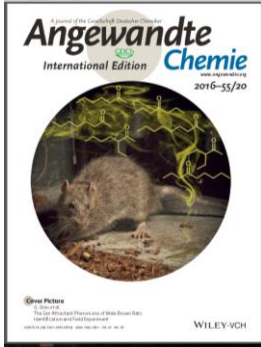


# Foraging & Communication Ecology of Brown Rats & House Mice

Stephen Takács, Regine Gries, Elana Varner, Huimin Zhai, Gerhard Gries




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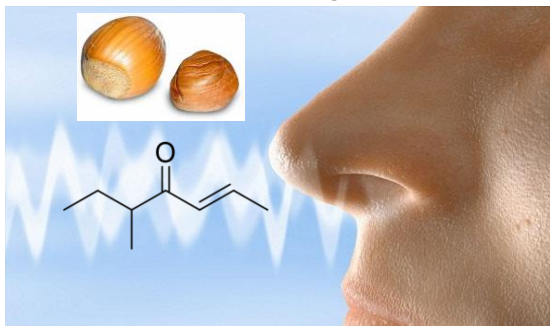
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Identified **all odorants** in target sources & used our nose to determine the signature chemical(s)



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Fresh rat carrion



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Fresh rat carrion      Blow flies



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Fresh rat carrion      Blowflies



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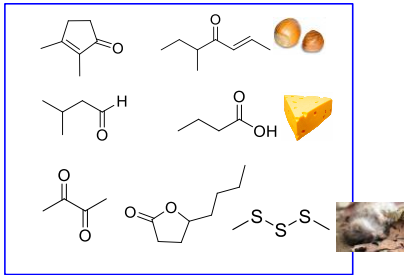
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## Cocktail of signature food odorants



**Captures** of rats in traps requires attraction to & feeding on the food bait



Wild brown rat responding to bait



Video: Elana Varner



Hunt for **feeding stimulants**




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Tested **> 50** different foodstuffs  
for feeding response

Hunt for **feeding stimulants**

Measured food consumption




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Food odorants + Feeding Stimulants =  
**SFU Bait**

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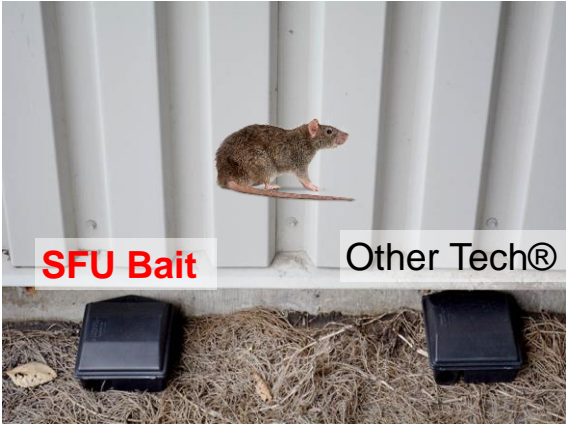
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Comparative field performance	
SFU Bait	LiphaTech®
SFU Bait	ProPest®
SFU Bait	Provoke®
SFU Bait	Peanut butter

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Comparative field performance	
SFU Bait 21	LiphaTech® 6
SFU Bait	ProPest®
SFU Bait	Provoke®
SFU Bait	Peanut butter

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Comparative field performance	
SFU Bait 21	LiphaTech® 6
SFU Bait 12	ProPest® 1
SFU Bait	Provoke®
SFU Bait	Peanut butter

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Comparative field performance	
SFU Bait 21	LiphaTech® 6
SFU Bait 12	ProPest® 1
SFU Bait 15	Provoke® 3
SFU Bait	Peanut butter

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Comparative field performance	
SFU Bait 21	LiphaTech® 6
SFU Bait 12	ProPest® 1
SFU Bait 15	Provoke® 3
SFU Bait 18	Peanut butter 2

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Comparative field performance	
SFU Bait 21	LiphaTech 6
SFU Bait 12	ProPest 1
SFU Bait 15	Provoke 3
SFU Bait 18	Peanut butter 2
SFU Bait (rats) superior to all others products	

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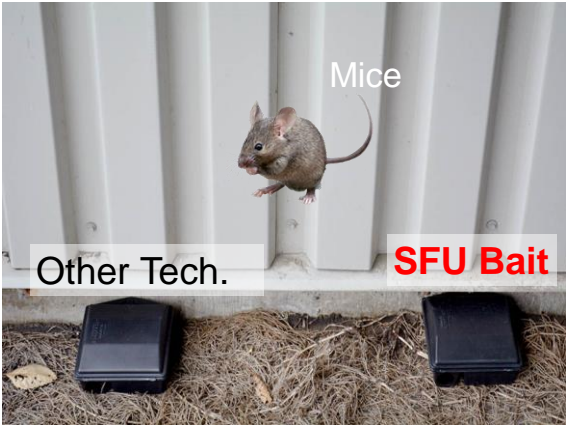
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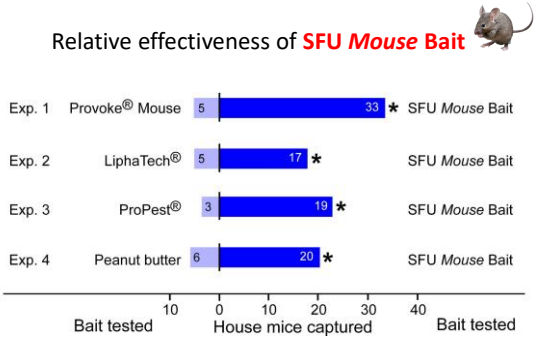
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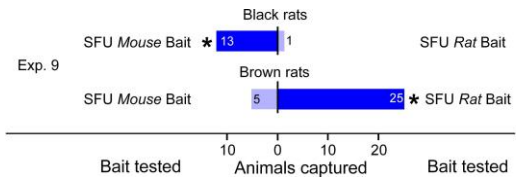
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Takács et al. (2017) Appl Anim Behav Sci; doi: [10.1016/j.applanim.2017.11.011](https://doi.org/10.1016/j.applanim.2017.11.011)



### Differential response of **brown rats** and **black rats**



Takács et al. (2017) Appl Anim Behav Sci; doi: [10.1016/j.applanim.2017.11.011](https://doi.org/10.1016/j.applanim.2017.11.011)



## Sound communication



Thieme: 1900. Die Straßenfeger von Barmen. G. Bredow: 1900.

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## Sound audition




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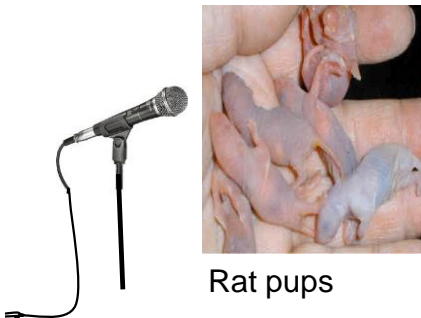
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## Sound audition



Rat pups

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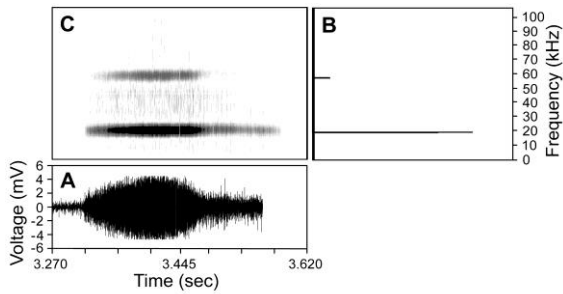
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## Vocalization by rat pups



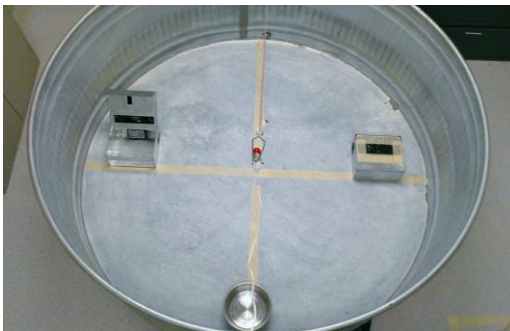
Takács et al. (2016) Pest Management Science 72: 1873–1882

## Gadget for rat pup sound emission



Algorithm to modify **intensity**, **frequency**,  
**duration**, **intermittent silence**

## Bioassay design



## Sample bioassay



Takács et al. (2016) *Pest Management Science* 72: 1873–1882

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## Sample bioassay



Synthetic sound gadget works...also in the field !

Takács et al. (2016) *Pest Management Science* 72: 1873–1882

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Food 😊  
**F...reproduction**  
 • Sound 😊  
 • Smell

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## Field experiment with rats

Food bait + sound  
vs  
Food bait + sound & soiled bedding

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## Field experiment with rats

Food bait + soiled bedding  
vs  
Food bait + soiled bedding & sound

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## Field experiments



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## Field experiment with rats

Food bait + **soiled** bedding **3**

vs

Food bait + **soiled** bedding & sound **14**

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## Field experiment with rats

Food bait + **sound** **3**

vs

Food bait + **sound & soiled** bedding **14**

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Bedding **soiled** with urine & feces  
from male (and female) rats

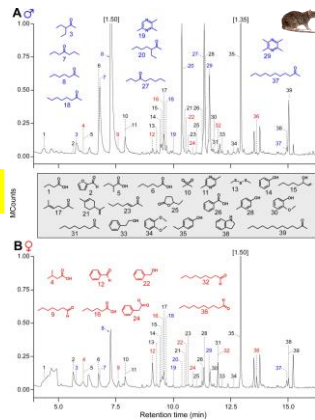


## Candidate pheromone components

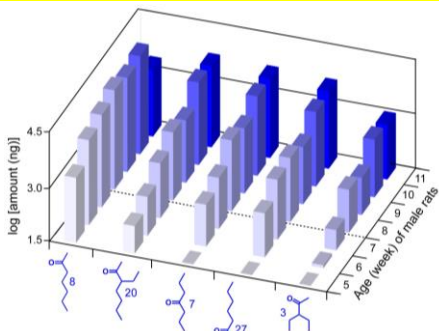
- Male-specific
- Increase in abundance in sexually maturing males

Urine odor profiles  
of male (top)  
& female rats

Male-specific and female-specific  
components

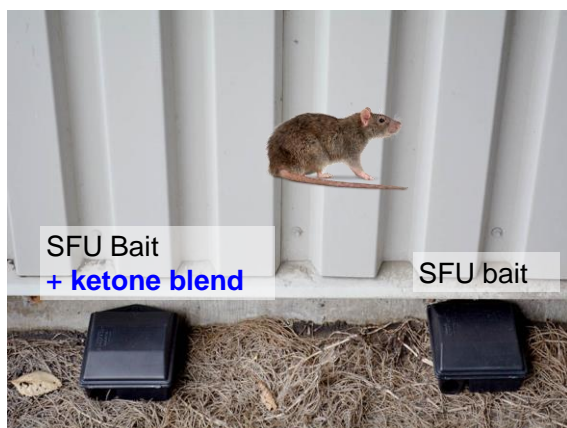
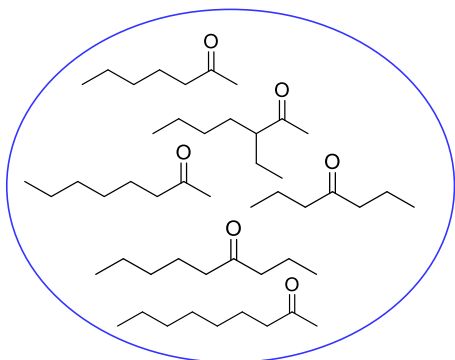


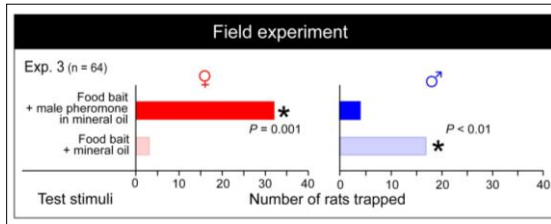
Male-specific **ketones** increase in sexually maturing males!



Takács et al. 2016. Angew. Chem. Int. Ed. 55, 6062–6066

**Synthetic blend of ketones**





Male sex pheromone **attracts females**  
but **deters males**

Takács et al. 2016. *Angew. Chem. Int. Ed.* 55, 6062–6066

Message in urine markings highly complex



Message in urine markings highly complex



Message in urine markings highly complex




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Message in urine markings highly complex




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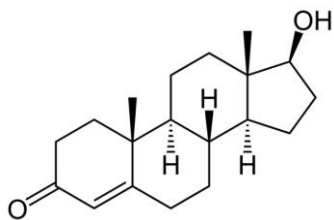
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Healthy males have lots of



Testosterone

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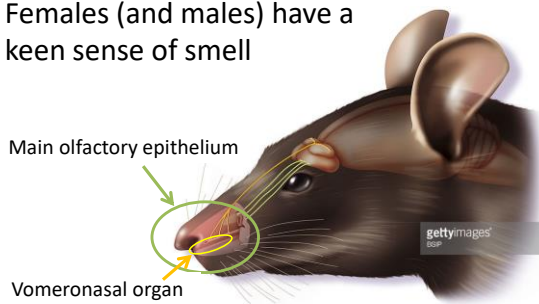
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Females (and males) have a keen sense of smell



Both receptor types sense testosterone!

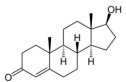
Females can discern urine deposits of

healthy      diseased  
males

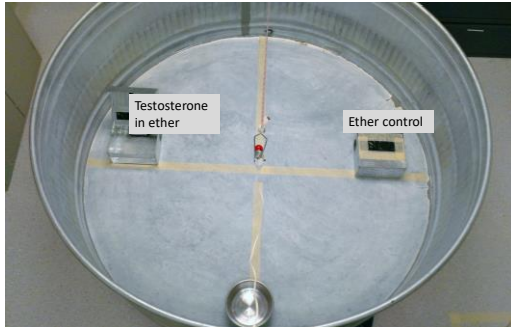


### Hypothesis

Testosterone has signal function for females = sex attractant pheromone



## Bioassay design




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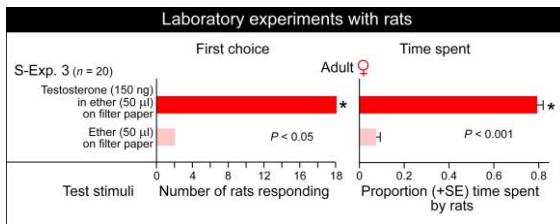
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**Testosterone = sex attractant pheromone in brown rats!**



Takács et al. (2017) ChemBioChem 18:1391–1395

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## Pheromonal communication in mice




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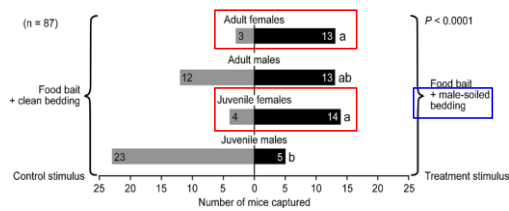
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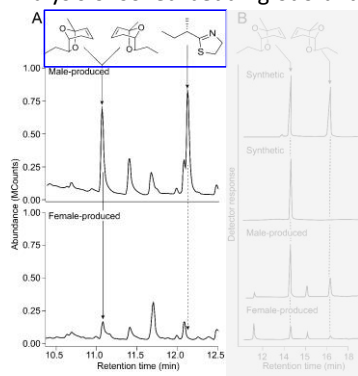


### Effect of bedding soiled by males

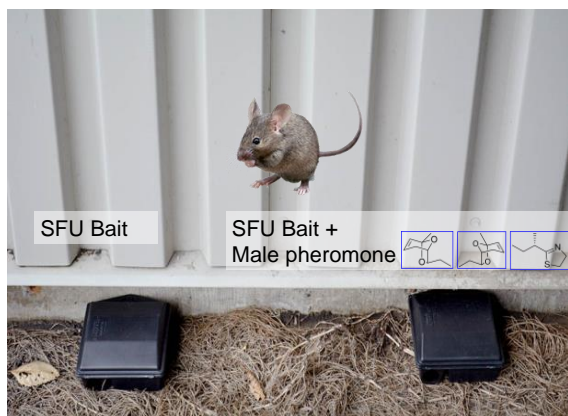
Male-soiled bedding contains sex attractant pheromone!



### Analysis of soiled-bedding odorants

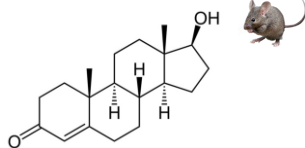
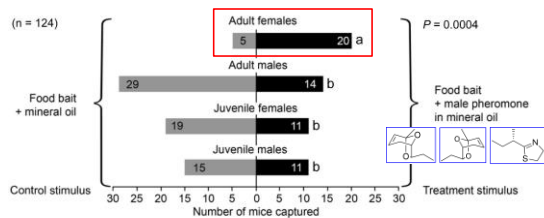




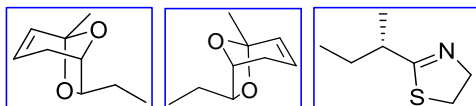


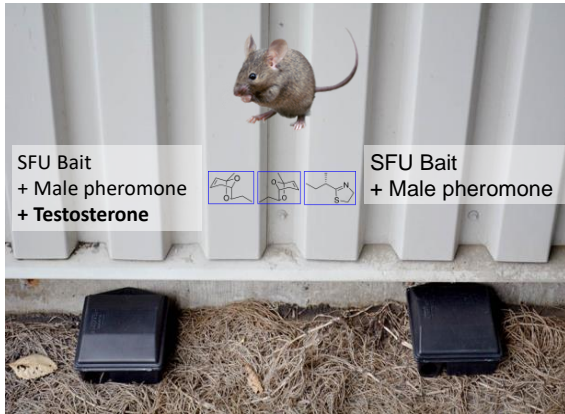
### Field testing of candidate pheromone components

Synthetic male pheromone components – effective in the field!



**Interaction** between testosterone &






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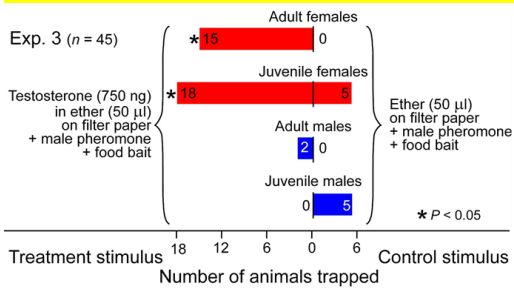
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**Testosterone = sex attractant pheromone component of male mice!**




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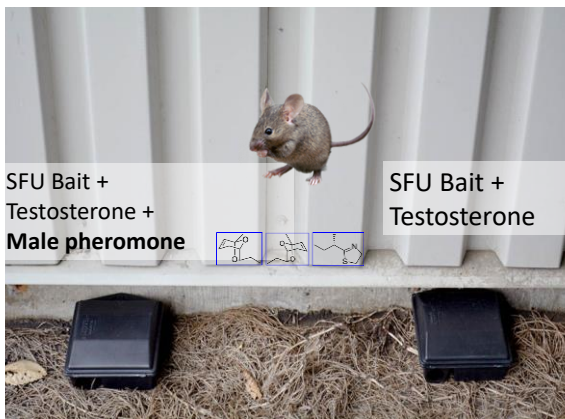
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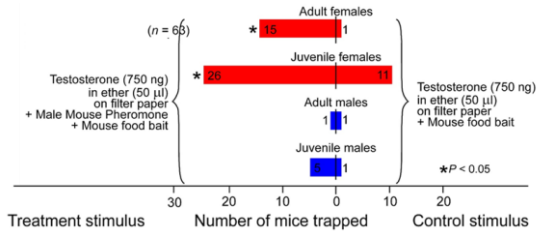
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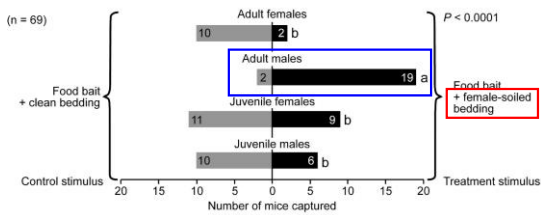
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### Interaction between testosterone & volatile sex pheromone components!



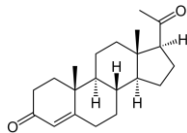
### Sex attractant pheromone of female mice

Effect of bedding soiled by female mice

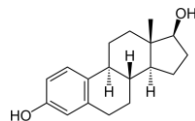


Females produce a sex pheromone (blend) that attract males!

### Are female sex steroids involved?



Progesterone  
316 MW



17β-Estradiol  
272 MW




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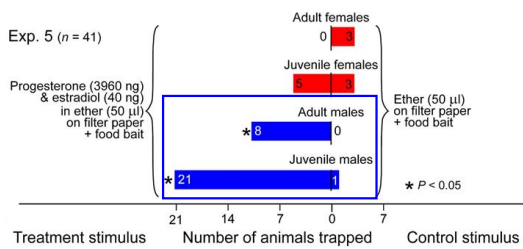
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**Progesterone & estradiol**  
= sex pheromone components of female mice!




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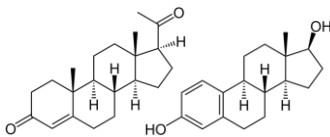
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**Interaction** between **progesterone & estradiol**  
and **3 volatile pheromone components**?

**A** **B** **C**

A & B & C: Elana Varner et al., unpubl.

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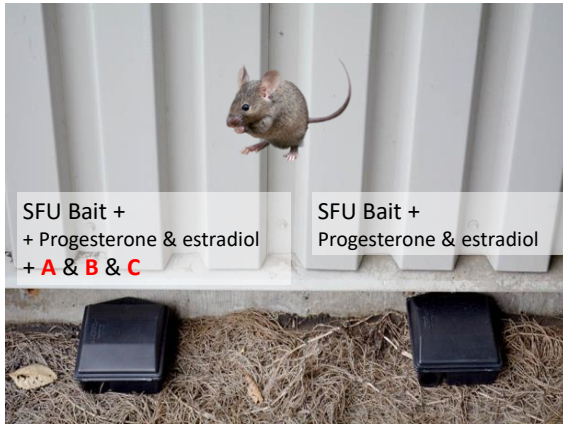
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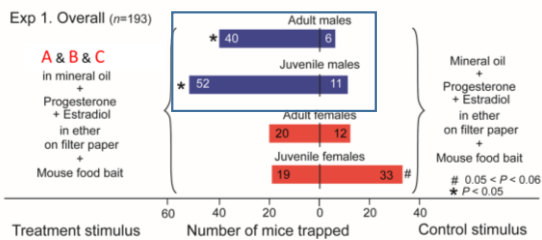
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### Interaction between steroids & volatile pheromone components A & B & C



## Discussion

- **Progesterone & estrogen** (female steroids) and **volatile pheromone components synergistically** attract male mice and male rats (*rat data not shown*)
- **Testosterone** (male steroid) and **volatile pheromone components synergistically** attract female mice and male rats (*rat data not shown*)

## Discussion

- All mammals including humans have steroids in their urine! *Are steroids pheromones in many mammals?*
- What are the underlying *mechanisms for species-specific communication?*




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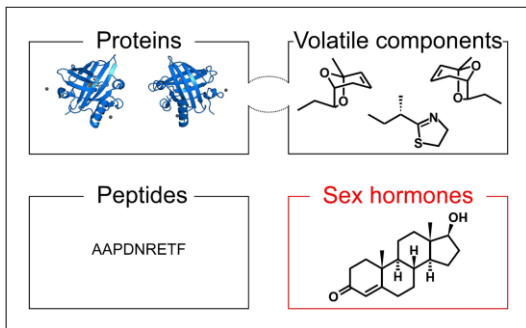
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## Discussion




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## Rationale for this research?

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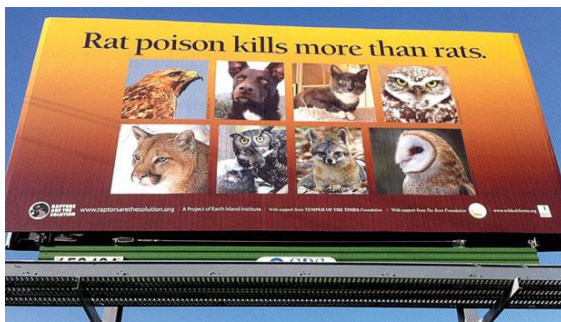
## Rationale for this research?

Put away with poison bait stations for rodents

## Rationale for this research?

Put away with poison bait stations for rodents

Poisonous baits: "economic" but not earth-friendly







### Ultimate objective

Couple **SFU Technology** (food baits;  
sound gadget; pheromone lures)  
&  
**self-resetting traps** that are capable  
of multiple killings

**Self-resetting trap capable of multiple killings**

[Goodnature:](#)



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