Honey bee lifecycle assessment and homing success in field observations with the help of visual bee monitoring technology

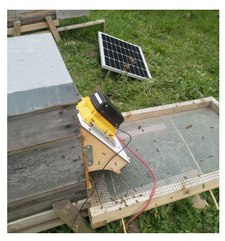
Silvio Knäbe[1], Julia Kisela[2], Frederic Tausch[2], Katharina Schmidt [2] & Gundula Gonsior[1]
[1]Eurofins Agroscience Services Ecotox GmbH; [2]apic.ai GmbH, Germany
Contact: SilvioKnaebe@eurofins.com

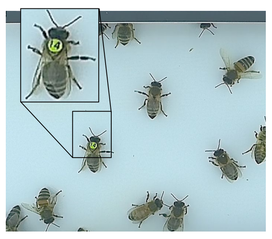
BACKGROUND

- Bee field-testing is including new technology, among them automatic counters
- apic.ai developed a visual bee monitroing system. As part of the BMEL funded project OCELI, algorithms were trained to detect bees equipped with markers
- A new OECD guideline was recently published that works with RFID chipped bees to observe survival, and/or homing behaviour (OECD 332)
- Since the apic.ai bee monitoring system is based on video, it can be used to track individual bees which were marked uniquely
- The technology could be used to include the continuous observation of cohorts of individual bees in bee field-testing, including also effects like foraging time or times bees need until they leave the hive as well as information about the foraging behaviour of bees

OBJECTIVE

- Determine the possibility of individual bee tracking after marking bees individually
- Can bees marked in winter be identified again next spring?
- Compare the marking success of an experienced and inexperienced team





**Pictures:
Study Site &
Camera window**

MATERIAL & METHODS

The study was conducted with two hives in an area where bees could fly freely and had access to natural nectar and pollen sources

Bee Detection and Tracking

- Two colonies were monitored for 28 days with the apic.ai systems
- Individual bee detection using image processing and neural networks
- Detection and tracking of individual bees marked with 4 different colours of opalith markers, their direction and whether they were carrying pollen using cloud processing resources
- Documentation of color and number based on manual assessment

Time Frame

- First marking 21st Sept. 2021 with experienced bee handlers and second 28th Sept. 2021 with inexperienced bee handlers
- First check after marking on 20th Oct. for bees in hive
- Regular monitoring of mortality until 22nd of March 2022

Hive a	Hive b
57 young bees 23 foragers	50 young bees 24 foragers
52 young bees 24 foragers	55 young bees 24 foragers

**Table 1: Distribution of marked bees
(Background of cells gives marker colour)**

Picture: Marking of bees

RESULTS

**Table 2: Marked bees found after 23 and 30 days
(Background of cells gives marker colour)**

Hive a	Hive b
18 young bees 0 foragers	24 young bees 0 foragers
22 young bees 0 foragers	19 young bees 0 foragers

**Table 3: Marked bees found after 175 and 182 days
(Background of cells gives marker colour)**

Hive a	Hive b
0 young bees 0 foragers	3 young bees 0 foragers
1 young bees 0 foragers	2 young bees 0 foragers

Figure 5 - Bee markers IDs

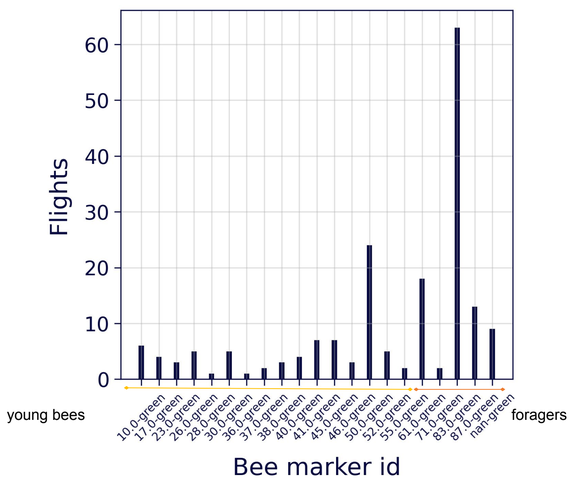
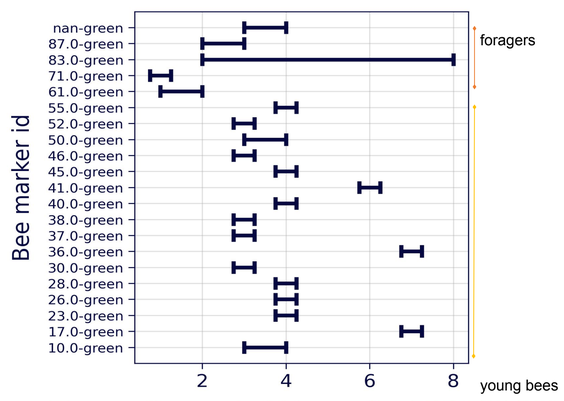


Figure 6- duration of the bee flights



- Only one forager bee (green 83) successfully returned with pollen.
- 6 month after marking still individual marked bees present
- Effect is still measurable at colony level after two brood cycles (Table 3)
- Better survival for in-hive bees if marked by experienced team (loss of 7 bees against 27 bees), no difference for foragers
- First beekeeper assessment about one month after marking – no foragers survived
- Marked foragers fly more often than, the marked young bees (Figure 6)
- Marker observation have shown that the young bees first appeared 3 - 4 days after the the marking (Figure 5)

SUMMARY

- In-hive bees can survive for up to 6 months over winter
- Foragers found end of September are most likely no winter bees.
- Determination of survival curves for cohorts is possible.
- The monitoring technology enables to perform individual bee tracking that makes it an alternative to RFID

OUTLOOK

Run a pilot semi-field study to see if chemical has an influence on cohorts of individual bees running in parallel with traditional assessment and bee counter

- Survival curves
- changes in foraging behaviour

Test Fluoron on the ceiling of the passage the bees take through the camera window to avoid missing bees with markers because they are filmed from the bottom.

References
[1] OECD 2021 GUIDANCE DOCUMENT ON HONEY BEE (APIS MELLIFERA L.) HOMING FLIGHT TEST, USING SINGLE ORAL EXPOSURE TO SUBLETHAL DOSES OF TEST CHEMICAL Series on Testing and Assessment, No. 332
[2] Alberto Prado, Fabrice Requier, Didier Crauser, Yves Le Conte, Vincent Bretagnolle and Cédric Alaux (2020) Honeybee lifespan: the critical role of pre-foraging stage Royal Society Open Science Volume 7, Issue 1
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