(Some) EC funded projects on bees *

CDG 13 November 2018

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Research Planning and Programming officer
DG Agriculture and rural development
B2 Research and Innovation

**: includes a compilation of slides by project coordinators*

HORIZON 2020

Structure of the presentation

1. *FP7 projects (completed)*

2. *H2020 projects (on-going)*

FP7 projects

<u>At least 20 projects addressing wholly or partly bees and/or pollinators/pollination</u>:

- FP7-**KBBE** - Specific Programme 'Cooperation' - Research Theme: 'Food, agriculture and fisheries, and biotechnology' : **AMIGA, BEE DOC, LIBERATION, QUESSA, SMARTBEES**
- FP7-**ENVIRONMENT** - Specific Programme 'Cooperation'- Research Theme: 'Environment (including climate change)' : **STEP**
- FP7-**SME** - Research theme: Research for the benefit of SMEs: **APIFRESH, CLEANHIVE, ECOSYN, SWARMONITOR**
- FP7-**IDEAS-ERC** - Specific Programme 'Ideas' implementing the Seventh Framework Programme: **FLORSIGNALS, SPACERADARPOLLINATOR, VIBES**
- FP7-**PEOPLE-**Marie Curie Actions: **BEEFUN, BEESPATNET, ColonyPersPOLs, DYVERSE, FLORDETERSIGNALS, NEUROBEECOG2012, Pynamite**

<u>Cumulative EU contribution</u>: EUR 39million (around half focussed on honey bees)

<u>COST Actions</u>: COLOSS, SUPER-B

Agriculture and Rural Development

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CLEANHIVE

Detecting the pathogen that threatens European bees

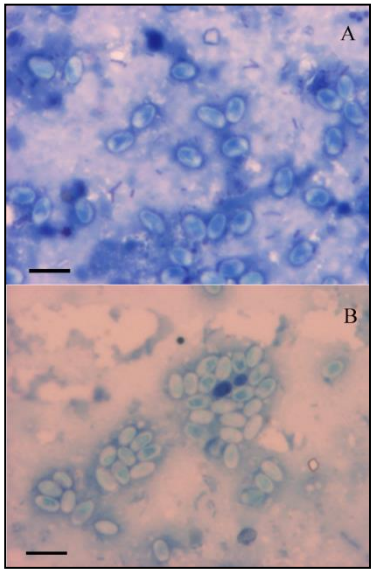
"Research for the benefit of SMEs' Associations"

2009-2011

Project overview

- **The problem:**
  - Depopulation of bees: alarming number of honey bee colonies have died all over Europe and the USA
  - Recent data point to a new pathogen as likely cause of some depopulation episodes: Nosema
- **The need:**
  - Diagnostic method for the detection

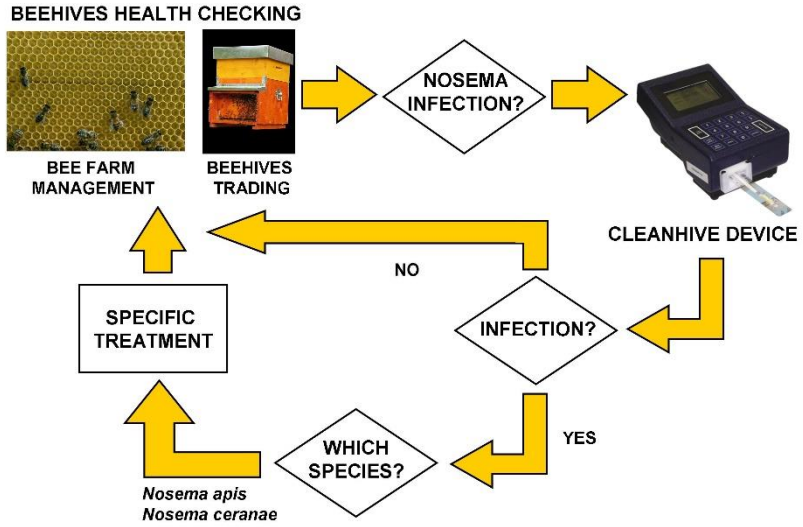
    of this new pathogen



Project objectives

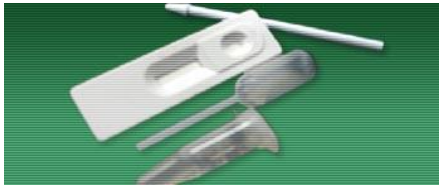
1. To develop a diagnostic method for the detection of microsporidians infecting bees
2. To disseminate the use of this technology among European beekeepers
3. To exploit the results of the project through the partners

To improve the competitiveness of the partners



Project overview

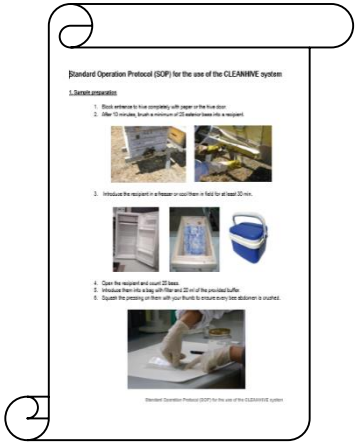
- **The diagnostic kit:**
- Lateral-flow System
  - low cost
  - easy to use

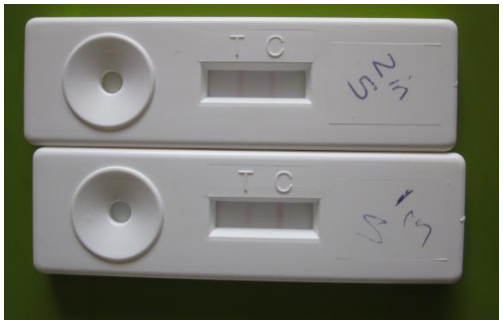


- Optical reader
  - Easy interpretation of results
  - Data management adapted to beekeeping

Project Results

- **Nosema antibodies Ok**
- **SOP OK** Meana A., Martín-Hernández R., Higes M. The reliability of spore count for the diagnosis of *Nosema ceranae* infection. J,Apic Res49 (2): 212-214; 2010
- **Lateral-flow System…. False positives¡¡¡¡**
- **Optical reader OK**


Standard Operation Protocol (SOP) for the use of the CLEANHIVE system



BEE DOC

Bees in EuropE & the Decline Of honeybee Colonies

project characteristics
Small or medium scale focused research network
KBBE-2009-1-3-03: Bee health: identification of emerging honeybee pests and diseases and re-emergence of pathogens and explaining the intimate mechanisms and the reasons for increased honeybee mortality

Bees in **E**urop**E** & the **D**ecline **O**f honeybee **C**olonies (**2011-2013)**

Consortium: Robin Moritz **-** Coordinator (MLU Halle)
SLU Uppsala, QU Belfast, INRA Avignon, Agroscope Bern, CSIC Murcia, SAS Bratislava, U Ghent, BRI Dol, U Hohenheim, U Umeo, BAS Sofia,

Budget: 3 Mio €

Objectives of the project

- fill knowledge gaps in honeybee pests and diseases, including the 'colony collapse disorder‘
- quantify interactions between parasites, pathogens and pesticides
- identify novel genes for disease resistance.
- address sublethal and chronic exposure to pesticides
- screen how apicultural practices affect colony health.

What was achieved in relation to the objectives of the project

- *Varroa* but not *Nosema* relevant for major colony losses
- Sublethal pesticides (thiacloprid, τ-fluvalinate) little effects at colony level
- Genetic underpinning of Nosema resistance (apoptosis and RNAi genes)
- BEE DOCTOR tool for virus diagnostics
- Secondary plant metabolites in honeys against pathogens
- Concept for subsequent EU-call on honeybee health

Mode of action and selectivity of pyrethroids on economically important mites and ticks

Acronym: PyNaMite. ~€280K (2012-2014)

MARIE CURIE ACTIONS

ROTHAMSTED RESEARCH

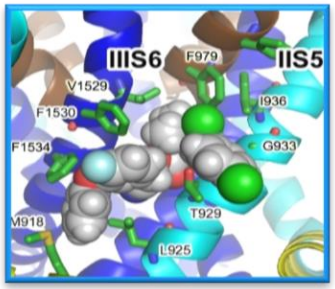
BBSRC bioscience for the future

VNIVERSITAT DE VALÈNCIA

BIOTECMED
Estructura de Recerca Interdisciplinar en Biotecnologia i Biomedicina

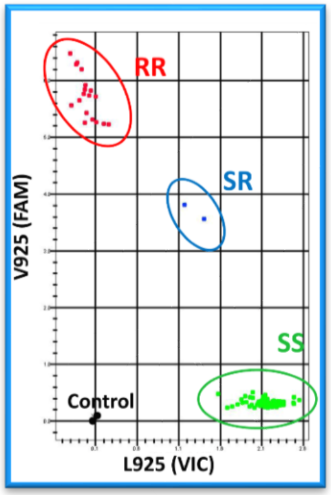
Objectives

1. To characterize the interactions of pyrethroids with tick/mite sodium channels at the molecular level.

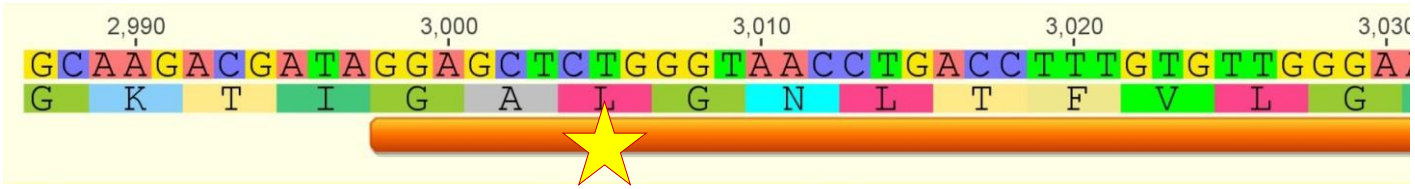


2. To identify novel resistance mutations in field populations of ticks/mites.

3. To develop rapid, high throughput DNA-based assays for diagnosing the presence/absence of resistance mutations in field populations of ticks/mites.



Summary



L925V, I, M

- **Resistance to pyrethroids in *Varroa* is target-site based**
- **Evolved independently in Europe and the US**
- **Robust methodology for accurate detection of mutations**

- **Mutations in high frequency only after recent treatment with pyrethroids**
- **Effective management: Proactive monitoring / acaricides rotation**

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Swarmonitor EU project

Full title:

Development of a tool for effective diagnostic monitoring of honey bee colonies.

Start: 1st Nov 2012
Ended: 31st Oct 2015

Bee Farmers Association of the UK, coordinator.
European Professional Beekeepers Association (D)
Centre Apicole de Recherche et d'Information (B)
CAPAZ GmbH, hive scale manufacturer (D)
ARNIA LTD, hive scale manufacturer (UK)
SZOMEL Kft, wireless com. consultants (HU)
Institut National de la Recherche Agronomique (F)
Nottingham Trent University (UK)

Budget : M€ 1.4

Swarmonitor EU project

The Swarmonitor consortium has extensively explored the use of accelerometers to monitor honeybee colony status.

Project Goals:

- Let the beekeeper know about the status of his colonies without the need to open the hives.
- Send an alarm to the beekeeper's mobile phone/e.mail when a colony intends to swarm.
- Send an alarm to the beekeeper's mobile phone/e.mail when a colony requires intervention

Initially ultra high performance accelerometers have been embedded in the centre of the central frame of 22 hives, 20 in France (Yves Le Conte's apiary) and 2 in the UK, and less expensive accelerometers were later used successfully on three apiaries.

EFSA workshop on Bee Health and Pollination
10th March 2016

What was achieved in relation to the objectives of the project

The Swarmonitor consortium has extensively explored the use of accelerometers to monitor honeybee colony status.

- Three apiaries have been set up with fully automated monitoring of vibrations, one of them also benefitted from regular detailed visual inspections. Some hives were monitored with solar powered electronics.

- Vibrational signals from multiple primary and secondary swarms have been captured. Healthy hives, and colonies exhibiting a broad range of health disorders have been successfully monitored over > 2 years, evidenced by thoroughly detailed 'ColEval' log books (each side of each frame was visually assessed each month).

- Inexpensive hardware has been developed, tested and installed on apiaries, to fulfil the required vibrational measurements. Ultra high performance hardware was also used, to acquire ultimate quality data.

EFSA workshop on Bee Health and Pollination
10th March 2016

What was achieved in relation to the objectives of the project

The Swarmonitor consortium has extensively explored the use of accelerometers to monitor honeybee colony status.

- Extensive software was developed to (i) correlate the vibrational measurements to the colony status and (ii) have inexpensive microcontrollers to 1- record, 2- analyse the vibrational data, and 3- wirelessly send diagnostic information, at the hive.
- An algorithm was developed to sense the colony's intention to swarm, several days before the primary swarm and the method used to generate the alarm was the subject of a patent application.
- A vibrational feature, characteristic of a colony's abnormal deterioration in the winter, was discovered.
- A vibrational feature, characteristic of the brood cycle status on the frame under investigation, was discovered and published.

EFSA workshop on Bee Health and Pollination
10th March 2016

What was not achieved in relation to the objectives of the project

- The swarming alarm algorithm has not yet deemed reliable enough by the SME's to allow the launch of a commercial product.
- The first season of the swarming process was not captured, due to equipment manufacturer's delays.

We have demonstrated the presence of highly valuable information within vibrational measurements in honeybee colonies.

The beekeeping practice will be made more efficient: the beekeeper will know about

- The colony's intention to swarm
- The presence of a healthy queen
- The colony's ability to survive the winter
- The colony's varroa infestation levels

Without having to visually inspect the hive(s).

The pollinator, in this case the honeybee, will benefit from an automated monitoring technique which could be applied on a large scale.

The origins and causes of the pollinator's stressors will be better understood, and remedial action taken more efficiently.

Project characteristics

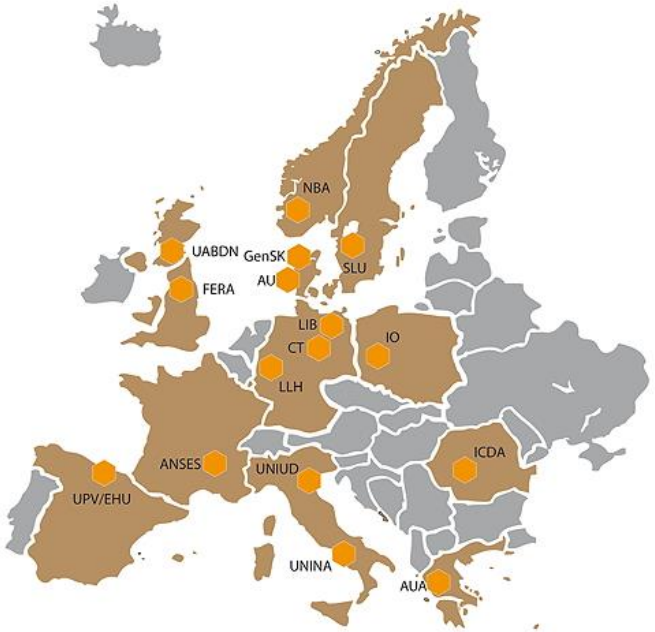
SmartBees

Sustainable **Ma**nagement of **R**esilien**t Bee** Populations

Budget: € 7.8 Mill.
Budget EU-funded: € 6.0 Mill.
Project duration: 11/2014 – 10/2018

16 Partners from 11 countries

10 Universities
4 Research Institutes
2 Companies



SmartBees has received funding from the European Union's Seventh Framework Programme for research, technological development and demonstration under grant agreement no 613960.

Beekeeping & Environment strongly differ

Preserving of original genetic recourses is the best life insurance to face the changes to come

Smartbees concept:
Conservation through utilisation

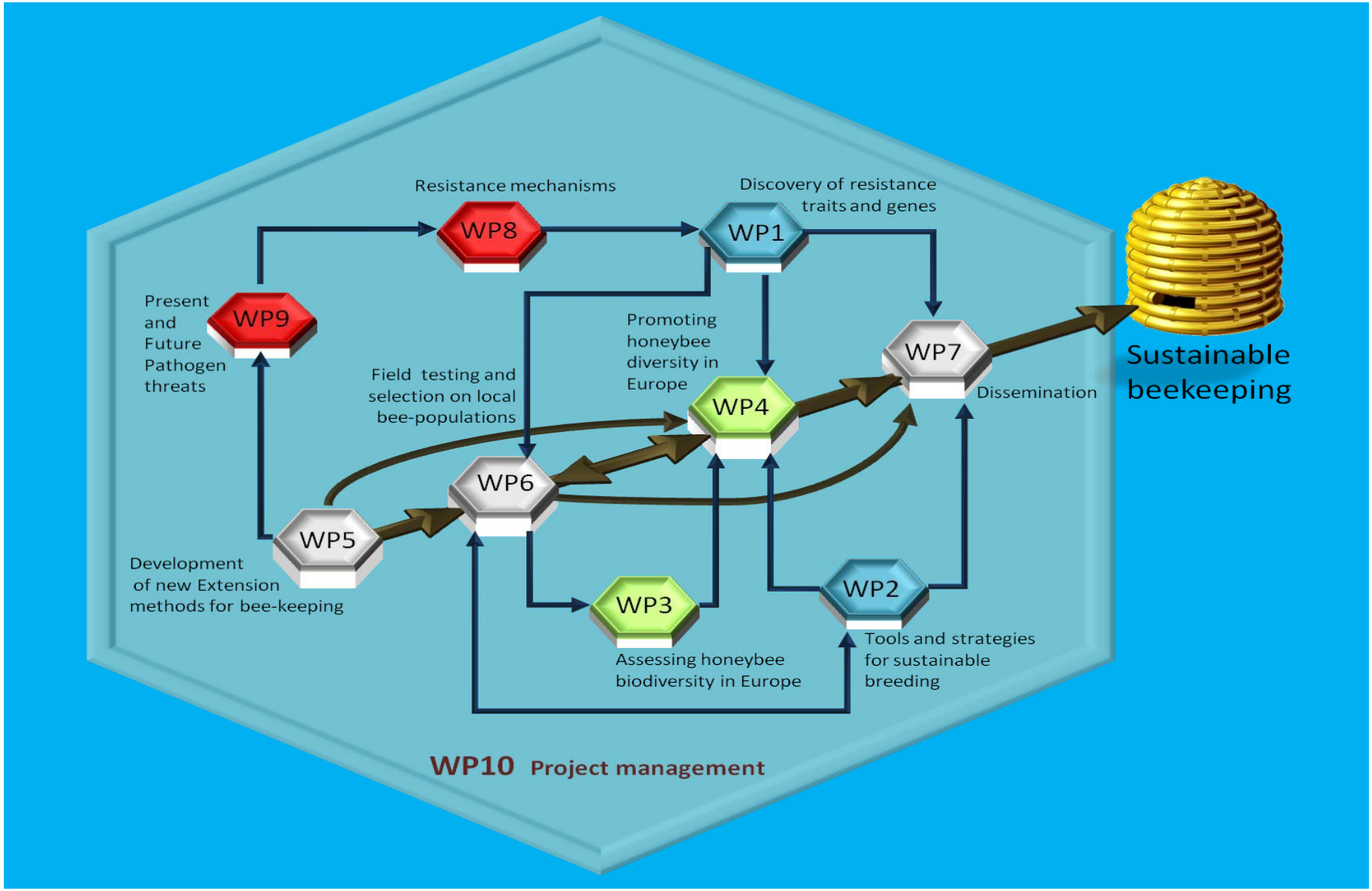
Breeding endangered honey bee species/ subspecies to meet the specific beekeepers' demands

But in addition
Cryoconservation of genetic resources in all, but especially in endangered subspecies

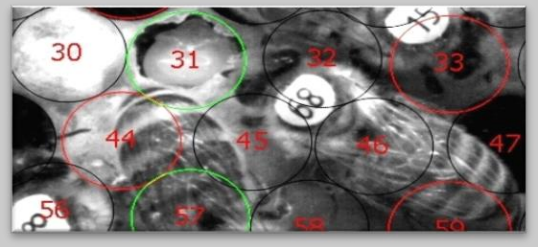
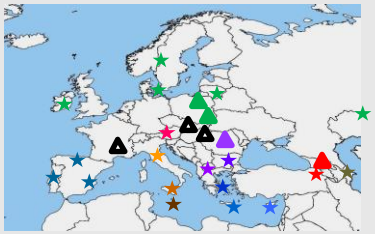
Objectives

- to identify crucial facets of **honeybee resistance** to colony losses, Varroa and viruses;
- to characterise the **genetic background** of the resistance mechanisms in honeybees;
- to develop **breeding strategies** to increase the frequencies of these valuable traits in local honeybee populations;
- to promote multiple local breeding efforts, to conserve **local resilient populations** and will develop molecular tools for describing and safeguarding future populations;
- to protect European natural honeybee heritage.

Objectives & structure



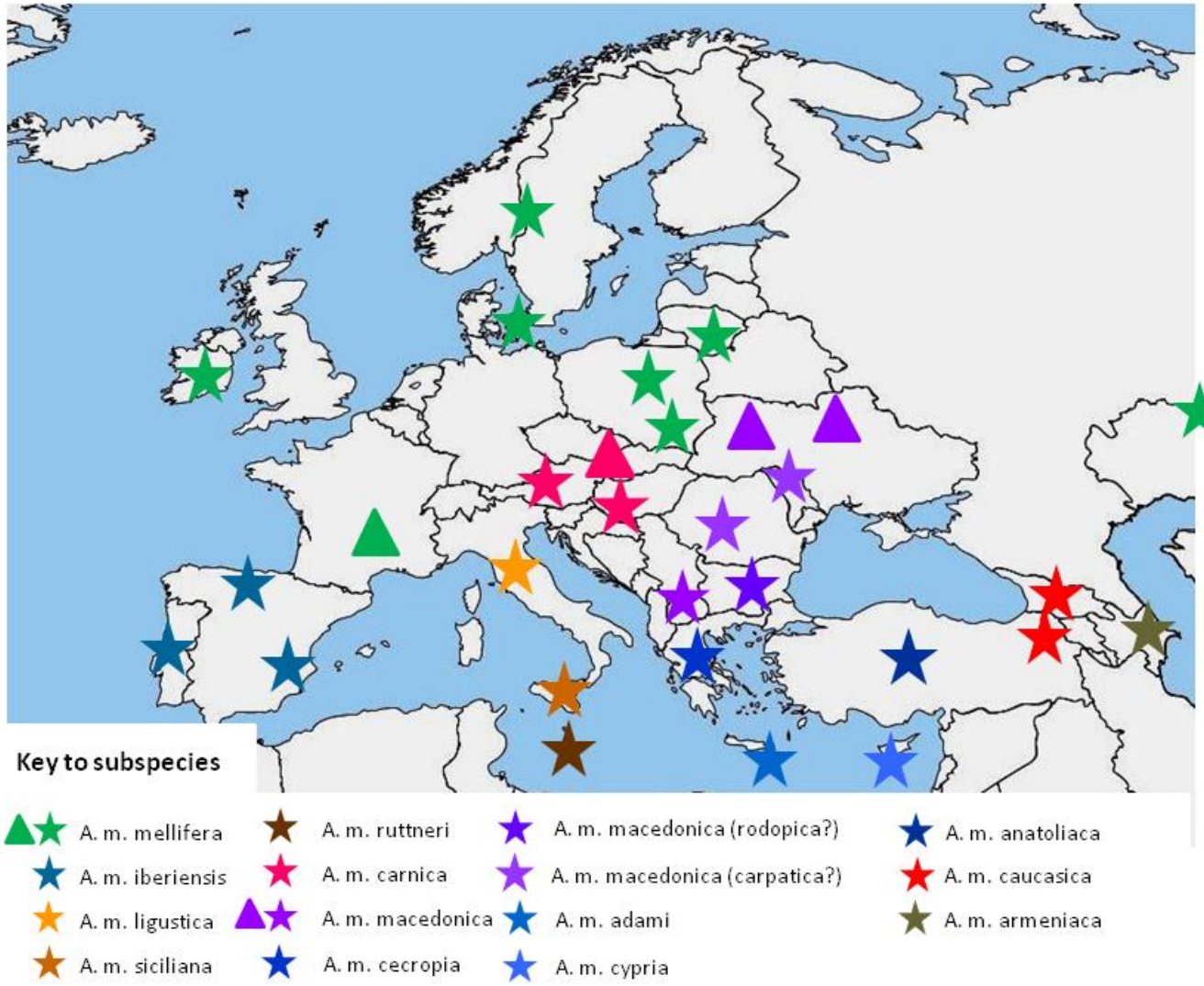
Plans & status

	Plan	Achieved so far
Group „Breeding“	Identify genes involved in resistance towards Varroa & DWV by pool-WGS Establish genetic evaluation and develop sustainable breeding strategies for all subspecies in Europe	46.000 bees individually screened for hyg. behaviour  Initiated experiments on other resistance factors (also in *A. cerana)*
Group „Biodiversity“	Assess and promote honeybee diversity in Europe Assess beekeepers‘ attitude & information needs regarding endemic bees	Collected 1.300 samples from all subspecies; sequencing & morphometric analyses started  Several thousand answered questionnaires (still open)

Plans & status

	Plan	Achieved so far
Group „Extension“	Initiate breeding programs for local populations Develop & disseminate new extension methods	Established 116 testing apiaries (1400 colonies) in 17 countries 
Group „Pathology“	Understand Bee-Varroa-DWV-interaction Identify immune genes & pathways involved in DWV resistance Determine effect of additional stressors on DWV-resistance Identify present and future pathogen threats	Developed infection assays in bees and cells 3500 bee larvae injected with DWV and subjected to gen expression studies 

Sampling for morphological und molecular subspecies testing



1500 samples
from > 900 beekeepers

Sampling
in progress

Sampling
completed

WP 3: M. Meixner et al.

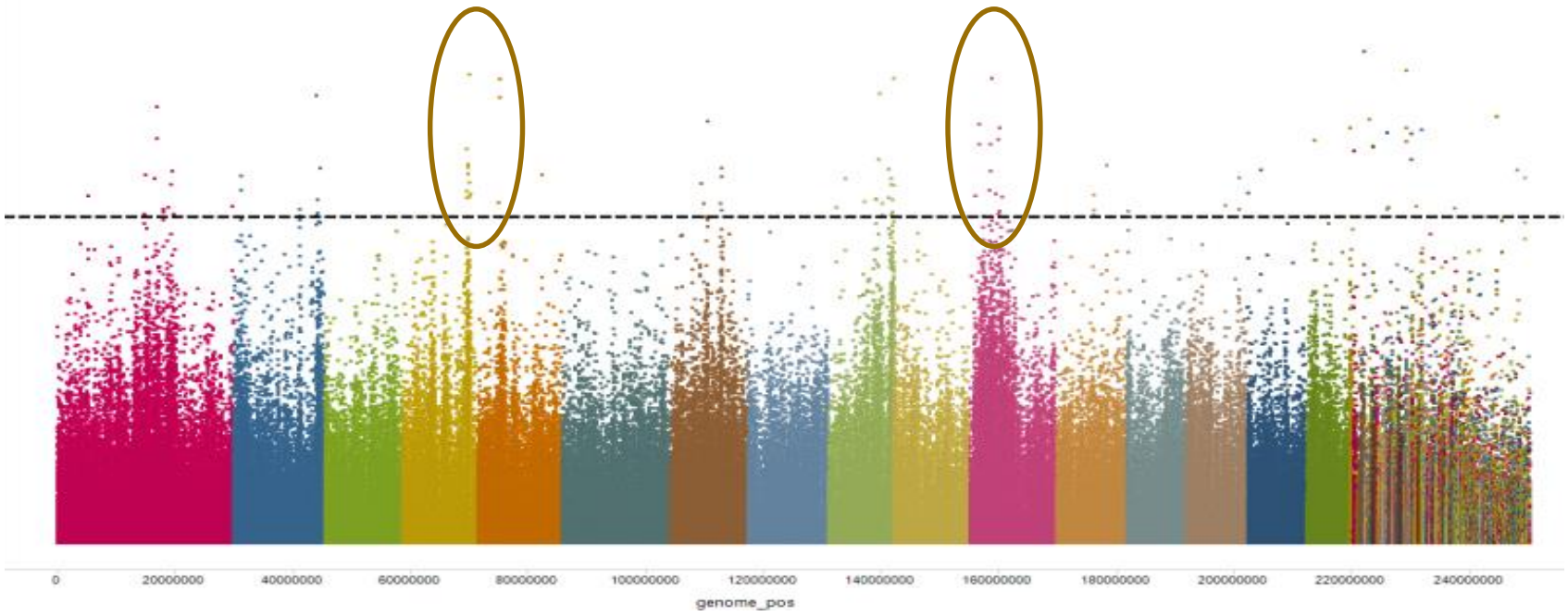
Dataset used for pooled whole genome Sequencing

	A. m. carnica	A. m. mellifera	A. m. macedonica	A. m. caucasica	Hybriden: car X mac	Hybriden: car X mel	**total**
Number of screened bees	24.040	20.904	24.680	16.409	13.708	14.550	**114.291**
Number of "beginners"	217	175	162	170	152	191	**1.067**
Number of "helpers"	492	374	439	280	325	429	**2.339**
Proportion of beginners+helpers (%)	2.9	2.6	2.4	2.7	3.5	4.3	**3,0**

Different subspecies and hybrids were used to provide insight into the genes /markers involved in hygiene behaviour across the subspecies.

Comparative molecular analysis of hygienic and non-hygienic pools of individuals

Data provided by our partners: L. Farajzadeh & C. Bendixen from Aarhus University



2407 significant SNP markers for Varroa hygienic behaviour were found and several of them were located near genes involved in odour sensitivity.

SMARTBEES

LIB Länderinstitut für Bienenkunde

es

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es

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colonies

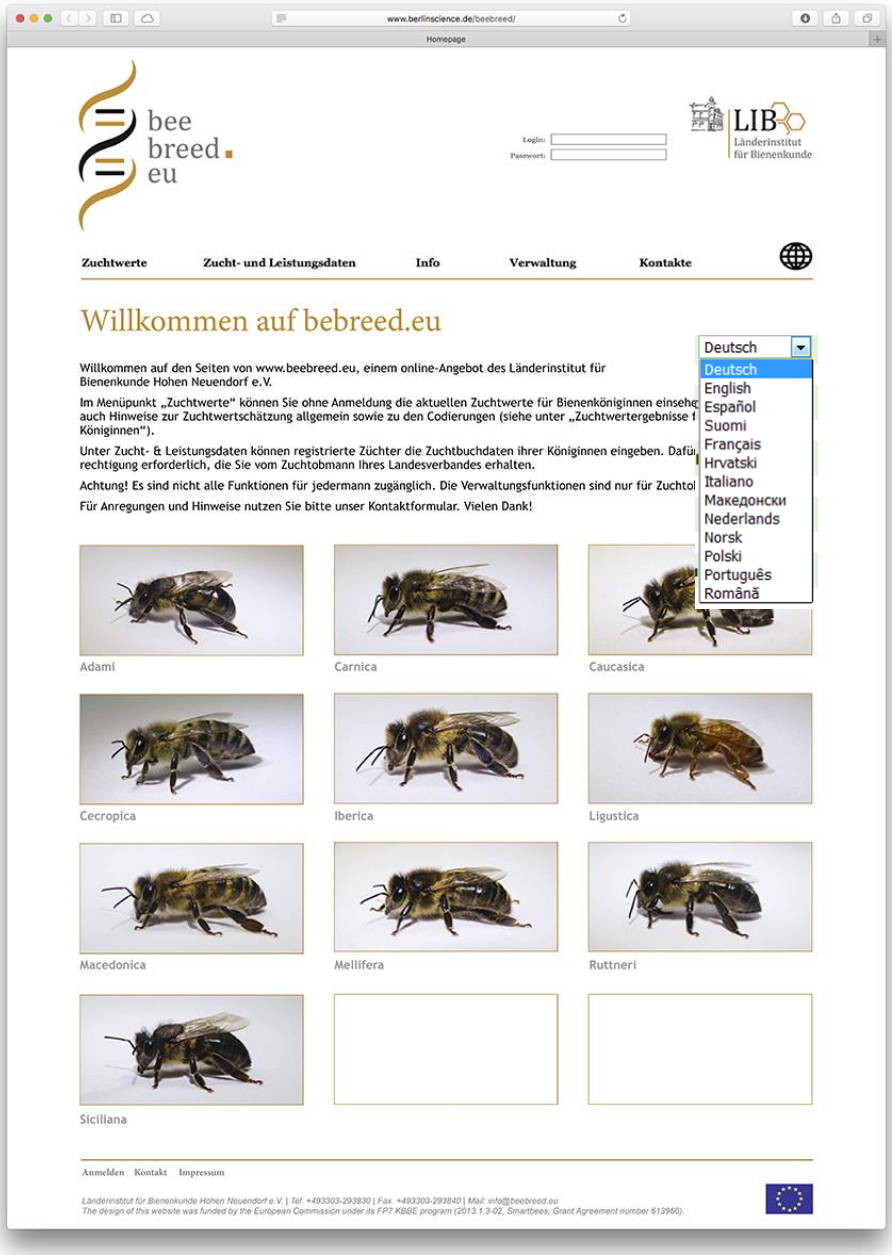
eminars for coordinators

raining locations
performance testing)

esting locations

Training for mating control
(II and mating stations)

ler, A. Uzunov



WP 2: K. Bienefeld, A.Hoppe

Horizon 2020 projects: honeybees

- **BeeDanceGap** - Honeybee communication: animal social learning at the height of social complexity (2016-2021) – http://cordis.europa.eu/project/rcn/193605_en.html - ERC - €1.42mio
- **MicroBeeOme** - Evolution of honey bee gut microbiome through bacterial diversification (2017-2022) –http://cordis.europa.eu/project/rcn/206057_en.html - ERC - €1.5mio
- **IoBee** - Beehive health IoT application to fight Honey Bee Colony Mortality (2017-2020) – http://cordis.europa.eu/project/rcn/210011_en.html - FTIPilot - €1,43mio
- **MICRO4BEE** - A sustainable organic solution for bees decline (2016) – http://cordis.europa.eu/project/rcn/200618_en.html - SC2/SME - €0.05mio
- **Hapi** - Hyperthermia in Apiculture - A new product against the Deformed Wing Virus of honey bees (2017) – http://cordis.europa.eu/project/rcn/210654_en.html - SC2/SME - €0.05mio
- **BEE LABEL** – a new remote beehive surveillance for better bee health and secured pollination (2018) - https://cordis.europa.eu/project/rcn/213651_en.html - SC2/SME - €0,05mio
- **3Bee Hive-Tech** - an innovative IoT system designed for monitoring beehives (2018) – https://cordis.europa.eu/project/rcn/213727_en.html - SC2/SME - €0,05mio
- **BEEOXAL** - Treatment against honeybee varroosis based on highly effective application of oxalic acid through sublimation (2017) - https://cordis.europa.eu/project/rcn/211476_en.html - SC5/SME - €0.05mio

Horizon 2020 projects: honeybees

- **DRiveR** - How does dopamine link QMP with reproductive repression to mediate colony harmony and productivity in the honeybee? (2018-2020) http://cordis.europa.eu/project/rcn/209660_en.html - MSCA/IF - €0.18mio
- **BeeSymOverSpace** - How to help the hive? Incidence and impact of heritable microbes on bee health (2016-2019) http://cordis.europa.eu/project/rcn/206460_en.html – MSCA/IF - €0,24mio
- **NO PROBleMS** – Nourishing PRObiotics to Bees to mitigate stressors – (2018-2021) - https://cordis.europa.eu/project/rcn/212973_en.html - MSCA/RISE - €0,34mio
- **MeeLiH** - Measure of the Ecological influence in Epigenetic-mediated Learning and memory formation in the Honeybee – (2018-2020) – https://cordis.europa.eu/project/rcn/215595_en.html -MSCA/IF – €0.15mio
- **SAMS** - International Partnership on Innovation in Smart Apiculture Management Services – (Jan2018-Dec2020) - https://cordis.europa.eu/project/rcn/216627_en.html - Ind Leadership/ICT - €2mio

Cumulative EU contribution: *€3,7 million*

ERA-NET SUSAN:

- New indicators and on-farm practices to improve honeybee health in the Aethina Tumida ERA in Europe – *€0,7 million*

  Develop new management practices (Good Beekeeping Practices – GBPs) adopting new clinical methods, biomechanical and innovative biomolecular techniques respecting the natural behaviour of bees

PoshBee - Pan-european assessment, monitoring, and mitigation of stressors on the health of bees (Jun2018-May2023) - *€9 million* – SC2

PoshBee

Pan-european assessment, monitoring, and mitigation of stressors on the health of bees

PoshBee: evidence, tools, practice, and policy for European bees

Professor Mark JF Brown

Royal Holloway University of London

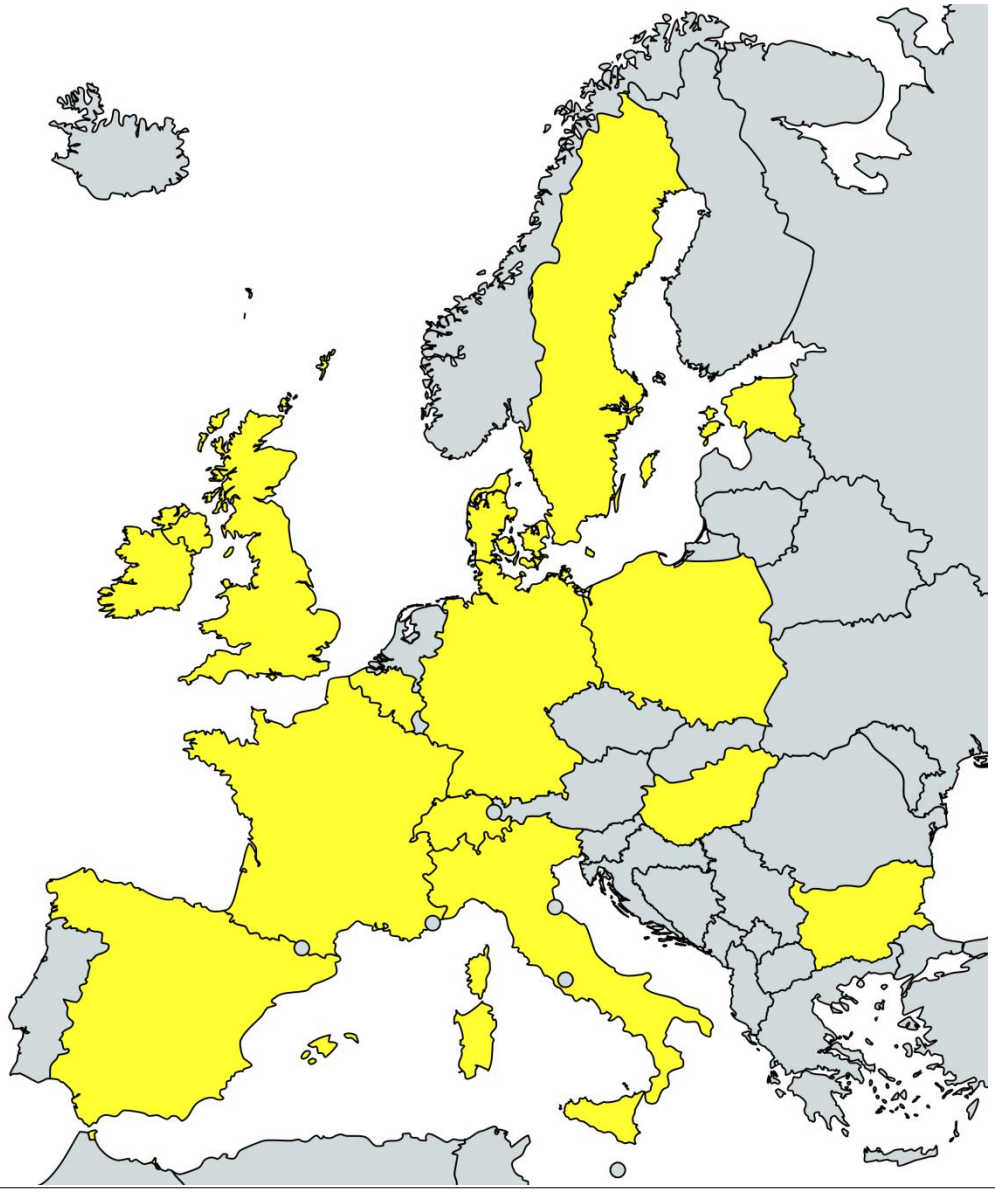
This project receives funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No. 773921

The Challenge – Bee Health

The PoshBee Approach

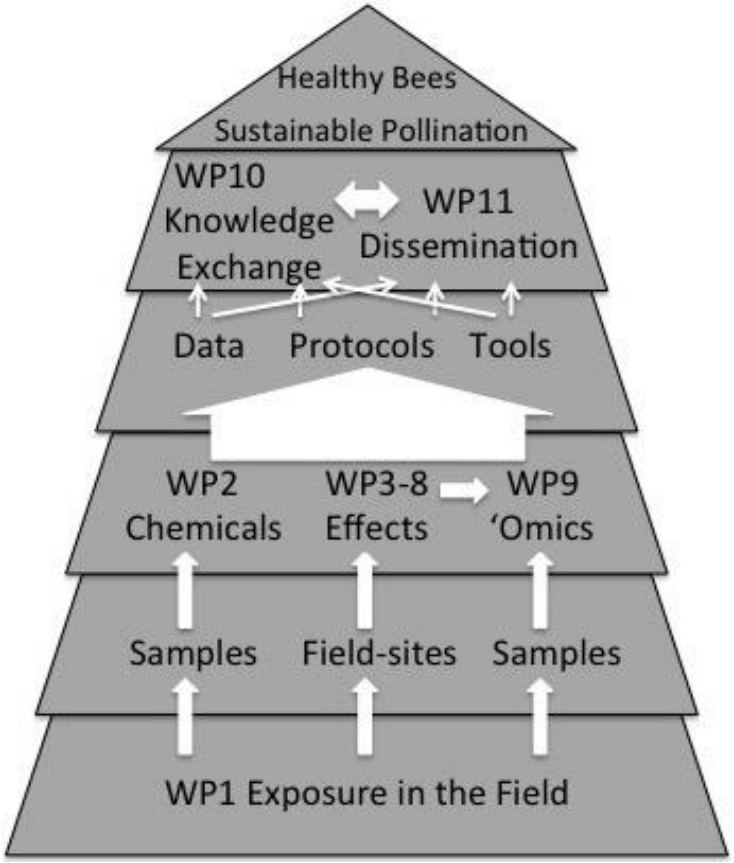
- Multi-actor
  - universities, research institutes, SMEs, local and national farming organisations, local beekeeping organisations
- Trans-disciplinary
  - apidology, ecotoxicology, nutrition, pathology, proteomics, social science
- Engagement with stakeholders
  - evidence for practice and policy

PoshBee – a pan-European project



PoshBee

PoshBee – research structure



A site network for stressors (WP1/2)

PoshBee

Outputs from site network (WP1/2)

- Exposure profile for bees across Europe in apple orchard and oilseed rape agroecosystems
- Health data for indicator bee colonies/populations in these agroecosystems
- Correlations between exposure and health to identify drivers

Assessing the effects of stressors (WP 3-8)

Agrochemicals **Nutrition** **Pathogens**

Lab → Semi-Field → Field

Outputs from causal experiments (WP 3-8)

- Toxicokinetics/dynamics of focal chemicals
- LD_{50} for bees for chemicals, chemicals x nutrition, chemicals x pathogens
- Broader impacts of chemicals and combinations from lab to field
- New model solitary bee species for assessing health impacts
- New protocols for risk assessment for bees

New tools for bee health (WP 2,4,9)

- New model systems for ecotoxicology
- Air sensors for chemical exposure
- Proteomics-based health card for bees
- Landscape-level risk-assessment models

European Commission

Thank you for your attention!

Agriculture and Rural Development