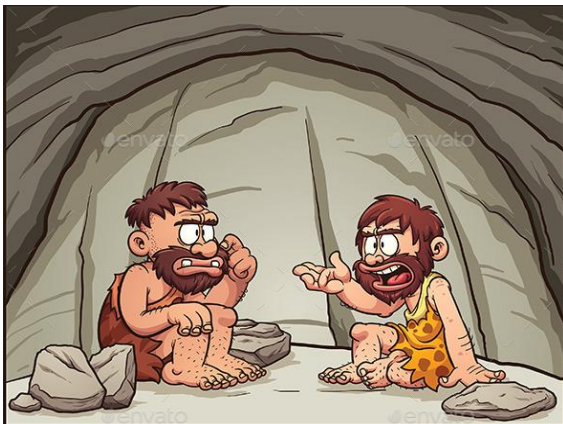


**180,000 bed bug bites later....**  
 ....the aggregation pheromone of the  
 common bed bug is finally identified

Regine Gries, Robert Britton,  
 Michael Holmes & Gerhard Gries

**SFU**

SIMON FRASER UNIVERSITY  
 THINKING OF THE WORLD





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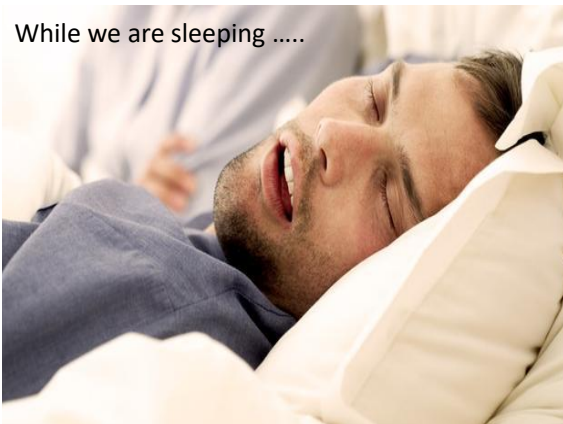
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While we are sleeping .....



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## Bed bugs

### Global resurgence

## Hospital statistics



Video: Mike Hrabar & Regine Gries

**Early detection** - key to prevention & eradication  
of bed bug infestations



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**(Early) detection**  
tricky, tedious & time-consuming



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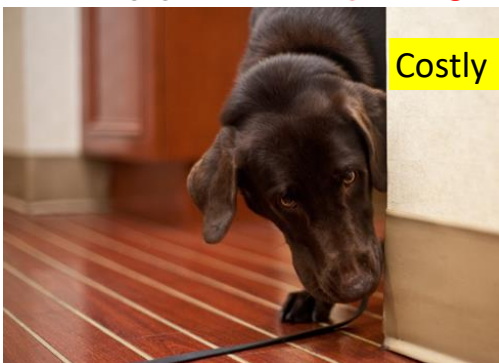
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Sniffer dogs good at **detecting bed bugs**



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## Needed

effective & affordable **lure** and **trap**

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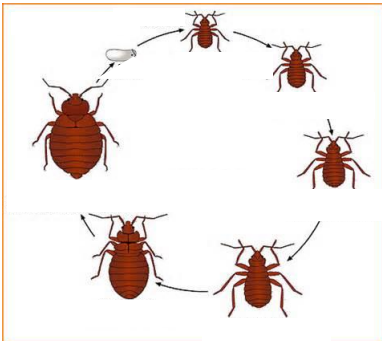
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## What **lure**?



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## What **lure**?



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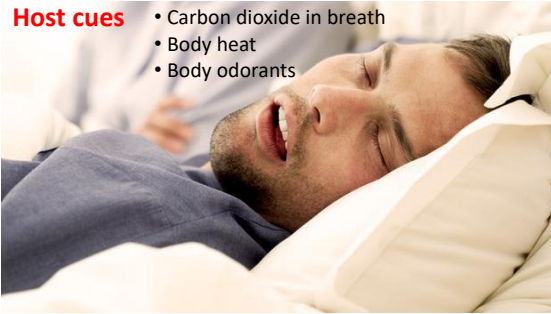
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# What **lure**?

## Host cues

- Carbon dioxide in breath
- Body heat
- Body odorants



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## NightWatch & the like effective but affordable?



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## Surge protector & bed bug trap (heat) effective? affordable?



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BEAP (mimics sleeping body)  
affordable, effective?




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BEAP (mimics sleeping body)  
affordable, effective?




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## Host cues

technically challenging, expensive  
or short-lived effect

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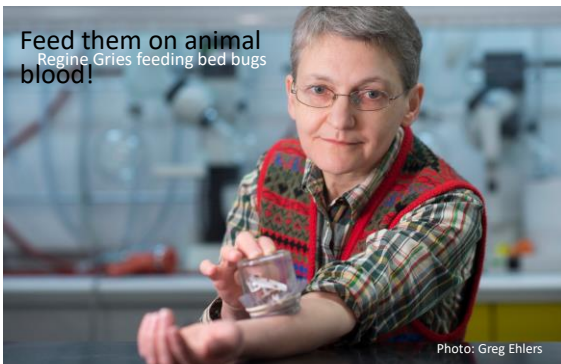
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Large bed bug colony to **accumulate pheromone**



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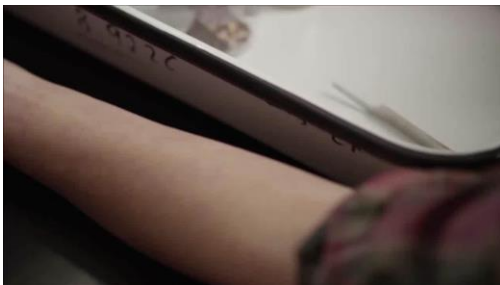
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Bed bug feeding video



Video: Hans Goksoyr

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Source of bed bug pheromone?



Cast cuticle

Feces

bb themselves

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Source of bed bug pheromone?



Cast cuticle

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**Host presence** — “their buddies” would have needed to feed before molting




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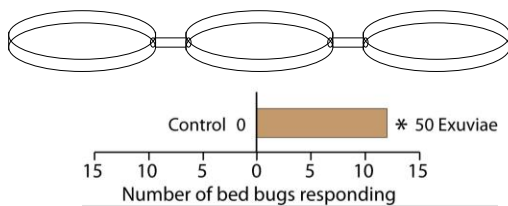
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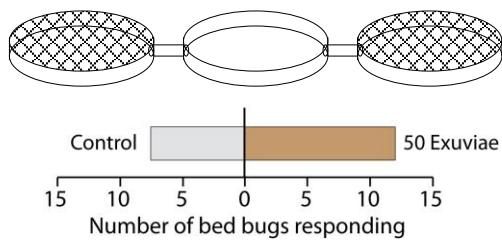
**Cast cuticle**  
source of pheromone?

Testing response to accessible cast cuticle



Cast cuticle contains pheromone

Testing response to inaccessible cast cuticle



Physical contact is needed to sense the pheromone.  
Pheromone causes **arrestment** but **not attraction**.

Extracted cast cuticles in solvent




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Withdrew extract of cast cuticles




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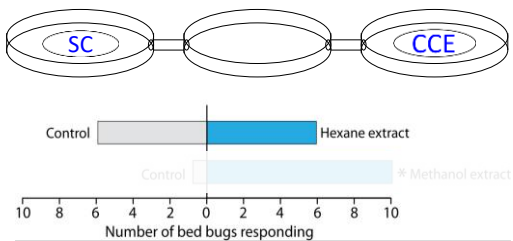
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Tested response to **Cast Cuticle Extract (CCE)**



**Methanol extract of cast cuticles contains arrestment-inducing pheromone!**

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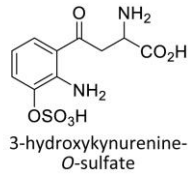
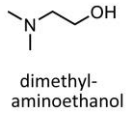
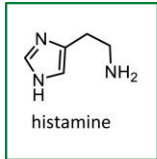
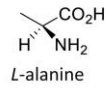
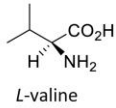
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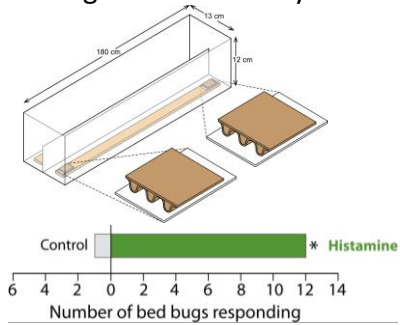
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## Two-dimensional NMR

Compounds in **methanol extract**



## Large arena bioassays



**Histamine = arrestment-inducing pheromone**

Field experiment Dec 2013

**Histamine** on its own  
in apartments: **no effect!**

**Histamine**  
not volatile  
not attractive



## Bed bug feces

Source of attractive components?



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Volatilized feces odorants

Analyzed headspace odorants by ion trap GC-MS



80 °C  
176 °F

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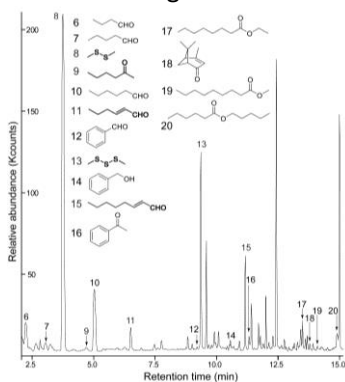
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Total ion chromatogram of feces odorants



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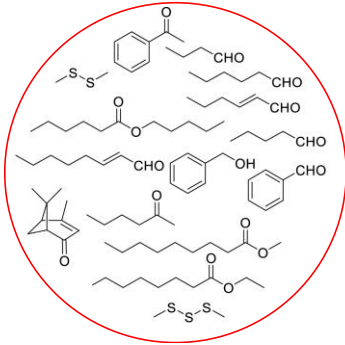
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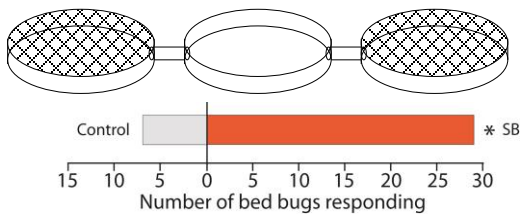
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## Synthetic blend (SB) of feces odorants



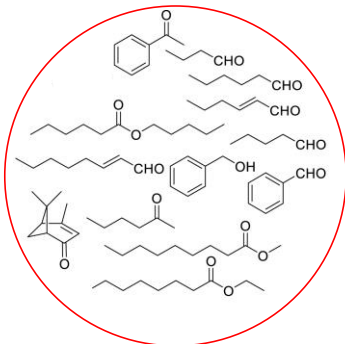
### Response to Synthetic Blend (SB)



**SB contains attractive volatile pheromone components (VPCs)**

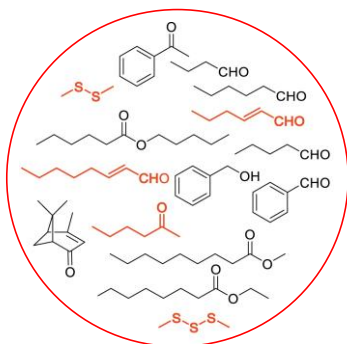
### What are the pheromone components?

#### Deletion experiments



35 experiments later.....

Volatile pheromone components (VPCs)!

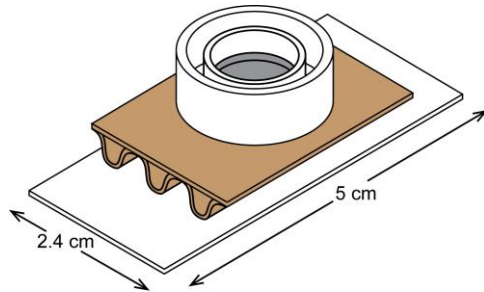


Field experiments April/May 2014

Tease apart the effect of the

**VPCs** & **H**

## Experimental trap & lure




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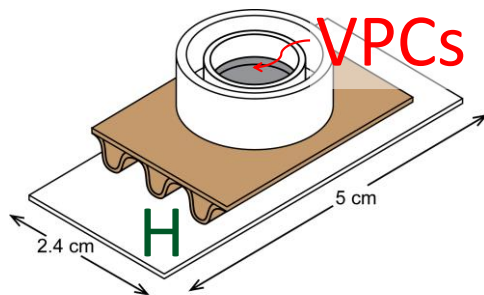
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## Experimental trap & lure




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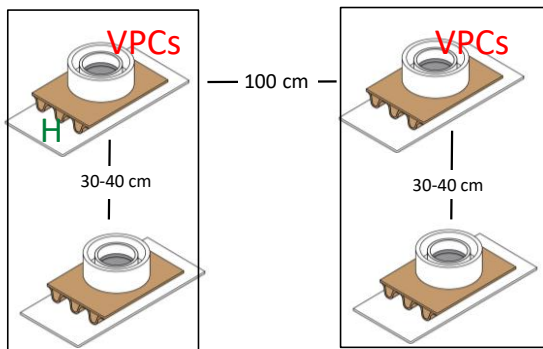
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## Paired design for field experiments




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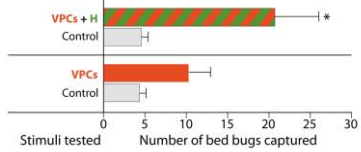
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## Field experiments




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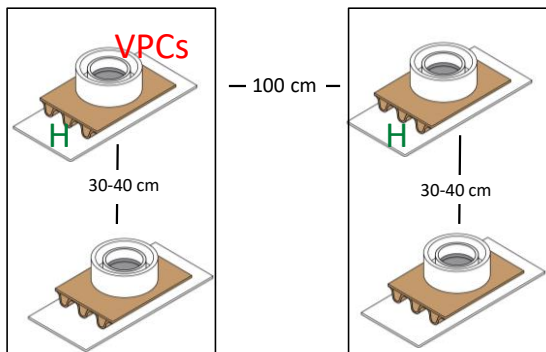
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## Paired design for field experiments




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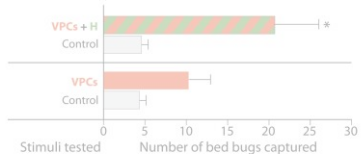
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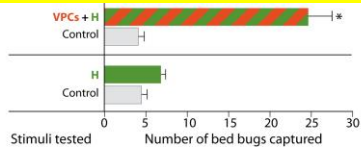
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## Field experiments



Combination of VPCs and H most effective!




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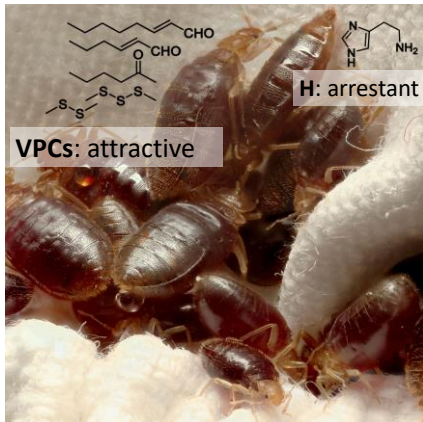
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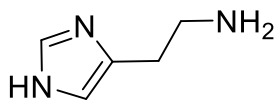
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Origin of pheromone components?



**Histamine** – harvested from human host?  
Not very likely!

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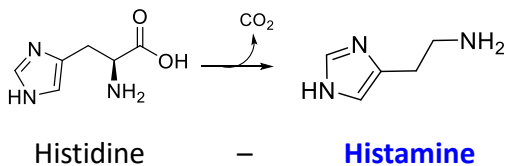
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Origin of pheromone components?




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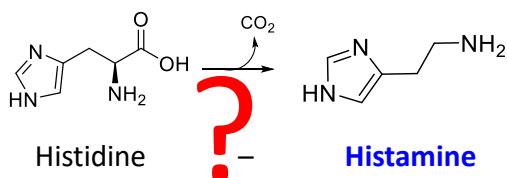
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Origin of pheromone components?




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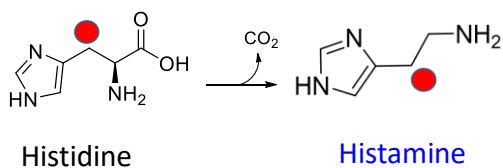
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Origin of pheromone components?



~~Allowed to be used on labelled histidine~~

But..... most histamine is produced *de novo*

Gries et al. (2017) Can. J. Chem.; doi: 10.1139/cjc-2017-0407

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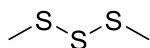
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Origin of pheromone components?



Dimethyl trisulfide

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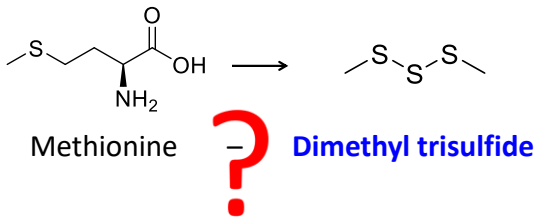
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Origin of pheromone components?




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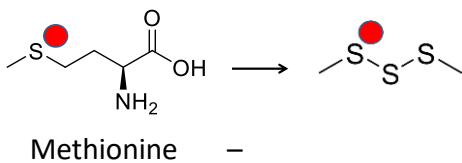
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Origin of pheromone components?



How do bed bugs get the labeled methionine

But..... most dimethyltrisulfide is produced *de novo*

Gries et al. (2017) Can. J. Chem.; doi: 10.1139/cjc-2017-0407

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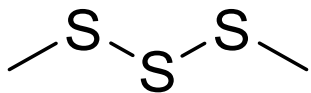
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**Dimethyl trisulfide**

Informative to bed bugs

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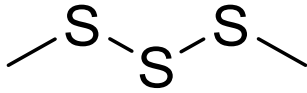
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**Dimethyl trisulfide**

**Common indicator** for protein or amino acid metabolism **in diverse taxa!**

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**Fresh rat carrion**



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## Fresh rat carrion      Blow flies




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## Fresh rat carrion      Blow flies




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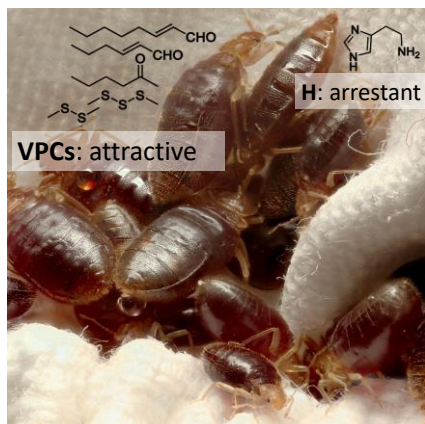
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Where to go from here?

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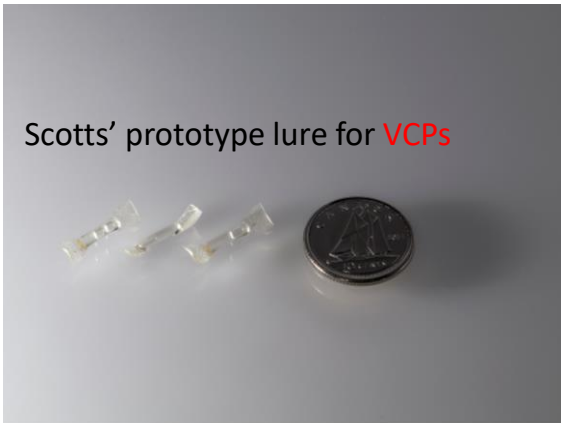
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Scotts' prototype lure for VCPs



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Video of lure preparation



Hans Goksoyr

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Cardboard with prototype lure  
& histamine-impregnated filter paper



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Choice experiment (sped up 6 x)  
Control trap vs pheromone-baited trap



Mike Hrabar & Regine Gries

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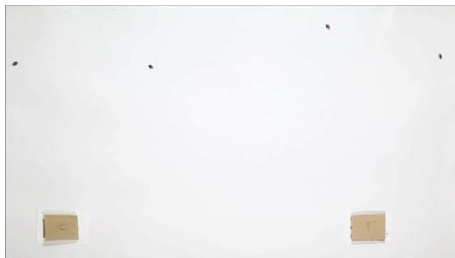
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Choice experiment (sped up 6 x)  
Control trap vs pheromone-baited trap



Mike Hrabar & Regine Gries

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## Needed

effective & affordable  **lure** and **trap**

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## Primary purpose of lure?

- **Detection** of small (incipient) bed bug infestations
- Assessment of insecticidal or thermal **treatment success**

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Can the aggregation pheromone **afford** or **enhance** bed bug **control**?

- Mass trapping (small infestations)?
- Combined with:
  - Diatomaceous Earth?
  - Amorphous silica?
  - Microbial insecticides (*Beauveria* spp)?
  - Pyrethroid insecticides?

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## Acknowledgements




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## Thank you!




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