Love at first bite
What are we going to cover?

- What are bed bugs
- History
- Resurgence
- Biology
- Signs
- Control
- Detection
- Disposal
- School
- Social impacts
- Chemical disasters
Anyone can accidently acquire bed bugs
What are bed bugs?

Blood feeding true bugs - order Hemiptera
Eggs hatch and immatures
go through
5 nymph stages
before
becoming
adults
Adults are about the size of an apple seed.
BED BUGS ARE NOT KNOWN TO TRANSMIT DISEASE ORGANISMS
History

- 1910 - 1940 bed bugs became a community-wide problem in US
- Infestations were worse in poorer, overcrowded communities, although wealthy households had problems as well

Fumigation with hydrogen cyanide
• Common pest in the US at the turn of the century
• Almost eradicated in 1940-50 due to DDT
• Resistance documented to DDT, malathion, carbamates and pyrethroids
• Pull beds away from walls
• Place bed legs in pans of oil
• Application of pyrethrum powder (dried chrysanthemum flowers) dusted between the sheets of a bed
• Vigorous housecleaning, washing bedding/beds
• Dousing slats, springs, and crevices with boiling water or grease from salt pork or bacon
People resorted to extremely dangerous practices.

“Sometimes it is possible to destroy a light infestation by thorough soaking of the bed and other places with high-test gasoline”

Doner and Thomssen 1943
Management relied upon

- Labor intensive
- Detailed work
- Constant monitoring

This is just as true today as it was then, despite technological advances
There was little understanding of chemical exposure risks.

DDT impregnated wall paper from 1947.
Some communities remain unaware of chemical exposure risks

**Resurgence**

2001 Arizona

Beds in school dorms were sprayed with diazinon weekly

Diazinon registration for in-home use withdrawn by manufacturer in 2004
**BEDBUGAPOCALYPSE!** Overall increase of 20% between 2012 and 2013

1. Chicago
2. Los Angeles (+1)
3. Columbus, Ohio (+3)
4. Detroit (-2)
5. Cincinnati
6. Cleveland/Akron/Canton (+2)
7. Dayton (+4)
8. Washington D.C. (-1)
9. **Denver** (-5)
10. Indianapolis (+6)
11. Richmond/Petersburg, Va. (+1)
12. Raleigh/Durham/Fayetteville, N.C. (+3)
13. Dallas/Ft. Worth (-4)
40 bed bugs are in a 70°F room on May 2. By Nov 2 how many are there? 5,905!
• Combine inspection with vacuum cleaning
• Use a brush, flashlight, canister vacuum with a crevice attachment
Why have bed bug infestations re-emerged in the developed world?

To a lesser extent:

• Immigration from third world countries
• Transient homeless during economic downturn
• Home transitions increased
• Loss of DDT? – Not likely!
Why Bed Bugs Have Returned
More significantly:

1. Changes in pest management strategies
   - Reduction in pesticide use indoors
   - Introduction and use of pest specific baits instead of liquid pesticides

   Bed bugs don’t eat baits!
Why Bed Bugs Have Returned

2. Increase in global and domestic travel

- Introduction of bed bugs into U.S. by foreign travelers, and re-infestation by native bugs previously restricted
- Mobile society that can carry bed bugs to all corners of the U.S.
Why Bed Bugs Have Returned

3. Bed bugs show increased resistance to insecticides that are widely used

- Metabolic enzymes
- Kdr mutations
- Cuticular proteins
- Abc transporters
BED BUGS ARRIVE

Passive
Bed bug is introduced hitchhiking on something:
• Furniture
• Mattress
• Things we carry or wear (purse, coat, shoes, backpacks)

Active
Bed bug moves by walking from an infested area:
• From one room to another
• From one apartment to another via pipes, telephone or cable wires
• Down a hallway after dropping of an item being discarded
BIOLOGY

Feeding

Hiding
Bed bug life cycle

- Egg (1 mm)
- First Stage (1.5 mm long)
- Second Stage (2 mm long)
- Third Stage (2.5 mm long)
- Fourth Stage (3 mm long)
- Fifth Stage (4.5 mm long)
- Adult (5.5 mm long)
• Bed bugs feed on the blood of humans, birds and mice
• Feed at night – mainly
• Saliva can cause a person to itch and cause swelling
• Scratching can lead to infected sores
Bites may occur in lines - usually on exposed skin
- One study found 30% had a reaction
- Another study indicated 96% (of refugees in Sierra Leone) had reactions
- Reactions vary depending on your immune system and number of bites
- Bites do not confirm bed bug infestations
Saliva causes a “sensitivity” to bites

- **5 stages:** no reaction; delayed reaction; both immediate & delayed; immediate reaction only; & finally, no reaction.

- True hypersensitivity can develop
- Anemia
- Asthma
- Skin lesions (multiple bites)
• Probe the skin to find a capillary space that allows the blood to flow rapidly
• May probe the skin several times before feeding
• Feed for 5-10 min
• After feeding, move to aggregations
• Bed bugs usually feed every 3-7 days
• After feeding adults become interested in mating
• They engage in traumatic insemination
• Females may be mated by many different males
• Females leave aggregations after being mated several times
• Females that mate only once will produce 25% more eggs than multi-mated females
• A single mated female can cause an infestation
• After taking a blood meal females produce 5-20 eggs over ~12 days
• Females produce ~143 eggs in a lifetime
• Aggregate in cracks and crevices all day
• If hungry they become active between midnight and 5:00 am
• Stimulated by the increase of CO$_2$ in the room
• Travel many yards to get to host
• Bed bugs detect temperature, CO$_2$, other chemicals
SIGNS

- Excreted digested blood
- Looks like cockroach feces but feels flat or smooth
• Frass 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 / the edge of carpeting
  – Ceiling / wall junctions behind pictures
  – Electrical outlets
  – In curtain seams
FECAL CRUST
Blind resident in disabled public housing
Not all aggregations are obvious
MOLTED SKINS
LESS OBVIOUS UNLESS YOU KNOW

• Looks like mold
• But are actually bed bug aggregations
BLOOD SMASH AND DRAG
• Most products will kill some bed bugs
• Consumers do not realize that killing bed bugs \textit{we can see} is not the problem

1 exterior
3 partial
16 internal
CONTROL

- Multiple applications of insecticides
- Crack and crevice applications
- Resistance to pyrethroid products is very high
- Not all populations are resistant to the same products
- Three general types of resistance occurring
RESISTANCE

• Metabolic enzyme cytochrome p450, helps to break down toxins – one gene variant that confers resistance enables the bed bug to produce large quantities of the enzyme
RESISTANCE

• Commonly used insecticides target an ion channel and cause nerves to fire continuously, paralyzing and quickly killing the insects - resistant bed bugs may carry a mutation in the ion channel that prevents the pesticide from binding

\textit{kdr-type}
RESISTANCE

• Reduced cuticular penetration – thickening or remodeling of the bed bug cuticle may contribute to decreased insecticide penetration
MANY LEGITIMATE PRODUCTS

- Novel pesticide formulations
  - Temprid (β-cyfluthrin & imidacloprid)
  - Transport (bifenthrin & acetamiprid)
  - Tandam (λ-cyhalothrin & thiomethoxam)

- Chlorfenapyr
  - pyrolle; “pro-insecticide”

- Alpine Dust
  - Dinotefuran and DE

- CimeXa
  - Amorphous silica gel
NON CHEMICAL METHODS

• Becoming the primary methods used in combination with chemical methods
  – Heat/Cold
  – Vacuuming
  – Mattress encasements
  – Desiccant dusts
  – Other
• Most PMPs provide preparation instructions
• Instructions make treatments easier for PMP
• Difficult for the resident: laundry bill
• Top complaint is lack of tenant cooperation

New way of thinking!
Leave the infestation in place
• Excellent detectors
• Can distinguish between live and dead bugs
• Good for lawsuit defense
• Expensive and require constant training
• Are only as good as their handler
• Training varies
• Verification differs
• Few third party certifications
PASSIVE MONITORS/TRAPS

- 4 Climb Up Interceptors
- 4 Bed Moat
- 4 CVT BB Trap
- BB Alert
- 6 BB Detection System
VACUUMING

• The value of vacuuming is it makes inspections easier

• Large infestations, harborage areas are filled with live bed bugs, dead bed bugs, molted skins, hatched egg shells, and feces
HEAT KILLS BED BUGS BEST OF ALL!

• Items can be placed in a hot dryer dry for 40 minutes after items are dry

• Washing only, does not kill bed bugs

• Heat box
Showering removes bugs from your person.
• Steam temperature (at the bed bug) must be 130° F (54° C) or greater
• The steam head must be large
• Steam power will kill bed bugs and their eggs
• Steaming is slow and labor intensive
HEAT CHAMBERS
WHOLE HOME HEAT

• Propane or electric
• Temperature ~140°F
• Time 4 hours
• Bed bugs exposed to CO₂ snow at -42° C
• The snow is pressurized through a nozzle that forms vapors
• Snow freezes the cells of the bugs
• This system will not eliminate a bed bug infestation if used alone
• Encasements for both mattress and box springs!
• Improved version has a zipper protector sewn in
• Traps bed bugs and eggs, bite proof and escape proof
NOT ALL COVERS PROTECT

Where the zipper closes and the zipper teeth are vulnerable to bed bug escape.
DESICCANT DUSTS

• Desiccant dusts are ultimately more effective than sprays
• Resistant strains died in ~36 hours
• Diatomaceous Earth
  – insecticide grade 2-3 days
• Silica dust
  – 2-3 days
• Lasts unchanged in wall voids for years in low humidity
Desiccant dusts

Best
So far
FUMIGATION WITH VIKANE

- Fumigation is generally considered a last resort due to price
- Effective for multi-unit housing
- Residents moving to and from different units
- Sharing of belongings
- Large communal areas
DIY stores are not helping
DISPOSAL

• Wrap and mark items for disposal
• Organize solid waste pick-up
WHY BED BUGS IN SCHOOL?

• Bed bugs are excellent hitchhikers
  – Clothing
  – Backpacks
  – Books

• Bed bugs are good runners
UNHAPPY BED BUGS

• Schools usually lack a food source at night
• Boarding schools are the exception
• Backpacks, books, clothing, wheelchairs from home provide harborage and transport
• Schools can be transitional locations
• In-school transfer can occur
• Accurately identify all specimens
• Provide basic information
• Inspect room, monitor, careful cleaning and vacuuming
• Reduce clutter
• Isolate student belongings in clear plastic bags
• Usually no need for residual insecticides
• No good preventative solution until unmanaged reservoirs in homes or elsewhere are addressed
Results:

Children missing school

Faculty and staff losing their jobs

Affected families move homes and schools

Extreme chemical use
Paradichlorobenzene
Dichlorvos
Naphthalene
PARENTS

• Inform parents how to send students to school free of bugs
  – Launder clothes, dry heat for shoes, backpacks, etc.
  – Clothing items stored separated from bed bug areas in airtight bags
IF A BED BUG IS DISCOVERED IN THE SCHOOL

- Do not panic or cause panic!
- Often it’s a stray, single bug
- Collect it for proper ID
- Do not evacuate the classroom or office
- Thoroughly inspect the room
SCHOOL PROTOCOL FOR “TREATMENT”

- Deep clean the affected area thoroughly
- Vacuum all floor and corner areas
- Wash desks and chairs
- Wash floors
- Temporarily remove rugs
- Steam clean rugs and furniture
• Shared articles can harbour bed bugs
  • Wheelchairs
  • Vacuums
  • Medical equipment
  • Electronics
  • Games
  • Clothing
  • Toys
Phoenix Union High School District – Bed Bug Policy

• Policy 2012-2013 school year
• 2013-2014 >75% reduction in roving bed bug sightings
• Cleaning and monitoring not “spraying”
PARENT AND COMMUNITY EDUCATION

WORKING THE BUGS OUT
Bed Bug Control—What Landlords and Tenants in Multi-Family Housing Need to Know in Arizona

Dawn M. Zenge, Carl Olson, Al Buitrago & Paul Baker

In 2011, Arizona joined several other states enacting bed bug control laws. The new legislation (SB 2380) targets specific responsibilities on landlords and tenants in multi-family housing. This law does not apply to single family residences. Under Arizona law, landlords are required to provide housing and new tenancy agreements to tenants who move in after June 2011. In many cases, landlords are required to provide written notification to tenants about potential bed bug infestations. Landlords may be required to notify the tenant of a bed bug infestation and disassociate from the landlord of a bed bug infested materials was a residence.

Summary of the Arizona law
- TENANTS are required to notify landlords in writing of the presence of bed bugs.
- TENANTS are prohibited from moving, selling or the building it they are known to be infested with bed bugs.
- LANDLORDS are required to provide written notification to tenants about potential bed bug infestations. The Arizona bed bug legislation can be read at http://www.azleg.gov/EmailDocument.aspx?DocID=2011-03938-T2-Eng

General pest management service contracts may not include bed bug remediation. It may be advisable not to purchase professional pest management if professional pest management is not a bed bug detection dog service. It is up to the landlord to determine if the bed bugs are being eradicated.
EDUCATE STUDENTS

Resource created by
Dr. Rebecca Baldwin
University of Florida
SOCIAL IMPACTS

• 2007-2011 data from individuals calling by phone, sending written correspondence, or attending educational / outreach events
Most commonly used pesticide choices for residents battling bed bugs was total release foggers, & aerosol sprays.

9% of residents had applied gasoline on their bed (one PHA training).

19% of people had attempted non-chemical control. 31% had used more than two chemicals.
• 42% people understand what behaviors put them at risk
• 89% indicated extreme stress, 100% indicated some anxiety
• 4.5% of residents attempted to seal cracks and crevices
• 8.9% had paid a company to remediate the infestation
• Few (>7%) people had no concerns when informed of average remediation costs

• 32% of specimens submitted as bed bugs or possible bed bugs were not bed bugs

$400-5000

1. Fumigation
2. Heat treatments
3. Pesticides
The poor are at greatest risk

Increased number of people reporting long-term (beyond a year) bed bugs
Socioeconomic risk
• Over the counter pesticides used in/on school backpacks
• Children missing school for more than 6 months
• Psychiatric patients refused admission to medical facilities
• Isolation from friends and family
• Bed bug detection dogs providing false positives
• Other observations

Doctors and PA’s misdiagnose bed bugs based on bite reactions
Loss of:

• Home and/or belongings
• Financial stability
• Mental stability
• Partner
• Employment
• Health
• Children?
In 2012 we developed an on-line survey tool to methodically determine bed bug impacts and analyze the behavioral risk factors associated with bed bug infestations.

2014 launch

Bed Bug survey in English: http://www.surveymonkey.com/s/DGLQS52
Bed Bug survey in Spanish: https://es.surveymonkey.com/s/F5NZXJK
Chemical disaster zones
Malathion

Lab results:
Malathion 581.09 ug
MISUSE – SEVIN DUST

- Grandparents used Sevin Dust to treat bed bugs ... “it worked for someone else”
Clean up procedures?
Unlabeled Mothballs Chinese Chalk Tres Pasitos

Products without a pesticide label are illegal!
DO NOT USE FOGGERS AND “BOMBS”
Bed bugs everywhere not just homes

Bed bugs are real. You can pick them up anywhere.

503-988-BUGS
BedBugsAreReal.org

Protect yourself.
MULTNOMAH COUNTY
IN A HOME,
WHERE DO BED BUGS HIDE?

(CHOOSE THE TOP 3)

a.) box springs
b.) couches / chairs
c.) mattresses
d.) night stand / dresser
e.) baseboards and moldings
f.) head boards and bed frames
g.) walls / ceilings
h.) TV remotes
i.) curtains / drapes
j.) toilets
Even in the loo!
Disturbing New Trend: Kids Are Now Smoking Bed Bugs To Get High

“Just when us adults thought that the children of today couldn’t get any more stupid, they come up with a new and amazing way to get high, rewriting the definition of probably a bad idea.”

This fad originated in Arizona, where a group of kids thought up the bright idea of capturing bed bugs, crushing up the bodies, and inserting the pieces into “bongs”. The children then light the bongs and inhale the fumes.

Inhaling the smoke coming off of the bed bug pieces, they experience visual and auditory hallucinations. Bed bugs are known in the scientific community to secrete an active hallucinogenic chemical, that produces a feeling that resembles “walking on wet concrete.”
Resources

http://www2.epa.gov/bedbugs
http://extension.arizona.edu/sites/extension.arizona.edu/files/pubs/az1563.pdf
http://webdoc.agsci.colostate.edu/ipm/Bed%20bug%20photos.pdf