

Bed Bugs and Human Health: Known Concerns and Emerging Threats



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Outline

1. History

2. Biology

3. Known Health Effects

4. Emerging Threats?





Advances in the Biology and Management of Modern Bed Bugs



Caption: "War on the bed bug". Postcard c. 1916. Clearly humanity's dislike of the bed bug has not changed through the years!

(not so) Recent Resurgence!

- Disappeared in the 1950s, but re-appeared in the early 2000s
- Found everywhere!

About 8,160 results (0.40 seconds)

BBC

Bed bug infestation forces Northampton man to sleep in his car

A pensioner is at his "wits' end" after being driven to sleep in his car due to a bed bug infestation in his flat owned by a retirement...

2 days ago



Las Vegas Review-Journal

Bed bugs are a pest to deal with for Las Vegas hotels

Bed bugs are an operational hazard for Las Vegas hotels, as over 50 reports of infestations have been investigated since 2022.

2 days ago



The Mirror

Horror bed bug infestation in flat forces man, 83, to set up bedroom and sleep in CAR

Pensioner Michael Kemp decided to set up a makeshift bedroom in his car after a bed bug infestation in his Northampton flat got so bad he...

9 hours ago



USA Today

Guests at seven Las Vegas hotels have found bed bugs the past year

Reports of bed bugs at seven hotels on the Las Vegas strip have recently come forward. Caesars Palace, Planet Hollywood, Circus Circus,...

1 month ago



The Independent



Bed bug infestation forces Northampton man to sleep in his car

2 days ago



Michael Kemp caught nine bugs at the start of the latest infestation



Michael Kemp says the bed bugs have forced him to sleep in his car



Bed Bugs Aren't Just a Problem In Paris. Here's Why

Bed bugs have an intimate relationship with humankind, and our behaviors have as

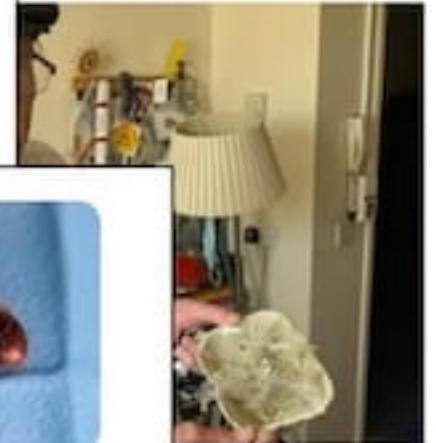


station forces
n man to sleep in his car



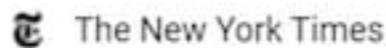
Bedbugs are everywhere—and they're very good at what they do

Compounding the issue, global travel has grown in the recent decades, making it



What you need to know about Europe's bedbug panic

Dermatologist Zeina Nehme says her clinic usually sees a number of cases every summer in which patients have been bitten by bedbugs while...



The Best Tip of Paris Fashion Week? Avoid Bedbugs.

There's an infestation in the City of Lights, and fashion folks are not immune.



Bedbugs and Balenciaga: Could Paris's bedbug infestation spread to the US?

Bedbugs and Balenciaga: Could Paris's Bedbug Infestation Spread to the US? ... As Paris finishes hosting Fashion Week, Balenciaga, Dior and Chanel...



Guests at seven
past year

Reports of bed bugs a
forward. Caesars Pala

1 month ago



Oct 4, 2023

Outline

1. History

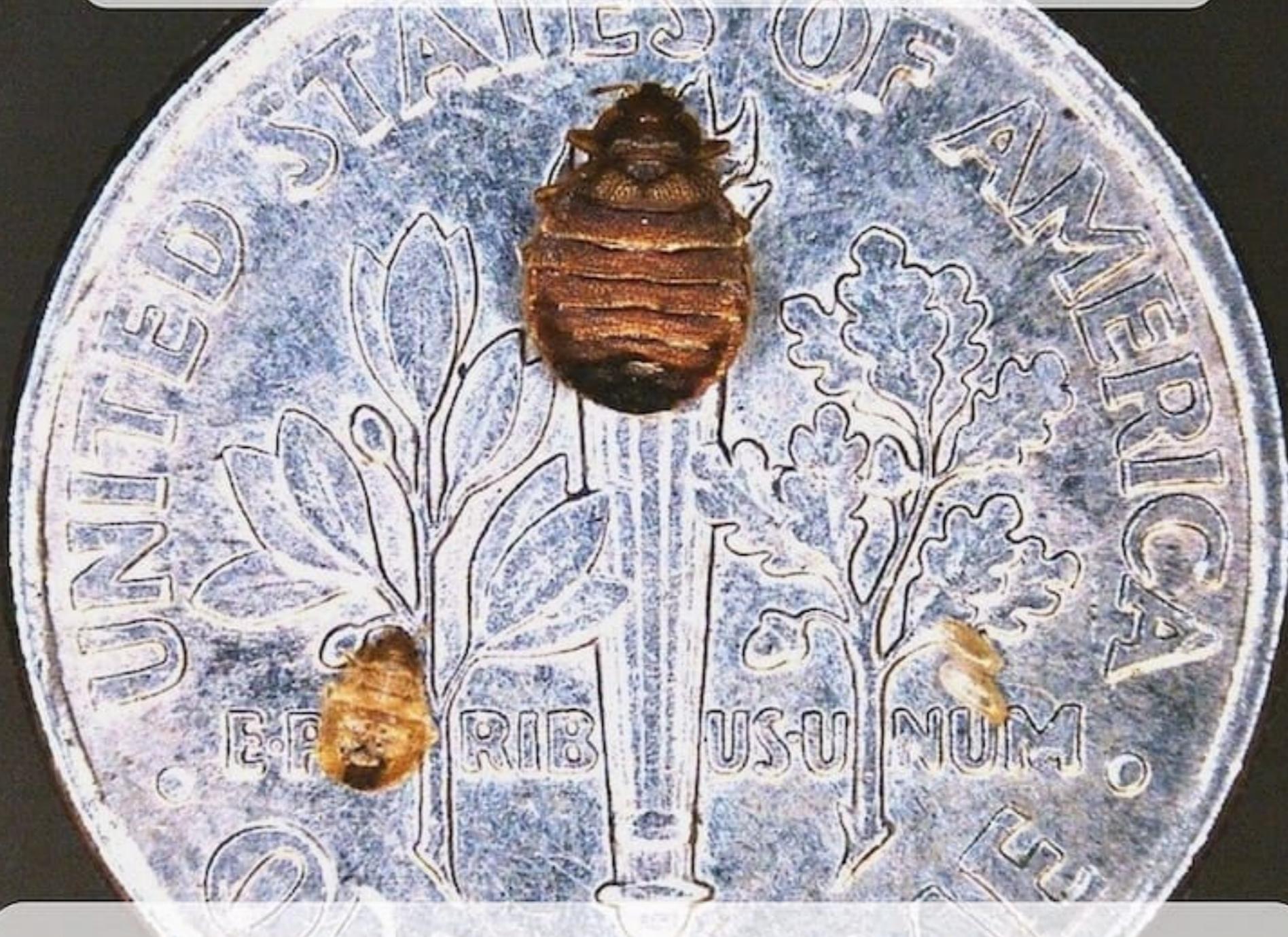
2. Biology

3. Known Health Effects

4. Emerging Threats?



Small, but visible



- Adults are $\frac{1}{4}$ " in length
- Some variability among populations



**Bed Bugs are “True Bugs”
(Order Hemiptera)**

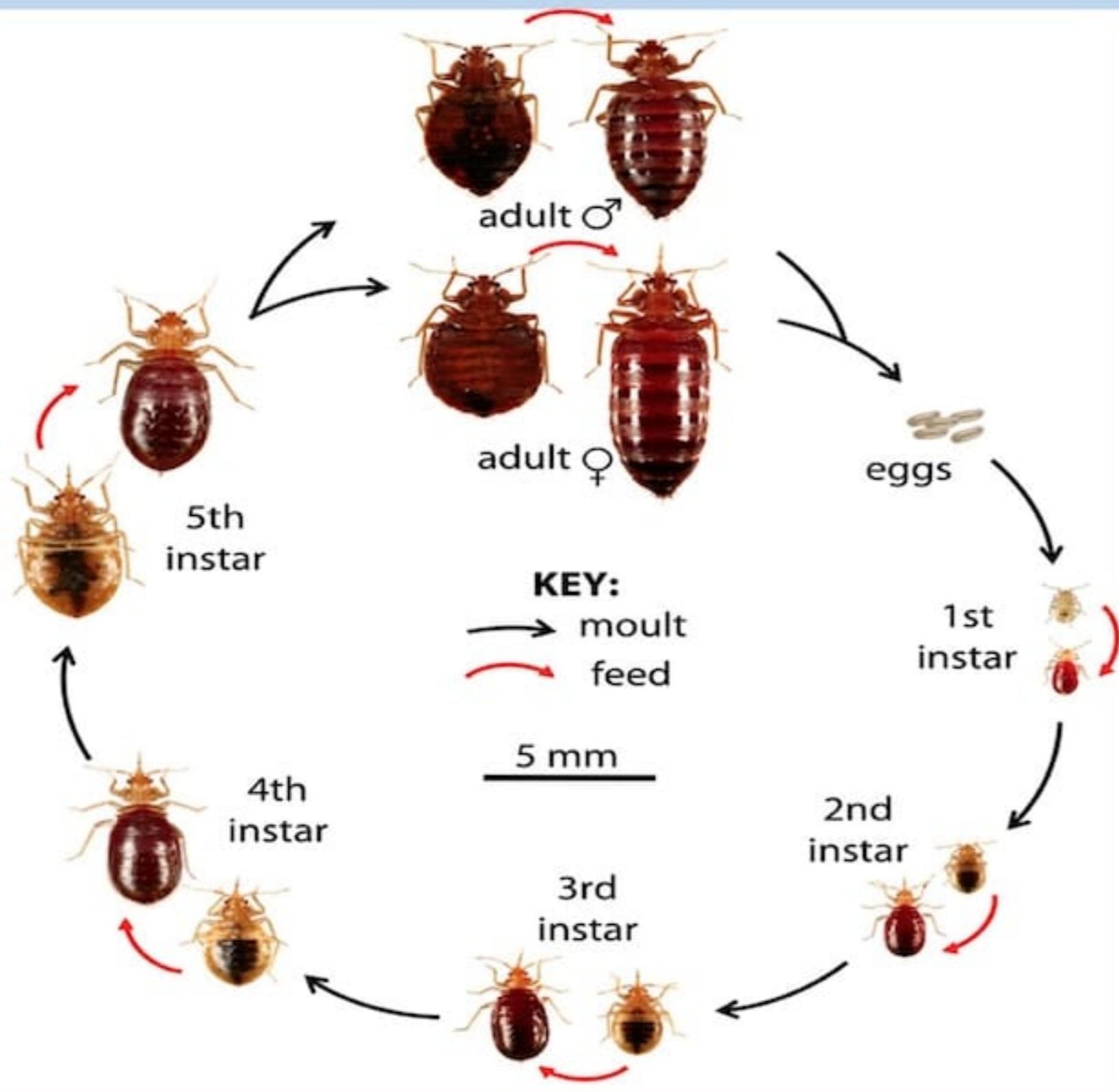
Feed on blood





- 2-10 minutes to feed
- Takes ~2x their weight in blood (4x for smaller instars)

Development



- Require a blood meal to molt
- Egg to adult in about 60 days (72 F)
- 5 nymphal instars (fixed)

Females and Males



Traumatic Insemination



- Bypass female reproductive tract when mating

Eggs



Photo Credit: James Kallsch, UNL Dept of Entomology

- 2-5 eggs per day
- 200-500 eggs in their lifetime
- Eggs are generally laid in cracks and crevices

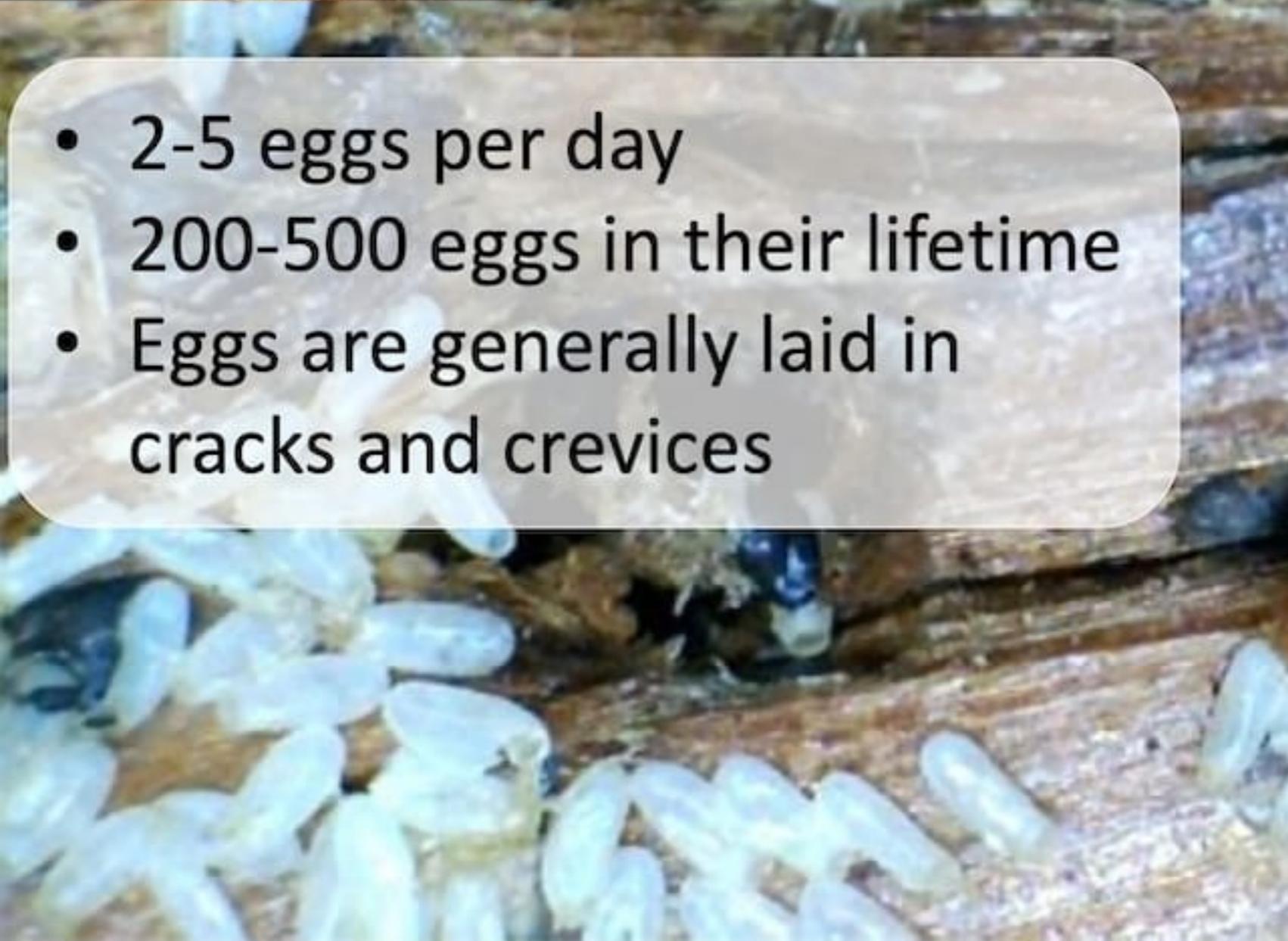
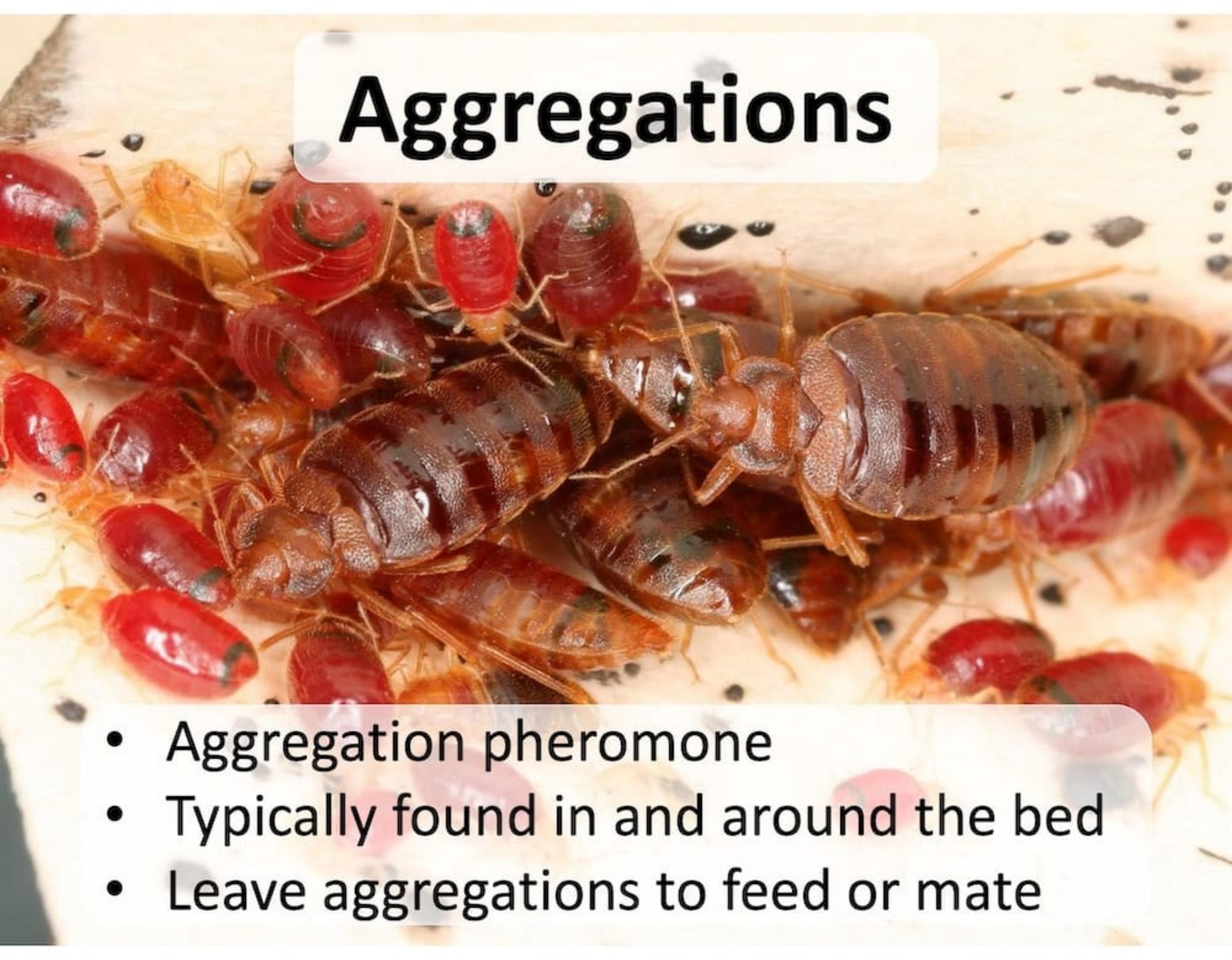


Photo Credit: James Kallsch, UNL Dept of Entomology



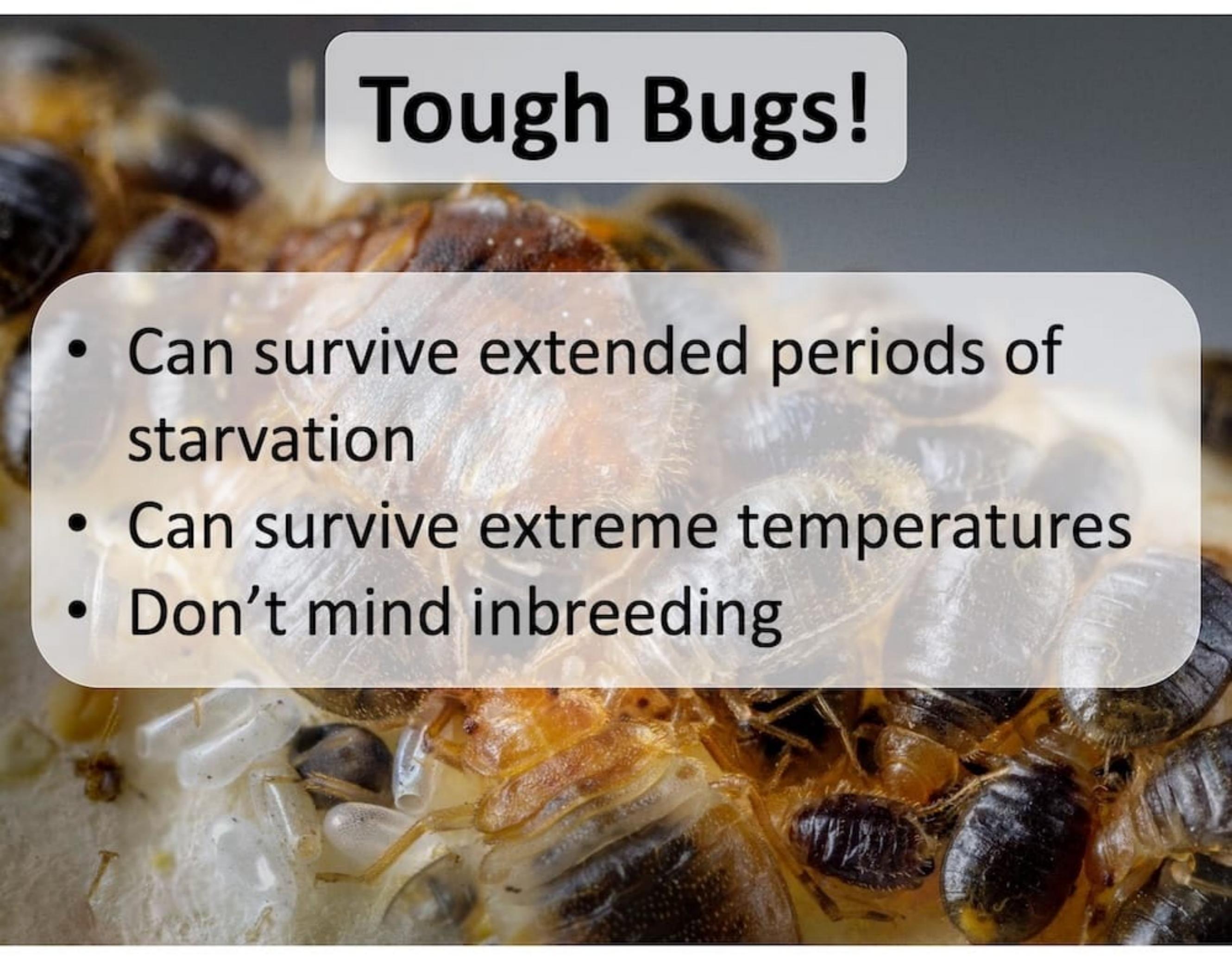
Aggregations



- Aggregation pheromone
- Typically found in and around the bed
- Leave aggregations to feed or mate

Tough Bugs!

- Can survive extended periods of starvation
- Can survive extreme temperatures
- Don't mind inbreeding



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Known Effects on Human Health



9 ON YOUR SIDE AT NOON
FD: FIRE STARTED WHEN TEEN TRIED TO BURN BEDBUGS
HAWAIIAN TERRACE IN MOUNT AIRY

abc 9
12:01 5



Bites

Disease
Transmission?



DIY Harm

Psychological

9 ON YOUR SIDE AT NOON
FD: FIRE STARTED WHEN TEEN TRIED TO BURN BEDBUGS
HAWAIIAN TERRACE

abc 9
12:01

Bites



9 ON YOUR SIDE AT NOON

FD: FIRE STARTED WHEN TEEN TRIED TO BURN BEDBUGS
HAWAIIAN TERRACE IN MOUNT AIRY

9
abc
12:01 5



Immediately after bite



24 hours after bite

- Severity of reaction changes over time
- Different people have different responses
- No clear or obvious patterns
- Secondary infections are very common
- Rare Cases: anemia and iron deficiency





What causes our reaction?

- Saliva contains >40 different proteins which play a variety of roles
- Some proteins likely to play a role in our immune response: nitrophorin (vasodilator), Factor X (coagulation inhibitor), apyrase (platelet function inhibitor)



Disease
Transmission?



9 ON YOUR SIDE AT NOON
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HAWAIIAN TERRACE IN MOUNT AIRY

9
abc
12:01 5



- Have been found to be naturally infected with >50 human pathogens
- Only a few papers show laboratory potential to vector pathogens



Bed Bugs (*Cimex lectularius*) as Vectors of *Trypanosoma cruzi*

Renzo Salazar, Ricardo Castillo-Neyra, Aaron W. Tustin, Katty Borrini-Mayorí, César Náquira, and Michael Z. Levy*
Chagas Disease Field Laboratory, Universidad Peruana Cayetano Heredia, Arequipa, Peru; Department of Epidemiology, Johns Hopkins Bloomberg School of Public Health, Baltimore, Maryland; Center for Clinical Epidemiology and Biostatistics, University of Pennsylvania School of Medicine, Philadelphia, Pennsylvania



- Bed bugs possess the ability to vector *T. cruzi* (causative agent of Chagas disease)

RESEARCH ARTICLE

Competence of *Cimex lectularius* Bed Bugs
for the Transmission of *Bartonella quintana*,
the Agent of Trench Fever

Hamza Leulmi^{1,2}, Idir Bitam^{2,3,4}, Jean Michel Berenger¹, Hubert Lepidi¹, Jean Marc Rolain¹,
Lionel Almeras¹, Didier Raoult¹, Philippe Parola^{1*}



- Bed bugs possess the ability to vector *Bartonella quintana* (causative agent of Trench Fever)

Testing the Competence of *Cimex lectularius* Bed Bugs for the Transmission of *Borrelia recurrentis*, the Agent of Relapsing Fever

Basma El Hamzaoui,^{1,2} Maureen Laroche,^{1,2} Yassina Bechah,^{1,2} Jean Michel Bérenger,^{1,2} and Philippe Parola^{1,2*}

¹Aix Marseille Univ, IRD, AP-HM, SSA, VITROME, Marseille, France; ²Institut Hospitalo-Universitaire Méditerranée Infection, Marseille, France



- Bed bugs possess the ability to vector *Borrelia recurrentis* (causative agent of Relapsing Fever)

Experimental Acquisition, Maintenance, and Transmission of Methicillin-Resistant *Staphylococcus aureus* by the Common Bed Bug, *Cimex lectularius*

Andrea L. Herrera, Michael S. Chaussee, and Jose E. Pietri[✉]

Division of Basic Biomedical Sciences, Sanford School of Medicine, University of South Dakota, Vermillion



- Bed bugs possess the ability to acquire, maintain, and transmit methicillin-resistant *Staphylococcus aureus* (MRSA)

All of these show potential, but do not link bed bugs to field transmission



Hard to show bed bugs are the sole cause in the places we find bed bugs, and few people really looking.

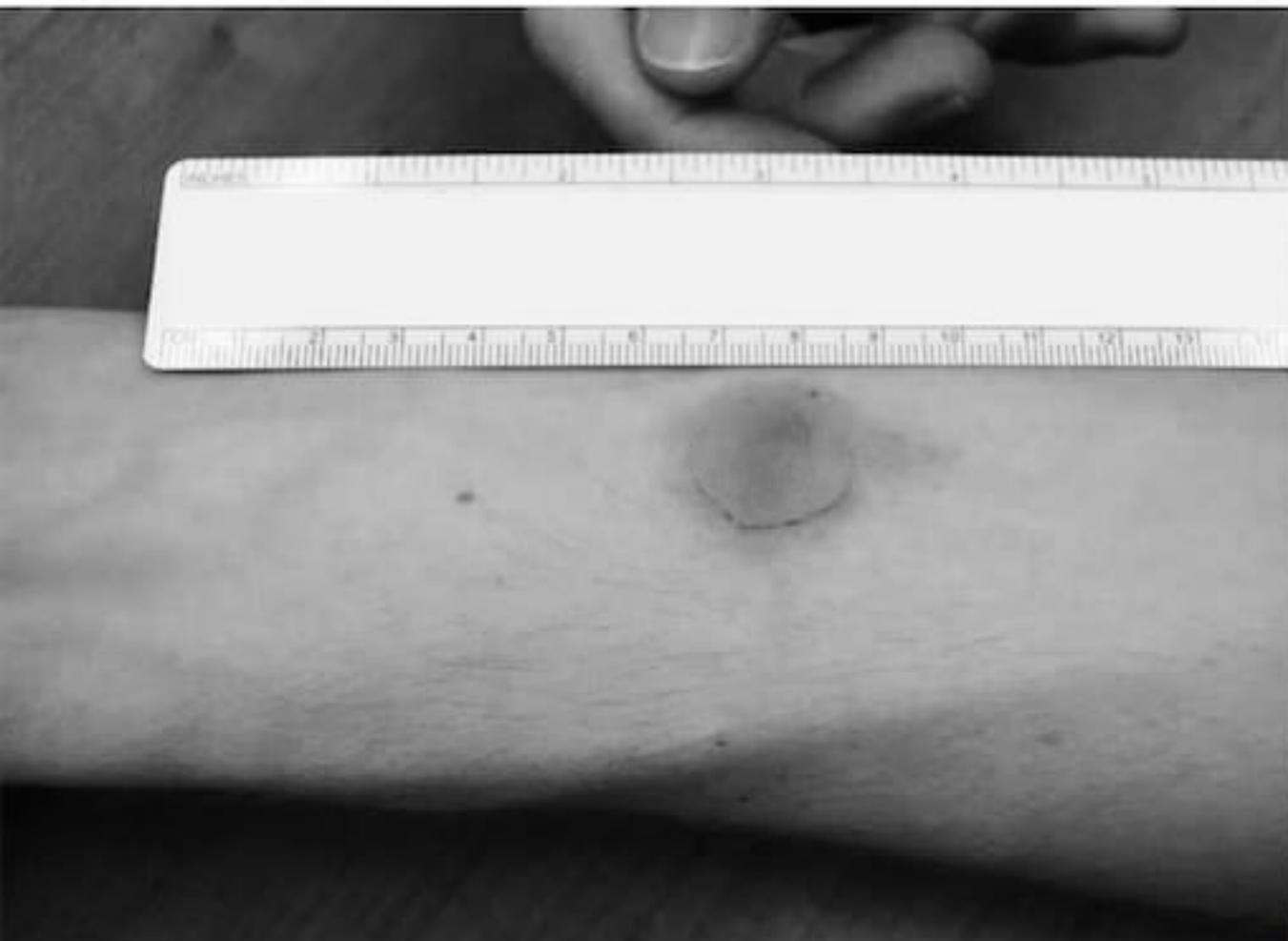
Work out of Ohio State showed bed bugs tended to defecate in close proximity to bite sites



Major Limitation to Pathogen
Transmission: Limited number of hosts



Locations of Concern: areas where bed bugs
and the causative disease agents are found,
and there is frequent turnover of people



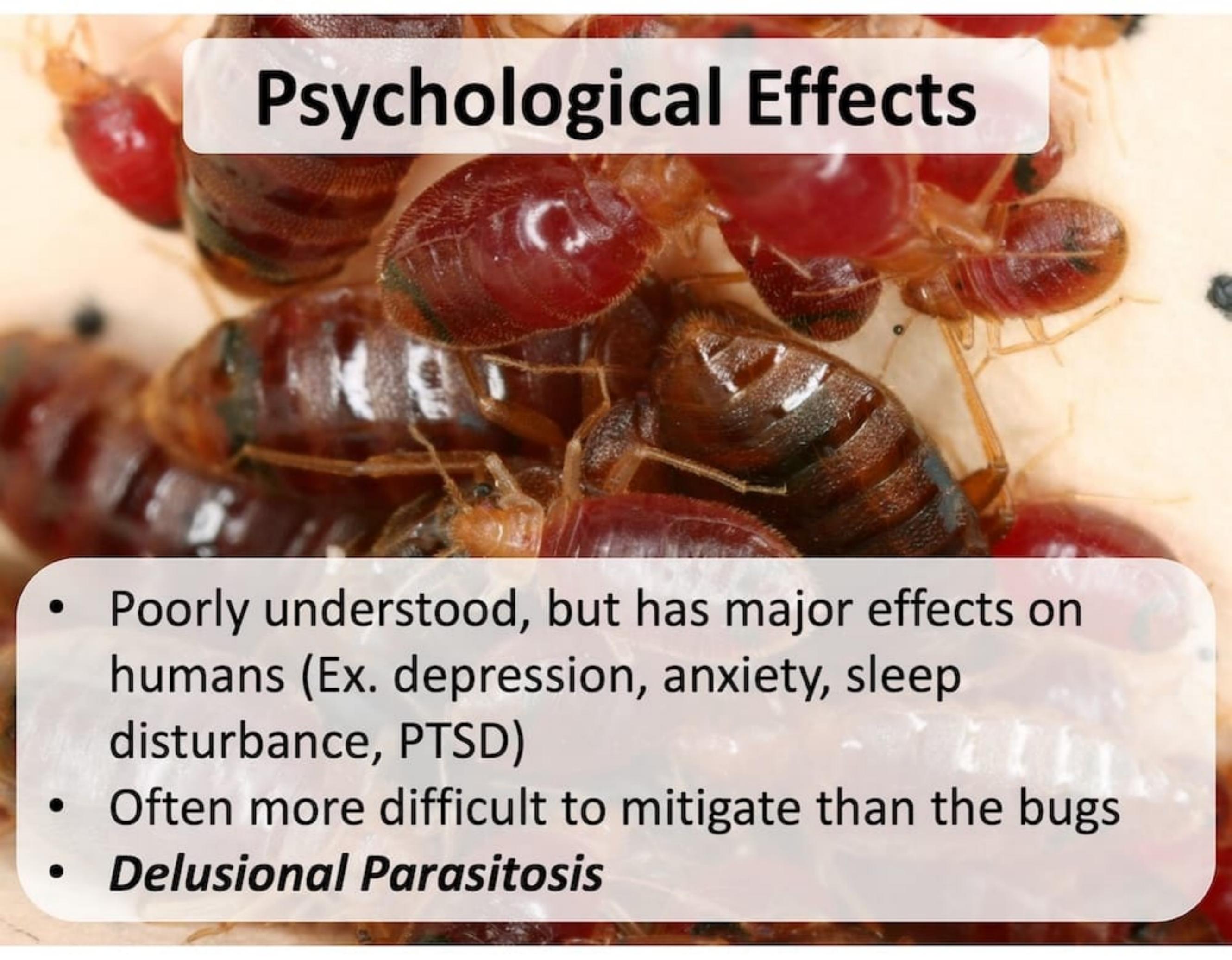
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abc
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Psychological

Psychological Effects



- Poorly understood, but has major effects on humans (Ex. depression, anxiety, sleep disturbance, PTSD)
- Often more difficult to mitigate than the bugs
- ***Delusional Parasitosis***



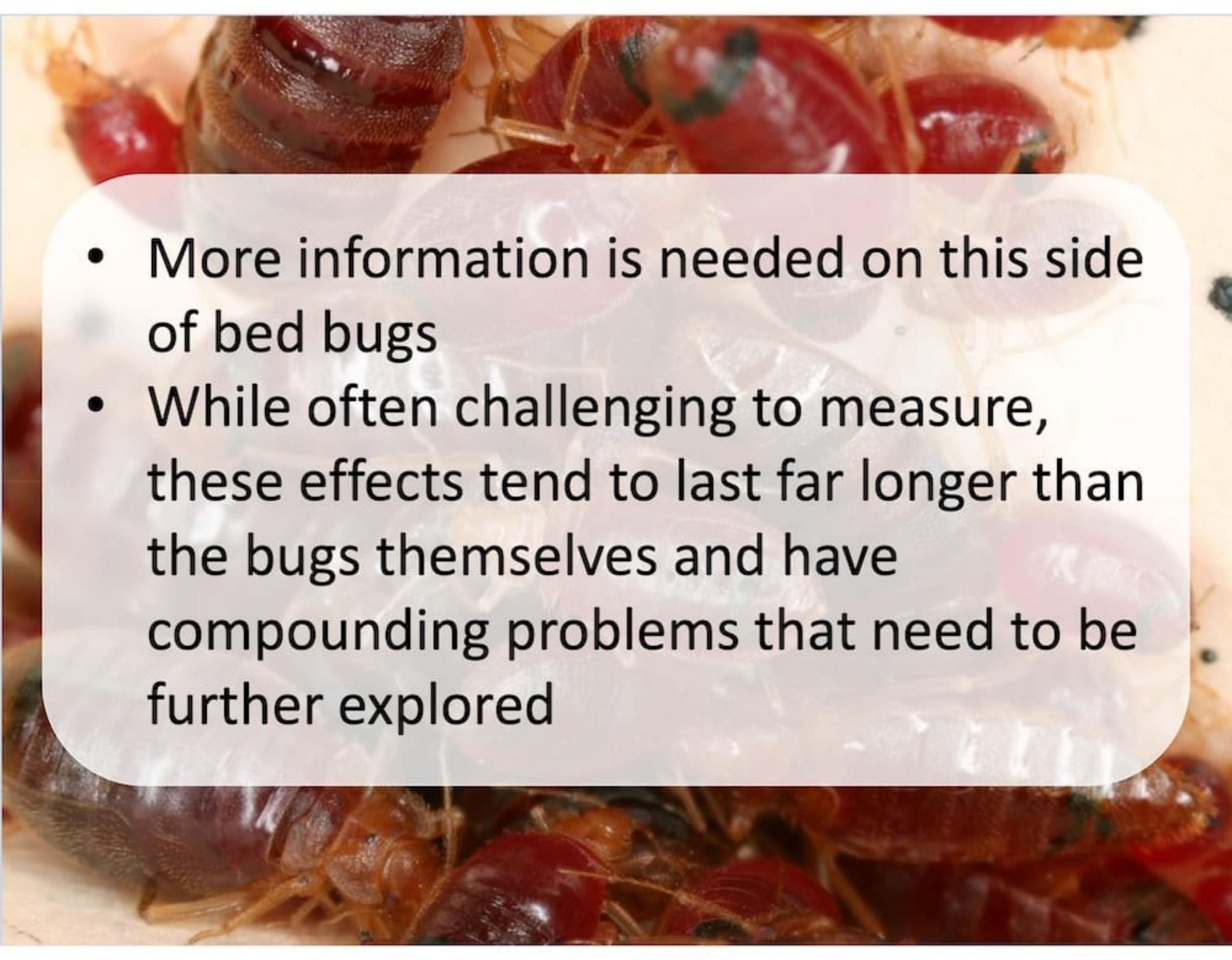


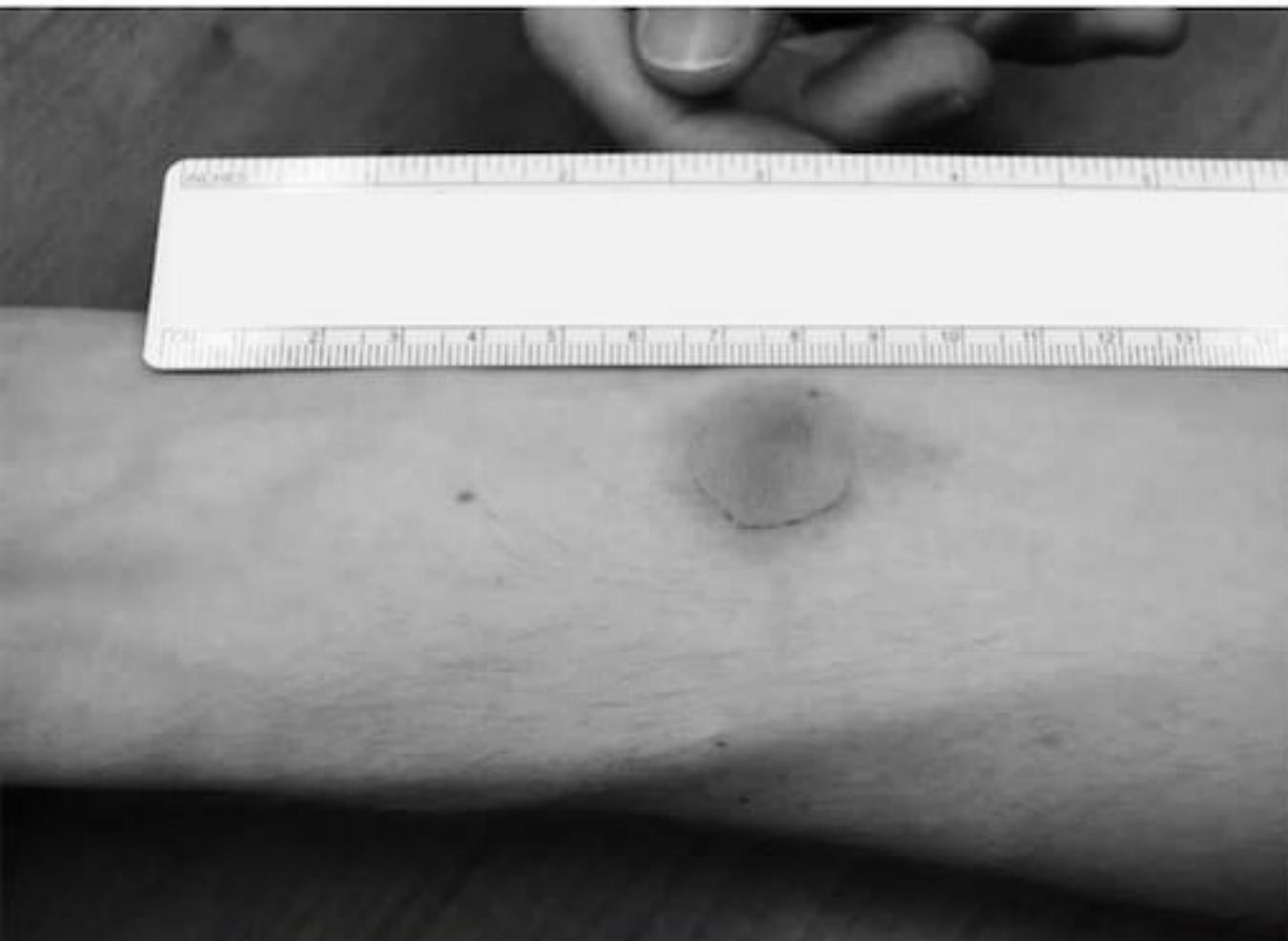


Mental health effects from urban bed bug infestation (*Cimex lectularius* L.): a cross-sectional study

Stephanie Rebecca Susser,^{1,2} Stéphane Perron,^{1,2,3} Michel Fournier,²
Louis Jacques,^{1,2} Geoffroy Denis,² François Tessier,² Pasquale Roberge⁴

- Bed bug infestations were strongly associated with anxiety and sleep disturbance
- One of the only papers to take an epidemiological approach to the impact bed bugs have on mental health (most are case studies or anecdotes)

- 
- More information is needed on this side of bed bugs
 - While often challenging to measure, these effects tend to last far longer than the bugs themselves and have compounding problems that need to be further explored



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PYRIPROXYFEN GROUP 7C INSECTICIDE

GUARANTEED! TO WORK, OR YOUR MONEY BACK!

CONTAINS NYLAR®
PREVENTS FLEAS FROM DEVELOPING
INTO THE BITING ADULT STAGE

Contiene NyLAR® - Evita que las pulgas
se conviertan en adultos mordedores



EACH CAN TREATS A ROOM
up to 16 ft x 16 ft with an 8 ft ceiling or
2,000 CU FT OF
UNOBSTRUCTED SPACE

CONTAINS
3
(2 OZ) FOGGERS

BEDBUG & FLEA FOGGER

Nebulizador para chinches de cama y pulgas

**KILLS BED BUGS,
FLEAS, LICE & TICKS** & other
listed insects

**INHIBITS FLEA REINFESTATION
FOR UP TO 7 MONTHS**

Meta chinches de cama, pulgas, piojos y garrapatas y otros insectos indicados
impide nuevas infestaciones de pulgas hasta por 7 meses

ACTIVE INGREDIENTS:

- Pyrethrin.....0.65%
 - (S)-cyano(3-phenylphenyl)(methyl)-(S)-4-chloro-
alpha-(1-methylethyl)benzenesulfonate.....0.10%
 - Pyrethrin I derivative.....0.90%
 - N-Octyl bicycloheptene dicarbodiimide.....0.15%
 - 2-(1-Methyl-2-(4-phenylphenyl) ethoxy) pyridine.....0.90%
- OTHER INGREDIENTS:** 99.89%
- 100.00%
- (Inchicabul) (E-propyl) ether and related compounds
 - MS-264, Insecticide Synergist
 - Nylar®, Insect Growth Regulator

KEEP OUT OF REACH OF CHILDREN

CAUTION See side panel for additional
precautionary statements.

MANTÉNGASE FUERA DEL ALCANCE DE LOS NIÑOS

PRECAUCIÓN

Consulte dentro de la caja para conocer
las declaraciones preventivas adicionales.

**INSTRUCCIONES EN
ESPAÑOL DENTRO
DE LA CAJA**

For terms of guarantee,
see bottom panel.

**Total Net Wt
6 oz (170 g)**

INSTRUCCIONES EN ESPAÑOL
DE LA CAJA ASESORÍA CALIFORNIA

STORAGE AND DISPOSAL

Do not combine with water, but in hot or dry
weather.
Residue Storage: Store the product in a cool, dry,
primary container. Do not use for any other purpose
or reuse for a purpose to which it is not intended.
Container Disposal: Do not reuse or refill.
Fragile: Do not use for any other purpose.
If party label call for local and state agency for
proper disposal.

PRECAUTIONARY STATEMENTS

HAZARD TO HUMANS AND DOMESTIC ANIMALS:
CAUTION: Irritant. Avoid breathing mist or spray
and avoid contact with eyes, nose, mouth, and skin.
Wash hands thoroughly with soap and water after
use. Avoid eating, drinking, or smoking while
using the product. Avoid contact with children and
pets.

FIRST AID

IF SWALLOWED: • Do not induce vomiting.
• Give milk or water to drink.
• Call a Poison Control Center or doctor for
further advice.

• If on skin: Wash with plenty of water.
• If in eyes: Flush with water for 15 minutes.
• If inhaled: Get fresh air immediately. If breathing
difficulty, call 1-800-4-A-S-A-I.

Physical or Chemical Hazard

• Irritant to eyes, nose, and throat.
• May cause dizziness or headache.
• May cause skin irritation.
• May cause respiratory irritation.
• May cause allergic reactions in
sensitive individuals.



Highly
Flammable
Liquid
N9500
California
Proposition
65



CAUGHT ON CAMERA

BUS NEARLY RUNS OVER STRIKERS

SEATTLE, WA

abc 13 ACTION NEWS

STATION 13 NEWS

U.S. NEWS

LOCAL

RIENCE. WAITING FOR UPDATE FROM POLICE ON POSSIBLE SUS

5:14

64°



Man trying to destroy **bedbugs** sets apartment ablaze

Detroit Free Press - Jan 8, 2016

But then, while sitting on the alcohol doused couch, the man lit a cigarette and also tried to s...



Family **home** burnt in attempt to kill **bed bugs**

Newstalk 106-108 fm - Feb 6, 2015

A family was forced to flee their burning **home** after an attempt to rid a **house** of **bedbugs** went horribly wrong. The **fire** broke out early Wednesday morning at the **house** in Columbus, Ohio after a child accidentally **set** alight a couch while trying ...



Invasion of the **KILLER** bedbugs

WND.com - Jan 10, 2016

Not everyone plagued with **bedbugs** is as fortunate as this victim. ... her didn't work – all because their **home** was infested with **bedbugs**.

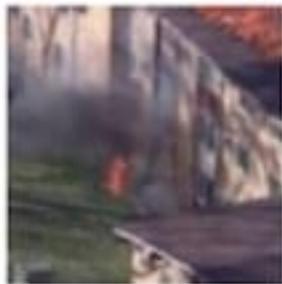
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Torment of **bedbugs** drove woman to **set** apartment **fire**

Detroit Free Press - Nov 5, 2015

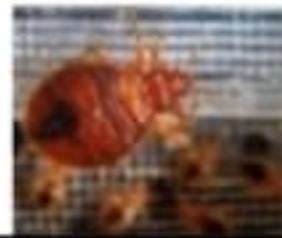
Sherry Young says she spent close to a year living in fear of **bedbugs**. So on Monday, sleep deprived and desperate, she turned



Woman who started blaze trying to kill **bed bugs**: 'I am so ...

Fox 2 Detroit - Nov 4, 2015

DETROIT (WJBK) - The apartment building in De
Distraught and ...



Man **Sets** **Fire** to 3 Cars While Trying to Get Rid of **Bed B...**

TIME - Apr 16, 2015

A New York man was hospitalized Tuesday after he accidentally **set** three cars on **fire** while attempting to remove **bed bugs** from a rental ...



New Jersey man **sets** house on fire trying to kill **bedbugs**

New York Daily News - Jun 14, 2013

WOODBURY, N.J. - A New Jersey **house** fire is being blamed on a ... high, sustained heat can kill **bedbugs**, but raising the temperature with the ...

Official: W
CBS Loca



A woman tried to kill bedbugs with alcohol -- and set a **fire** that left 10 ...

Washington Post - Dec 10, 2017

Three people were hospitalized and several others lost their homes after a woman accidentally started a **fire** inside a multifamily building while trying to kill **bed bugs** with alcohol, authorities said. The **fire** broke out late Friday in Cincinnati's Avondale neighborhood, just north of downtown. Randy Freel ...

90
FD: FIRE STARTER
HAWAIIAN TERR

WRE
50

Bites

Disease
Transmission?

Clearly, bed bugs can
have a substantial impact
on human health

DIY Harm

Psychological

9 ON YOUR SIDE AT NOON

FD: FIRE STARTED WHEN TEEN TRIED TO BURN BEDBUGS
HAWAIIAN TERRACE

9
abc
12:01



What else do we need
to worry about?

Outline

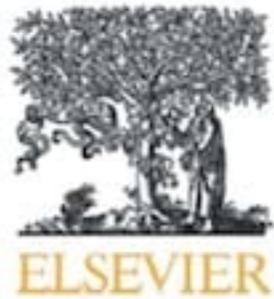
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Contents lists available at ScienceDirect

Science of the Total Environment

journal homepage: www.elsevier.com/locate/scitotenv



Bed bugs shape the indoor microbial community composition of infested homes



Madhavi L. Kakumanu^{a,*}, Zachary C. DeVries^{a,b}, Alexis M. Barbarin^{a,c}, Richard G. Santangelo^a, Coby Schal^{a,**}

^a Department of Entomology and Plant Pathology and Center for Human Health and the Environment, North Carolina State University, Raleigh, NC, United States

^b Department of Entomology, University of Kentucky, Lexington, KY, United States

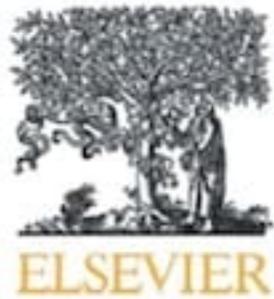
^c Division of Public Health, Communicable Disease Branch, Raleigh, NC, United States

- The microbial communities differ between infested and uninfested homes





Photo courtesy of Peter Wendorf (Rose Pest Solutions)



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Bed bugs shape the indoor microbial community composition of infested homes



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^a Department of Entomology and Plant Pathology and Center for Human Health and the Environment, North Carolina State University, Raleigh, NC, United States

^b Department of Entomology, University of Kentucky, Lexington, KY, United States

^c Division of Public Health, Communicable Disease Branch, Raleigh, NC, United States

- Bed bug eradication can shift the composition back towards that of uninfested homes
- Health risks for the shifted microbiome are unknown but concerning.

Allergens and Other Contaminants?



Photo courtesy of B. Campbell

**Lessons learned
from the German
cockroach!**



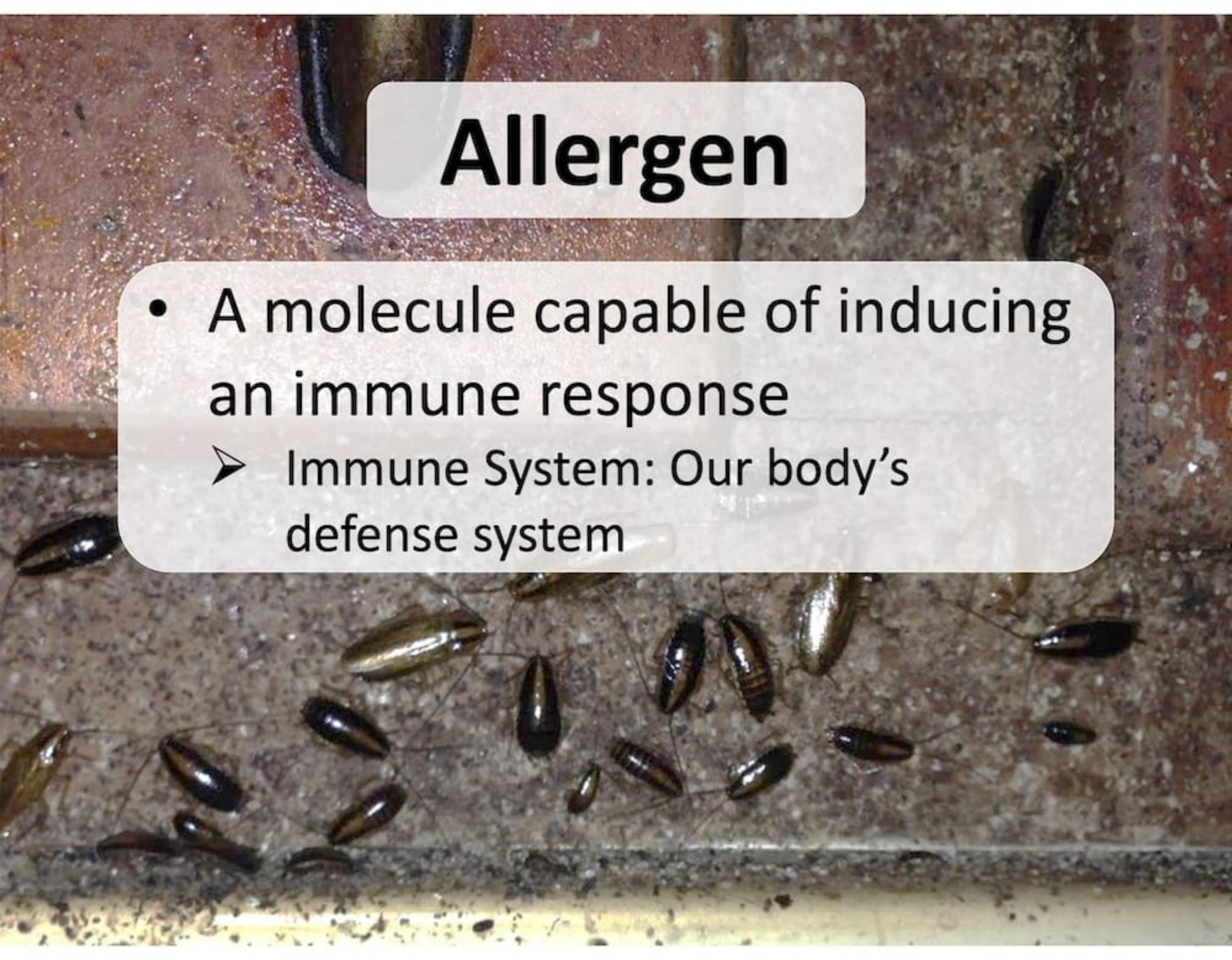
Cockroach Allergens

- Produce several potent allergens
- Found in feces, muscles, tergal glands, others
- What is an allergen?



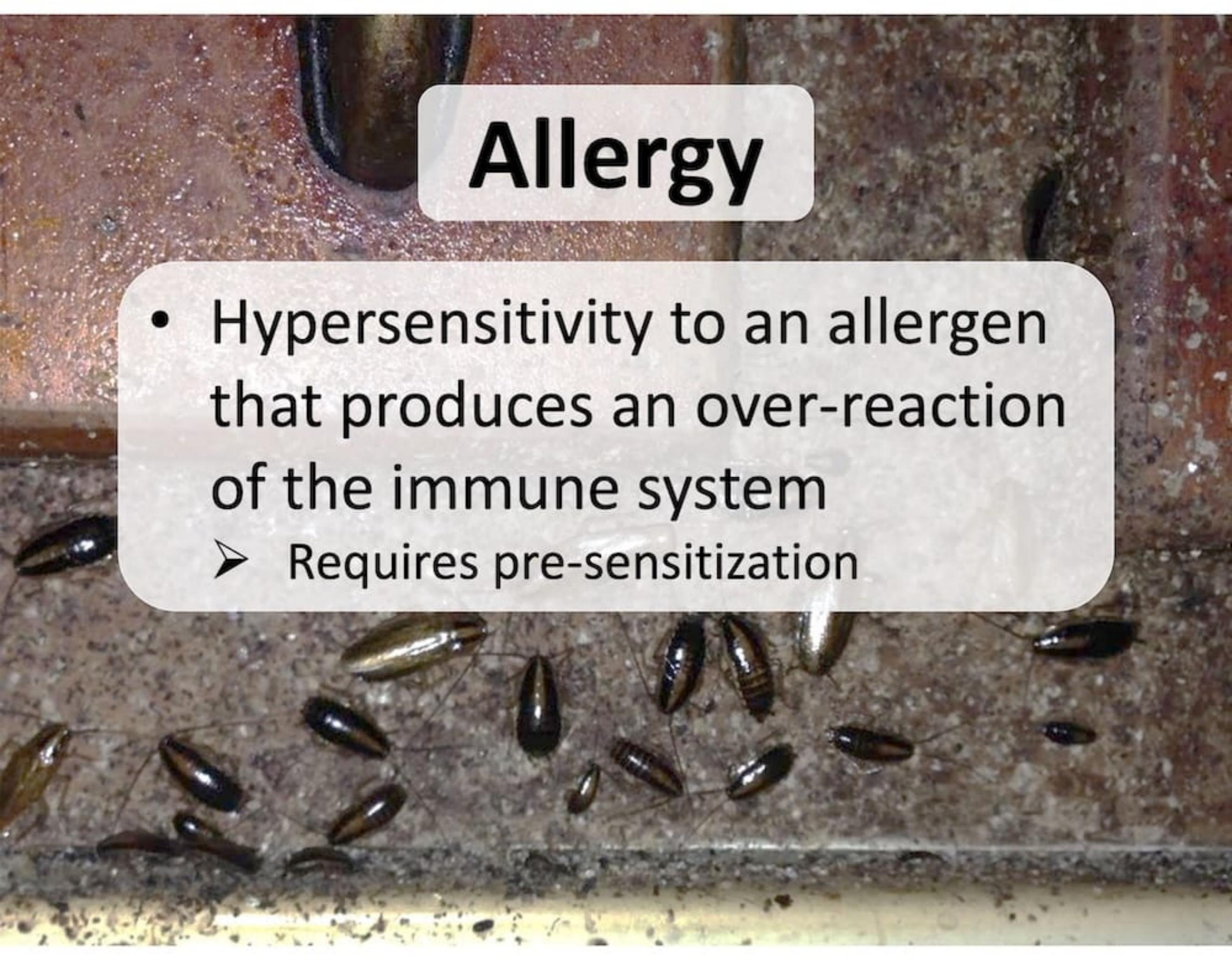
Allergen

- A molecule capable of inducing an immune response
 - Immune System: Our body's defense system



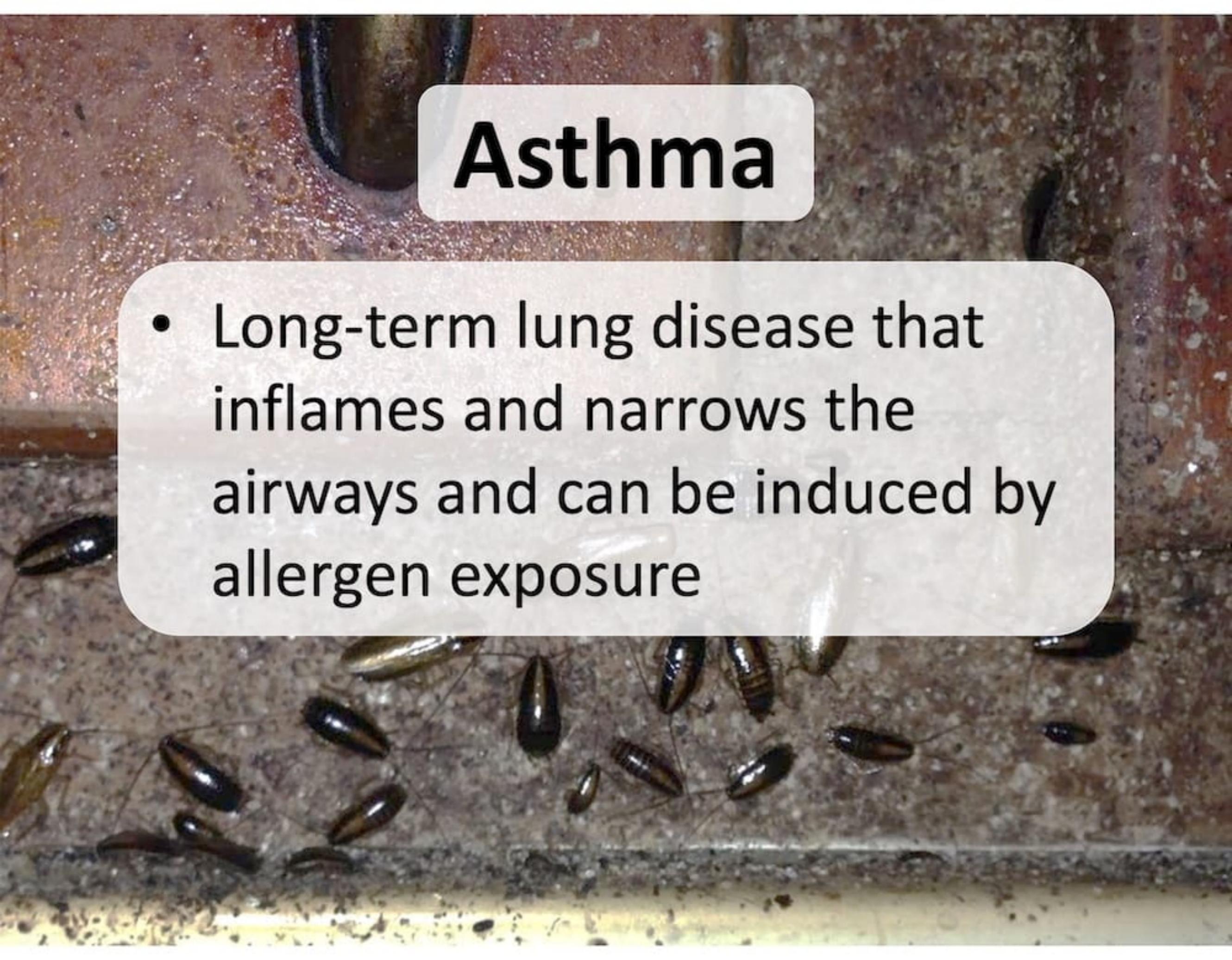
Allergy

- Hypersensitivity to an allergen that produces an over-reaction of the immune system
 - Requires pre-sensitization



Asthma

- Long-term lung disease that inflames and narrows the airways and can be induced by allergen exposure



Importance of Asthma

- Number of people currently affected in the United States
>25 million (>7 million children)
- Estimated cost in the United States
\$82 billion annually
- Percentage of US population allergic to cockroaches
>26% (44-81% for inner-city children with asthma)

Asthma Disproportionally Effects Children, Women, Minorities, and those Living in Poverty

- Children have 2x as many ER visits compared to adults
- Asthma associated deaths are 2x higher in women compared to men
- Asthma hospitalization rate is 3x higher among African Americans compared to Caucasians
- Low-income environments were found to be associated with the development of asthma

Risks Factors:

- Pollution
- Moisture
- Air circulation
- Allergen levels
- Diet

Ast

Through cockroach control alone, we can reduce or eliminate the environmental factor

nt

~~environment~~

~~environment~~

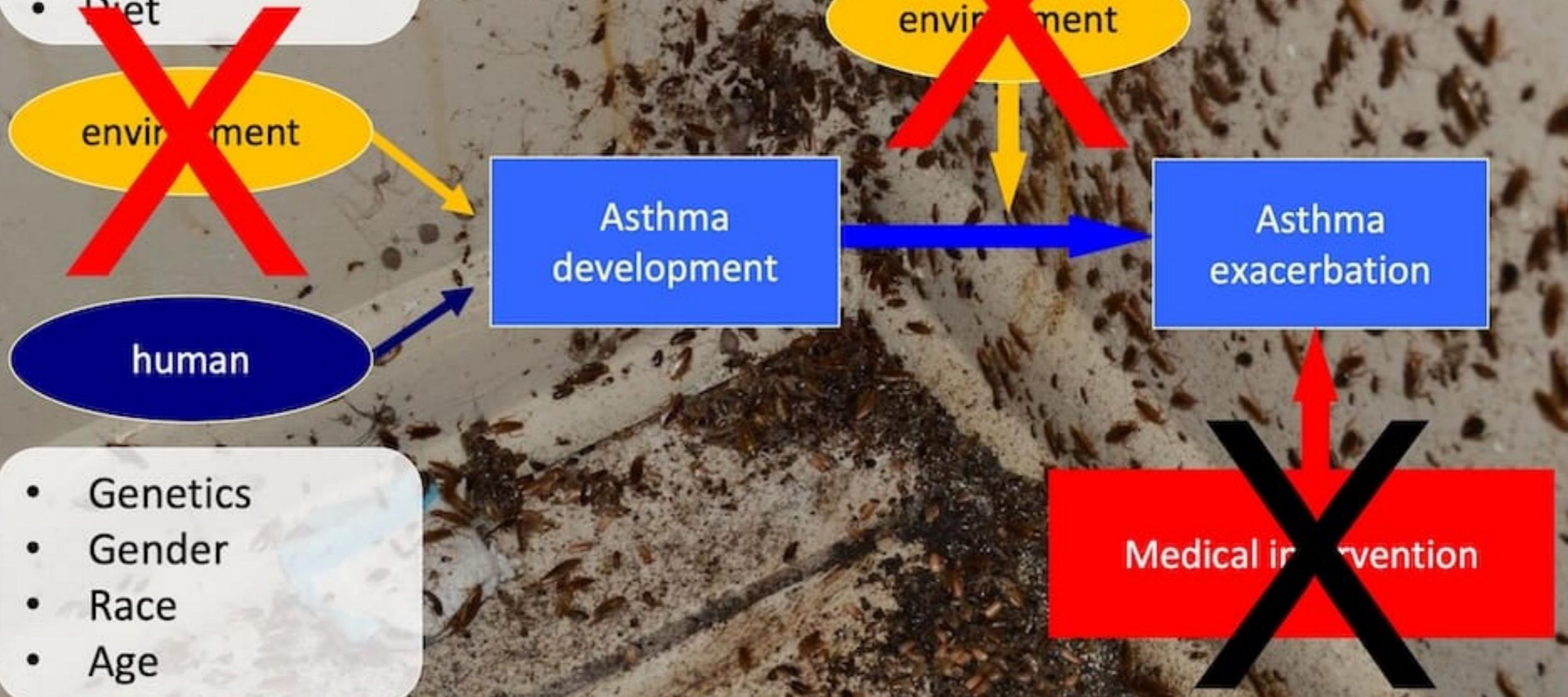
human

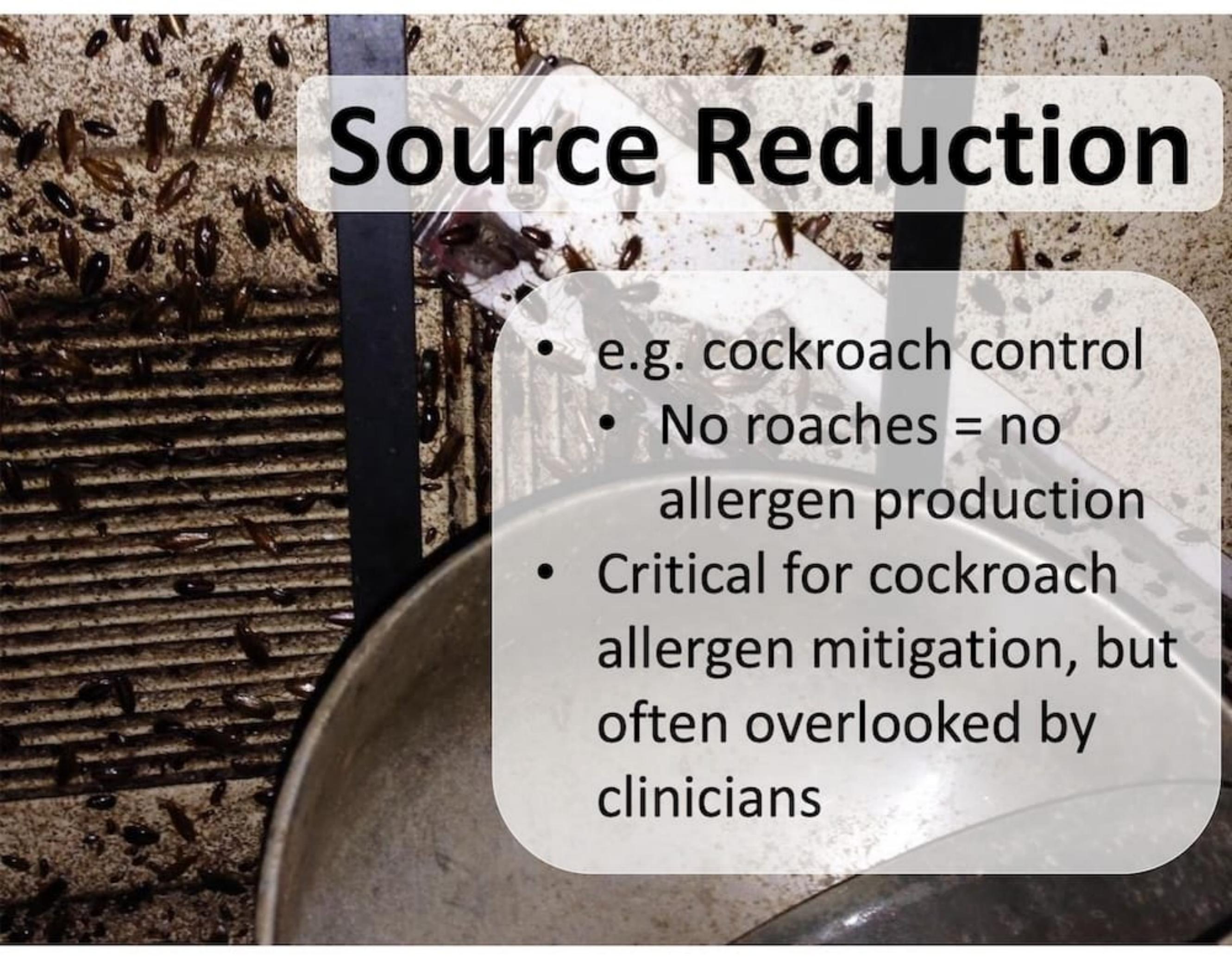
Asthma development

Asthma exacerbation

- Genetics
- Gender
- Race
- Age

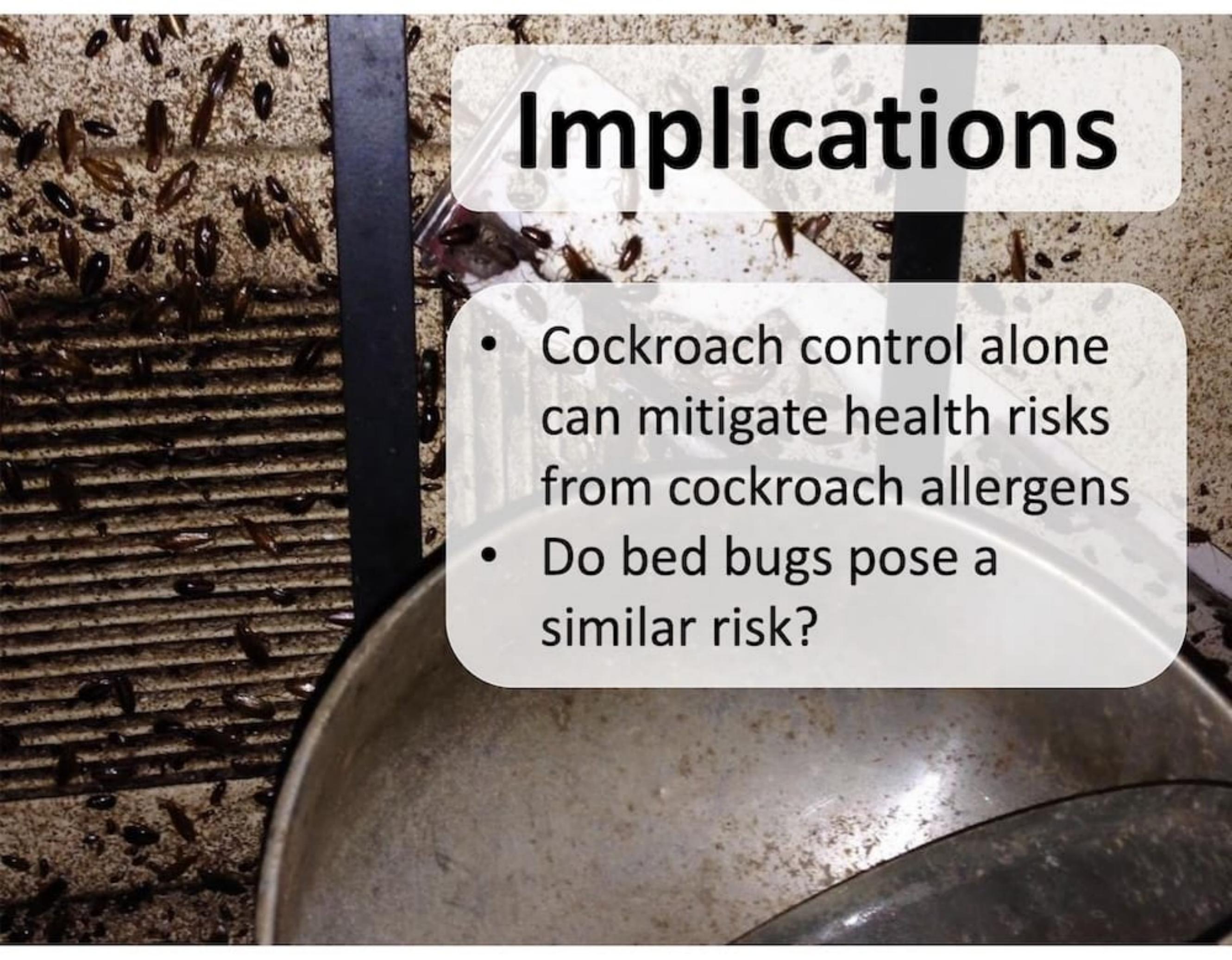
~~Medical intervention~~





Source Reduction

- e.g. cockroach control
 - No roaches = no allergen production
- Critical for cockroach allergen mitigation, but often overlooked by clinicians

A photograph showing a large number of cockroaches on a light-colored floor. The cockroaches are concentrated around a metal grate on the left and a metal pan on the right. The background is a plain, light-colored wall.

Implications

- Cockroach control alone can mitigate health risks from cockroach allergens
- Do bed bugs pose a similar risk?



Photo courtesy of B. Campbell



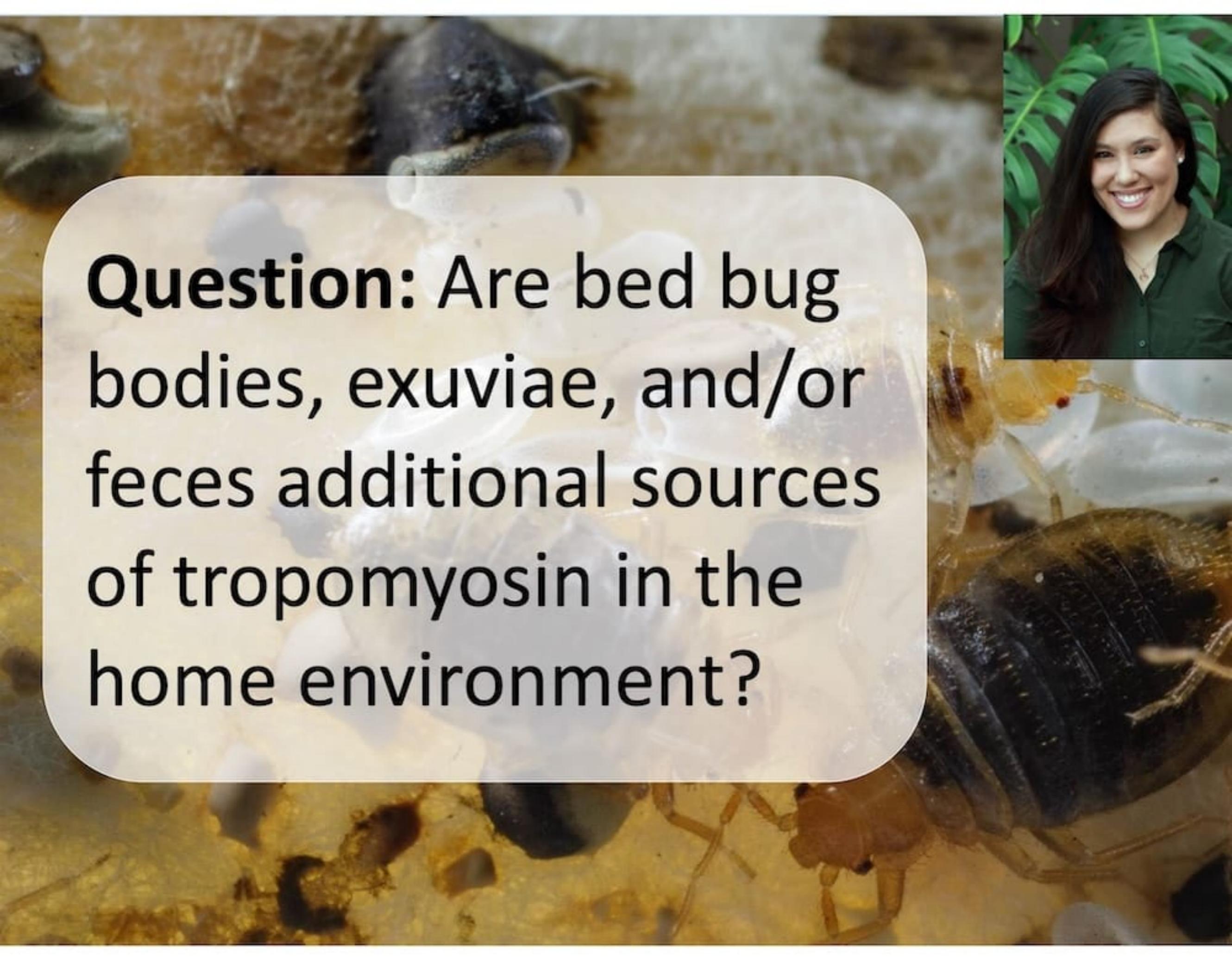
Photo courtesy of Peter Wendorf (Rose Pest Solutions)

Tropomyosin

- Long fibrous protein found in muscles
- Ubiquitous among all animals, but structures varies by group
- Known Pan Allergen

Pan Allergen

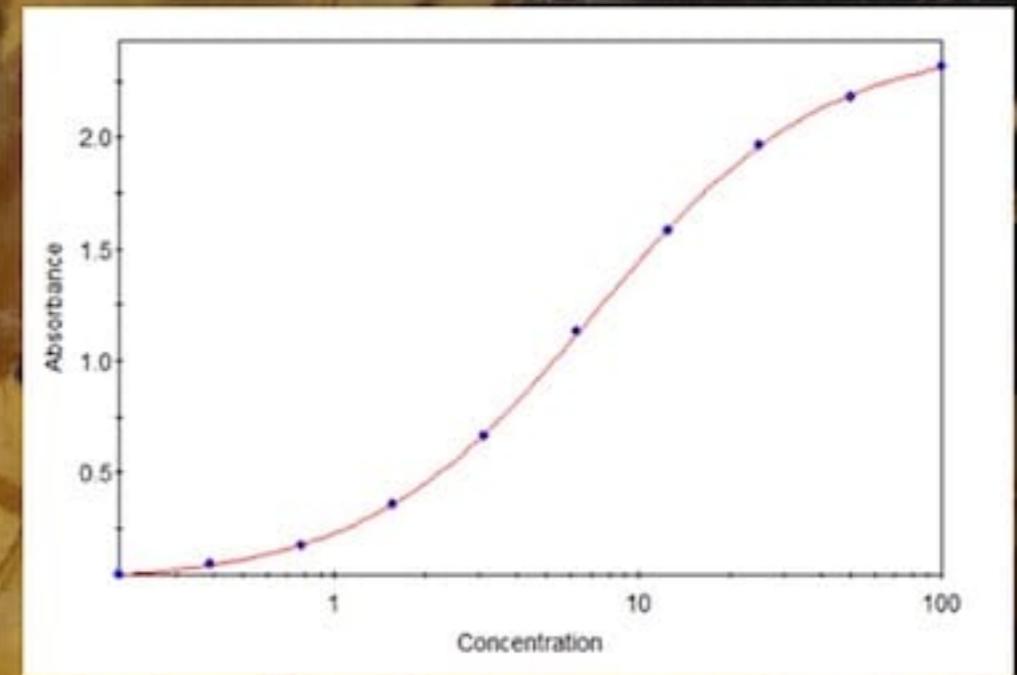
- An allergenic protein, found across different organisms, that can cause cross-reactivity across distantly-related species
- Cross-reactivity: when the proteins in one organism are similar to the proteins in another – results in similar immune response



Question: Are bed bug bodies, exuviae, and/or feces additional sources of tropomyosin in the home environment?



Tropomyosin Analysis



Bed bug bodies must be ground to release tropomyosin into the environment

ng tropomyosin/ bed bug

400
300
200
100
0

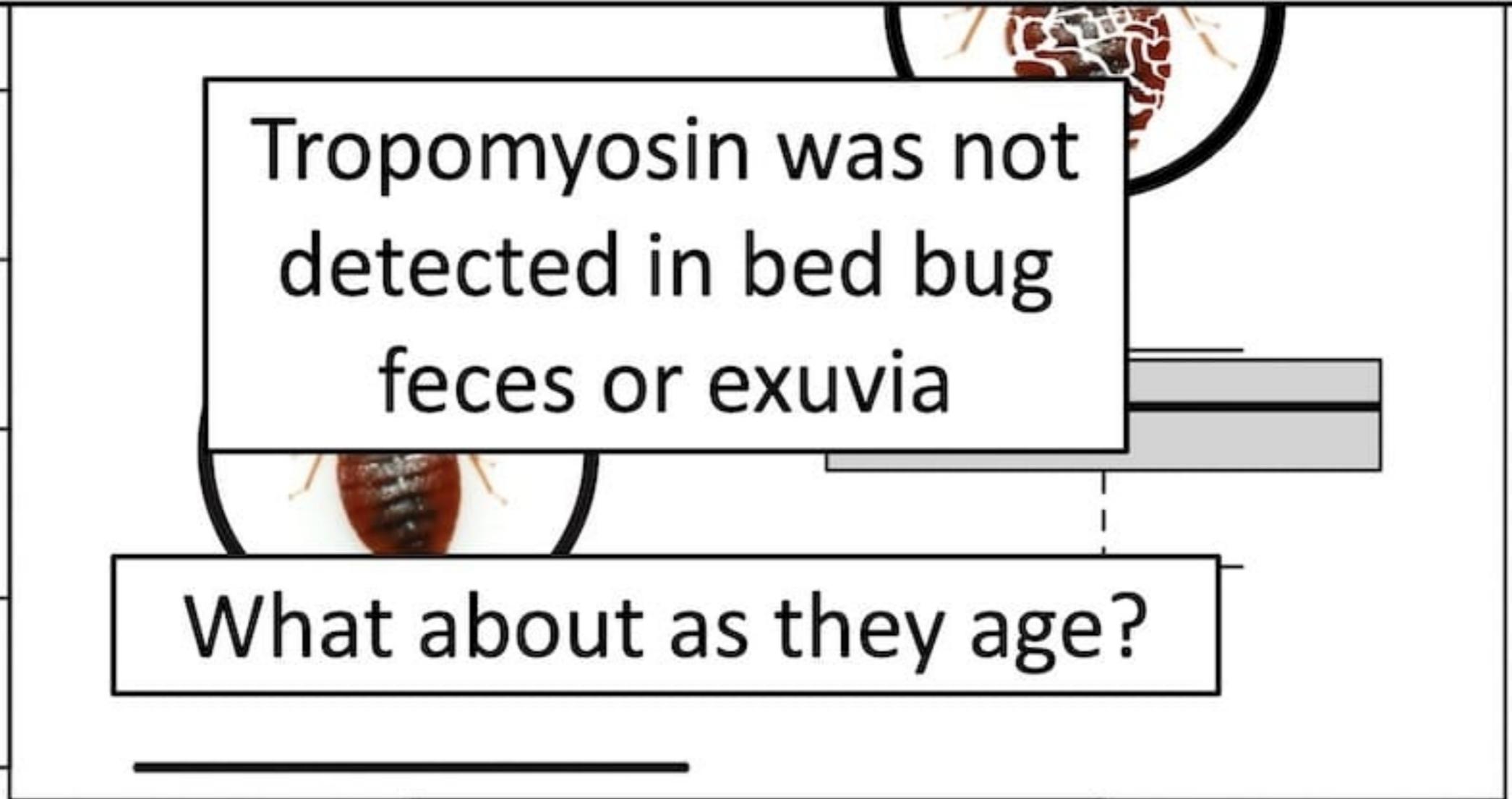
Tropomyosin was not detected in bed bug feces or exuvia

What about as they age?

Whole Body (24 hr)
n = 10

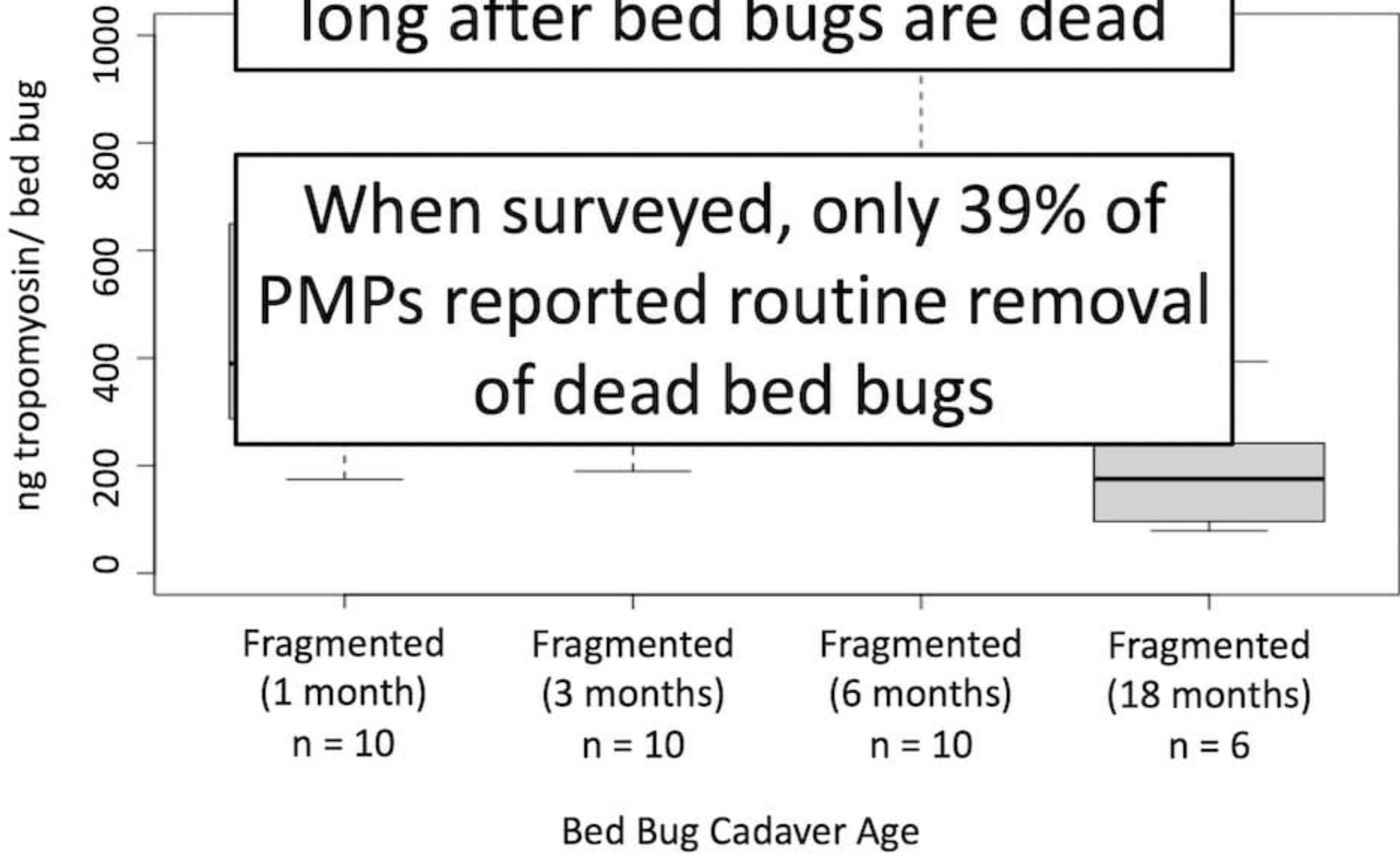
Fragmented Body (24 hr)
n = 9

Bed bug condition



Bed bug tropomyosin persists long after bed bugs are dead

When surveyed, only 39% of PMPs reported routine removal of dead bed bugs



Implications

- Bed bug cadavers may act as ticking “tropomyosin” time bombs
 - Could also be true for other indoor allergens!
- If we don't remove dead insects, we may be trading one problem for another.

Bed Bug Histamine



Insect Pheromones



Bed Bug Aggregation Pheromone Finally Identified**

Regine Gries, Robert Britton, Michael Holmes, Huimin Zhai, Jason Draper, and Gerhard Gries**

Aggregation Pheromone

1. Dimethyl disulfide
2. Dimethyl trisulfide
3. (E)-2-hexenal
4. (E)-2-octenal
5. 2-hexanone
6. Histamine



Insect Pheromones

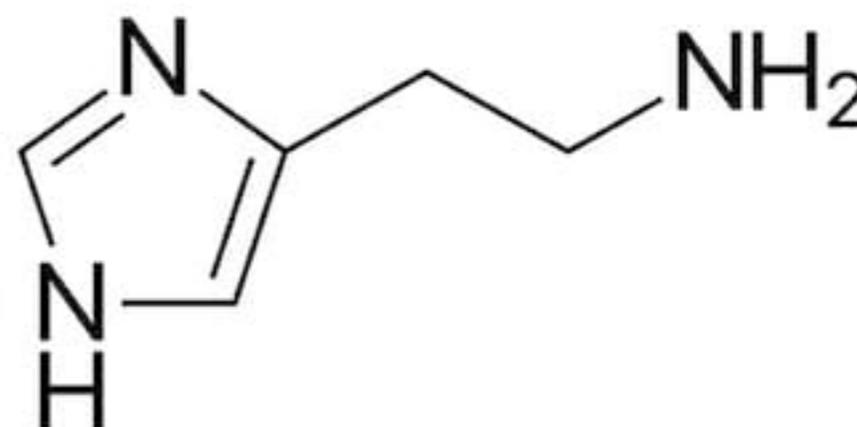


Bed Bug Aggregation Pheromone Finally Identified**

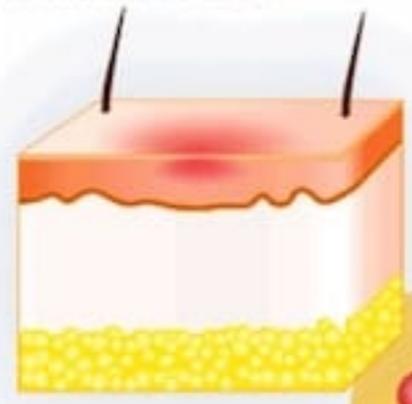
Regine Gries, Robert Britton, Michael Holmes, Huimin Zhai, Jason Draper, and Gerhard Gries**

Aggregation Pheromone

1. Dimethyl disulfide
2. Dimethyl trisulfide
3. (E)-2-hexenal
4. (E)-2-octenal
5. 2-hexanone
- 6. Histamine**



Swelling and Inflammation



Adrenaline Release



Bronchoconstriction (as in asthma or allergies)



Activated Histamine

Stimulation of Gastric Acid Secretion



Dilation of Blood Vessels



Blood Clotting



Vessels and Capillaries Increase In Permeability



Frequent Heartbeat

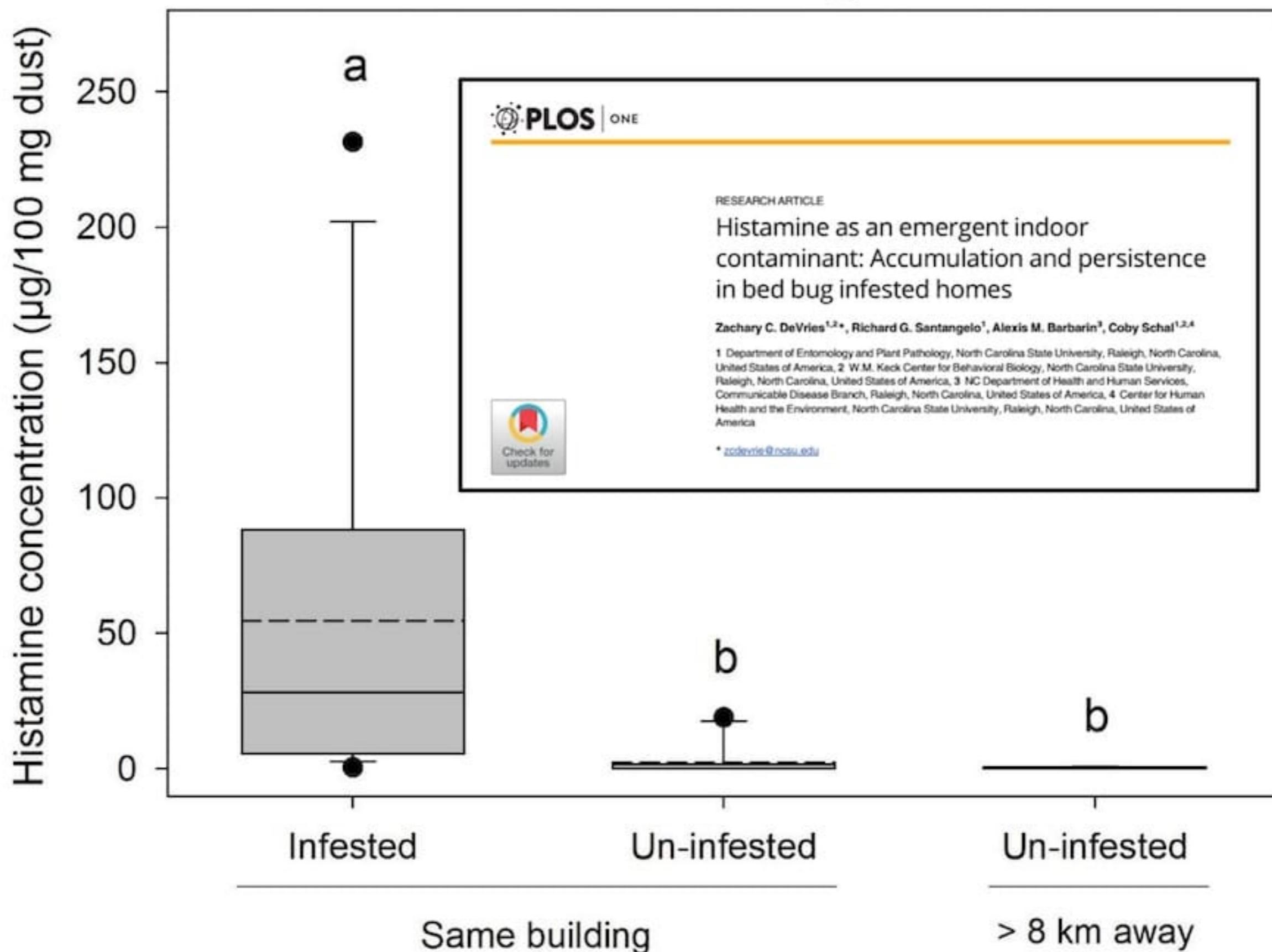
**Does histamine
accumulate indoors?**



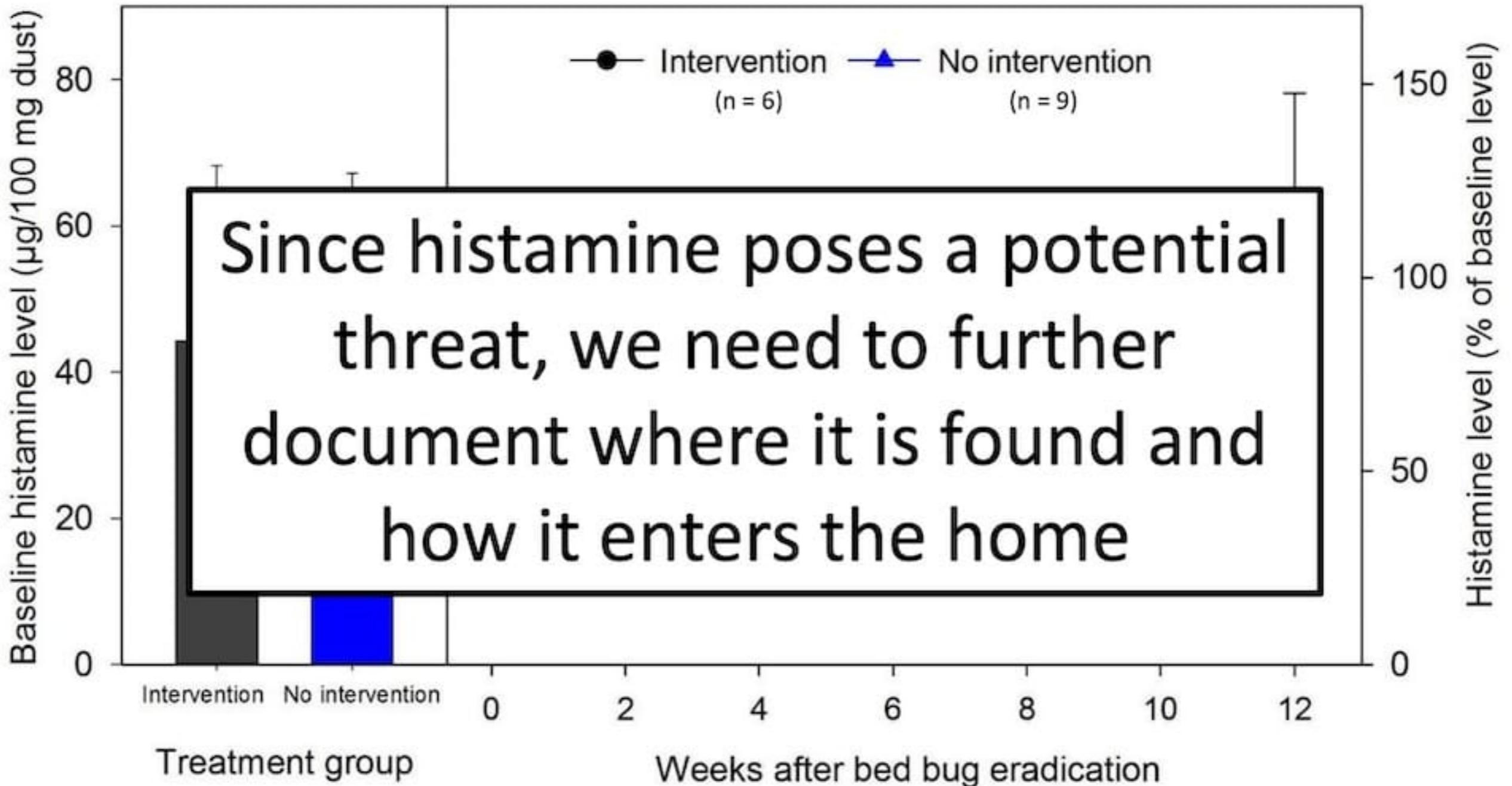




Histamine is found in bed bug infested homes

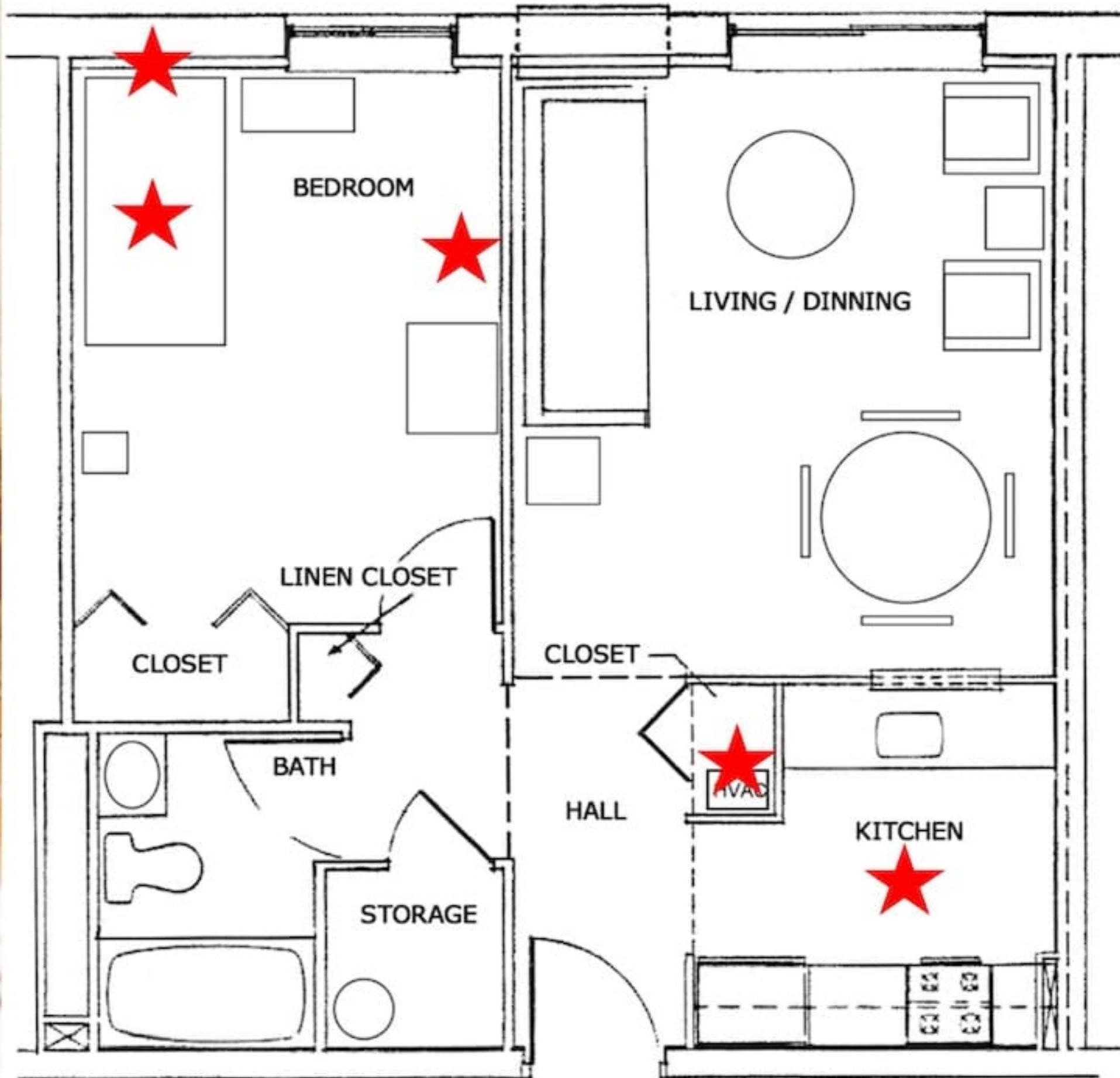


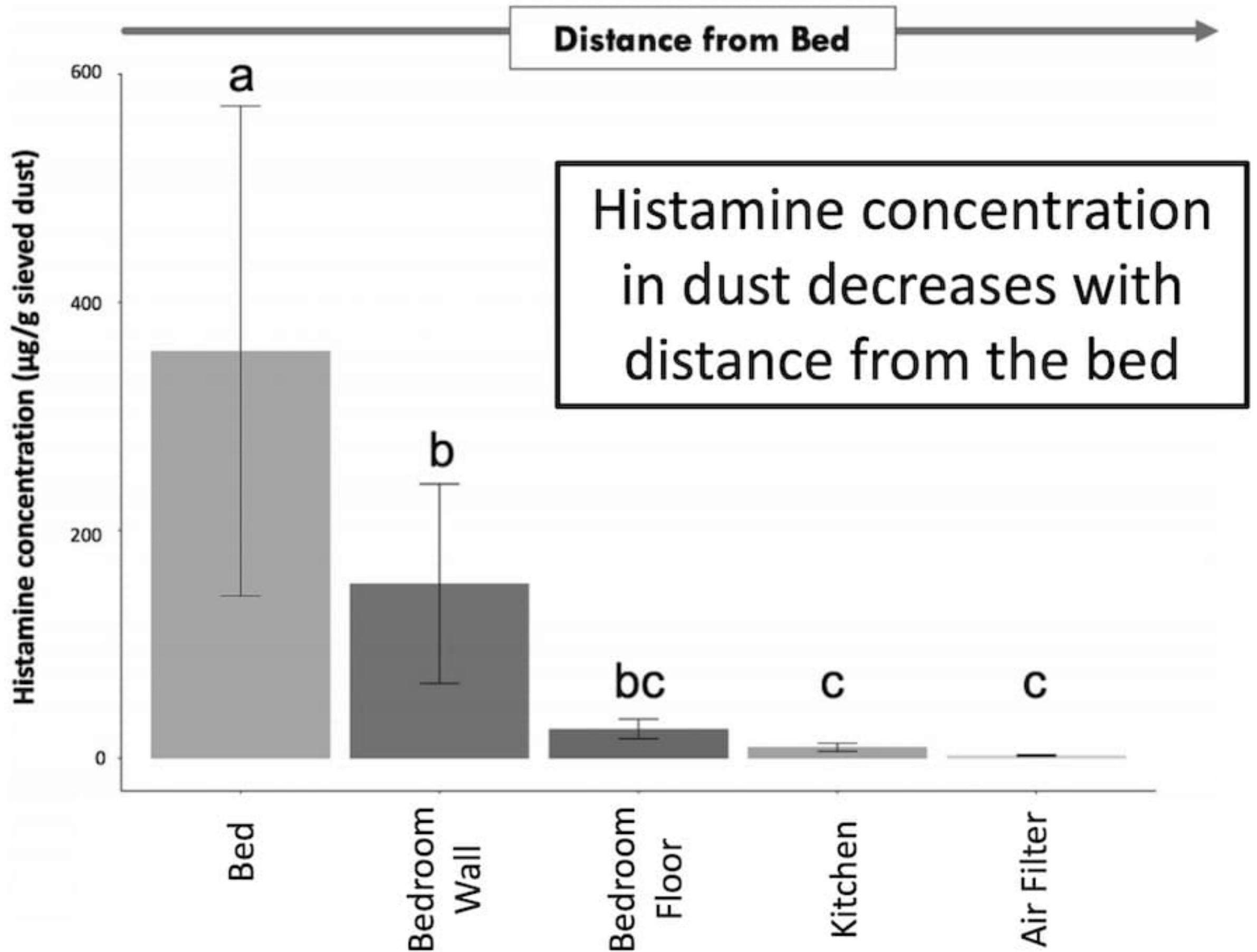
Histamine persists after bed bug eradication



Where is histamine found indoors?







**Is histamine unique
to bed bugs?**



Histamine Screening

- Standardized collection kit
- Collection from rearing containers
- 3 replicates per species
- Population size and life stage recorded



Indoor Pests



Mold mite



Borer beetle



Fruit fly



Carpet beetle



Red flour beetle



Oriental cockroach



American cockroach



Grocer's itch mite



House dust mite



German cockroach



House fly



Indianmeal moth

Blood Feeders



Cat flea



Yellow fever mosquito



Lone star tick

Hemipterans

Plant feeding Hemipteran



Brown marmorated stink bug

Blood feeding Hemipterans



Bed bug



Bat bug



Tropical Bed bug



Triatoma rubida



Rhodnius prolixus

Kissing bugs

Histamine detection	Presence/Absence
Indoor pests	
German cockroach (<i>Blattella germanica</i>)	
American cockroach (<i>Periplaneta americana</i>)	
Oriental cockroach (<i>Blatta orientalis</i>)	
Eastern subterranean termite (<i>Reticulitermes flavipes</i>)	
House fly (<i>Musca domestica</i>)	
Fruit fly (<i>Drosophila melanogaster</i>)	
Indian meal moth (<i>Plodia interpunctella</i>)	
Varied carpet beetle (<i>Anthrenus verbasci</i>)	
Borer beetle (<i>Oligomerus pullus</i>)	
Red flour beetle (<i>Tribolium castaneum</i>)	
House dust mite (<i>Dermatophagoides farinae</i>)	
Mold mite (<i>Glycyphagus domesticus</i>)	
Grocer's mite (<i>Glycyphagus domesticus</i>)	
Blood-feeding species	
Yellow fever mosquito (<i>Aedes aegypti</i>)	
Lone star tick (<i>Amblyomma americanum</i>)	
Cat flea (<i>Ctenocephalides felis</i>)	
Phytophagous Hemipterans	
Brown marmorated stink bug (<i>Halyomorpha halys</i>)	
Blood-feeding Hemipterans	
Bed bug (<i>Cimex lectularius</i>)	
Bat bug (<i>Cimex adjunctus</i>)	
Tropical bed bug (<i>Cimex hemipterus</i>)	
Kissing bug (<i>Rhodnius prolixus</i>)	
Kissing bug (<i>Triatoma rubida</i>)	

Principato et al.,
2023, J. Medical.
Entomology

Histamine detection	Presence/Absence
Indoor pests	
German cockroach (<i>Blattella germanica</i>)	×
American cockroach (<i>Periplaneta americana</i>)	×
Oriental cockroach (<i>Blatta orientalis</i>)	×
Eastern subterranean termite (<i>Reticulitermes flavipes</i>)	×
House fly (<i>Musca domestica</i>)	×
Fruit fly (<i>Drosophila melanogaster</i>)	×
Indian meal moth (<i>Plodia interpunctella</i>)	×
Varied carpet beetle (<i>Anthrenus verbasci</i>)	×
Borer beetle (<i>Oligomerus pullus</i>)	×
Red flour beetle (<i>Tribolium castaneum</i>)	×
House dust mite (<i>Dermatophagoides farinae</i>)	×
Mold mite (<i>Glycyphagus domesticus</i>)	×
Grocer's mite (<i>Glycyphagus domesticus</i>)	×
Blood-feeding species	
Yellow fever mosquito (<i>Aedes aegypti</i>)	
Lone star tick (<i>Lone star tick</i>)	
Cat flea (<i>Cat flea</i>)	
Phytophagous species	
Brown mite (<i>Brown mite</i>)	
Blood-feeding species	
Bed bug (<i>Bed bug</i>)	
Bat bug (<i>Bat bug</i>)	
Tropical bed bug (<i>Cimex hemipterus</i>)	
Kissing bug (<i>Rhodnius prolixus</i>)	
Kissing bug (<i>Triatoma rubida</i>)	

Histamine not detected
in any other common
indoor arthropods

Histamine detection	Presence/Absence
Indoor pests	
German cockroach (<i>Blattella germanica</i>)	×
American cockroach (<i>Periplaneta americana</i>)	×
Oriental cockroach (<i>Blatta orientalis</i>)	×
Eastern...	
House f...	
Fruit fly	
Indian r...	
Varied c...	
Borer b...	
Red flo...	
House dust mite (<i>Dermatophagoides farinae</i>)	×
Mold mite (<i>Glycyphagus domesticus</i>)	×
Grocer's mite (<i>Glycyphagus domesticus</i>)	×
Blood-feeding species	
Yellow fever mosquito (<i>Aedes aegypti</i>)	×
Lone star tick (<i>Amblyomma americanum</i>)	×
Cat flea (<i>Ctenocephalides felis</i>)	×
Phytophagous Hemipterans	
Brown marmorated stink bug (<i>Halyomorpha halys</i>)	
Blood-feeding Hemipterans	
Bed bug (<i>Cimex lectularius</i>)	
Bat bug (<i>Cimex adjunctus</i>)	
Tropical bed bug (<i>Cimex hemipterus</i>)	
Kissing bug (<i>Rhodnius prolixus</i>)	
Kissing bug (<i>Triatoma rubida</i>)	

Histamine not
detected in other
blood feeding species

Histamine detection	Presence/Absence
Indoor pests	
German cockroach (<i>Blattella germanica</i>)	×
American cockroach (<i>Periplaneta americana</i>)	×
Oriental cockroach (<i>Blatta orientalis</i>)	×
Eastern subterranean termite (<i>Reticulitermes flavipes</i>)	×
House fly	
Fruit fly (A)	
Indian me	
Varied ca	
Borer bee	
Red flour	
House du	
Mold mite (<i>Glycyphagus domesticus</i>)	+
Grocer's mite (<i>Glycyphagus domesticus</i>)	+
Blood-feeding species	
Yellow fever mosquito (<i>Aedes aegypti</i>)	×
Lone star tick (<i>Amblyomma americanum</i>)	×
Cat flea (<i>Ctenocephalides felis</i>)	×
Phytophagous Hemipterans	
Brown marmorated stink bug (<i>Halyomorpha halys</i>)	×
Blood-feeding Hemipterans	
Bed bug (<i>Cimex lectularius</i>)	
Bat bug (<i>Cimex adjunctus</i>)	
Tropical bed bug (<i>Cimex hemipterus</i>)	
Kissing bug (<i>Rhodnius prolixus</i>)	
Kissing bug (<i>Triatoma rubida</i>)	

Histamine not found
in a plant-feeding
hemipteran

Histamine detection	Presence/Absence
Indoor pests	

Histamine appears to be common among blood feeding hemipterans

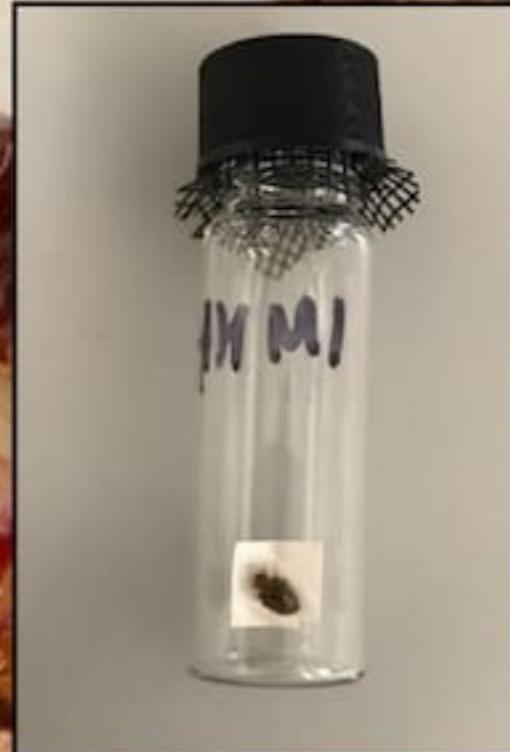
Bed bugs are the most important species to worry about for indoor contamination

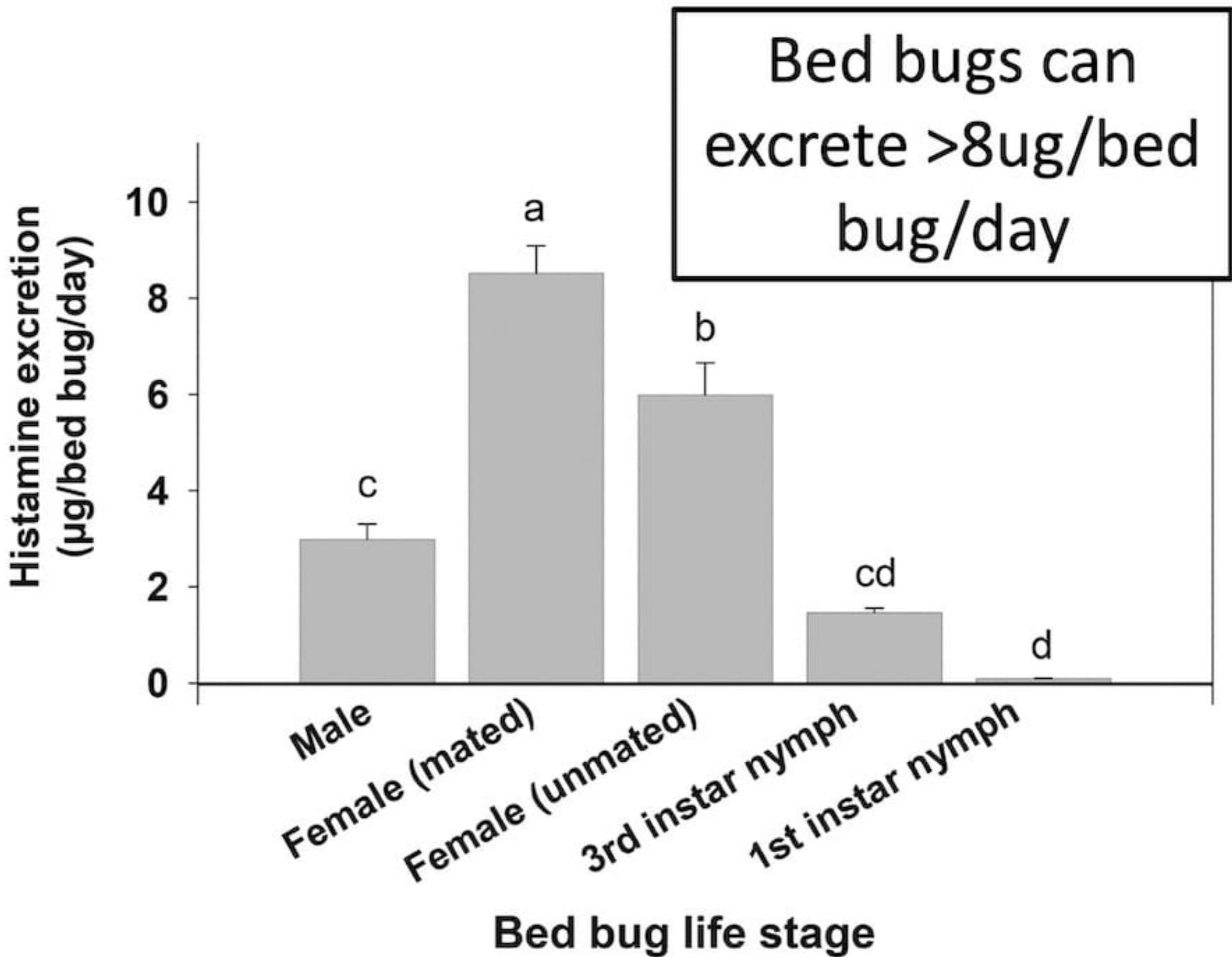
Cat flea (<i>Ctenocephalides felis</i>)	✗
Phytophagous Hemipterans	
Brown marmorated stink bug (<i>Halyomorpha halys</i>)	✗
Blood-feeding Hemipterans	
Bed bug (<i>Cimex lectularius</i>)	✓
Bat bug (<i>Cimex adjunctus</i>)	✓
Tropical bed bug (<i>Cimex hemipterus</i>)	✓
Kissing bug (<i>Rhodnius prolixus</i>)	✓
Kissing bug (<i>Triatoma rubida</i>)	✓

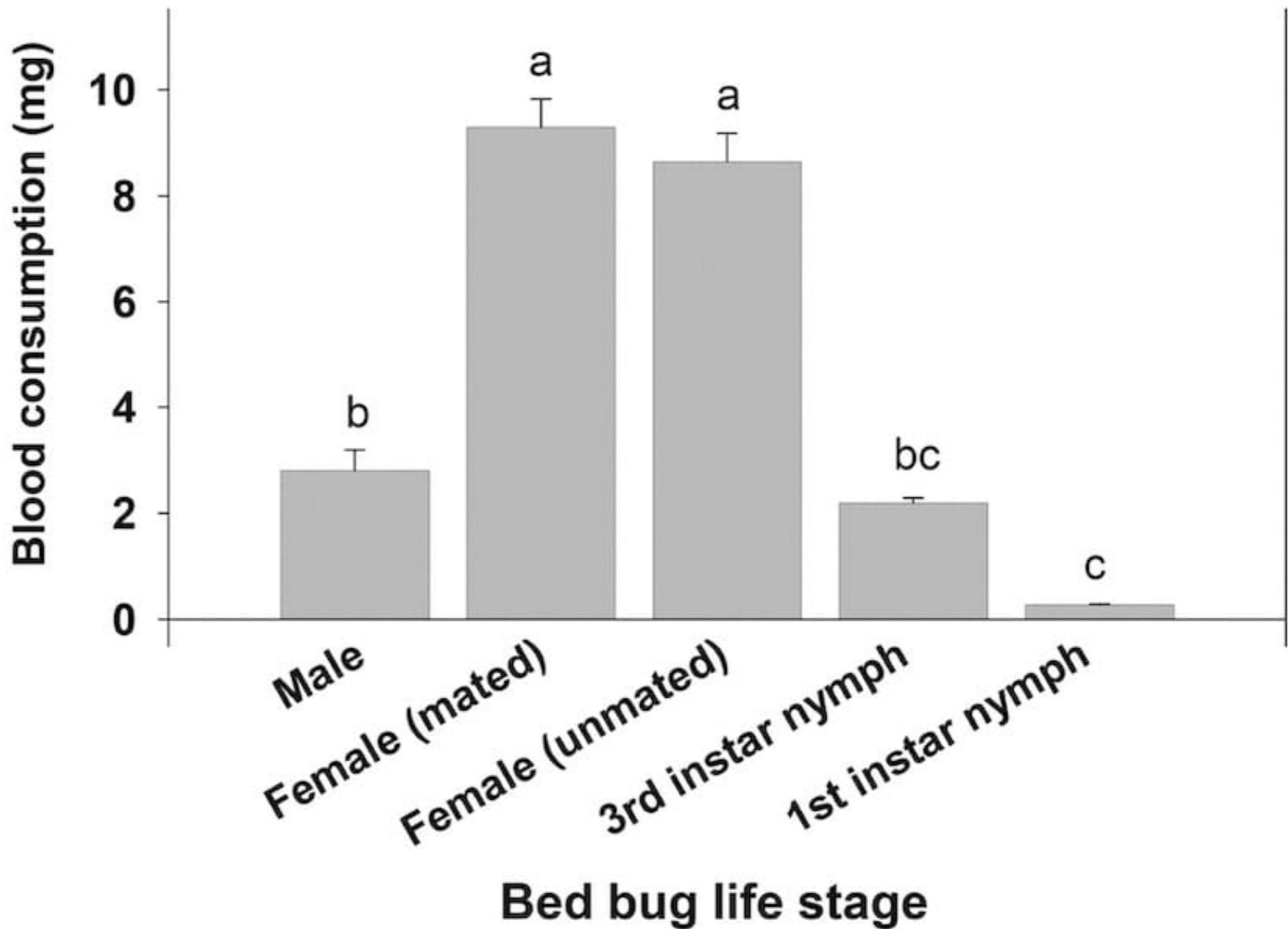
Histamine excretion dynamics?

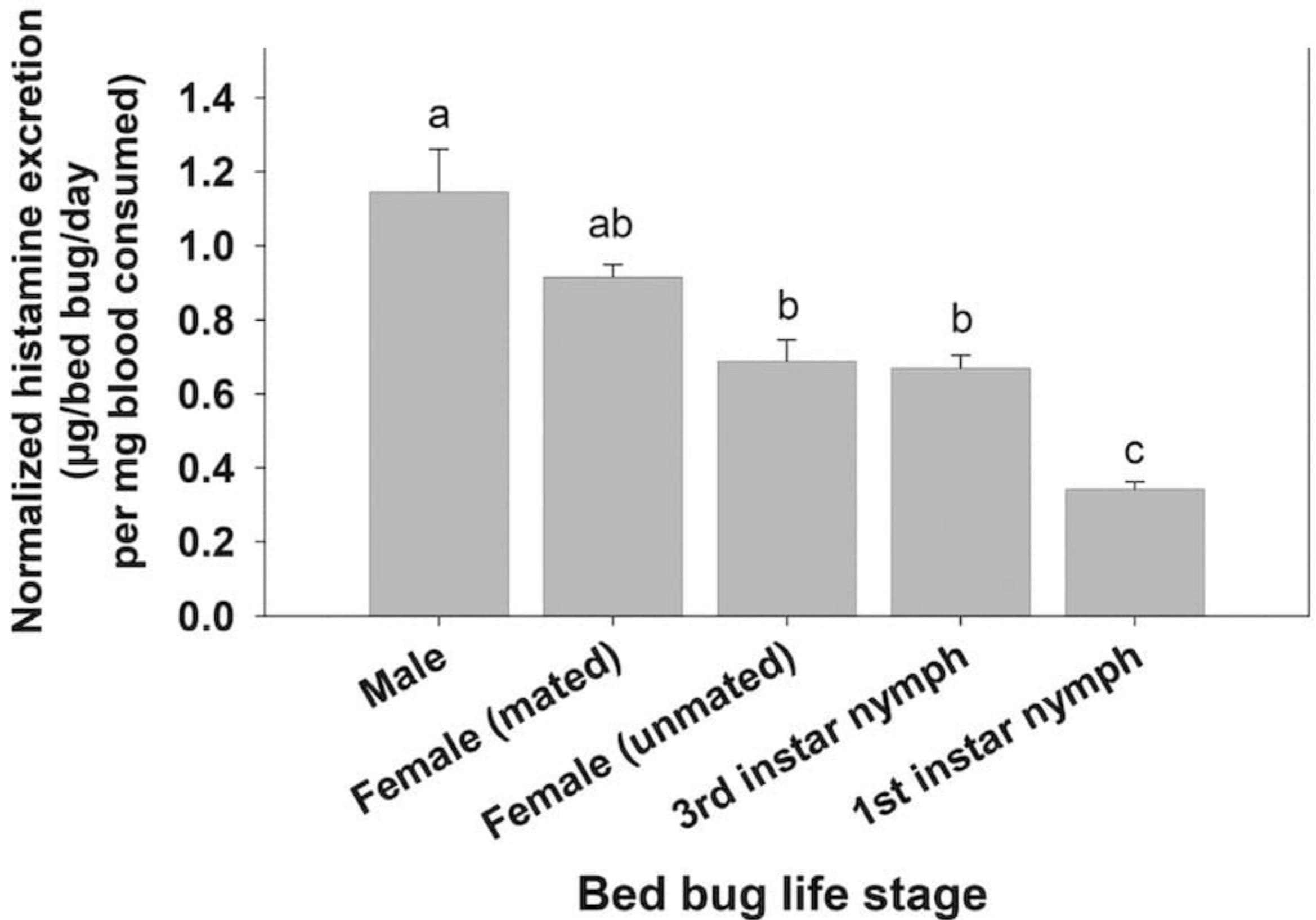


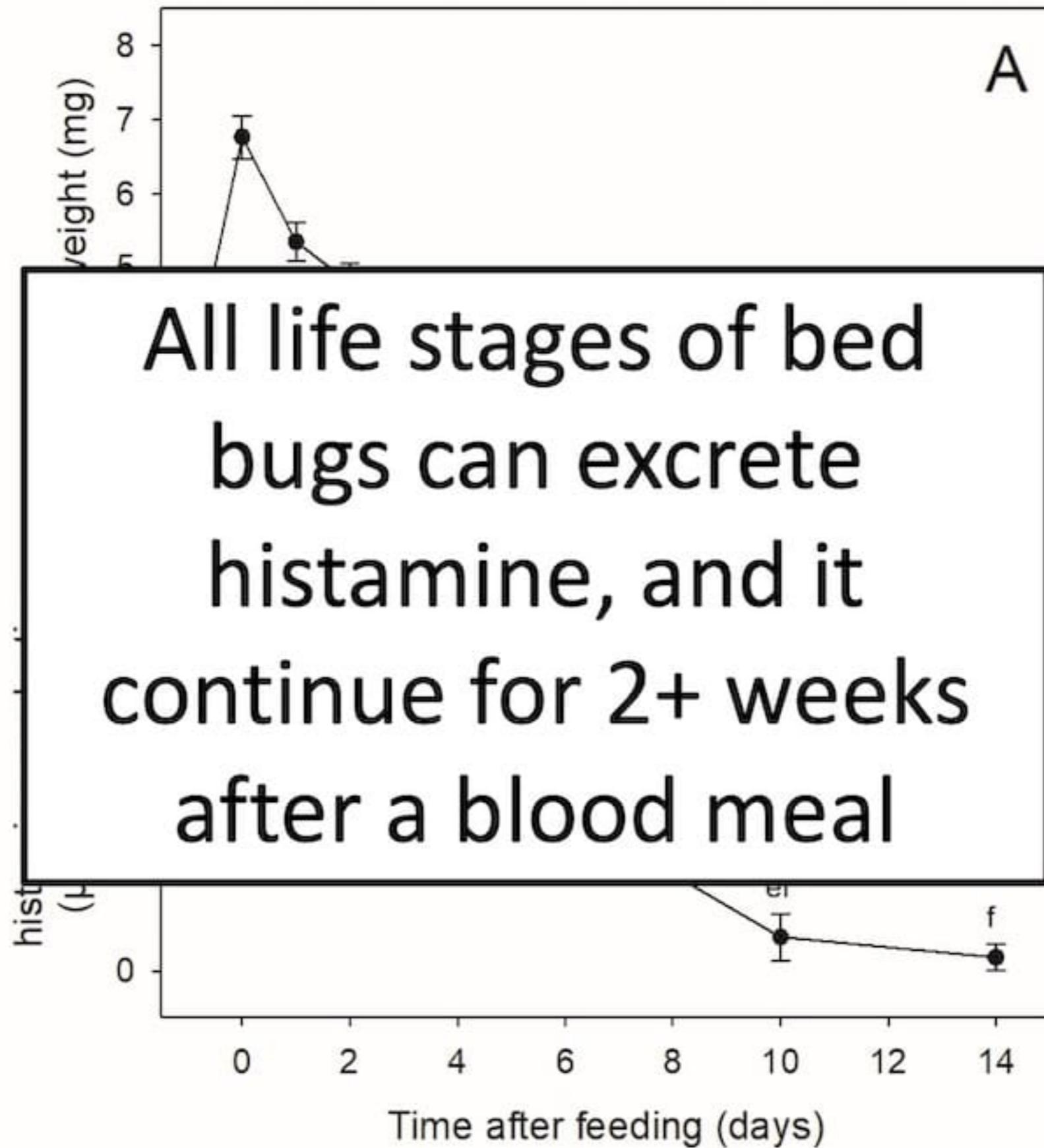
Bed Bug Fecal Collection/Screening







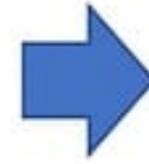




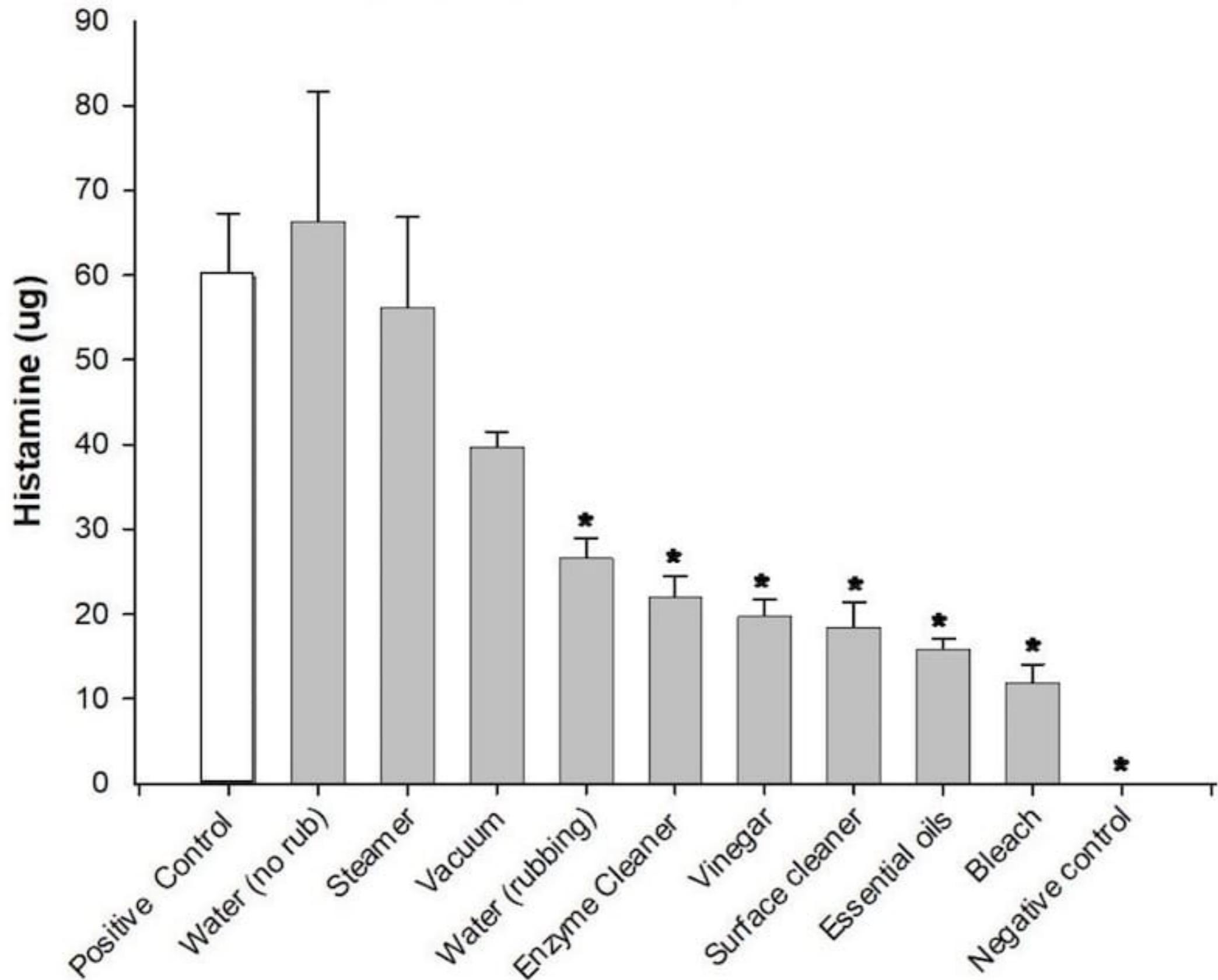
**How do we
remove histamine
from homes?**



Histamine Cleaning/Removal



Efficacy of soft cleaning methods in reducing histamine from unfinished wood



Histamine and human health?



Conclusions:



- Bed bugs can contaminate the indoor environment with both allergens and novel contaminants (histamine)
- Unclear what the long-term health effects are from exposure to exogenous histamine, but we suspect there is an effect

Importance and Implications

- We don't have all the answers, but bed bug infestations pose a multitude of risks for people
- When we consider where they are predominantly found (low-income environments), this raises questions of environmental justice.

Importance and Implications



- If we do our jobs and eliminate bed bugs, we can make a real difference; if we don't, we could leave people to deal with any number of negative health consequences
- The work we do matters!



Thank You!



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COMMISSION ON
PESTICIDE REGISTRATION



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