

Beehive Chemistry: Chemical Communication

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What are honey bee pheromones?

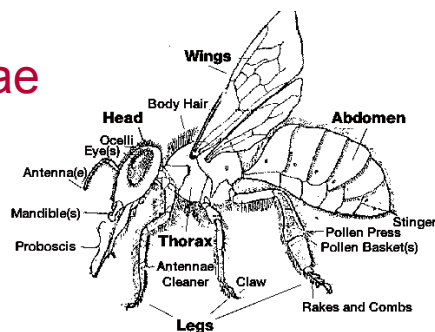
- Pure chemical substances or mixtures
- Released by individual bees
- Cause physiological or behavioral changes in other bees

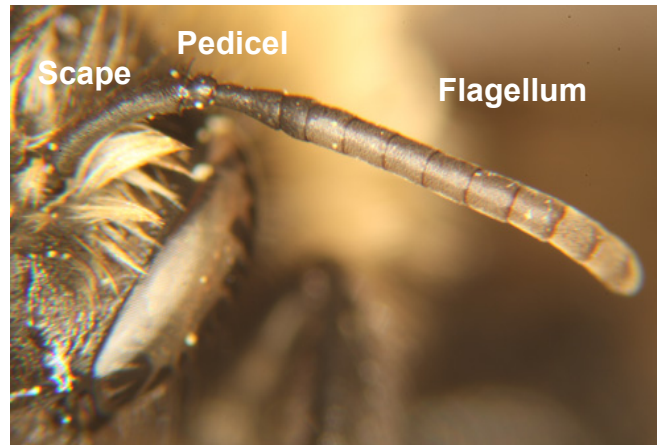
Complex Chemical Communication

- 15 known glands
- Secreted by queens, drones, workers
- Volatile and nonvolatile liquids
- Sensed by antenna and other body parts

Honey Bee Antennae

- Olfactory organs
- Acuity similar to humans
- Workers are 10-100
more sensitive to wax
and flowers





Types of Pheromones – broad categories

1. Releaser pheromones

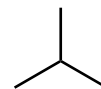
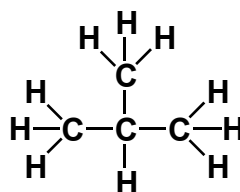
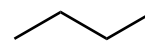
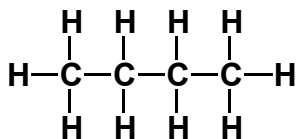
Immediate *behavioral* response, but temporary effect

2. Primer pheromones

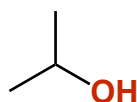
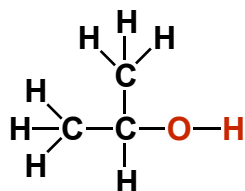
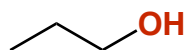
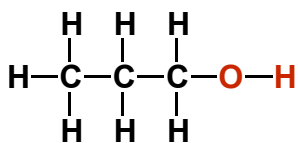
Long-term *physiological* effects

Alkanes

- Contain only C, H
- Alkyl groups
(R-groups)



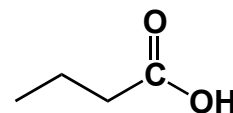
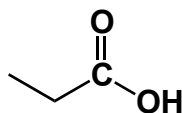
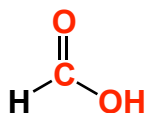
Alcohols – alkanes with OH groups



R-OH

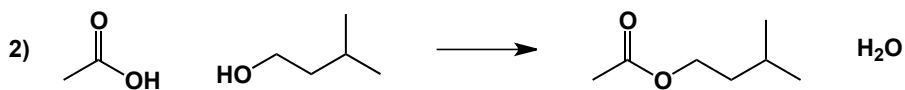
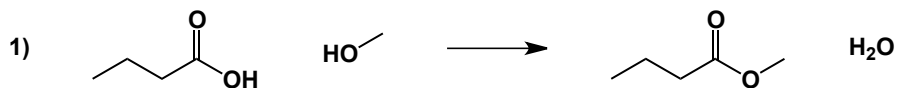
Carboxylic acids

- Generally, strong, foul odors
- Offensive to humans and honey bees



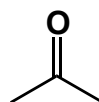
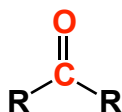
Esters

- Combination of an alcohol and a carboxylic acid
- Pleasant odors



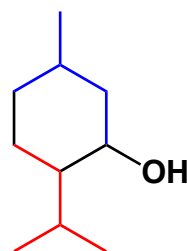
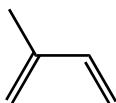
Ketones

- C=O carbonyl group
- Flanked by alkyl groups (C-groups)



Terpenes

- Combinations of 5-carbon isoprene units
- Monoterpene = 2 isoprene (C₁₀)
- Sesquiterpene = 3 isoprene (C₁₅)
- Diterpene = 4 isoprene (C₂₀)

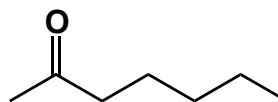
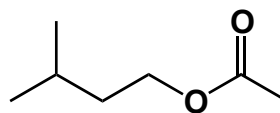


Types of Pheromones – specific categories

- | | |
|-----------------------------|--------------------------|
| 1. Alarm | 6. Footprint |
| 2. Brood recognition | 7. Forager |
| 3. Drone | 8. Nasanov |
| 4. Dufour's gland | 9. Queen specific |
| 5. Egg marking | |

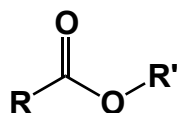
Alarm Pheromone

- Koschevnikov gland
 - Esters and alcohols
 - Released when a worker stings
- Mandibular secreted
 - 2-heptanone
 - anesthetic



Brood Recognition Pheromone

- Signals workers not to lay in a hive that still has developing brood
- Mixture of 10 different esters
- Inhibits ovarian development in workers
- Distinguishes worker larva, drone larva, and pupa



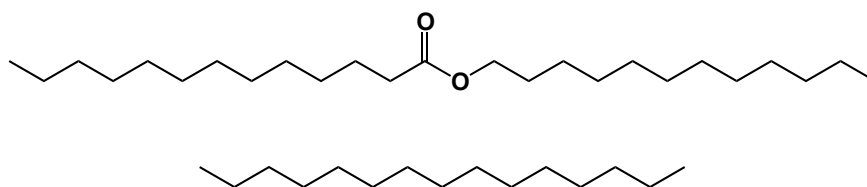
Drone Pheromone

- Produced by drones
- Attracts other drones to a place suitable for virgin queen mating



Dufour's Gland Pheromone

- Deposited on eggs as they are laid
- Lets workers distinguish queen laid eggs from worker laid eggs
- Complex mixture, ~24 compounds identified



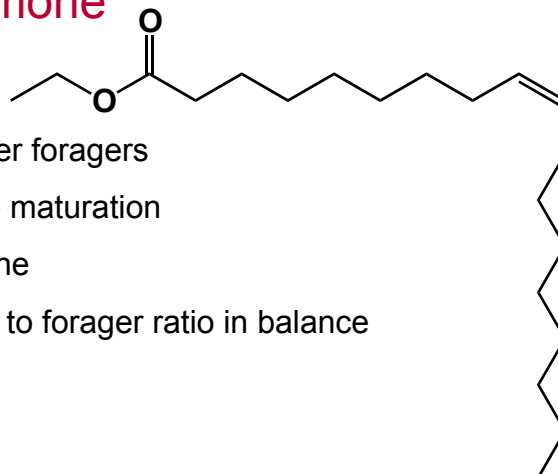
Footprint Pheromone

1. Emitted by bees as they walk, enhances Nasanov pheromone (locating nectar)
2. Also exuded by queen's tarsal glands
 - Oily
 - Inhibits queen cell building
 - Less produced as the queen ages



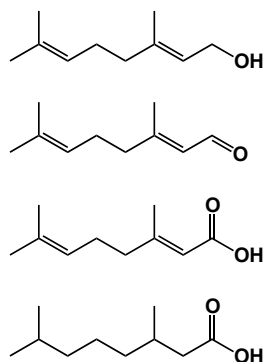
Forager Pheromone

- Ethyl oleate
- Released by older foragers
- Slows nurse bee maturation
- Primer pheromone
- Keeps the nurse to forager ratio in balance



Nasanov Pheromone

- Secreted by workers to orient other workers
- Monoterpenoids



Queen Bee Pheromones

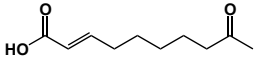
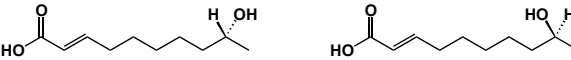
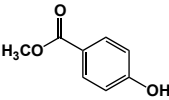
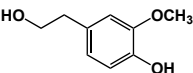
1. Queen Mandibular Pheromone
2. Queen Retinue Pheromone



Queen Mandibular Pheromone - QMP

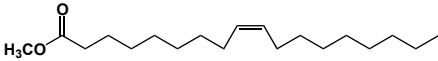
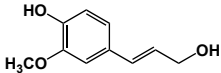
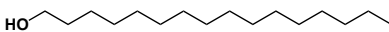
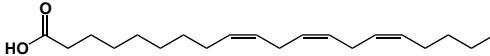
- Social behavior
- Hive maintenance
- Swarming
- Mating behavior
- Inhibition of worker ovary development
- Retinue attraction

Queen Mandibular Pheromone - QMP

- 9-ODA 
- (R/S)-9-HDA 
- HOB 
- HVA 

Queen Retinue Pheromone - QRP

Mixture of QMP and the following:

1. Methyl oleate 
2. Coniferyl alcohol 
3. Cetyl alcohol 
4. α -Linolenic acid 

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