The Honey Bee's Exocrine Glands and Their Pheromones

Exocrine defined:

- Exocrine glands: glands that produce materials that are secreted outside the body (sweat glands)
- Endocrine glands: produce chemicals (usually hormones) that are internally circulated (thyroid glands)

Chemical signals:

- Pheromone: communication within the same species, usually mutualistic.

- Allomone: communication between different species, receiver is harmed.

  e.g. chemical mimicry of the honey-stealing sphinx moth.

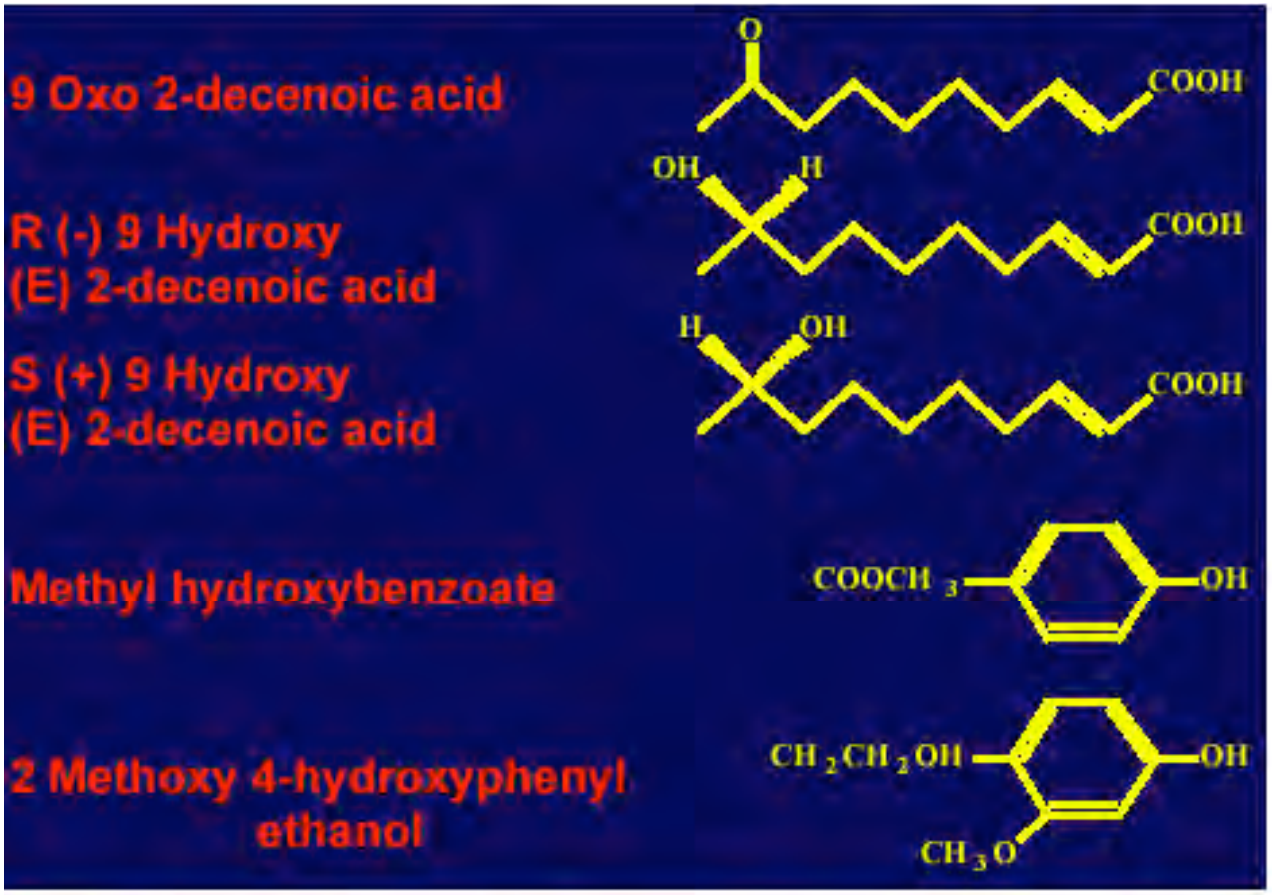
- Kairomone: communication between different species, receiver benefits.

  e.g. chemicals from larvae that attract V arroa mites.

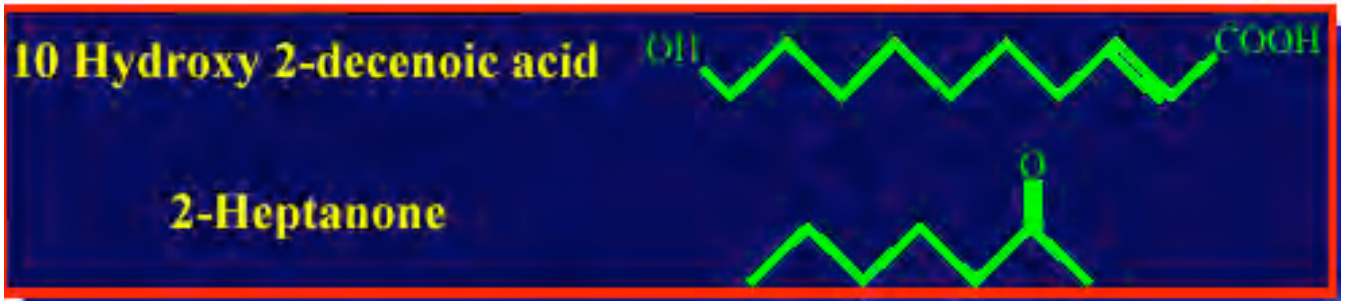
Retinue behavior: workers surrounding, licking and feeding her

1. Queen Mandibular Pheromone

Queen



Worker



Two types of pheromones:

1). Release pheromone:
immediate change in behavior
e.g. retinue behavior, alarm pheromone

2). Primer pheromone:
slow acting, physiological changes, then behavioral changes.

e.g. ovary development in workers takes about one week when queen and open brood are both gone.

Queen Mandibular Pheromone has both effects:

1). Releaser effect:

Retinue behavior (to workers)
Sex attraction during mating (to drones)
Swarm stabilization (to both)

2). Primer effect:

Inhibiting swarm cell construction
Inhibiting swarming process
Inhibiting worker ovary development
Delay foraging age in workers
Simulating foraging and brood rearing

QMP and beekeeping:

1. Workers “know” that the queen is gone within 4 hr

2. Queen strips available (PheroTech)
    1. Workers show retinue behavior to strips
    2. Swarm attraction
    3. Catching stray bees in extraction room
    4. “Queenless package bees?”
    5. Temporary queen surrogate for mating nuc
    6. Sprayed to fruit trees for better pollination (Fruitboost, PheroTech)

http://www.pherotech.com/fruit_boost_with_qmp_for_polli.html

Fruit Boost with QMP

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Phero Tech has developed semiochemical products to manage beneficial insects. Pollination problems can be remedied with Fruit Boost; a honey bee pheromone product that makes crops more attractive to worker honey bees.

Questions? Browse Fruit Boost´s FAQs or contact us

Fruit Boost with QMP (Queen Mandibular Pheromone) attracts and holds honey bees to flowering crops giving more complete pollination. This results in improved fruit size and fruit quality.

Fruit Boost:

- Increases the number of honey bees working the crop.
- Increases the foraging time per bee and the flowers visited per bee.
- Increases seed set.
- Increases fruit size, grade and overall yield.

2. Brood pheromone

1960s

It is has been shown (by S.C. Jay, Canada) that open brood can inhibit worker ovary development (more potent than the queen herself).

A colony only becomes “hopelessly” queenless, when both the queen is lost and all the sealed brood are emerged.

1972

As stimulus for “warming behavior” for brood. This chemical was identified as glycerol-1,2-dioleate-3-palmitate, in 1972 by N. Koeniger.

1989

The chemicals in brood were identified (by Yve Le Conte), this was done because of the releaser effect on mites (as a kairomone for the Varroa mite). The blend from larval cuticles turns out to be very simple chemicals, 10 of them.

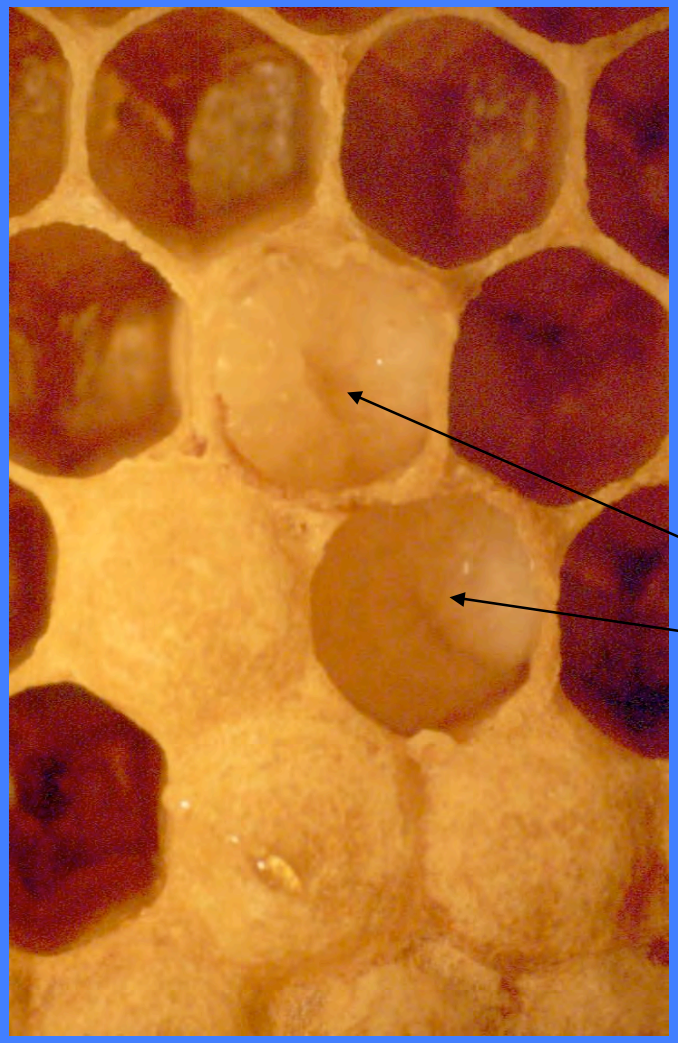
They are methyl and ethyl esters of five different fatty acids:

FATTY ACID ESTERS IDENTIFIED ON THE LARVAE

- methyl and ethyl Palmitate $C_{15}H_{31}COO\text{-}R$
- methyl and ethyl Stearate $C_{17}H_{35}COO\text{-}R$
- methyl and ethyl Oleate $C_{17}H_{33}COO\text{-}R$
- methyl and ethyl Linoléate $C_{17}H_{31}COO\text{-}R$
- methyl and ethyl Linolénate $C_{17}H_{29}COO\text{-}R$

$R = -CH_3$
$R = -C_2H_5$

LE CONTE *et al* , 1989 ***Science***, 245, 638-639

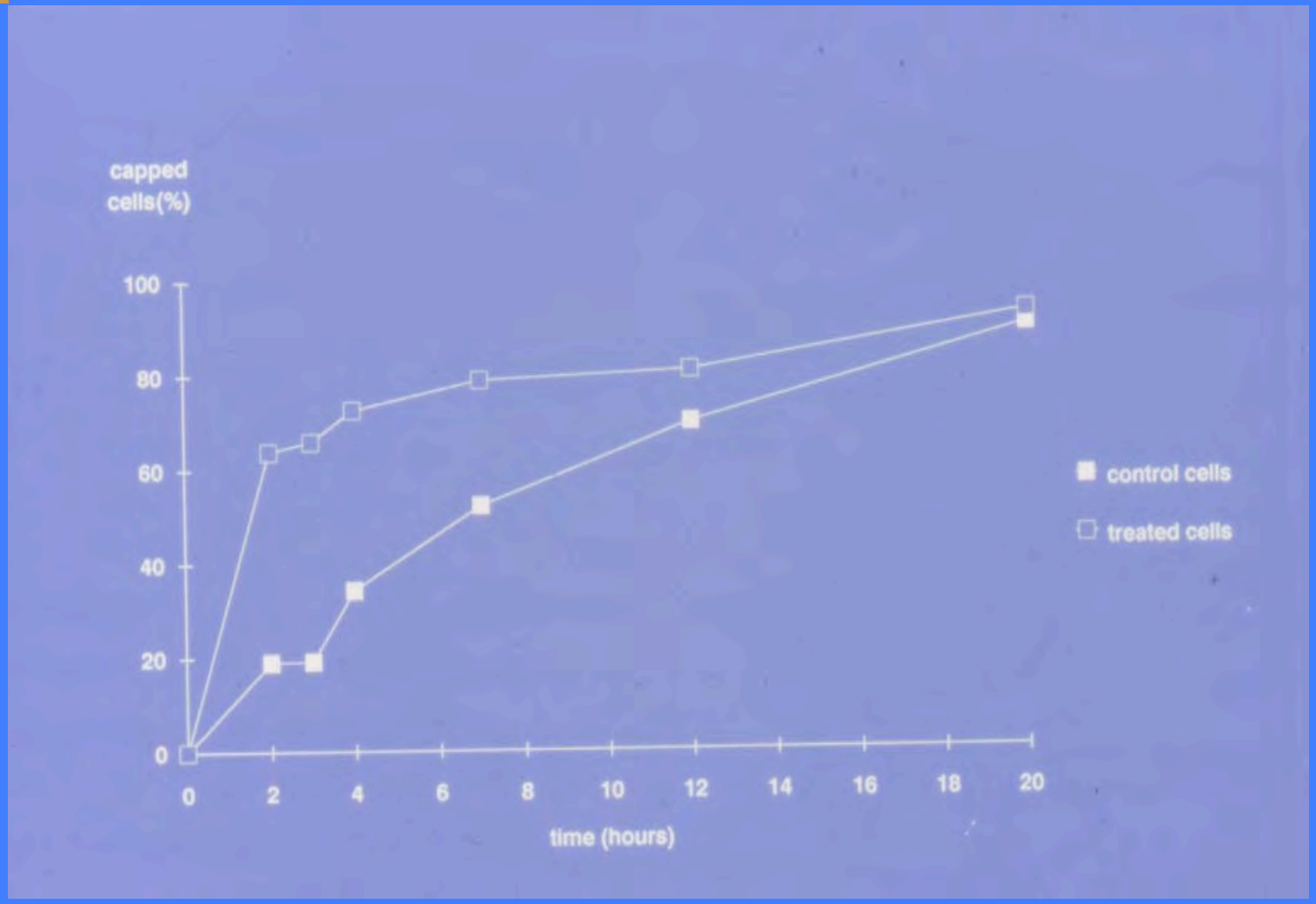


5 to 20 more esters during
the capping of the cell

=>

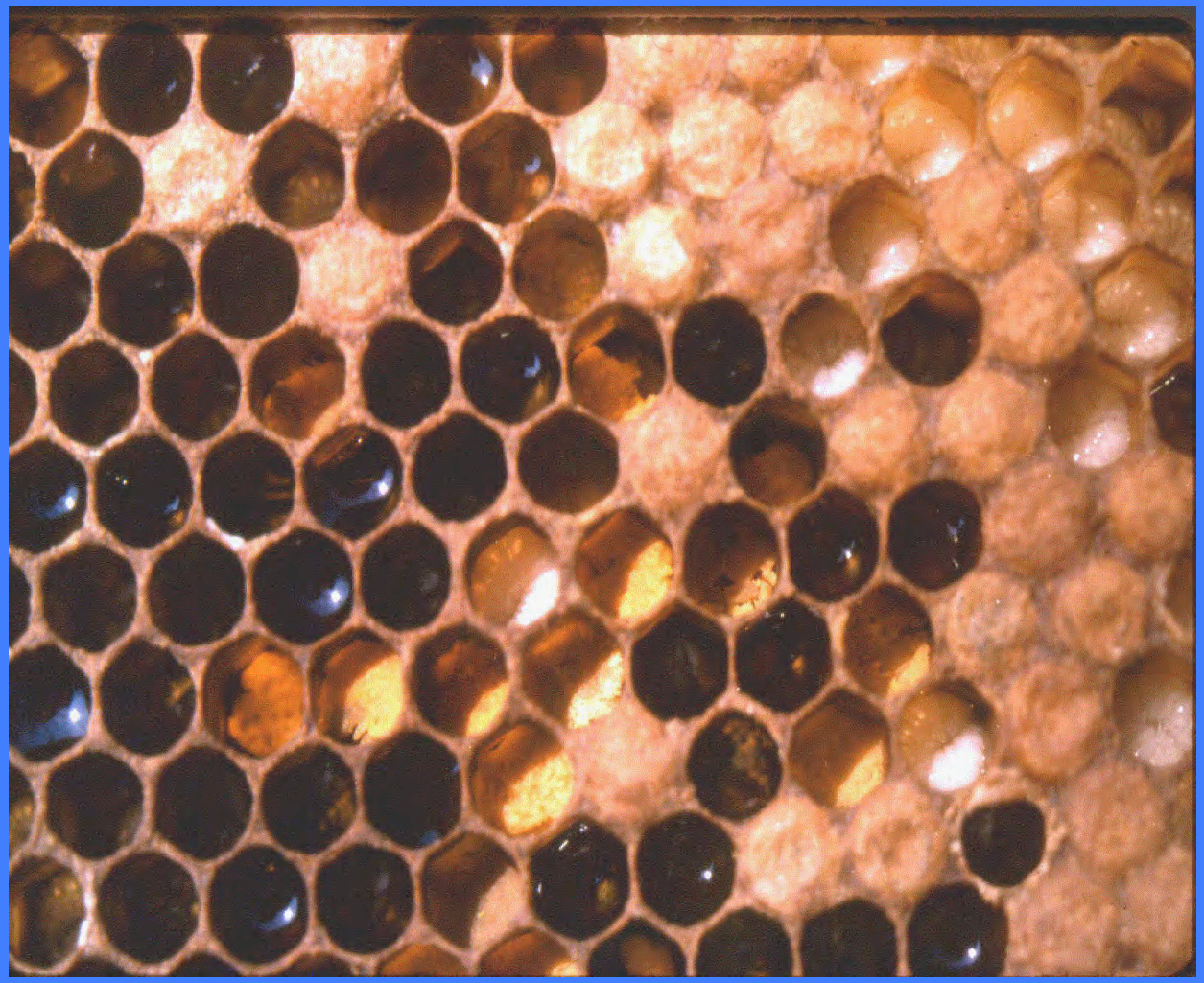
Topical applications

Topical applications



Dummies containing the different esters

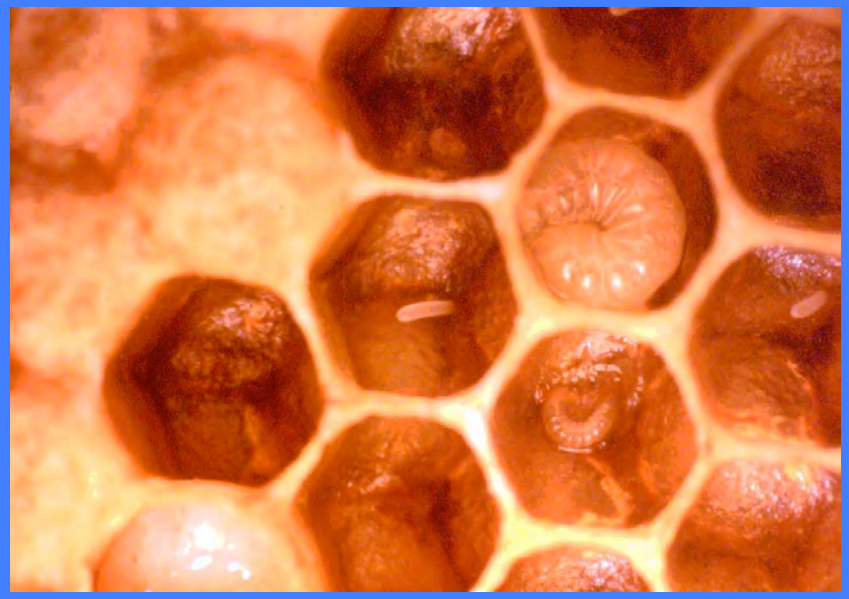
Capping of the cells



Methyl Palmitate Oleate, Linoleate and Linolenate

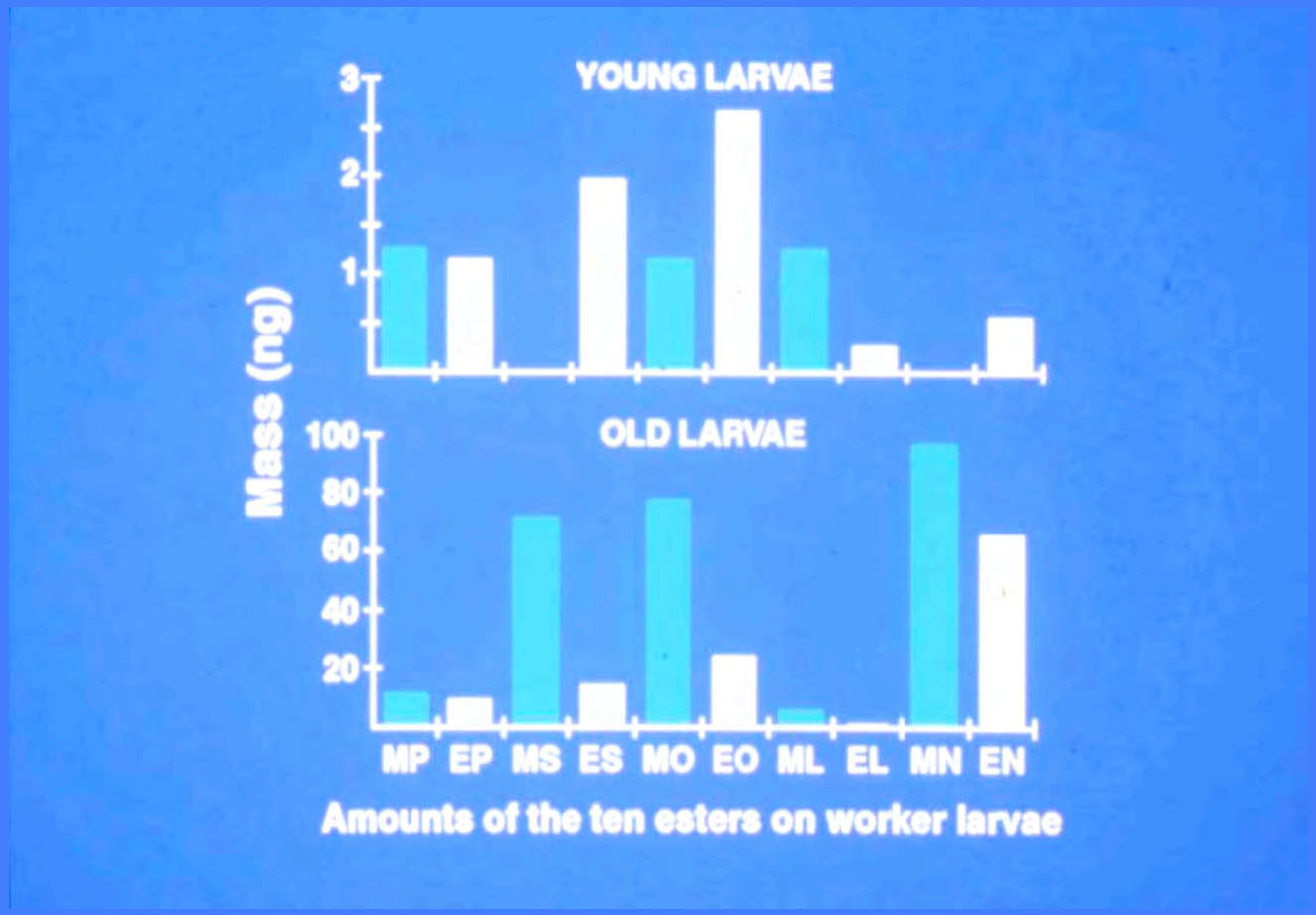
LE CONTE ***et al*** 1990 - ***Naturwissenschaften***, 77, 334-336

Age of larvae



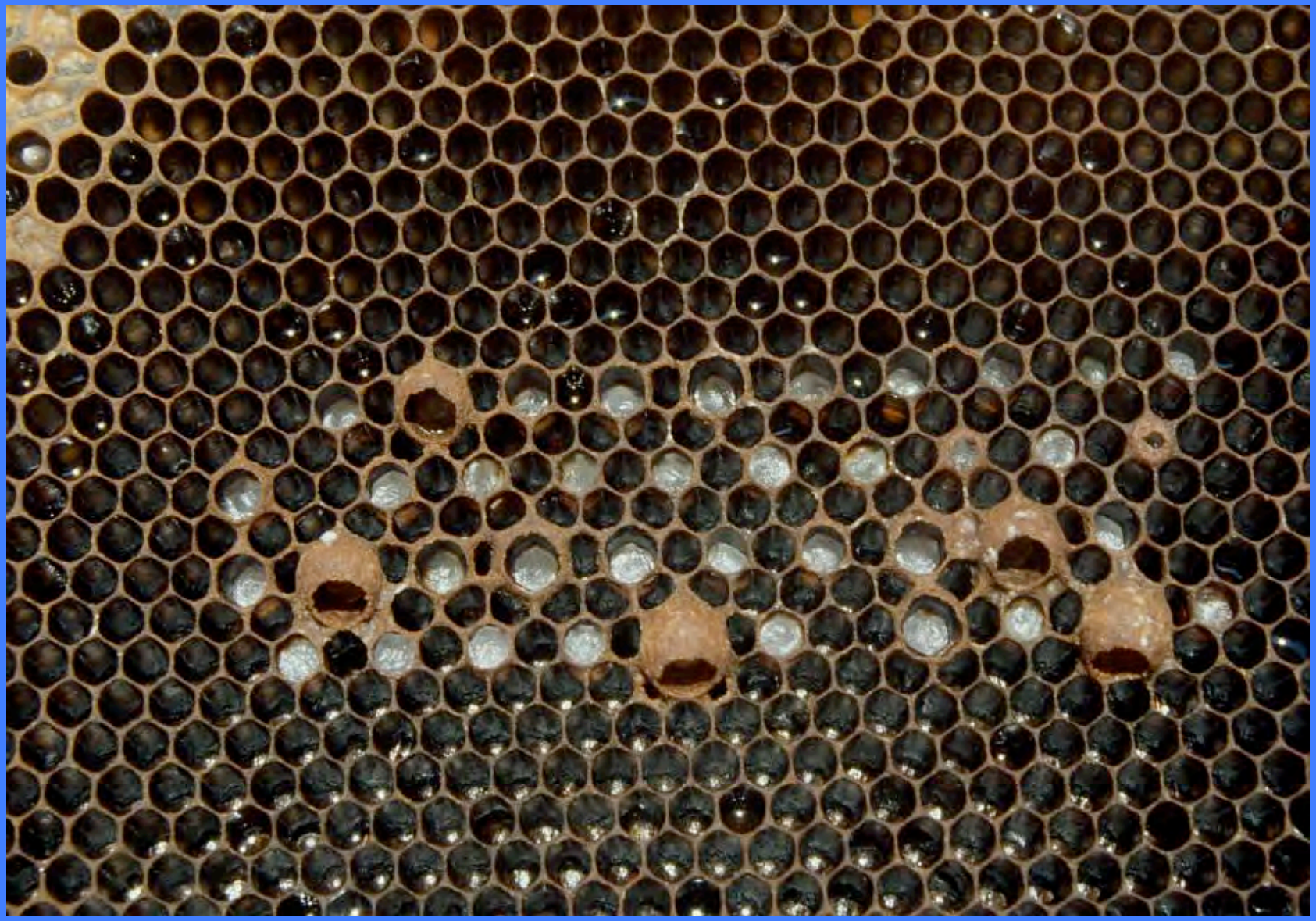
Different mixture of the blend (quantities and proportions)

Age of larvae



Different mixture of the blend (quantities and proportions)

Age of larvae



Different mixture of the blend (quantities and proportions)

LE CONTE *et al*. ***Naturwissenschaften,*** 1994, 81, 462-465.

Effects of Brood Pheromone

Releaser

1. As cues for brood capping (hey, I am ready to be capped)
2. As kairomone for the Varroa mite (signal for mite entering)
3. Stimulate pollen collection

Primer

1. Inhibit worker ovary development
2. Stimulate development of hypharyngeal glands
3. Increase royal jelly production
4. Delay foraging and inhibit juvenile hormone levels

BP and Beekeeping
(if commercially produced)

1. As varroa attractant (already in testing)
2. Increase royal jelly production
3. Stimulate pollen collection: good for pollinating hives?

3. Worker inhibitor

1992: Huang & Robinson showed that foragers can prevent young bees from becoming foragers.

They developed the “Social inhibition” model (originally called activator-inhibitor model)

Based on these facts:

- Workers can forage precociously when no old bees present
- This production of precocious foragers can be ‘inhibited’ by putting foragers in
- Rearing bees in isolation caused early foraging

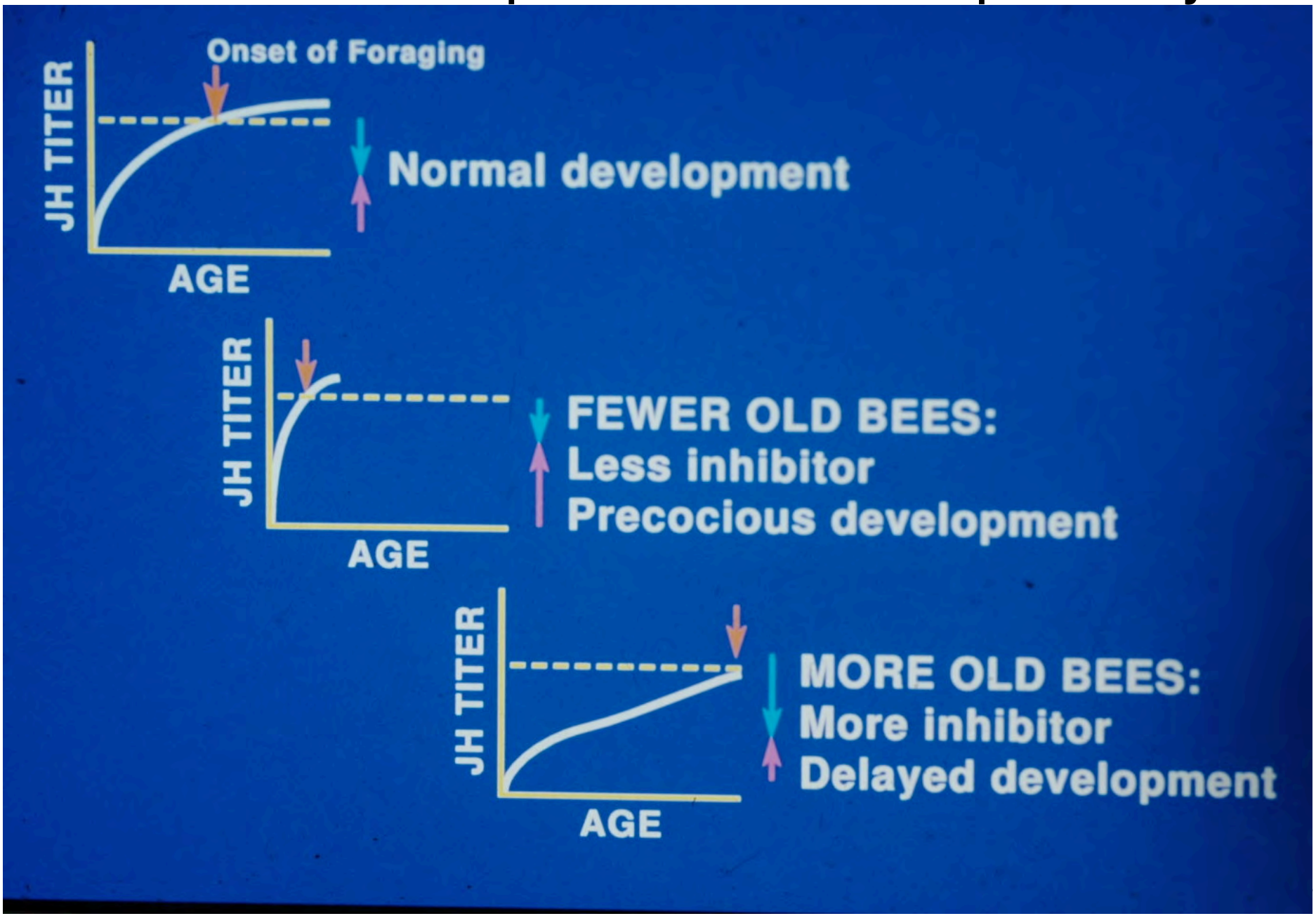
A “social inhibition” model was developed

Activator-Inhibitor Model

(Huang & Robinson 1992)

1. JH is an intrinsic activator of behavioral development.
2. There is a socially transmitted inhibitor of JH and behavioral development.
3. Activator and inhibitor are linked developmentally.
4. Rate of behavioral development depends on pattern of social interaction.

This model explains 3 forms of plasticity



Testing the modality of the inhibitor

Three tests

1. Will “rain” slow down development?
2. Will forager removal cause faster development?
3. Is reversion independent of brood?

The long silence: 1998 - 2004

Regulation of behavioral maturation by a primer pheromone produced by adult worker honey bees

Isabelle Leoncini*, Yves Le Conte*, Guy Costagliola†, Erika Plettner‡, Amy L. Toth§, Mianwei Wang‡, Zachary Huang¶, Jean-Marc Bécard*, Didier Crauser*, Keith N. Slessor‡, and Gene E. Robinson§‖**††

*Laboratoire Biologie et Protection de l'Abeille, Unité Mixte de Recherche Institut National de la Recherche Agronomique/Université d'Avignon et des Pays de Vaucluse Ecologie des Invertébrés, Site Agroparc, Domaine Saint-Paul, 84914 Avignon Cedex 9, France; †Groupement de Recherche et d'Analyse des Pesticides dans les Produits Alimentaires, Unité Mixte de Recherche Institut National de la Recherche Agronomique/Direction Générale de l'Alimentation, 84914 Avignon Cedex 9, France; ‡Department of Chemistry, Simon Fraser University, Burnaby, BC, Canada V5A 1S6; Programs in §Ecology and Evolutionary Biology and **Neuroscience and ‖Department of Entomology, University of Illinois at Urbana–Champaign, Urbana, IL 61801; and ¶Department of Entomology, Michigan State University, East Lansing, MI 48824

Communicated by May R. Berenbaum, University of Illinois at Urbana–Champaign, Urbana, IL, October 18, 2004 (received for review July 30, 2004)

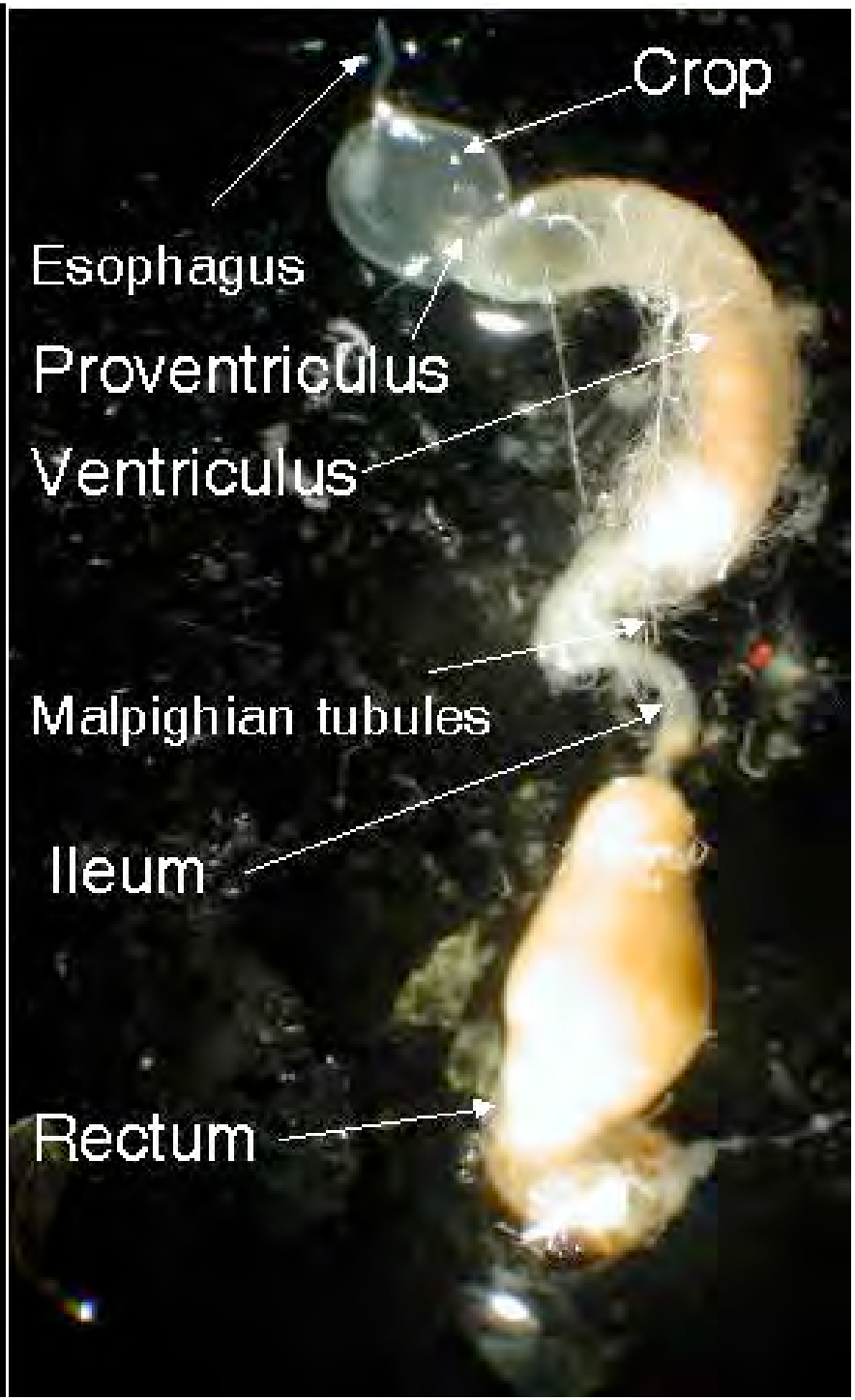
Proceedings of National Academy of Sciences

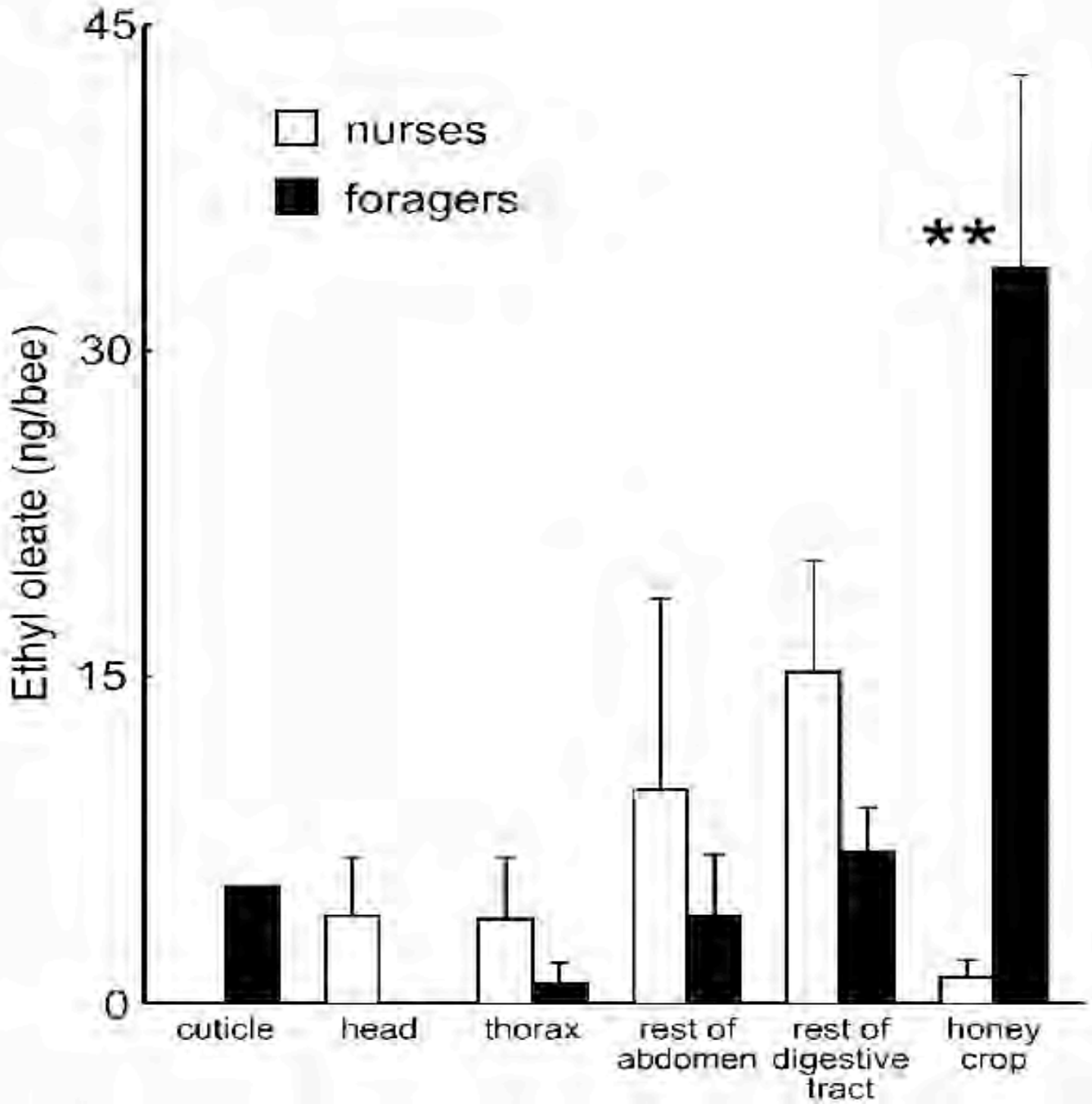
Worker inhibitor recently identified as ethyl oleate

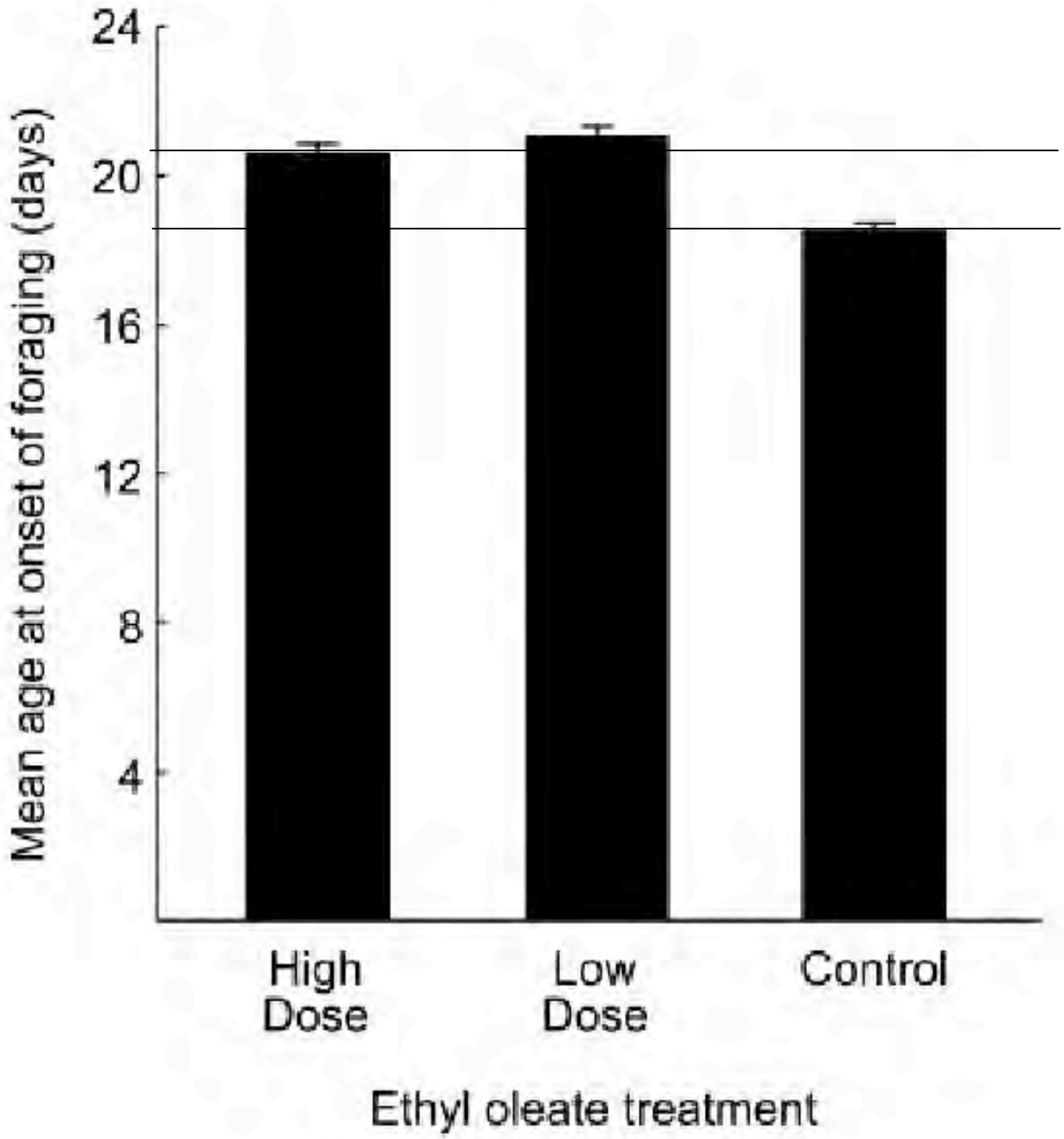
Produced by honey crop

Much higher in foragers
Passed to other bees

Feeding of this chemical to young bees delayed their age of foraging




45
30
15
0
Ethyl oleate (ng/bee)
nurses
foragers
**
cuticle
head
thorax
rest of abdomen
rest of digestive tract
honey crop


24
20
16
12
8
4
Mean age at onset of foraging (days)
High Dose
Low Dose
Control
Ethyl oleate treatment

Perhaps transferred to others from foragers via mutual feeding

Cover photo of Proceedings of National Academy of Sciences (12/14/04)

SPECIAL REPORTS

Last updated: Mon Nov 29 17:29:11 2004

Contact: Zachary Huang, (517) 353-8136 or bees@msu.edu; or Sue Nichols, University Relations, (517) 353-8942, nichols@msu.edu

New pheromone creates buzz about the clout of older bees

EAST LANSING, Mich. – A recent discovery unveils the chemical secret that gives old bees the authority to keep young bees home babysitting instead of going out on the town.

A hard-to-detect pheromone explains a phenomenon Michigan State University entomologist Zachary Huang published 12 years ago – that somehow older forager bees exert influence over the younger nurse bees in a hive, keeping them grounded until they are more mature, and thus more ready to handle the demands of buzzing about.

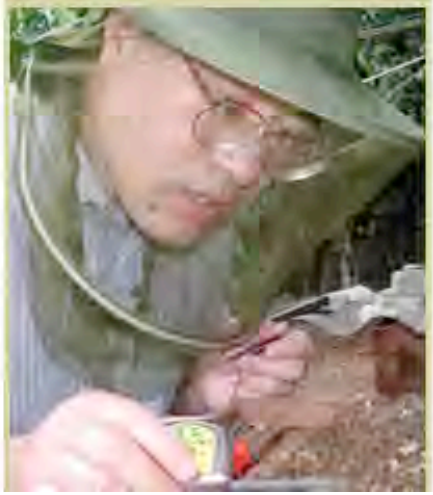
The work that identifies the chemical, "Regulation of Behavioral Maturation in Honey Bees by a New Primer Pheromone" is publishing in Proceedings of the National Academy of Science Biological Sciences, Population Biology, Early Edition the week of Nov. 29.

"If the older ones don't keep them in check, the young ones can mature too quickly," Huang said. "It's kind of the same thing as with people, you need the elders to check on the young, even if the young are physically able to go out on their own, it's not the best situation for anybody and now we know how it works."

Huang worked with a team that spanned from the United States , France and Canada to explain how the bees kept an exquisitely consistent balance between the ones that go out to collect nectar and pollen and defend the hive, and those that stay home and nurture the larvae. Huang had documented that this balance is controlled by the elder bees, those that typically spend the final one to three weeks of their five-week lifespan out in the field.

Experiments showed that if a significant number of

A honey bee worker (top left corner) feeds four others simultaneously. Honey bee social feeding was long thought to involve the exchange of communicative substances, in addition to food. The report in the Proceedings of the National Academy of Sciences is the first discovery of a primer pheromone produced by adult worker honey bees that is thought to be transferred via food exchange. (Photo courtesy of Zachary Huang.)
Hi-res jpg



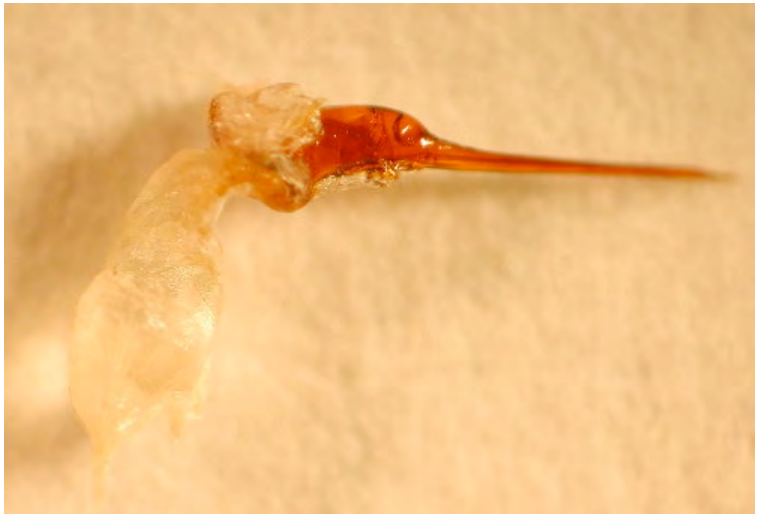
Worker Inhibitor and Beekeeping

1. Possible use for queen rearing colonies
2. Increase royal jelly production

4. Alarm pheromones

Mandibular gland: 2-heptanone

Sting glands: isopentyl acetate.



Relevance to Beekeeping

1. One sting will increase likelihood of more stings. But no directional cue.

2. Reduce defensiveness by “habituating” the bees to the alarm odor?

5. Nasonav Pheromone

5. Nasonav Pheromone

Components:

isomers of citral, nerol, geraniol, nerolic acid, geranic acid and farnesol.

Important for orientation when colony is disturbed, or during swarming

Use in Beekeeping

Swarm attraction (used for Africanized bees)

6. Virgin Queen Pheromone

Virgin queen defecation
- Smells good for humans
- Repels worker bees

Chemical identified as:
- o-aminoacetophenone

Possible use: increase queen acceptance?

7. Queen Fighting Pheromone

When two queens are together, they almost always fight (usually till one dies)

Recently proven to be a chemical signal and identified by German scientists

But not published yet

Queen trap?

Chemicals to negate the effects of this pheromone (antagonist): two or more queens per colony?

Un-identified pheromones

Trail Pheromones:

Workers: mark visited flowers?

Queen: tarsal pads deposit pheromone that inhibits queen cell construction

Summary

1. Queen mandibular pheromone (PheroTech)
2. Brood pheromone (Sigma)
3. Worker inhibitor (Sigma)
4. Alarm pheromone
5. Nasonav pheromone
6. Virgin queen pheromone
7. Queen fighting pheromone

Thank you for your time

http://photo.bees.net/gallery

www.beetography.com