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INSIGNIA consortium

The INSIGNIA-EU study is a citizen science pan-EU biomonitoring study with honey bee colonies, using a range of in-hive passive samplers; the APIStrip for pesticides, the APITrap for microplastics, silicone bands for VOCs and PAHs, propolis for heavy metals, honey for a selection of 8 polar pesticides, and trapped pollen. The target compounds were 450 pesticide residues, microplastics, eleven heavy metals, 35 PAHs, and 19 VOCs known to be hazardous to humans. Pollen is also sampled to determine pollen diversity. The protocol of the study is available on the EU pollinator information hive (EU pollinator information hive). The study was carried out in 315 apiaries selected by dominant land-use: agriculture, artificial, or forest/nature. In the 5,525 APIStrips, 202 pesticide residues were detected. There was no apiary in the EU where no pesticide was detected. In the 2,390 APITraps, 52,099 synthetic polymer fibres and 7,244 synthetic polymer fragments plus films, mainly polyester, polypropylene, and polyethylene were detected. The target VOC and PAH were found, and appeared to be omnipresent as were the heavy metals. Both metals and PAH/VOC results indicated emission sources. In 6% of the honey, the polar pesticides glyphosate and AMPA were found. In the trapped pollen 501 plant genera were identified, the most frequently recorded genera being Trifolium, Plantago, Brassica, Rubus, and Castanea. Brassica was mostly in the northern and Plantago in the central and eastern European sampling sites) The bee-collected pollen mean diversity was higher in artificial (mean number of genera = 9.1) than in agricultural (mean number of genera = 8.5) or forest/natural (mean number of genera = 8) land-use types. The predictive models show the changes in the risk of pesticide exposure and pollen diversity available for honey bees. Up to now, the study has generated fourteen peer-reviewed scientific publications, and more will follow. More information about INSIGNIA-EU is available on our website www.insignia-eu

INSIGNIA – EU



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the European Union

Apimondia Copenhagen, 24 Sept 2025



J. van der Steen
het INSIGNIA consortium / Alveus AB Consultancy



INSIGNIA – EU: Action Agreement



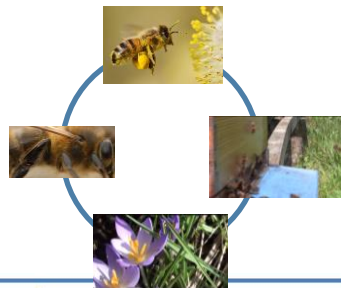
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“Preparatory action for monitoring of environmental pollution using honey bees”

Grant No. 09,200200/2021/864096/SER/ENV.D.2.

Biomonitoring study using honey bee colonies for pesticides, microplastics, air pollution (polyaromatic hydrocarbons PAH and volatile organic compounds VOC), heavy metals and pollen diversity.

The study was conducted in all 27 EU countries, in cooperation with the pan-EU INSIGNIA beekeeper-citizen-scientists, the INSIGNIA-EU consortium, 27 National coordinators, and 630 honey bee colonies that collected the pollution and pollen.

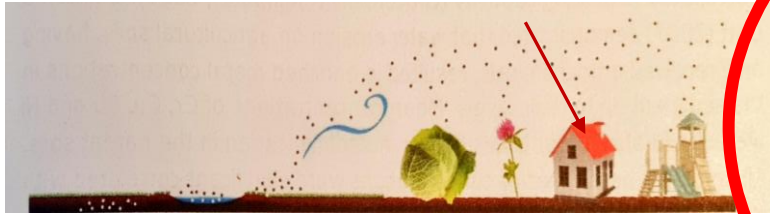


INSIGNIA – EU; non invasive sampling



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The honey bee colony as a bio-monitoring tool



Honey bee: collects non-measurable quantities of pollutants during foraging

Honey bee colony: accumulates pollutants to measurable quantities

The honey bee colony collects the pollutants and next the beekeeper citizen scientist collects the pollutants from the colony using “**in-hive passive samplers**” and without harming the bees



APIStrip: pesticides

APITrap: microplastics

Silicone band: PAH/VOC

Propolis: metals

nectar / fresh honey: pesticides

INSIGNIA – EU: Insignia apiaries / land-use



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Pollen diversity



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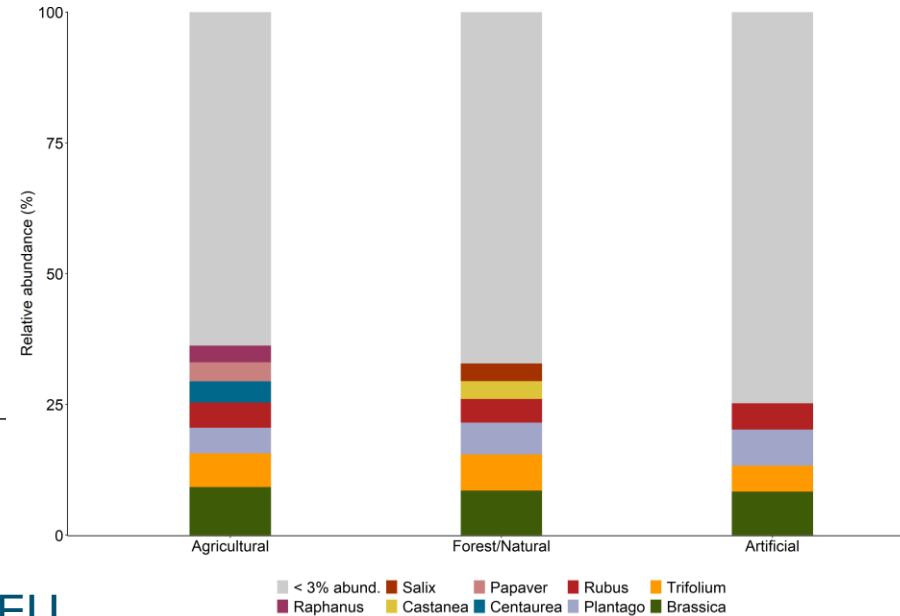
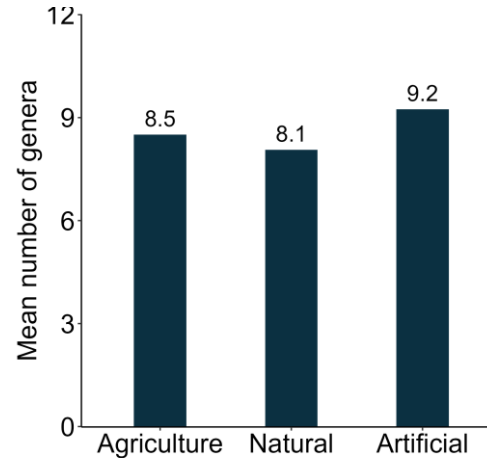
Alice Pinto: CIMO/LA SusTEC, Politechnic Institute of Bragança, Portugal



2,500 samples,

DNA metabarcoding (ITS2)

*Asteraceae, Brassicaceae, Fabaceae,
Rosaceae, and Plantaginaceae* all over EU.



INSIGNIA – Polar pesticides



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Konstantinos M. Kasiotis - Benaki Phytopathological Institute, Greece



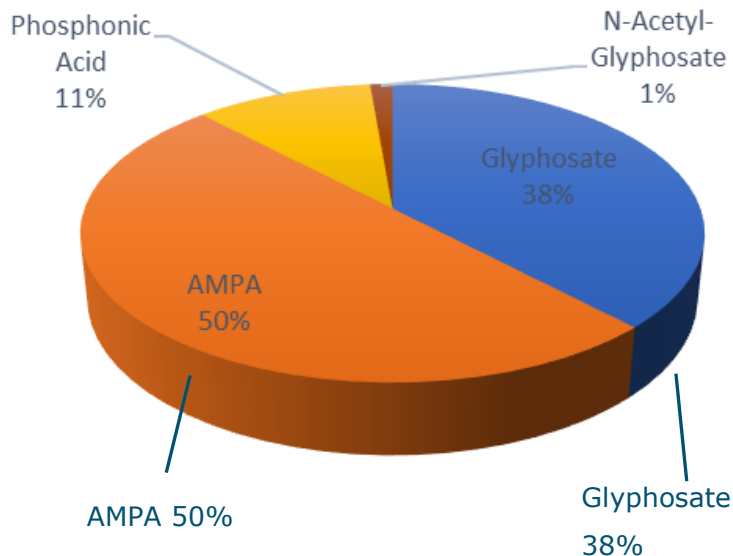
nectar/fresh honey:
polar pesticides (water soluble)

Results: medians / land-use

Agricultural : 0

Artificial: 0

Forest / nature: 0



Samples: 1,260 / 1,164

8 target pesticides

4 pesticides found

6.3 % of the samples
had at least 1 target
pesticide

INSIGNIA – Metals



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Ivo Roessink – Wageningen Environmental Research, The Netherlands

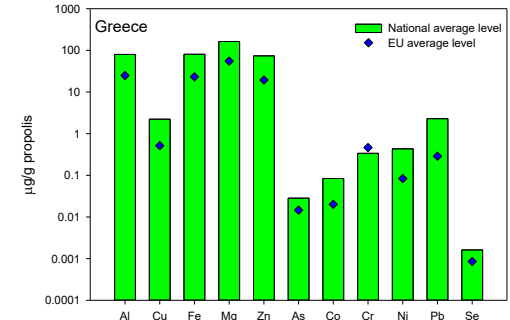
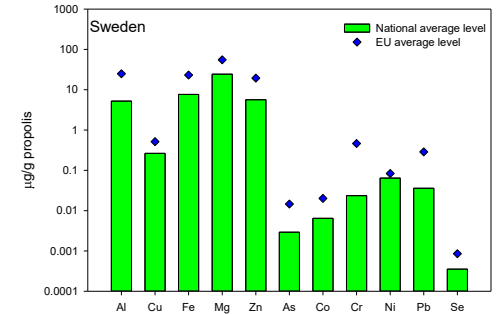
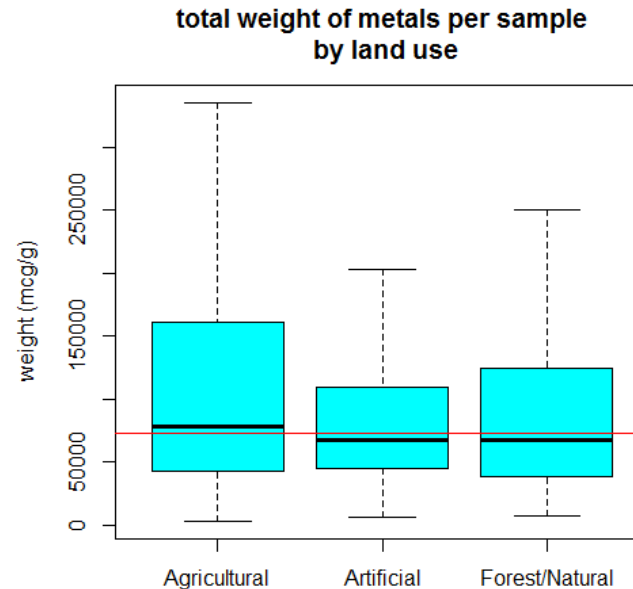


Propolis: metal

Target metals: Mg, Al, Fe, Cu, Zn, Cr, Co, Ni, Se, Pb

All metals were detected.

Detection emission spots



INSIGNIA – Silicone wristbands:



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Polycyclic Aromatic Hydrocarbons & Volatile Organic Compounds

Konstantinos M. Kasiotis – Benaki Phytopathological Institute, Greece



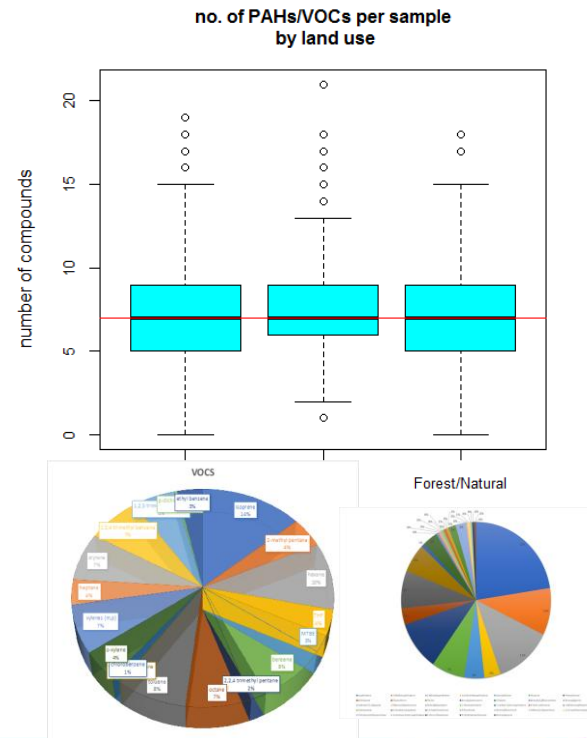
Omnipresent

Samples: 1,216 (96.5%).

Selection VOC (20) en PAH (33)
for synthetic compounds
hazardous to life.

Silicone: air pollutants VOC / PAH

Highest concentrations: Isoprene
(VOC), benzene (VOC) and hexane
(VOC), naphthalene (PAH)



INSIGNIA – Microplastics



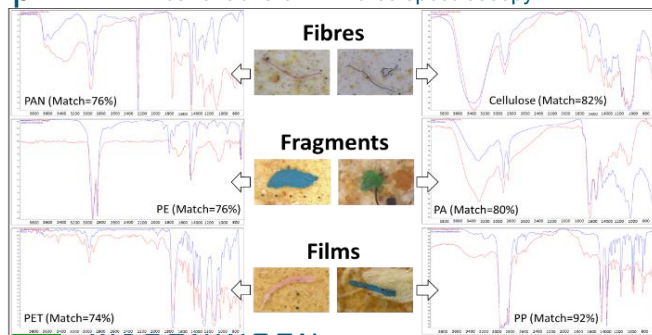
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Maria Jesus Martinez Bueno – University of Almería, Spain



APITrap, microplastics

μFTIR: Fourier-transform infrared spectroscopy

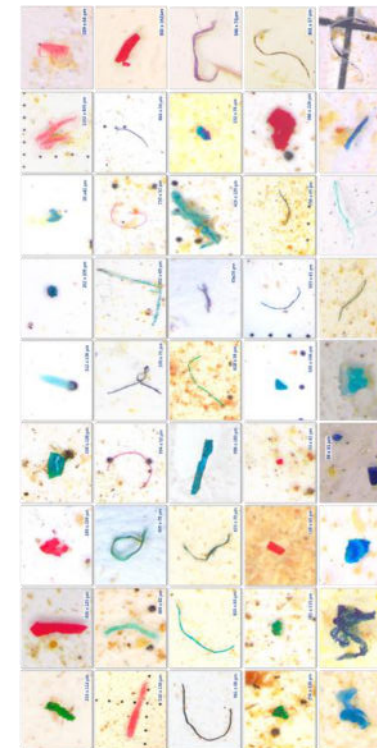
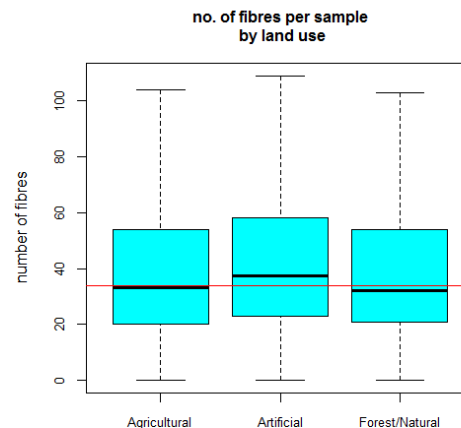


Omnipresent

Detected synthetic microplastics

52,099 fibres

7,244 fragment + films



INSIGNIA – Pesticides & Biocides



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Amadeo R. Fernández-Alba – University of Almería, Spain



Omnipresent

315 apiaries

5,985 APIStrips analysed

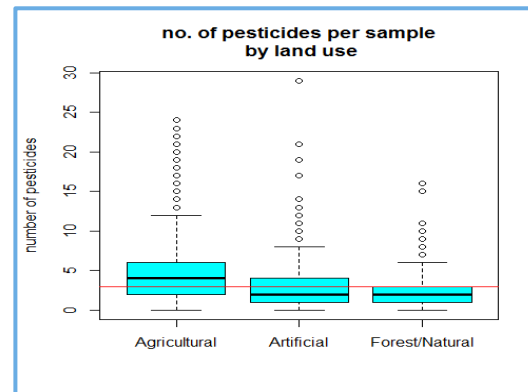
442 target compounds

202 pesticides detected

17 563 data



Apistrip: non- and semi
polar pesticides



Land use	Nº of detections	Percentage of total land use
Agricultural	11 936	68,4%
Artificial	2 712	15.6%
Forest / natural	2 797	16.0%

INSIGNIA – Pesticides & Biocides



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Amadeo R. Fernández-Alba – University of Almería, Spain

Top 3 detected pesticides (in almost every apiary)

Azoxystrobin (fungicide)

Boscalid (fungicide)

Acetamiprid (insecticide)

DDT, 276 detections in 68 apiaries

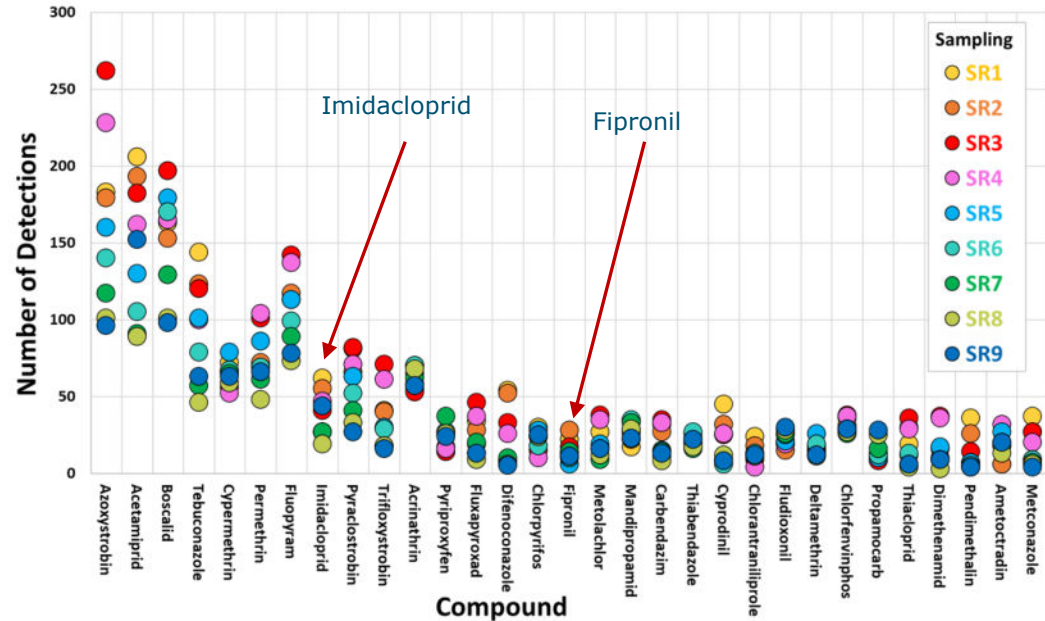


Figure 3. Compounds detected in more than 40 sampling sites across all apiaries throughout the nine sampling rounds (SR1–SR9).

INSIGNIA – Pesticides & Biocides



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Amadeo R. Fernández-Alba – University of Almería, Spain

Synthetic varroacides are widely used. The study found these miticides are across most EU regions.

No **chemical** varroacides in the majority of the Insignia apiaries in Austria – Germany – Denmark – Sweden – Italy, Latvia, and Finland.



Photos WageningenUR

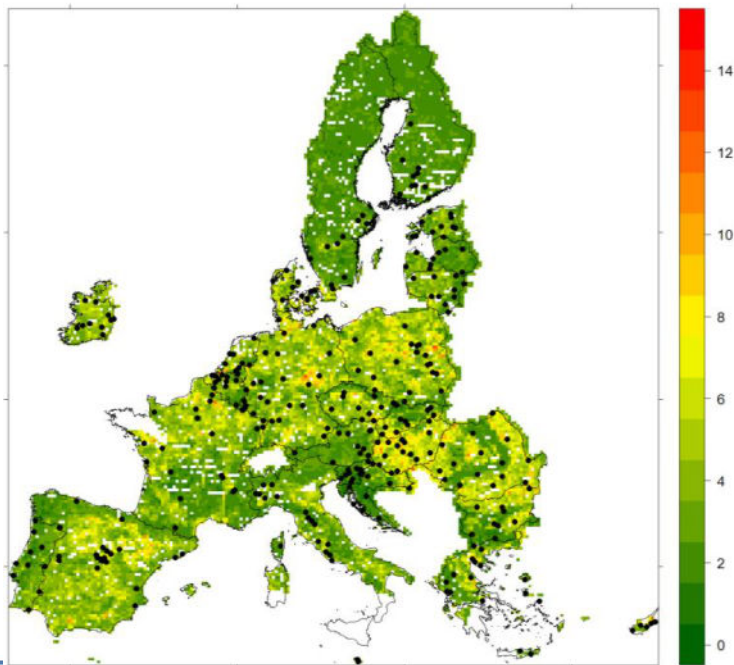
INSIGNIA – Predictive models



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Bas Buddendorf – Wageningen Environmental Research, The Netherlands

Predicted number of PPPs
in May



- Increase in number of pesticide detections in the period May - June
- Decrease in number of pesticide detections in the period July - August;
- Increase in September
- Large natural features are visible in the models (e.g. the Alps)
- Agricultural dominated land-use areas are clearly visible in the models (e.g. northern France and Poland).

INSIGNIA – EU: Conclusions



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INSIGNIA-EU developed a non-invasive biomonitoring citizen science methodology to biomonitor the environment for pollutants.

Pesticides: Omnipresent; bees exposed to a mixture of 28 pesticides including non-legislated compounds

Pesticides in the nectar: in 6.3% of the samples, glyphosate or derivatives detected (below MRL)

Microplastics: Omnipresent in the environment

Air pollutants:(VOC/PAH): Omnipresent in the environment, detectable emission sources

Heavy metals: Natural background concentrations. Detectable emission sources.

Pollen: most pollen in EU come from *Asteraceae*, *Rosaceae*, *Brassicaceae*, *Plantaginaceae* and *Fabaceae*.

Predictive models both spatial and temporal

INSIGNIA – EU: recommendations



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- *Repetition of the monitoring every 3 years*
- *Check of not-approved pesticides and biocides*
- *Sentinel apiaries to detect pesticides, pfas and microplastics*
- *Study the **ecotoxicological** impact of pollutants on honey bee colonies*
- *e-DNA study for airborne human and veterinary pathogens in pollen*
- *Cooperation with other EU pollinator studies*



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Scientific publications. Current status - 16 scientific papers

INSIGNIA-EU: The end report of the EU preparatory action for monitoring of environmental pollution using honey bees

The INSIGNIA consortium: J. van der Steen, V. Brusbardis, O. Kilpinen, F. Vejsnaes, N.L. Carreck, A. Gray, I. Roessink, B. Buddendorf, H. Baveco, D. de Graaf, E. Danneels, A. Fernandez-Alba, M. Murcia, M.J. Martínez Bueno, A. Pinto, A. Quaresma, M. Pietropaoli, G. Formato, K. Kasiotis, E. Tzanetou, F. Hatjina, L. Charistos, K. Gratzner and R. Brodschneider.



EU publications and
INSIGNIA website

Guideline for apicultural citizen science to use the honey bee colony for biomonitoring of the environment

Edition 2. June 2024



EU Pollinator Information
hive and INSIGNIA
website



INSIGNIA-EU
Preparatory action for
monitoring of environmental
pollution using honey bees



INSIGNIA-EU receives funding from the European Union under project No 09.200200/2021.864096/SER/ENV.D.2.

INSIGNIA-EU is the first pan-European project for a citizen science environmental pollution baseline measurement using honey bee colonies

EU Pollinator Information
hive and INSIGNIA website



Thank you for your attention

www.insignia-bee.eu



J. van der Steen
24 September 2025