Assessing the attractiveness of hive volatiles to small hive beetles(*Aethina tumida*)

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Introduction

- Small hive beetle

Coleoptera

Nitidulidae

Aethina tumida

- Native to sub-Sahara, parasitic to honeybee hive
- In hive pest of honeybee Apis mellifera
- Adult and larvae both damage honeybee and hive materials
- Recent invasion into Korea 2016. Sep. 20

Ellis (2005) Bee. World. 86 (3), 56–62

Global distribution

Invasion pathway of the honeybee pest, small hive beetle, *Aethina tumida* in the Republic of Korea inferred by mitocondrial DNA sequence analysis. Saeed Mohamadzade Namin et al., Journal of Asia-Pacific Entomology (2019) 22:963–968

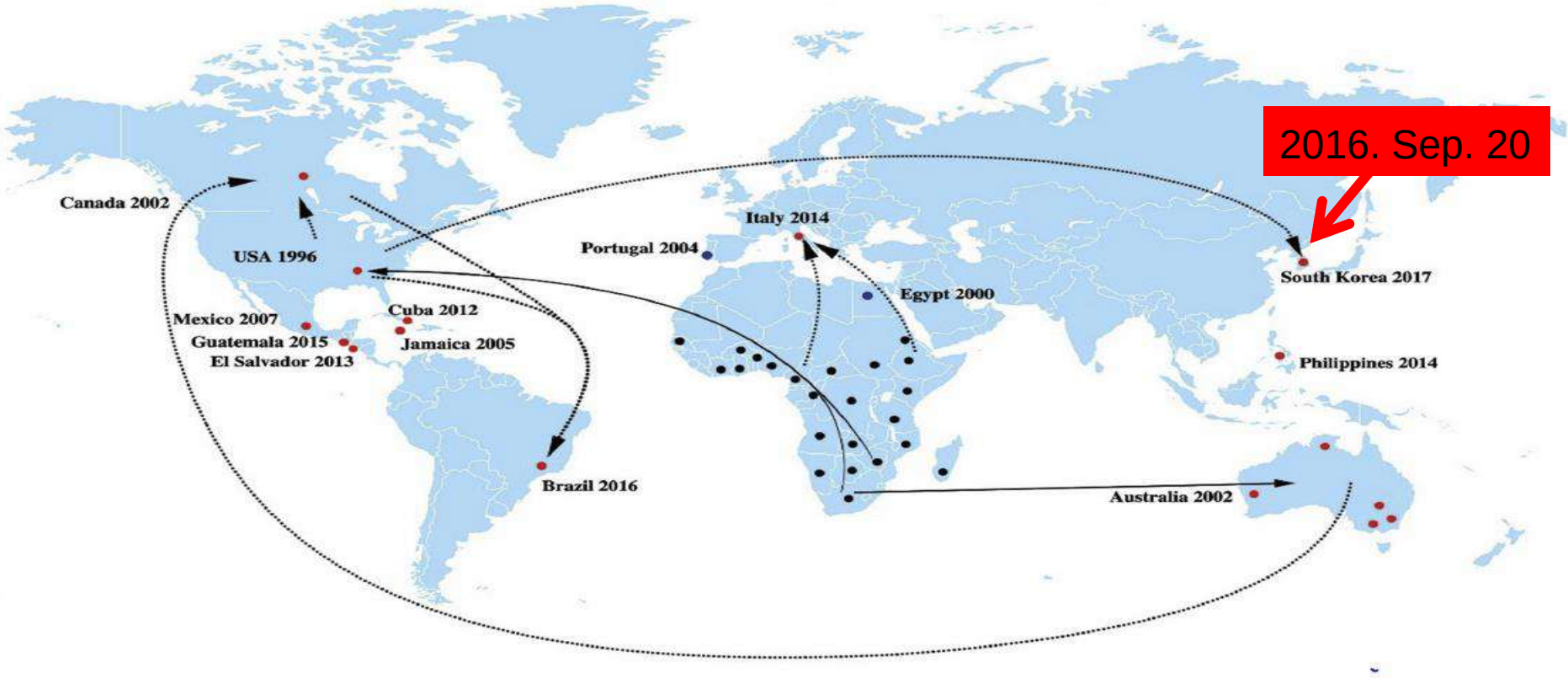

Fig. 1. Global distribution of small hive beetles up to June 2019. Red circle : distribution of SHB, black circle : native range; red circle : well-established populations; blue circle : unestablished areas (for further information, Neumann et al., 2016). (For interpretation of the references to colour in this figure legend, the reader is referred to the web version of this artivle.)

Invasion into Korea

https://m.nongmin.com/news/

농민신문

정책

꿀벌에 치명적인 외래해충 국내 첫 발견

입력 : 2016-10-05 00:00

가 가

벌집을 망가뜨리고 꿀을 부패시키는 등 꿀벌에 치명적 피해를 주는 외래해충인 '작은벌집딱정벌레(사진)'가 경남 밀양에서 국내 처음으로 발견됐다.

<1면용>경남 밀양 양봉농가서 '작은벌집딱정벌레' 국내 첫 발생

밀양에서 40여년간 양봉을 해온 이모씨는 9월23일 벌통 대부분에서 작은벌집딱정벌레와 애벌레가 증식한 것을 발견하고 인근 검역기관에 신고했다.

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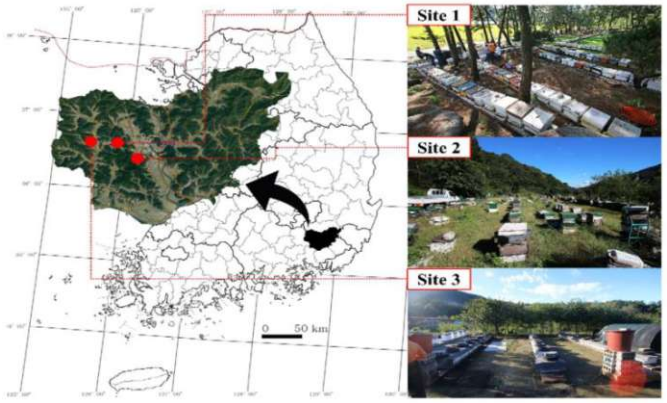
ELSEVIER

Review of the subgenus *Aethina* Erichson s. str. (Coleoptera: Nitidulidae: Nitidulinae) in Korea, reporting recent invasion of small hive beetle, *Aethina tumida*

Seunghyun Lee [a,b], Ki-Jeong Hong [c], Yun Sang Cho [d], Yong Soo Choi [e], Mi-Sun Yoo [d], Seunghwan Lee [a,b,*]



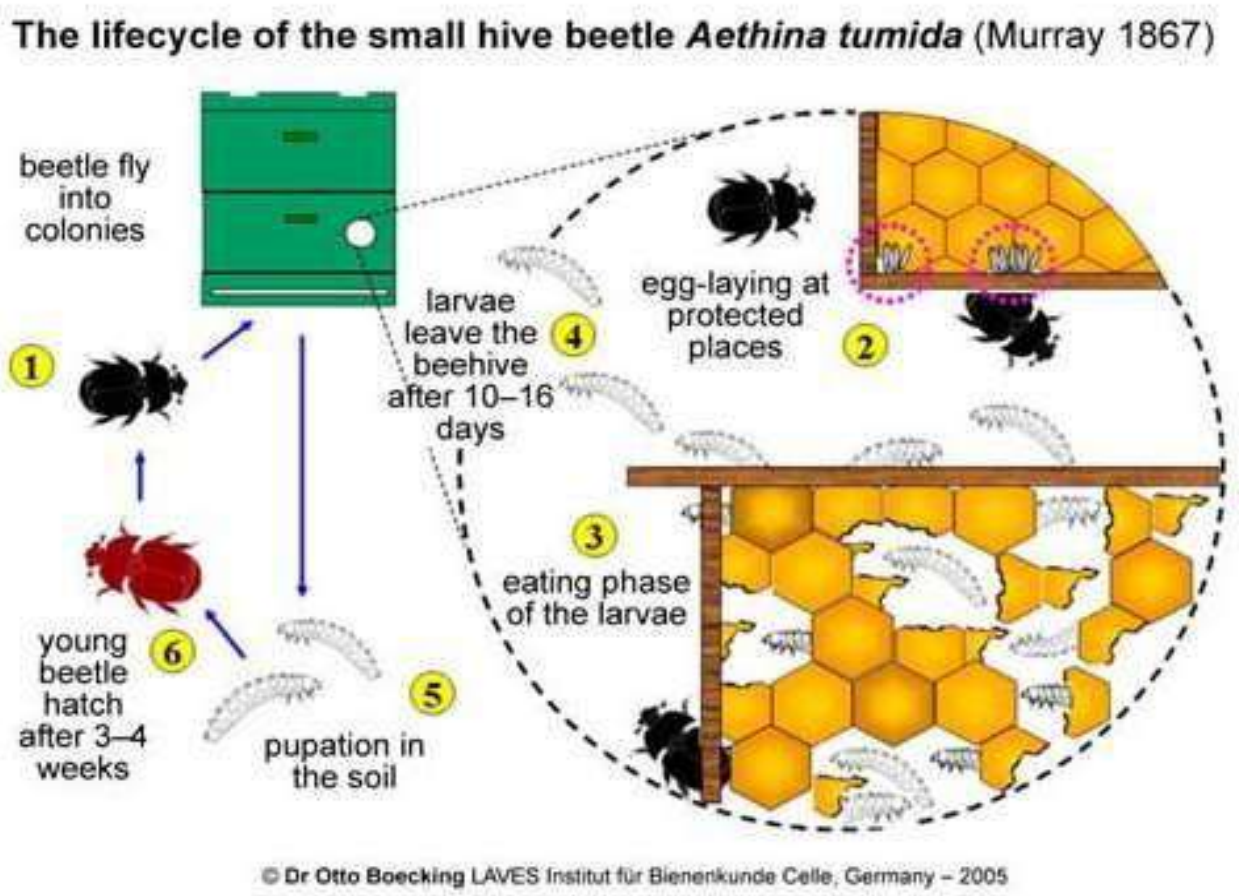
Left: invasion site of *Aethina tumida*, Miryang city

Site 1: 12–3, Gabok 4an-gil, Muan-myeon, Miryang-si, Gyeongsangnam-do, Korea;

Site 2: 823, Hwabong-ri, Muan-myeon, Miryang-si, Gyeongsangnam-do, Korea;

Site 3: 196–54, Songpo-ro, Bubuk-myeon, Miryang-si, Gyeongsangnam-do, Korea

Life cycle and pest potential



Honeybee brood : direct feeding and competition
Honeybee adult : interference and expelling
Honey : contamination + fermentation
Combs : feeding and borrowing

Life cycle and pest potential

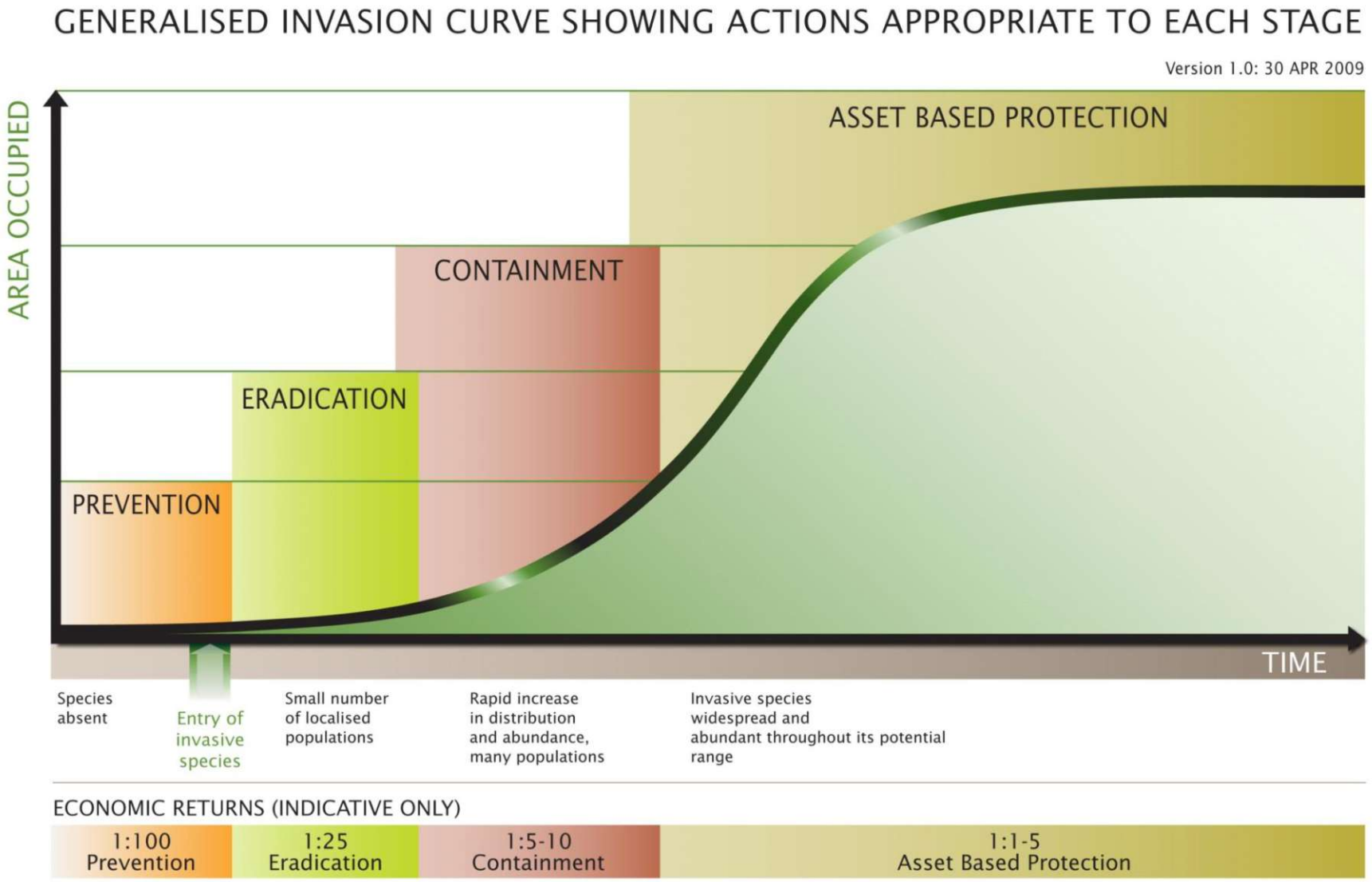
- Egg on the crevices of hive 3-7d → Larva feed on honey and comb, larave 10-16d → wandering larvae move out from hive into soil for pupation 1-3d→ pupa 33-6wk→ adult

- Adults can fly 8 km per night to locate a hive by odor: pollen/honey

- Once in the hive the beetle mix pollen, honey with the symbiotic yeast (*Kodamaea ohmeri*) and produce alarm pheromone to attract a mate.

- high environmental resistance: Survive on comb for 50 days, honey for 6 months and survive 14 days without food or water.

Control of invaded pest



Concerns on early stage of invasion

Q1. Location of beetle ? Monitoring method / efficiency

Q2. Control or Eradication : target, agent

Hong and Jung, 2018 medicine screening

Q3. Containment :

Environmental adaptability (Temperature, humidity)

Dispersal pathway

Host distribution or movement

Hong and Jung, 2017 distribution

Hong and Jung, 2017 temperature growth

Q1. Location of beetle ? Monitoring

- **Mechanical traps**

  - the Hood Trap,
  - the West trap,
  - the Freeman Beetle trap,
  - disposable plastic trap

  <u>Use vegetable oils / pollen for bait</u>

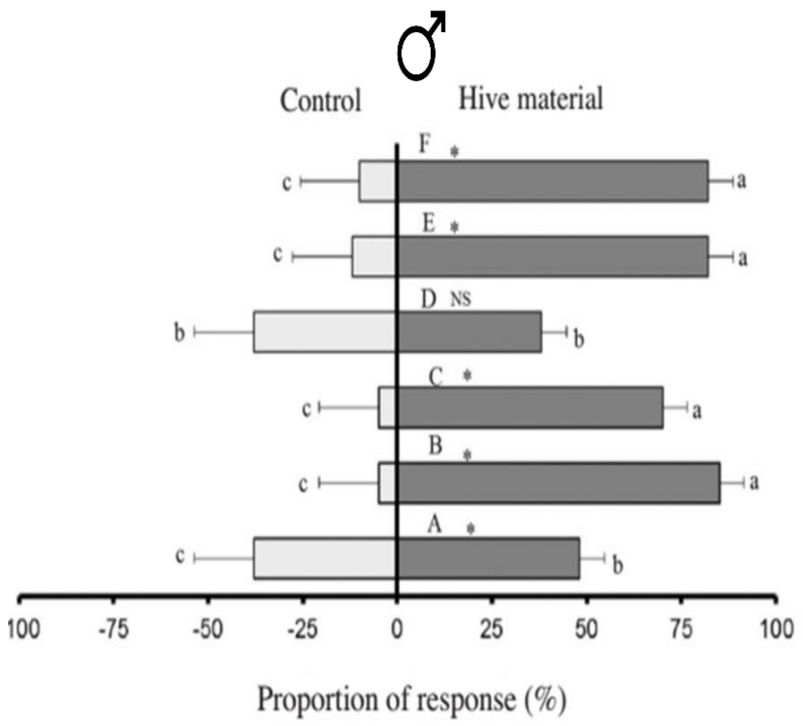
Fig. 2. Disposable plastic trap

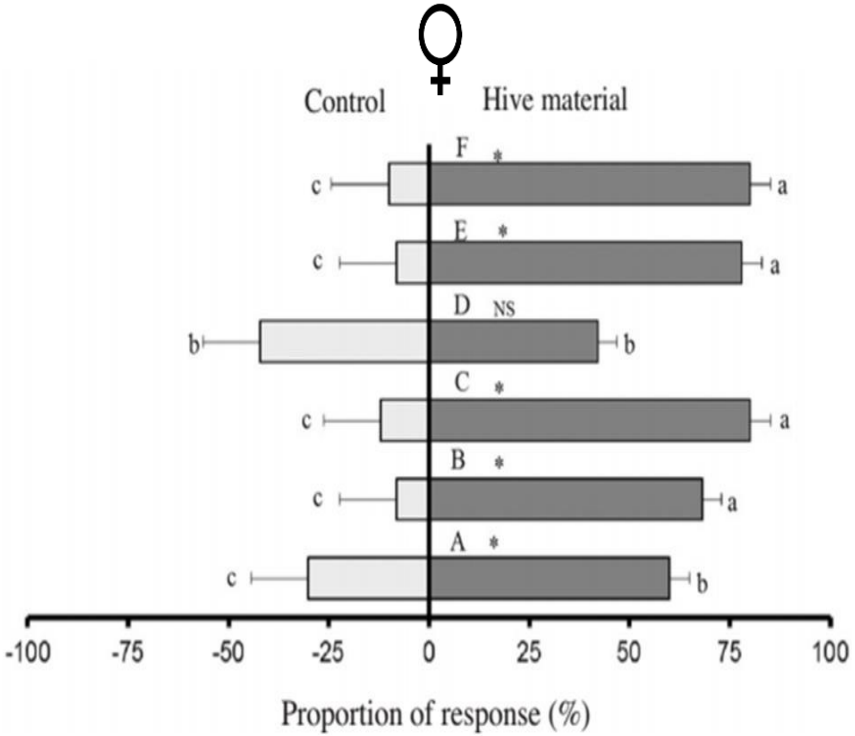
- Plastic trap which is designed to be placed between two top bars in the bottom brood chamber or supers. It should be half-flled with vegetable oil and checked at every inspection .
- The outer two compartments should be filled a third to half full with vegetable oil while the middle section can be filled with cider vinegar in order to attract the beetles and larvae.

Zawislak Managing Small Hive Beetles. University of Arkansas, United States Department of Agriculture, and County Governments Cooperating (Available online).
The National Bee Unit National Agri-Food Innovation Campus Sand Hutton York YO41 1LZ, UK

Preliminary result

- Y-tube olifactometer bioassay: <u>22 d –fermented pollen dough</u>





F: Worker bees
E: 20 day-fermented honey
D: Fresh honey;
C: 22 day-fermented pollen dough
B: 13 days fermented pollen dough;
A: Fresh pollen patty;

Dekebo et al. , 2017. Attractiveness of the Small Hive Beetle (*Aethina tumida*) to Volatiles from Honey bee (*Apis mellifera*) and Beehive Materials. J. Apic.. *32*(*4*) *: 315~326*.

Objective of the study

- To test olfactory responses of SHB to volatiles we identified from essential oils of beehive materials
- Specially from 22-d old fermented pollen dough.

Materials and Methods

Small Hive Beetles

The beetles were reared in acrylic cages (38 x 38 x 34 cm) at room temperature (25 ± 2°C, 60 ± 5% RH) with 12L: 12D photoperiod. Beetles were fed on a mixture of pollen and honey.

Materials and Methods

Chemicals

All the individual chemicals were pruchased from Sigma Aldrich, South Korea.

Each compound was dissolved in concentration of 0.01, 0.1, 1 and 10 mg/ml.

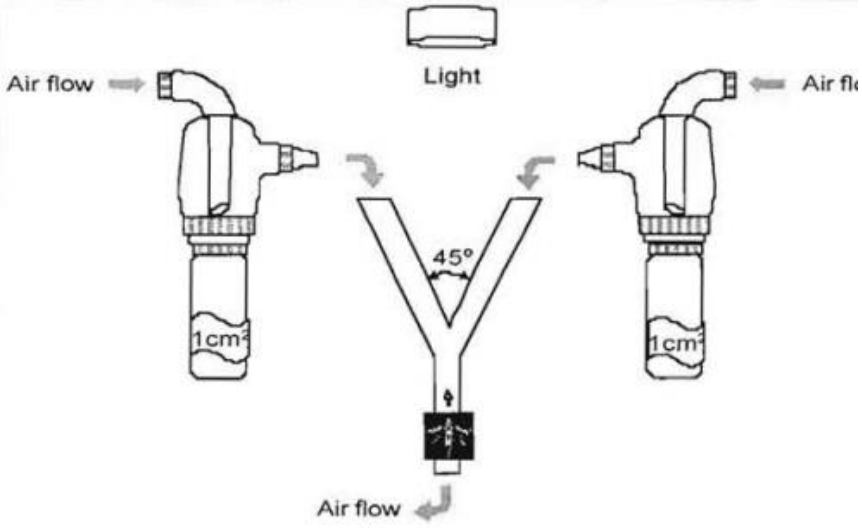
•Ethyl palmitate (≥ 98.5%) + n-hexane,

•Ethyl linolenate (≥ 98%) + n-hexane,

•Eetracosane (≥ 99%) + Chloroform,

•Oleamide (≥ 99%) + Chloroform,

•5-methyl-2-phenyl-1H-indole + Methanol.



A. *Y-tube*

GC-MS Instrument

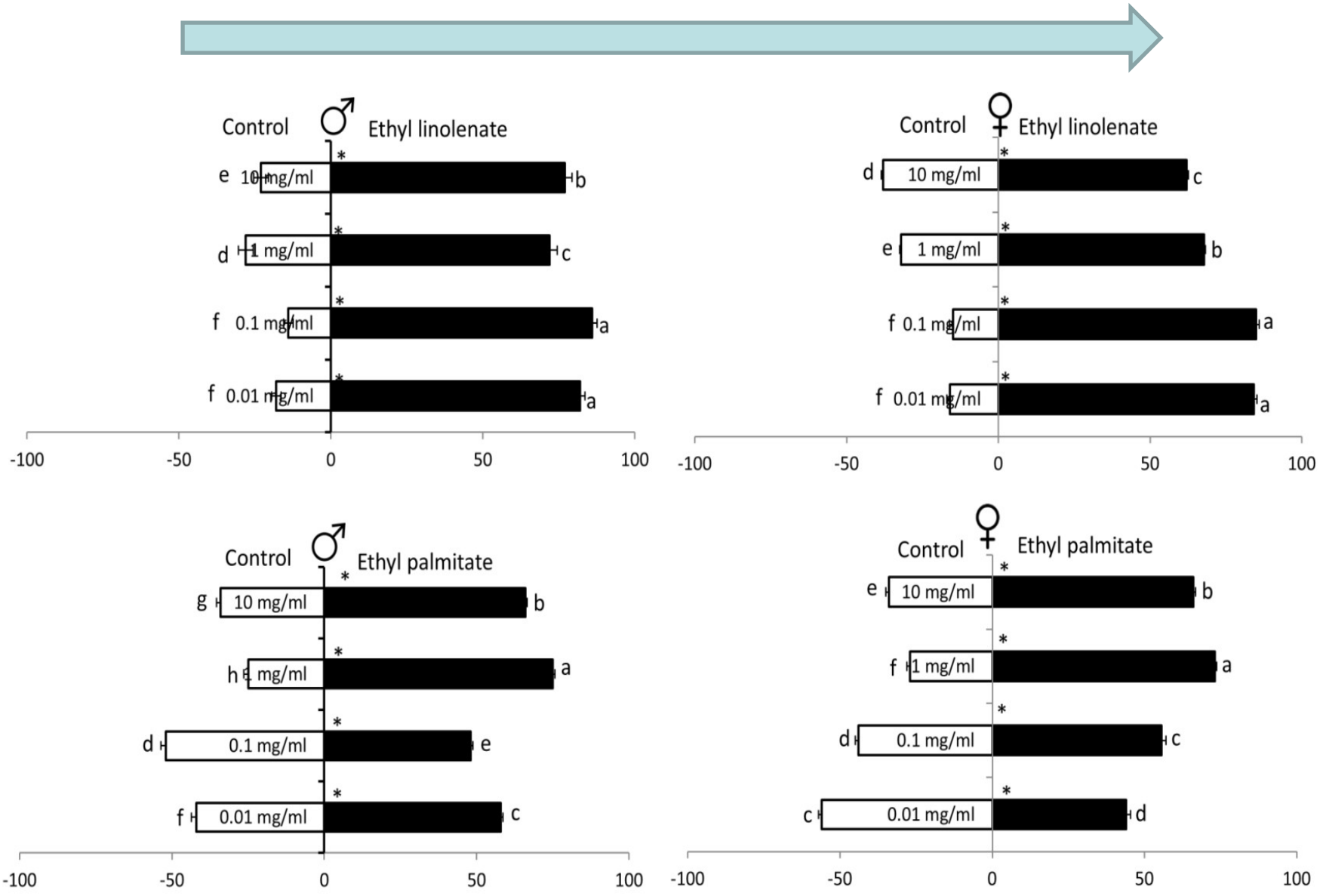
B. Two arm olifactometer

Olfactometers for recording responses of SHBs to volatiles

HPLC instrument

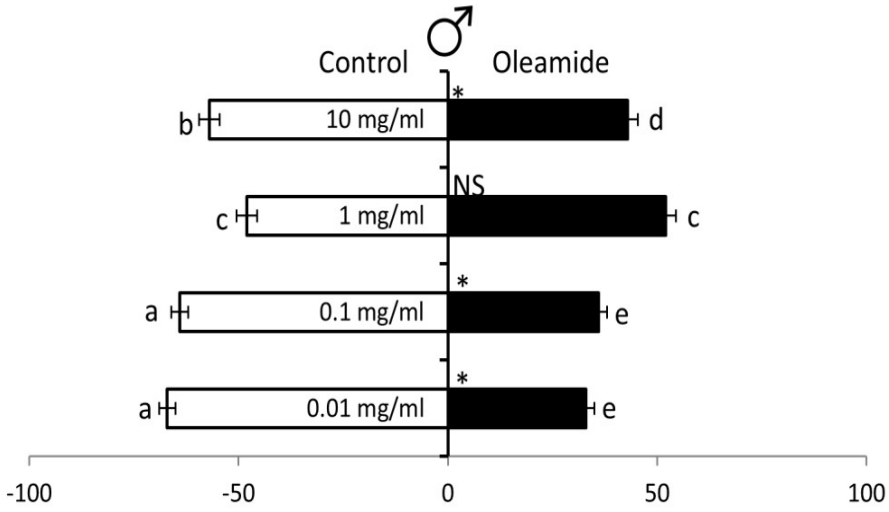
Results

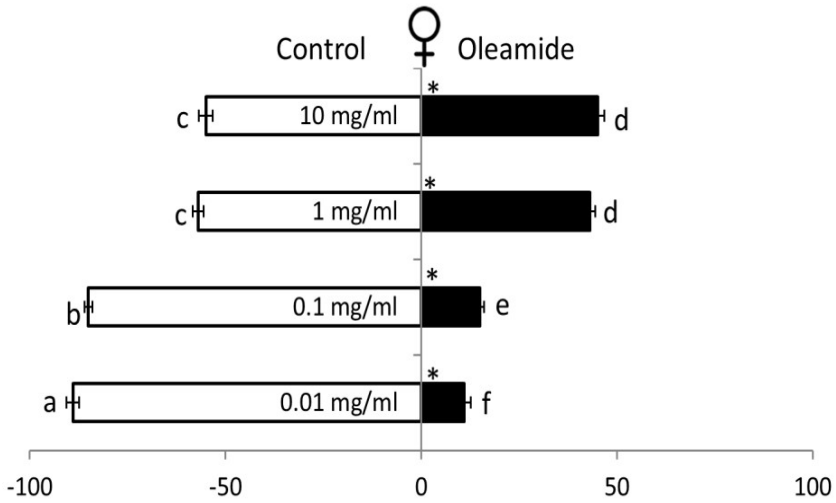
- Ethyl linolenate & Ethyl palmitate (ANOVA : P< 0.05)

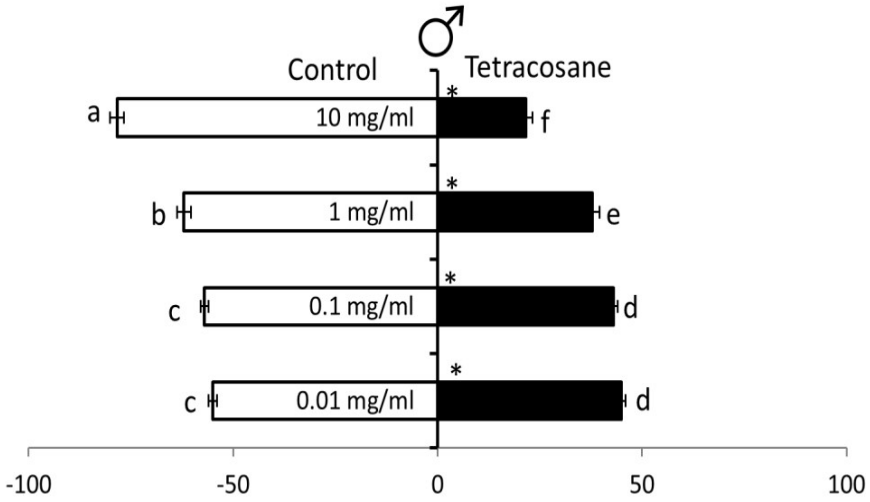


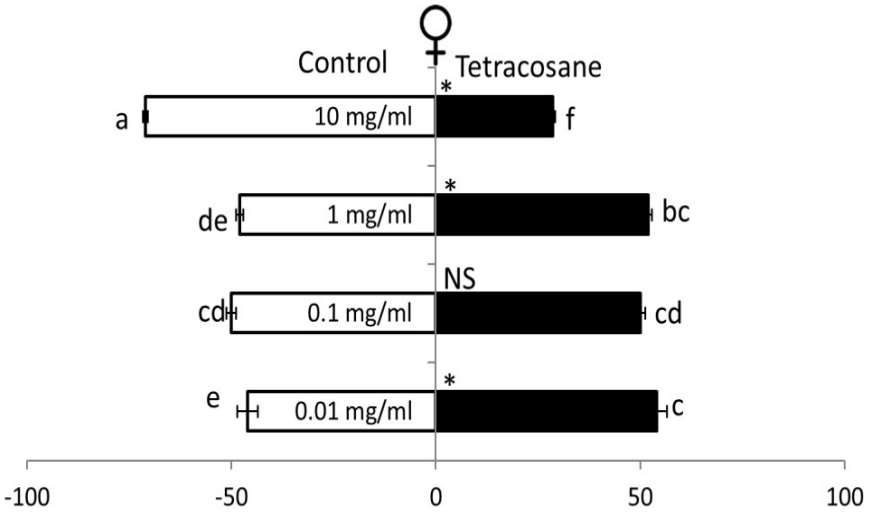
Results

- Oleamide & Tetracosane (ANOVA : P< 0.05)



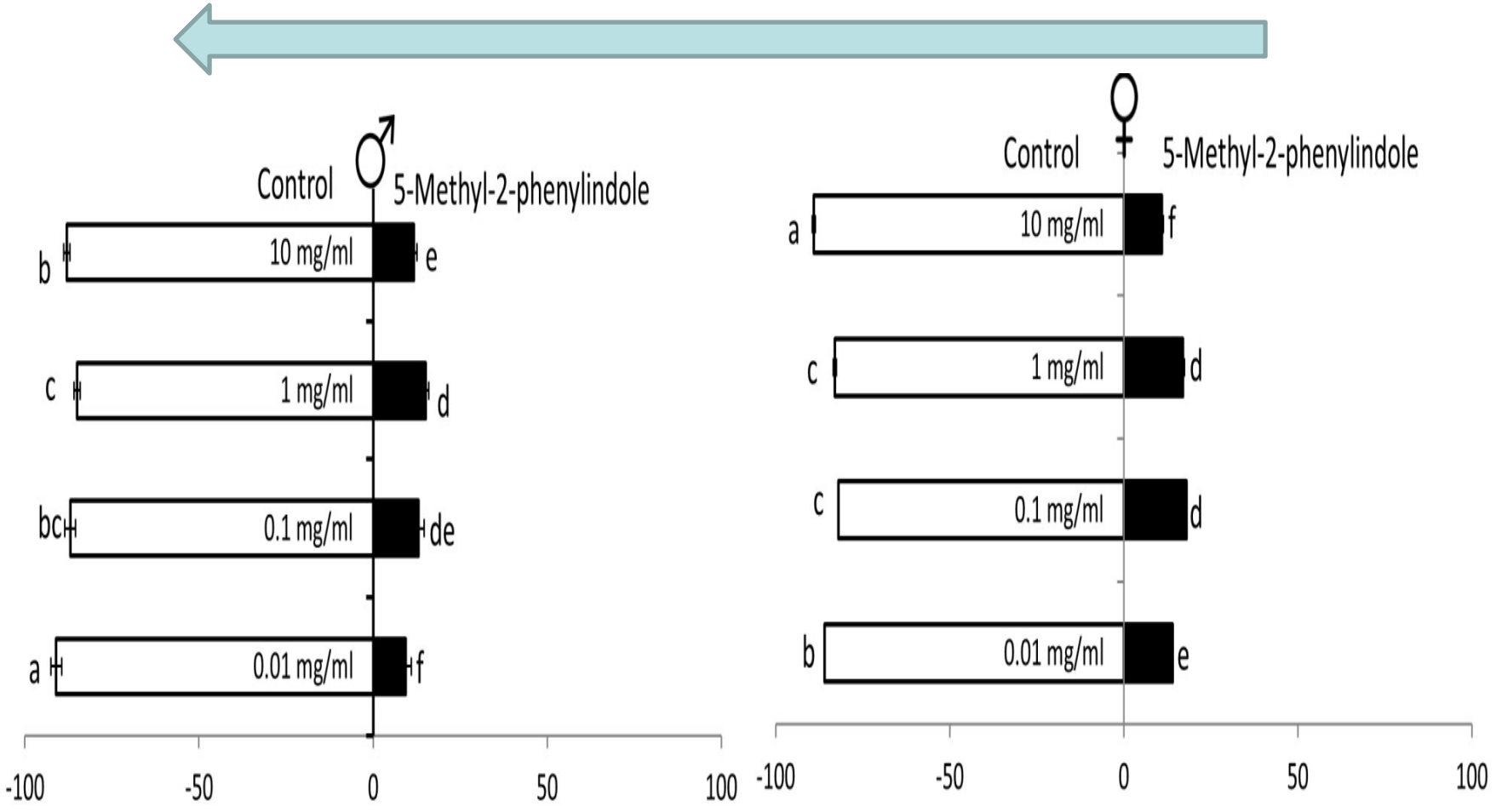






Results

- 5-Methyl-2-phenylindole (ANOVA : P< 0.05)



Summary

- Ethyl palmitate and Ethyl linolenate are attractive to SHB.
- Oleamide have a deterrent effect at lower concentration.
- Tetracosane is repulsive at higher concentration.
- 5-methyl-2-phenyl-1H-indole is repulsive at all concentration.

Discussion

- It is interesting to note the presence of ethyl palmitate and ethyl linolenate as principal compounds in fermented pollen dough produced by the action of SHB(Dekebo, et al., 2017) in common with the brood pheromone of honey bees, which can be a possible explanation for attraction of SHB to honey bee hives.

- SHB might utilize the chemical cues from possible food source of pollen dough or indicatives of reproductive sites of honey bee hive from honey bee brood pheromone.

Discussion

- Our previous study indicated 20 **day-fermented honey** contains oleamide and tetracosane (Dekebo, et al., 2017).

- The repellant effects of both oleamide and tetracosane that we documented in the present study indicated that adult SHB may interpret contaminated honey as a repulsive cue.

- Because the resource was already taken by earlier conspecific intruders of the hive, leaving less chance for the new intruder to successfully reproduce in the hive.

Discussion

- Oleamide and 5-methyl-2-phenyl-1H-indole were previously reported as major components of worker bees (*Apis mellifera*) (Dekebo, et al., 2017).

- These were repulsive to SHB, indicating SHB might more attractive to brood or hive materials but not for adult worker bees which are responsible for colony defense.

Based on the previous reports and our findings we believe compounds with ester functional groups might have the potential to lure SHB to hives.