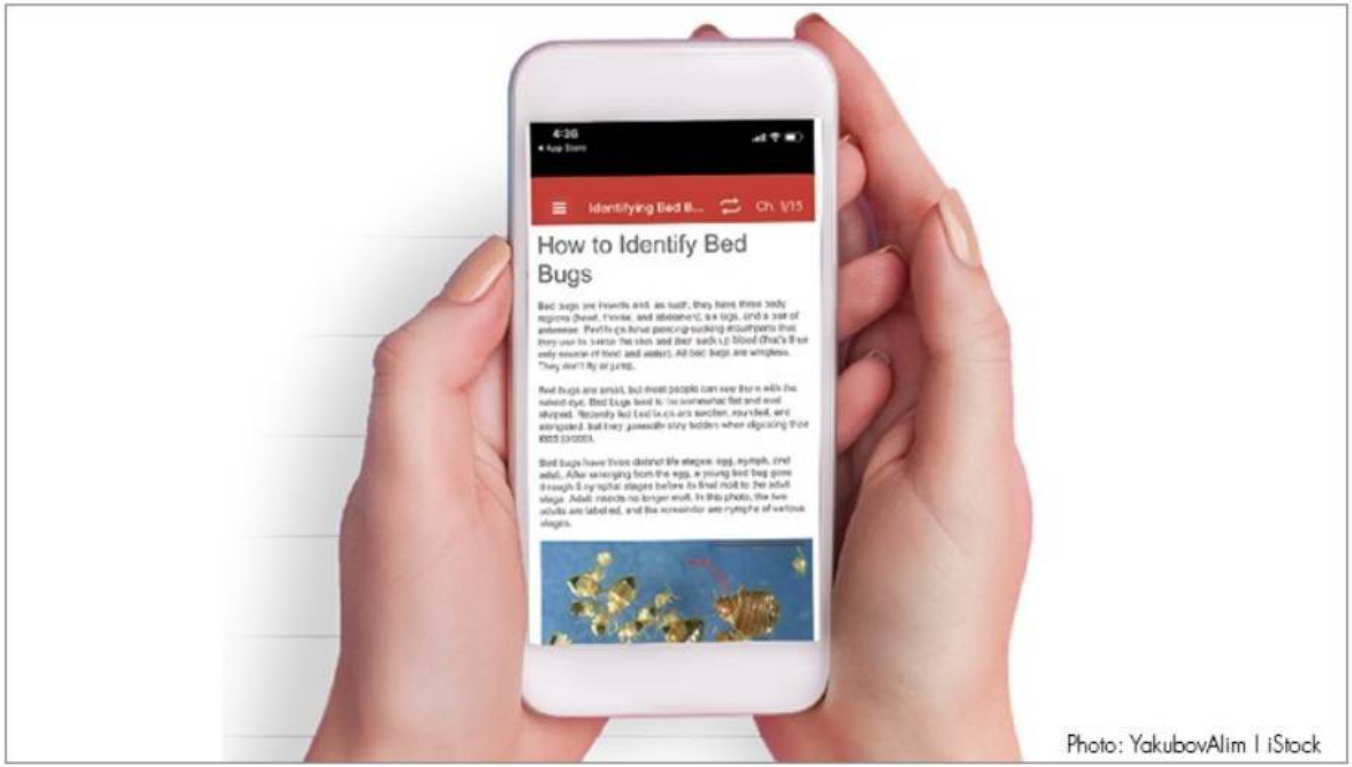


Photo: YakubovAlim | iStock

OSU's Jones Develops Bed Bug Field Guide App

Dr. Susan Jones has created an app that comes complete with photos, descriptions and other bed bug information.

January 4, 2019

Posted by the PCT Staff

Bed Bugs Research

Questions?

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University of Tennessee
Entomology & Plant Pathology