HONEY BEE

PHEROMONES

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Pheromones

- 1926 von Frisch discovered importance of chemical smells (nasonov gland) in honey bees.
- 1954 C. Butler discovers and names queen substance.
- 1960 9-OH manden isolated from queen mandibular gland.
- 1962 Dr. Norman Gary discovers mating attractiveness of queen.
Pheromones = communication

- Chemical substances secreted by exocrine gland that elicits behavioral or physiological response by another animals of same species
- Key factor for generating and maintaining complexity of bee colony
- Primer pheromones – long term developmental/behavioral changes – mainly queen
- Releaser pheromones – shorter term behavioral change – mostly worker
The queen
**Queen substance/signal/essence**

- Chemicals picked up via retinue
  - odor
  - antennal contact
  - mouthpart contact
- Chemicals picked up via food transmission
- Chemicals picked up from beeswax comb
Queen Substance/essence

- queen mandibular gland pheromone
  - 9-oxo-2 decenoic acid (9 ODA) 1960
  - Cis-9 hydroxydec-2-enoic acid (c9 HDA) 1988
  - Trans-9 hydroxydec-2-enoic acid (t9 HDA)
  - methyl-p-tydroxybenzoate (HOB)
  - 4-hydroxy-3-methophenylethanol (HVA)
  - 12 additional measurable compounds

Queens secrete 200 micrograms 9-ODA, 80 micrograms 9-HDA, 20 micrograms HOB & 2 micrograms HVA every 24 hrs = 1 Qeq
Virgins queens produce less 9-HDA & HOB & no HVA
Queen essence changes

* Virgin queens – [weak signal] mainly Oleic acid (OLA) + 2 cmpds of worker Mandibular gland 10 HDA & HDAA
* Mating queens – 9 –ODA & some 9-HDA & 10-HDA
* Prime queens [strong signal] – 9-ODA, 9-HDA, less OLA moderate HVA, HOB, little 10 HAD & 10 HDAA
* Older queen – [weakening signal] HVA stronger along with HOB

But different studies contradictory
Releaser effects
Retinue behavior

Queen signal

Primer effects
Queen rearing

Worker reproduction

Swarm clustering

Worker activities

Drone attraction and mating

Comb building
Brood feeding

Guarding
Foraging
Qn Substance Functions

- retinue behavior  
- swarm stabilization  
- Sex attraction  
- inhibition of rearing replacement queens  
- Suppression of worker ovaries  
- Worker behaviors - Hive functions
Queen substance – queen “signal”

Good retinue

No retinue
However – retinue behavior not just mandibular gland

Coniferyl alcohol (CA)
Methyl oleate (MO)
Hexadecane-1-0l (PA)
Linoleic acid (LA)
* retinue behavior  
* swarm stabilization  
* Sex attraction 
* inhibition of rearing replacement queens 
* Suppression of worker ovaries 
* Worker behaviors - Hive functions
Swarm stabilization

Queens better than QMP
Qn Substance Functions

* retinue behavior       RELEASER
* swarm stabilization    “
* Sex attraction         “
* inhibition of rearing replacement queens
* Suppression of worker ovaries
* Worker behaviors - Hive functions
Sex attraction

Initially 9-0DA but QMP more effective
Landing 9-HDA & 10HDA + aphrodisiac
2 resources

- Bee Sex Essentials
  - Lawrence John Connor

- Mating biology of honey bees (Apis mellifera)
  - Gudrun Koeniger
  - Nikolaus Koeniger
  - Jamie Ellis
  - Lawrence Connor
  - Wiewas Press
Qn Subst Functions

* retinue behavior     RELEASER
* swarm stabilization
* Sex attraction
* inhibition of rearing replacement queens  PRIMMER
* Suppression of worker ovaries
* Worker behaviors - Hive functions
Inhibition of rearing replacement queens

Emergency cells - after Queen removal
Replacement queens

- Swarming & supersedure – colony size and dispersal of QMP

APPLICATION  Supplement with QMP
Qn Subst Functions

- retinue behavior
- swarm stabilization
- Sex attraction
- inhibition of rearing replacement queens
- Suppression of worker ovaries
- Worker behaviors - Hive functions
An additional function attributed to queen substance is suppression of worker ovary development – conflicting study results.

Queen ovary – showing many ovarioles – round structure above is spermatheca (where 1/10th sperm obtained during mating is stored).

 Likely
Juvenile hormone (JH)
+ QMP + Dufour’s +
Brood pheromone
Ethyl palmitate
Methyl linoleate
Application

QMP – Queen Mandibular Pheromone

blocks advesive behavior learning

See Scientificbeekeeping 2010
http://scientificbeekeeping.com/the-primer-pheromones-part-4-reproduction-and-survival/
Qn Subst Functions

* retinue behavior
* swarm stabilization
* Sex attraction
* inhibition of rearing replacement queens
* Suppression of worker ovaries
* Worker behaviors - Hive functions
Role of the other queen glands
both releaser & primer pheromones

Worker retinue
Methyl oleate (MO)
Hexadecane-1-0I (PA)
Linoleic acid (LA)

Retinue behavior
Tergal glands impot
AHB & Cape bee
Z form 9-ODA
Virgin qn
Inhibits worker ovaries
kin recognition?
Role of the other queen glands

- Methyl oleate (MO)
- Hexadecane-1-0l (PA)
- Linoleic acid (LA)

- Tergal glands
- Hypopharyngeal gland
- Mandibular gland
- Tarsal glands
- Salivary glands
- Koshevnikov gland
- Queen signal
- Dufour's gland

Fertility signal
Egg marking
Enabling worker policing
Role of the other queen glands

Worker retinue
- Methyl oleate (MO)
- Hexadecane-1-0l (PA)
- Linoleic acid (LA)

28 cmpds – not present in worker Balling behavior? Aging signal?
Worker glands

Caste specific secretions in workers = pseudoqueens (inhibit worker sisters)

10-hydroxy-2-decenoic acid (10-HDA)
10-hydroxydecanoic acid (10_HDAA)

Caste specific secretions in workers = pseudoqueens (inhibit worker sisters)
Orientation/recruitment

* Orientation/recruitment
  * Nasanov gland
  * Trail pheromone
  * Hive odor
  * Dancing bee odor

Mixture of 7 terpenoids: E- & Z- citral, nerol, nerolic acid, geraniol, geranic acid & farnesol

Mark Hive entrance, swarm clusters, forging sites (water?), cells to rear as queens
Swarm capture

Application
Use
Swarm Lure

2 parts Citral
1 part Geroniol
1 Drop Lemon Oil
Lemongrass?
QMP?
Worker glands

Works with scent gland to mark entrance – also marking of visited flowers?
Worker pheromones

- Dancing bees have recruitment pheromones - from unspecified glands
Nestmate recognition

- Nestmate recognition
  - Cuticular hydrocarbons

- Hive odor
  - Nest odors (wax)
  - Diet,
  - Colony environment
  - Queen distinctiveness
Hive Odor

Guard bee
Worker Pheromones

- **Worker activity**
  - Primer pheromone ethyl oleate

Ethyl Oleate produced in the epithelium of the honey crop through the transformation of ethanol derived from fermented nectar and exuded through the exoskeleton – workers pick it up both via physical contact and vaporization
- Also produced in brood & by queens

- Sequence of duties is regulated by
- A COLONY PHEROMONE
Other Pheromones

* Brood pheromone
  * Primer a blend of 10 cmpds
    Methyl & ethyl palmitate, oleate, stearate, linoleate & linolenate

Young brood = E-β-ocimene

R. Williamson Photo
SUPERBOOST
John H. Borden
Contech Enterprises Inc

BROOD PHEROMONE

Blend of 10 fatty-acid esters produced in larval salivary glands.

Stimulates foraging for pollen and nectar.

Causes enriched protein content in the hypopharyngeal and mandibular glands, which is fed to the larvae and the queen.

Maintains colony vigour
SUPERBOOST

- Twist off disc and pop ball through crossed slots
- Hang between frames in brood super
- Rotates so that pheromone membrane always exposed (arrow)
By Day 70, 11 control colonies and 10 treated colonies had survived. Compared to controls, surviving colonies treated with SuperBoost had consumed 75.5% more BeePro®, had 2.4x greater brood comb area, and had 2.0x more bees.
In both BC and New Zealand significantly more colonies treated with SuperBoost during spring build-up produced splits than untreated control colonies.
In an experiment run from 28 Aug to 9 Oct 2007 in SE Texas, the weight of pollen carried back to the hive per bee on Days 8 and 27 was significantly higher in colonies treated with SuperBoost than in untreated control colonies.

Data from T. Pankiw
In three locations, treating colonies with SuperBoost resulted in substantial increases in honey harvest. In a fourth, colonies were treated too late, and no effect was seen by harvest time. Return on investment in Louisiana 13.5x, in New Zealand 4.4x. Not calculated for BC, because results from three experiments were averaged.
Taking into account both colony die off and splits, package bee colonies treated six times with SuperBoost had 2.5x greater survival after one year than untreated control colonies.
• The study ran for four years, 2009-2012.
• Honey bee colonies were placed in second-year carrot fields by beekeepers in June at a density of 7.4/ha (3/acre).
• They were immediately treated with SuperBoost.
Colonies were left in the fields for the duration of bloom.

(Note narrow male bay to right of colonies and wide female bay to the left)
For both male and female flowers there were 45.1% and 48.1% more visits by honey bees to male and female flowers, respectively, in fields pollinated by colonies treated with SuperBoost than in fields pollinated by untreated control colonies.

Carrot fields pollinated by colonies treated with SuperBoost produced significantly more seed than fields pollinated by untreated control colonies.
Six of 10 SuperBoost fields experienced gains in yield, four fields had no gain or a slight loss compared to control fields. Overall mean percentage gain in yield = 18.3%.
Ten replicates of paired treated and control fields of the same variety of Canola.
A 20.2% gain in yield in the three replicates with no weather damage, 14.1% gain in yield for all eight replicates, including five where yield was estimated as what it would have been with no weather damage.

**Mean % Gain**

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<th>N = 3 (no weather damage)</th>
<th>N = 8 (weather damage included)</th>
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<td>Gain (Mean)</td>
<td>20</td>
<td>15</td>
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SUMMARY OF SUPERBOOST PERFORMANCE

• Increases ratio of pollen to non-pollen foragers for up to five weeks
• Induces workers to bring heavier pollen loads back to the hive
• Enhances colony vigor during spring build-up
• Enhances colony vigor at end of summer and during fall feeding
• Improves overwintering survival
• Can result in larger honey harvests
• May be used to improve yield in selected crops
Drone pheromones

* Drone mandibular glands attract other drones to DCA
* Drone tarsal glands have different cmpds from workers – function?
* Age-related recognition as when forced out in fall
One more thing.....
Worker Pheromones

- **Alarm** – over 40 compounds 15 important
  - *sting glands* – isopentyl acetate & 2-nonanol
  - *mandibular gland* – 2-heptanone

Sting left in victim

Note: liquid at top right is from digestive system

Also raise abdomen and fan wings to disperse AHB “throw’ venom

Guards bees + soldier (=stingers)
Worker glands - alarm

Also raise abdomen and fan wings to disperse – AHB “throw’ venom.
Compound Z-11 eicosenol prolongs (extends) activity
AHB Iso-pental acetate + 3-methyl-2-buten-1-yl acetate 3M2BA + lower threshold
Worker glands - alarm

2-heptanone – lower activity to recruit defensive behavior
Anesthetic in biting + marking for aversive behavior at flowers?
Colony defense

* Bee with propolis on hind leg

* Nest mate recognition
Sting allergies
When I go to bees ---

MY ASS IS COVERED
Bee hives are smelly