OP-081 [Bee Biology]
Status Report on BeeGuards Innovative Breeding Strategies

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Background
The BeeGuards project (EU Horizon Europe, grant 101082073) aims to make beekeeping more resilient, by providing, among others, sustainable management practices and novel breeding strategies.

Problem description
Conventional beekeeping commonly relies on calendar-based treatment applications for Varroa control, irrespective of the actual infestation levels. Such an approach allows non-selective propagation of genotypes to the next generation, regardless of their resistance level. However, a few dedicated breeding initiatives aimed at enhancing Varroa resistance utilize natural selection strategies, particularly when performance testing colonies and drone producing colonies (DPC) are exposed to high infestation levels. Validating such concepts so far has not been done.

Methodology
The joint study is performed in 4 European countries (DE, IT, PL and MK), with 3 honey bee subspecies (A. m. carnica, A. m. ligustica & A. m. macedonica) including 150+ colonies/year (N=3). Colonies of uniform genetic background are differentially managed (conventional treatment regime vs. innovative threshold-based management) during performance testing under local conditions. Subsequently, queens are propagated from these colonies and mated with drones from their respective treatment cohort. Innovative management and breeding entails Varroa treatment based on local infestation thresholds, while controlled mating occurs in conditions of high infestation pressure of DPC. The aim is to verify the hypothesis that drones that successfully mate with queens under these circumstances carry genes for Varroa resistance. The primary decision-making framework is a field study combined with genomic breeding value estimation (EBV). While previously published gene associations are validated, additional insights will be gained.

RESULTS: Besides the opportunity to promote the pivotal role of mating stations, we will evaluate whether the approach can be adapted when using instrumental insemination. In addition, the possibility of accelerating traditional breeding cycles is tested under real-life beekeeping conditions and combined with EBV. The results of performance test in the first season will be reported.

Practical implications
Improved breeding strategies, applied within the general beekeeping community, can support sustainable and chemical-free beekeeping by using resistant stock and biotechnical methods for Varroa control. In addition, the acceleration of breeding cycles holds the potential to foster the genetic gain.

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Resilient beekeeping and breeding to safeguard natural genetic resources and pollination services

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Status report on
BEE-GUARDS
Innovative Breeding Strategy

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(Abstract 0788)

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WP2 – Breeding for resilience

- Leader: Uzunov A. @UKIM -

Acceleration

- Investigate a novel breeding program design for genetic improvement

Natural Selection

- Validate the reproductive fitness of Varroa-challenged DPC & add ‘resilience’ traits

Cryo-preservation

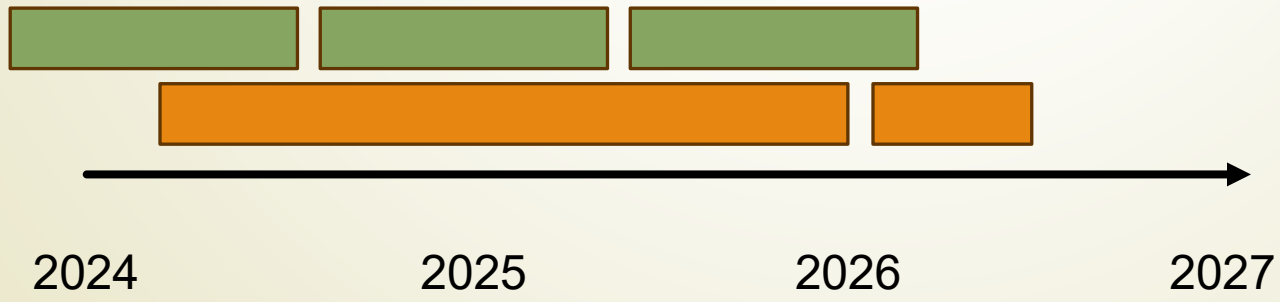
- Establish cryopreservation as an instrument for protection

The “INNOVATIVE” breeding concept

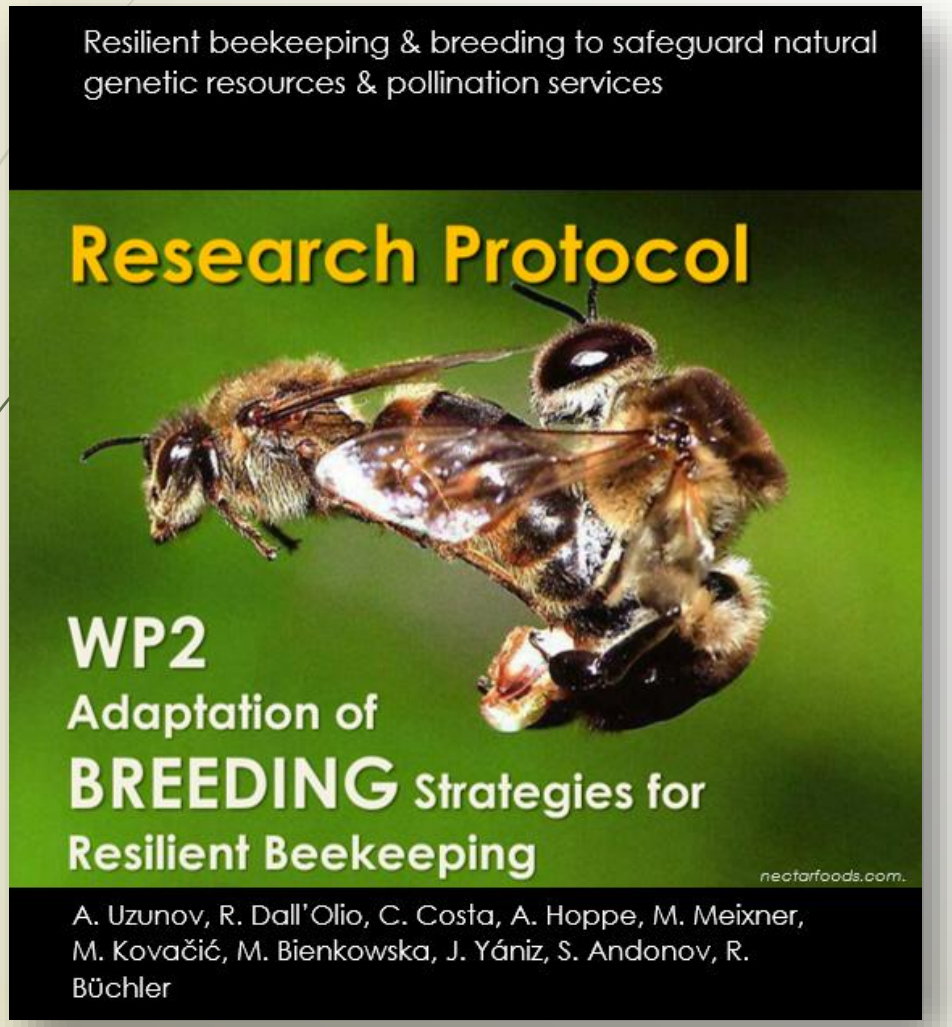
- Starting from (3) Local populations/subspecies
- Shortened PT season (oct→may)
- Fitness traits added & No treatments during PT (monitoring/threshold)
- Diversity & Varroa challenged DPCs for propagating resilience genes – parallel MSs
- [“blind” (no PT) trust on F2, if possible]

Risk factors & mitigation plan

- Limited period (generations)+2023
- Complex mating plan > adjusted env.
- Varroa infestation > losses > monitoring
- Practical aspects > competent team



Performance Testing



Parameter/Trait	Period & frequency
Adult bees (AB)	BW x 1 m, PW x 4-5 m
Brood (BF)	BW x 1 m, PW x 4-5 m
Brood central frame (CF)	BW x 1 m, PW x 4-5 m
Drone brood (DB)	PW x 4-5 m
Empty frame construction (EF)	PW x 2 m
Brood pattern* (BP)	BW x 1 m, PW x 1
Colony weight (0.1 kg) (W)	BW x 1 m, PW x 4-5 m
Nectar intake (0.1 kg) (NI)	Early/ spring nectar flow (3 consecutive days)
Defensive behaviour (DB)	BW x 1 m, PW x 4-5 m
Calmness (C)	BW x 1 m, PW x 4-5 m
Swarming behaviour(SB)	Regularly during the swarming period
Other diseases	Any inspection. Record when symptoms/incidents observed.
Adult bee infestation (VA)	BW x1, PW x 1, every 4 w till end PT, every 3 w late Jul-Oct
Worker brood infestation (VWB)	BW x 1, PW x 1
Mite fall (MF)	1- or 2-weeks interv
Hygienic behaviour (HYG)	BW x 1 m, PW x 1 m
SMR/REC	Sample/freeze on the

Field Study Report

2023 start

- PT
  - Many measurement due to extended season
  - No ‘honey yield’ trait collected due to early mating season (& F2 wish..)
  - Proximity with other apiaries
  - Y2_INN Bottleneck (4 survived)
  - Now starting Y3 (22_INN & 24_CON)
- MS
  - 2 parallel and “isolated”; Urban (CON) & Natural (INN)
  - Y1 natural cell building (also F2) vs Y2 grafting (new mating nucs for F2)
  - F2 feasible (Y1_CON “neighbours” issue)
  - Y1 Drone diversity but Y1_INN reduced Drone population (transport)
  - Y2 mating success (80%) & selection for (6) DPC_CON vs survival DPC_INN

Field Study Report

2023 start

- PT
  - Original queen supersedures
  - Environmental effect
  - Treatment efficacy or resistance (a.i. Amitraz used in CON)
    - NOTE same issue reported from prevented an early 2023 start
- ~~MS~~
  - Only Instrumental Insemination is performed
  - F4 will enter 2025-2026 PT

Field Study Report

- PT
  - Labour intensive
  - Diversity in Empty Frame building (vitality trait)
  - New cycle ready to start (21_INN & 21_CON)
    - High adult bee infestation in F1_INN before OA treatment
    - Queen supersedure F1_INN 38%
- MS
  - 1545m a.s.l. – harsh access & weather (Mating success 56%)
  - Extreme summer conditions (heat/draught/pasture)
  - Drone diversity (>15DPCs)
  - Only F1 performed

Field Study Report

- PT
  - Difference in infestation clearly outlined difference in colony size
  - Difference in infestation related to reproductive fitness trait (drone production)
  - Now ready new PT cycle (21_INN & 21_CON)

- MS
  - Drone diversity secured (19 DPCs on 21 potential donors)
  - Huge effort in mating boxes to secure in-line progeny
  - One MS active - Only F1 performed
  - 2 consecutive rounds (1^{st}_INN, 2^{nd}_CON) – low flexibility

Activity Report

- International Apicultural Asia Regional Symposium in Beijing
- Field Test Protocol published
- Sampling for REC/SMR & other WPs
- Genotyping started
- Updated protocol for semen collection
- Online Training School on cryopreservation
- Hands-on Training School on cryopreservation
- V.velutina defence trait implemented in beebreed.eu
- Novel Varroa resilience trait (infestation shift) added in beebreed.eu

Perspectives - Entering 2025-2026 PT season

- Keep going testing/mating scheme 4 countries / 160+ hives
- PT (preliminar) data analysis – beebreed integration? Breeding model development?
- (2026) Creation of (6) germplasm repositories
  - **Croatia** (*A. m. carnica*) / **Greece** (*A. m. cecropia, A.m. macedonica*) / **Macedonia** (*A.m. macedonica*) / **Italy** (*A. m. Ligustica, A. m. Siciliana*) / **Poland** (*A. m. mellifera, A. m. carnica*) / **Spain** (*A. m. iberiensis).*
- (2026-2027) New technique for bee embryo cryopreservation
- Extra queens distribution to beekeepers
- Identify genetic markers for resilience

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Thanks for your attention

Acknowledgement

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