CONFERENCE PROCEEDINGS GROIX FESTIVAL JULY 2022

POLLINIS

A NOT-FOR-PROFIT NGO REGISTERED UNDER FRENCH LAW, POLLINIS IS FUNDED EXCLUSIVELY BY DONATIONS FROM INDIVIDUALS TO PROTECT WILD AND HONEY BEES, AND TO PROMOTE SUSTAINABLE AGRICULTURE IN ORDER TO HELP PRESERVE POLLINATORS.

TURNING ISLANDS INTO REFUGES FOR POLLINATORS

SUMMARY OF THE SCIENTIFIC CONFERENCES

GROIX ISLAND, JULY 7, 8 AND 9 2022

AN EVENT ORGANISED BY

POLLINIS
STOPPONS L'EXTINCTION DES POLLINISATEURS

IN PARTNERSHIP WITH

ASAN.GX · Île de Groix · Réserve Naturelle François Le Bail

AND WITH THE SUPPORT OF

Morbihan · Région Bretagne · Lorient

A FESTIVAL DEDICATED TO THE WILD POLLINATORS AND BEES ON THE ISLAND OF GROIX

On 7-9 July 2022, POLLINIS organised the first scientific festival dedicated to wild pollinators and bees of the island of Groix, where an international scientific conference entitled "Turning Islands into Refuges for Pollinators" was held. This event brought together renowned biologists, entomologists and ecologists for the first time, and enabled the priceless natural heritage of the Breton island to be honoured.

The island of Groix is a preserved natural environment where wild pollinators and bees live in a remarkable setting, almost free of pesticides and intensive beekeeping. The island offers an exceptional field of experimentation for the study of conservation solutions for wild pollinating insects and local bees that can be replicated and adapted worldwide.

Since 2019, POLLINIS, a non-profit organisation fighting against the extinction of pollinators, has been conducting several scientific field researches in order to document the unique situation on the island, which is notably home to the least hybridised populations of endemic dark honey bees (*Apis mellifera mellifera*).

Aware of the necessity and urgency of protecting the bees and pollinators of Groix from all threats, POLLINIS and its partners - the Association for the Safeguard of the Black Bee of Groix, ASAN.GX, the municipality of Groix, the International Federation of Beekeepers' Associations, Apimondia and the François Le Bail Nature Reserve - have organised this festival in order to raise awareness of the specificity of Groix and its pollinators among the general public, the scientific community and the political class.

This first festival hosted an international scientific conference entitled "Turning Islands into Refuges for Pollinators'', where some twenty eminent biologists, entomologists and ecologists from all over the world shared the results of their scientific studies on the conservation of pollinators, the impact of pesticides and the biology of the honeybee. Several specific studies being carried out on the island of Groix were also presented during the three days of debate.

All of these presentations are summarised here and can be found in full on the POLLINIS website: www.pollinis.org.

SUMMARY

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DAY 1 | HOW TO PROTECT POLLINATORS: FINDING THE RIGHT BALANCE

WELCOME SPEECH

Nicolas Laarman, co-founder and Director general of POLLINIS

On a global scale, we are witnessing a considerable decline in pollinators. In Europe, in less than 30 years, the mass of pollinating insects – among which *Apis mellifera* bees and solitary wild bees – has decreased by 80%. Even though bees play an essential role in plant biodiversity and agricultural production, they remain largely unknown. According to the IUCN (International Union for Conservation of Nature), we lack scientific knowledge for more than half of Europe's 1,100 solitary bee species.

Scientific studies have shown that the causes of pollinators' decline are pesticides and environmental stressors, including habitat degradation, but also for honeybees, loss of genetic diversity, pests, and pathogens. The *Varroa destructor* mite is a major global threat. In France, it is classified as a second category health hazard. In this context, the island of Groix presents a unique situation. The natural environment is preserved by several types of protection: national reserve, Natura 2000 zone, coastal conservatory, zone of ecological, faunal and floral value, etc. In addition, there is no intensive agriculture on the island; the beeswax in the managed colonies does not contain pesticides; the flora is essentially endemic; and more than 70% of the island is free of agricultural cultivation.

The island is an ideal natural conservation area for the protection of pollinators. Beekeeping on Groix is natural and aligns with the Darwinian beekeeping described by Professor Thomas Seeley. The Conservation Association for the Black Bee of Groix, ASAN.GX, is dedicated to the preservation of the native black bee. The beekeepers do not conduct any beekeeping management in the apiaries: they do not treat against varroa and do not feed the bees with syrup. The bees live and die without human intervention, a very rare situation, now documented by scientists.

I would like to thank the beekeepers of ASAN. GX for their work in conserving the black bee, with special thanks to Christian Bargain, the founder of the association. It was while working with him and Dr Lionel Garnery at the European Federation of Black Bee Conservatories, FEDCAN, that we discovered the extraordinary situation of the black bee population on the island of Groix and the symbolism and hope they represent for the conservation of endemic populations of honey bees, both wild and domestic, in other parts of the world.

I also want to thank the scientists who travelled across France, Europe and sometimes the world to present their research. They have a strong interest in pollinators and biodiversity; and all represent a certain vision of conservation. Their work serves this vision of conservation.

▲ SUMMARY RETURN

Located in the north-east of the island of Groix, the Gripp hosted the scientific conference "Turning Islands into Refuges for Pollinators", organised by POLLINIS and its partners from 7 to 9 July 2022. © Ph. Besnard/POLLINIS

KEYNOTE SPEECH

EXPLORING CONNEXIONS BETWEEN POLLINATORS AND HUMAN HEALTH

by Professor Lucas Alejandro Garibaldi,
Universidad Nacional de Rio Negro

POWERPOINT

Professor Lucas Garibaldi explores how we might restore and improve pollination, as well as the health of bees and humans, and what barriers must be overcome for a pollinator-friendly agriculture and environment.

Professor Lucas Garibaldi's research has identified four pathways for the connection between pollinator and human health:

1. Pollinator-dependent plants: bees pollinate plants and allow their reproduction. We use the seeds and the fruits they produce. The healthier the pollinators, especially bees, the better the quality of the food. The crops that are more bee-dependent are usually among the richest in terms of nutrients. The diversity of bee species also plays a crucial role in improving pollination and nutrition.

2. Pollinator-derived products: bees provide humans with propolis and honey, but even more importantly, they are key to the pollination and reproduction of approximately 28,000 medicinal plants.

3. Green spaces and biocultural landscapes: in general, the connection with bees and other pollinators affects people's happiness. For example, bees maintain plants that are the essence of nature; thanks to them, we can have a walk in nature, observe, and feel good and happy.

4. Clean water, air, and food: bees are good indicators of the quality of our environment. Places with healthy pollinators and bee communities are not likely to be contaminated with chemicals that also harm humans. Hence, a pollinator and bee-friendly environment is also a human-friendly environment.

"The problem of biodiversity loss is the problem of humanity."

Agriculture and biodiversity loss

Unfortunately, we are destroying the environment for bees and all species. Studies report that, each year, we are losing species at a record rate, and that extinctions are following an exponential course.

The main cause of biodiversity loss lies in how we produce trees, breed animals and crops. We have opted for a destructive, unnatural industrial way. This widespread conventional agricultural process is based on two pillars:

- Creating homogeneous landscapes for a single type of plant or one type of livestock, thus displacing diversity; and
- Adding external inputs, like fertilisers, pesticides and managed hives.

SUMMARY RETURN

The main solution to stop this destructive pattern is to produce differently. We must move away from conventional intensification, and closer to ecological intensification. Instead of using external inputs, we can take care of the soil and create regenerating landscapes, or use biological pest control instead of chemical pesticides. We can also minimise the presence of domestic honeybees and favour native and wild pollinators.

Ecological intensification

Unfortunately, not everybody chooses ecological intensification, albeit for unjustified reasons. There is evidence of the benefits of this method:

Productivity: Dr Garibaldi and his team studied 344 fields from 33 pollinator-dependent crop systems comparing conventional versus ecological intensification for five years (2010-2014). Their results showed that ecological intensification enhances the abundance and diversity of bees and allows an increase of more than 24% in yields.

Cost effectiveness: farmers using ecological intensification generate more profit by hectare due to less use of costly external inputs and obtain more yields.[1]

Knowledge: conventional agriculture is less knowledge-intensive. It is simple and easy to implement. Ecological intensification, on the other hand, requires more extensive knowledge. Farmers need to know about plants, pollinators, soils, worms, and pests but do not need to learn this all at once: being a farmer in ecological intensification is undertaking a journey, where there's constant monitoring, learning and improving.

Pollination services

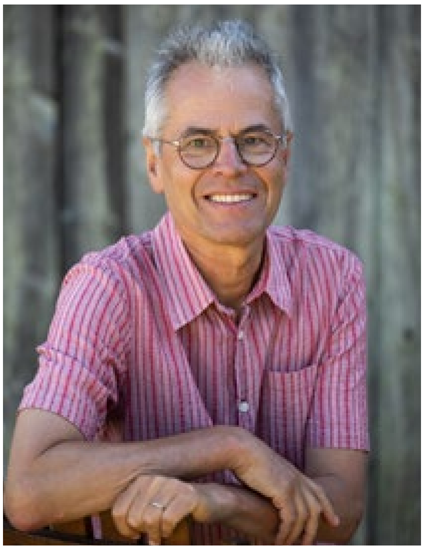
For functional pollination, two conditions are needed:

An abundance of bees: Honeybees are abundant only if there are many bees inside the colonies. They are also a complementary revenue for poor people from rural areas in many parts of the world. But in big monoculture areas where there is only one type of crop in thousands of hectares, the plants flower simultaneously, and there is a very high demand for pollination services during a very short period. This phenomenon puts enormous pressure on bees and often results in a pollination deficit.

A diversity of bees: All species play a fundamental role[2] and we shouldn't ask too much of only one bee species. Ecological intensification should also apply to beekeepers, because some may harm the environment and the health of bees by moving hives for crop pollination.

We need to understand and respect the way our planet works. Of the eighteen internationally identified contributions of nature to people, fourteen are declining.[3] Our planet is losing its capacity to sustain human life, and still humans are negatively affecting the current situation. We need to learn from, invest and duplicate good initiatives, like the ones in Groix, and recognise what we are doing, focusing on how to protect the environment in which we live.

[1] Study published in Science — https ://www.science.org/doi/10.1126/science.aac7287
[2] Rader, R, Bartomeus, I, Garibaldi, L et al. 2016, 'Non-bee insects are important contributors to global crop pollination', PNAS - Proceedings of the National Academy of Sciences of the United States of America, vol. 113, no. 1, pp. 146-151. https ://researchers.anu.edu.au/publications/120797
[3] Brauman, K.A.; Garibaldi, L.A.; Polasky, S.; Aumeeruddy-Thomas, Y.; Brancalion, P.H.S.; DeClerck, F.; Jacob, U.; Mastrangelo, M.E.; Nkongolo, N.V.; Palang, H.; Pérez-Méndez, N.; Shannon, L.J.; Shrestha, U.B.; Strombom, E.; Verma, M. (2020) Global trends in nature's contributions to people. Proceedings of the National Academy of Science (USA) (Online first: 07 December 2020) ISSN: 0369-8203 https ://www.pnas.org/doi/full/10.1073/pnas.2010473117



1. RESTORATION OF INSECT COMMUNITIES IN THE RURAL LANDSCAPE

By Hans de Kroon, Radboud University (NL)

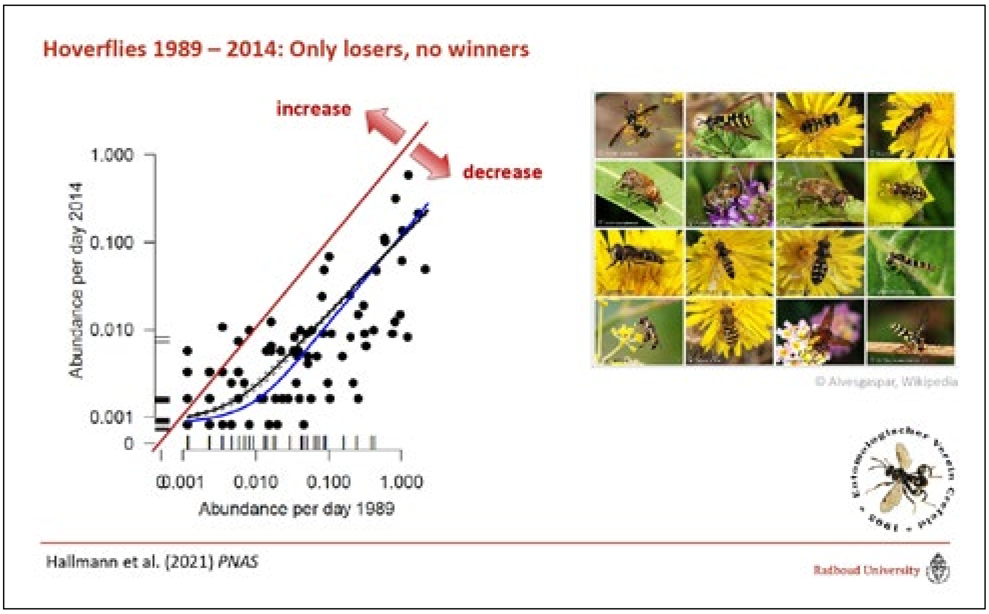
POWERPOINT

Hans de Kroon *is a plant ecologist from the Radboud University in the Netherlands. His experimental research over the last 20 years has focused on plant interactions, particularly below ground, including studying the maintenance of plant biodiversity from underlying mechanisms. Concerned about endangered biodiversity, Professor de Kroon has initiated new interdisciplinary research projects to work on healthy landscapes for plants, animals and humans in the future.*

In 2017, Hans de Kroon reported that there was an overall decline in insect biomass in protected areas. He and his team are now studying solutions such as flower dikes to restore insect communities.

Seven years ago, Hans de Kroon and his team showed that the decline of farmland birds was associated with insecticides. His hypothesis was that this decline was not due to pollution, but to a lack of food, particularly insects. In 2017, studying various factors, including landscape diversity and weather conditions, Hans de Kroon and a team of scientists, including C. Hallmann and D. Goulson reported a decline of 76% in insect biomass in protected areas in Germany over 27 years.[4] A subsequent study[5] focused only on hoverflies and reported that all species had declined. Moderately common species were more extinct than expected.

"We noticed something unusual. It wasn't just the very rare species that were experiencing a decline, it was the whole community that was going down."



[4] Hallmann, Caspar A *et al.* "More than 75 percent decline over 27 years in total flying insect biomass in protected areas." PloS one vol. 12,10 e0185809. 18 Oct. 2017.
[5] Hallmann, C. A., Ssymank, A., Sorg, M., de Kroon, H., & Jongejans, E. (2021). Insect biomass decline scaled to species diversity : General patterns derived from a hoverfly community. Proceedings of the National Academy of Sciences, 118(2).

SUMMARY RETURN

The inventory was conducted by the Entomological Society of Krefeld in protected areas in Germany from 1989-2016, using Malaise traps.

This decline was not the result of a single cause, such as climate change or the management of nature reserves, surrounded by agricultural landscapes. It is a combination of factors, intensive agriculture and pesticide use being the main ones. Natural habitats have declined significantly and their fragmentation also impacts flying insects.

Solution to the decline of pollinators: new habitats and corridors on dikes

What can be done to address this decline? Professor de Kroon recommends working outside protected natural areas. For example, his team is working on diked meadows. Dikes exist to contain water and are usually composed of grassland. The team is working to increase the proportion of flowering herbs on these dikes. Dikes are an asset for both water management and bee diversity. In these areas, wild bees flourish. According to their research, flowering riverbanks now harbour over 100 wild bees, 17 species of cleptoparasites and 14 red-listed species.

For some of these species, dikes seem to be a completely new habitat. For Professor de Kroon, it is necessary to restore a part of the landscape, so that insects can complete their life cycle with less pesticides, healthy soil and pure water where they can spend the winter.

Towards a collaboration with farmers in transition

De Kroon's team is also working on a project to encourage farmers to improve soil quality, to adopt circular agricultural practices and overall increase biodiversity. For example, they are examining the benefits of restored flower strips and hedgerows; they are also working on soils, through the process of ecological intensification. Changes take time and ecologists can not act alone. The landscape has to be healthy, for bees, for plants, but certainly also for farmers. To this end, De Kroon's team is intentionally working with institutions and conventional farmers in transition who are reluctant but interested in implementing new practices.

2. ECOLOGY AND CONSERVATION PLAN OF WILD-LIVING HONEY BEES IN EUROPE

By Fabrice Requier, Université Paris-Saclay, CNRS, IRD, UMR Évolution, Génomes, Comportement et Écologie (FR)

POWERPOINT

Fabrice Requier, *of the EGCE (Evolution Genome Behaviour and Ecology) laboratory at the University of Paris-Saclay in France, is interested in agroecology and pollinator ecology. His research focuses on pollinator adaptation to changes in landscape structure, exposure to agrochemicals and pressures from biotic (invasive) factors, and the implications for biological conservation and ecosystem services.*

Fabrice Requier and his team studied the tree cavities in which wild honey bees nest in Europe to better understand their history, presence, their ability to survive and to develop ways to promote their conservation.

The western honey bee, *Apis mellifera*, is an iconic species. Its importance for honey production and pollination services is widely acknowledged. However, it is also widely acknowledged that its health status is critical because it is threatened by multiple stressors, such as pathogens, pesticides, and lack of forage. While much attention is given to managed honey bee colonies, its fascinating existence in the wild is often overlooked. Collective imagination on honey bees, often focuses on beekeeping and professional apiaries. Honey bees evoke industrial practices as well, and the migration of thousands of hives for crop pollination.

Apis mellifera also exists in a lesser-known wild state.. This state is only native to Europe, Africa and Western Asia, and has been introduced by humans everywhere else. There are many possible reasons negatively affecting the existence of wild colonies. For similar reasons affecting the decline of managed colonies, like the intensification of agricultural practices, plant and floral resources and pesticides, as well as diseases and viruses, including *Varroa destructor*, scientists have suspected an eradication of these wild colonies.

Similarly, the intensification of forestry may have limited the number of tree cavities, which are the original niches of honey bees. Despite the increase in forest areas in countries like France, these are managed forests, not wild ones. There are therefore few cavities available, which must be shared with woodpeckers, bats and certain mammals. The tree species present might also have an impact: particularly, coniferous forests have far fewer cavities, they are smaller and unusable by *Apis mellifera*, whereas beech trees are the ideal tree species.

Scientists also feared that genetic hybridisation and the transfer of parasites and pathogens from beekeeping had taken its toll on wild swarms.

Overview of the ecology of wild-living honey bees

Professor Tom Seeley, the world's leading expert on wild colonies, has been monitoring free-ranging swarms for a decade in the United States, where the bees are not native but exotic. In Europe, a number of more recent studies are beginning to reveal some knowledge about these wild bees:

- In Poland, a very well conducted study inventoried thousands of cavity trees, to see if they hosted wild colonies. They found 45 of them on 3500 trees. This gives a density of 0.1 colony/ km^2 of forest. For comparison, in Africa the density of wild colonies is 10 colonies per km^2 of forest.

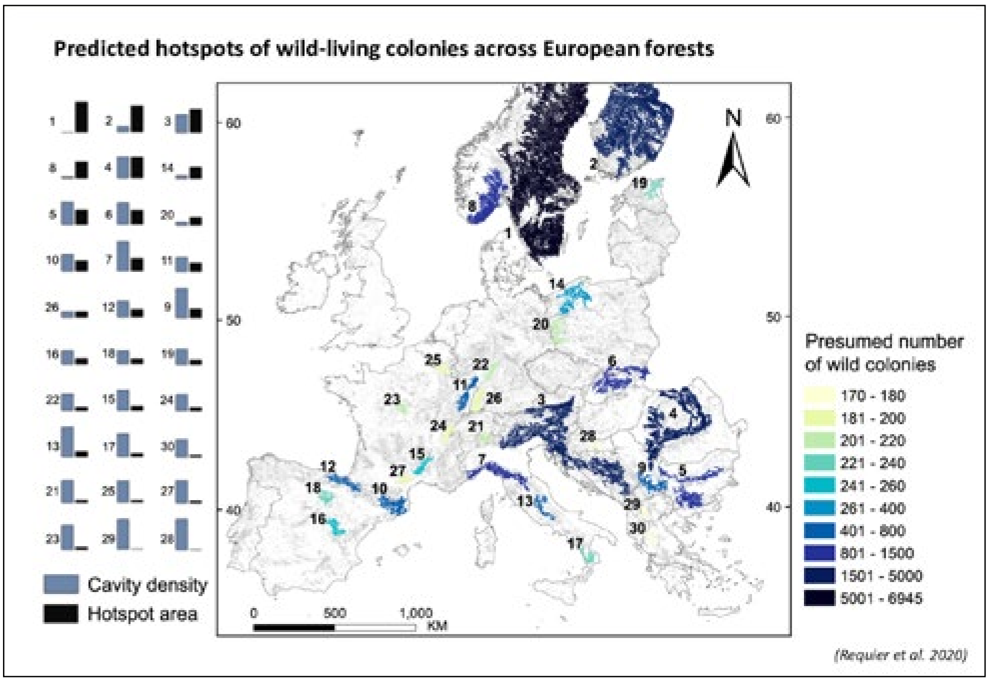
- In Germany, in protected areas and national parks, scientists have explored black woodpecker cavities. They found 0.12 colonies per km2 of forest.

These field studies show that in Europe, despite researchers' fears, wild colonies still do exist in forests.

> *"Based on recent calculations, there are an estimated 80,000 wild colonies of Apis mellifera in European forests. It is probably an underestimation since it only includes forested areas."*

A first estimate on a European scale

In 106 European forests, the presence of tree cavities was monitored from north to south. These forests have up to 60 cavities per hectare. Dr Fabrice Requier calculated how many wild colonies could nest there, by extrapolating the data obtained in Germany and Poland. He reported that 80,000 wild colonies of Apis mellifera are currently nesting in the wild in European forests. This figure is not negligible: it represents between 1 and 2% of the bee populations.



(Requier et al. 2020)

Survival and conservation plan

An ecologist, Vincent Albouy, has monitored colonies in the wild in French agricultural areas over five consecutive years. Based on this five-year follow-up, Fabrice Requier and Vincent Albouy have analysed whether these wild-living colonies would survive without human intervention in summer and winter. The results show that only 35% of the colonies survive winter, without treatment or human management. More surprisingly, in summer, not all colonies survive, as 20% of them don't live to see autumn.

SUMMARY RETURN

These bees show a potential for natural survival that poses a conservation challenge on a European scale. The Fabrice Requier team proposes a conservation approach that seeks to preserve both the adaptability and survival potential and the genetics of wild *Apis mellifera*, as well as the harmony with all other wild pollinators. They suggest that in forest heartlands where wild colonies are known to be present, no hives should be allowed except in the outer areas - within a 5km limit to avoid genetic introgression. The acceptable density of hives is yet to be established, and recommendations are being explored in the field.

Even if hedgerows and bocages with many hollow trees and small woods can host wild colonies, as can isolated trees, conservation plans do not consider these types of habitats, because they are often recent swarms coming from apiaries, composed of hybrid bees that do not survive the winter as well.

Dr. Requier also underlines the importance of carrying out a genetic analysis to understand the history of these forest bees: are they survivors that have inhabited the area since time immemorial, or do they come from distant swarms of apiaries?

"Science has found that our health is linked to the health of bees", said Professor Lucas Alejandro Garibaldi in his keynote address to the conference.

▲ SUMMARY RETURN

3. INFLUENCE OF PLANT ASSEMBLAGES ON POLLINATOR VISITS AND COMMUNITIES

By Floriane Flacher-Geslin & Franck Herbrecht, GRETIA (FR)

POWERPOINT

The first part of this presentation was supposed to be about the interactions between plants, and their effects on bees, based on the thesis work of Floriane Flasher-Geslin. It was cancelled because she was unable to attend. In the second part of the talk, Franck Herbrecht presented a naturalist study carried out in Mayenne on the *aculeate hymenoptera pollinators* - bees and wasps - of moors.

Floriane Flacher-Geslin *is currently working for GRETIA (Groupe d'étude des invertébrés armoricains), where she is in charge of regional projects in Brittany (observatory of continental invertebrates, action plans on butterflies and pollinators). Previously, she worked in the academic field on plant-pollinator interactions and on plant and animal phenology in the context of climate change.*

Franck Herbrecht *is an entomologist and the scientific coordinator of GRETIA. He works mainly on entomological field inventories and on functional approaches to ecosystems. In terms of systematics, he focuses on the Hymenoptera Vespoidea, mainly in the Pompilidae (French species), but is also interested in other insect groups.*

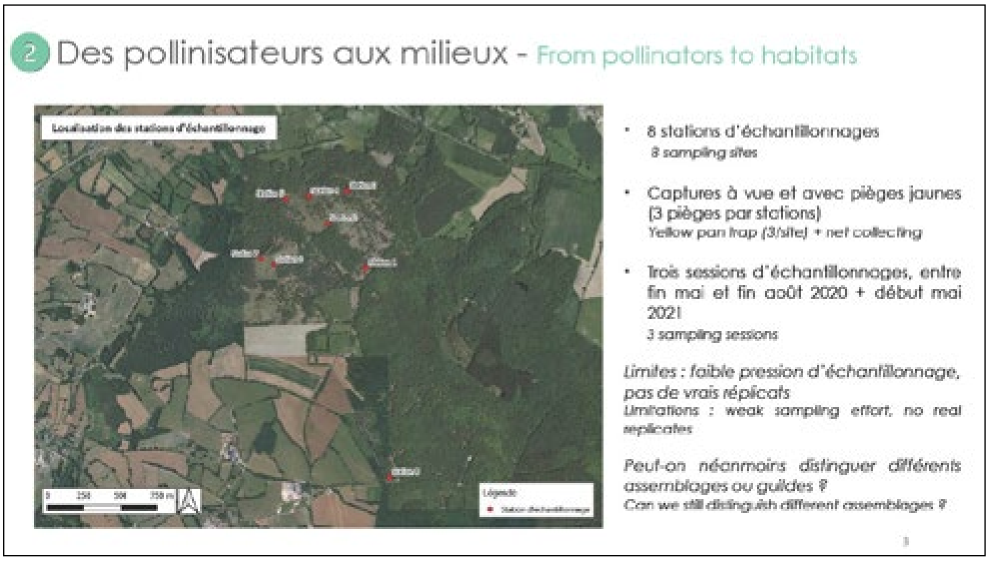
The study focuses on the species associated with the moors of the Mont des Avaloirs regional nature reserve, in the north of Mayenne (Pays de la Loire Region, France), on the top of the Armorican Massif. This region is cooler and wetter than average in Pays de la Loire, which, coupled with a particular geological context, allows the presence of a variety of moors: bilberry moors, dry heather moors, etc. This study was made possible thanks to Natura 2000 funding from the Ministry of the Environment (DREAL Pays de la Loire) and the European Union (ERDF) on the Natura 2000 site FR5200640 - Forêt de Multonne, Corniche de Pail.

Objectives of the study

- to improve knowledge of the biodiversity and heritage assessment of the site;
- to highlight the structural and functional value of moors for wild bees and solitary wasps;
- to determine which moor habitat structures are the most favourable for the reception of this fauna (e.g. nesting habits) and to cross these results with the moor restoration programme and its management.

Locations, samples, methods

This naturalistic study includes eight moorland sampling stations. To carry out the study, visual captures and yellow trapping (three traps per station) were carried out between the end of May and end of August 2020, and the beginning of May 2021.



Results of the study

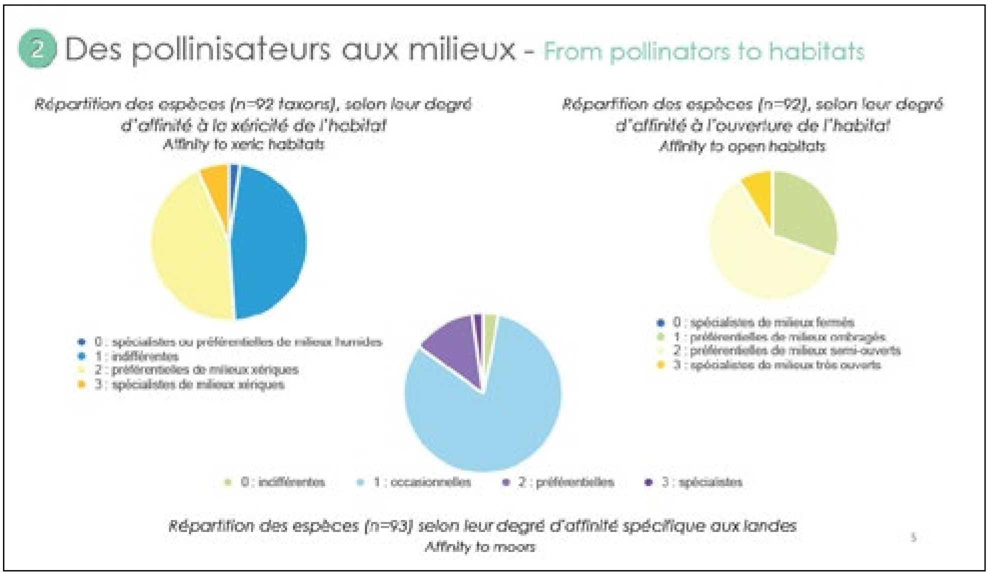
The study identified new assemblages and recorded 500 individuals of 94 taxa, including 57 species of bees and 37 wasps. The role of wasps as pollinators and as a major provider of biodiversity still goes unnoticed. However, there are almost as many wasp species as there are wild bees in Pays de la Loire. The study revealed several remarkable species: one in the North-West of France, and twelve in Mayenne, including three strictly living in moors (*Colletes succinctus, Andrena lapponica, Andrena fuscipes*).

The study distinguished between terricolous (soil-nesting), lignicolous and/or rubicolous (wood- and/or stem-nesting) and aerial-nesting species. The terricolous ones were in the vast majority. The study did not find any lapidicolous (i.e. rocks, cliffs) species. The other life traits taken into account in the study correspond to the degree of affinity to the dryness and the openness of the habitats. As the study was carried out in a moors context, the degree of dependence on moors was difficult to determine.

Barely a third of the species identified are moor specialists, including three bee species that forage solely on moor plants: one on blueberry and the other two on Erica and Callune. It is rare to find specialist species, especially in the moors.

Finally, the study highlighted the conservation challenge of this site at a regional level, as no other known site in the Armorican Massif harbours as many moor preferential species (15% of preferential species).

▲ SUMMARY RETURN

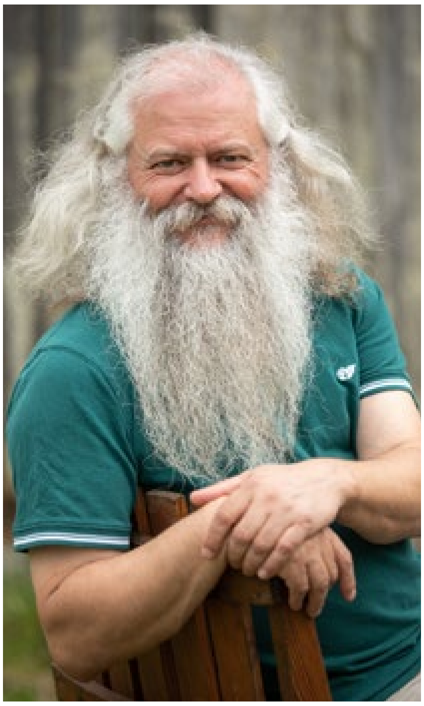


Moor species were observed in all environments except in the wettest and most closed ones. Several species of thermophilic bees, with affinities to xeric and very open environments, but with no usual affinity to the moors, were also recorded.

Finally, there is a formal complementarity between the young/pioneer moors (open xeric environments) and mature moors. One of the objectives of the "Life" project justified by the presence of remarkable bird species (European Nightjar and Hen Harrier), was to reopen the moor areas by removing grasses over tens of hectares. The present pollinator study shows that it is necessary to conserve a mosaic of more or less open and closed moorland, not forgetting the older moorland, which is essential for certain species. The structure and dynamics of the vegetation, soil texture and trophic availability remain to be explored with more precise means to explain the local distribution of moorland species.

"What worries me about dry moorland, is the drift that can be seen in the vegetation, even though it is not, or no longer, exploited and has never had any inputs. Just the precipitation of atmospheric nitrogen can lead the vegetation to drift, with brambles developing, for example."

▲ SUMMARY RETURN



4. MANAGING SOLITARY BEES, BUMBLEBEES AND HONEY BEES IN A LITTLE ISLAND OF TUSCAN ARCHIPELAGO: A CONSERVATION THREAT FOR NATIVE SPECIES AND SUBSPECIES?

By Antonio Felicioli, Università di Pisa, Dipartimento di Scienze veterinarie (IT)

POWERPOINT

Antonio Felicioli *is Associate Professor of Biochemistry in the Veterinary Sciences Department of Pisa University, Italy, with more than ten years of experience as a biologist in the Agricultural Faculty (1991-2001). His main focus is on rearing solitary bees, bee-parasite interaction, plant-pollinator syndrome, biochemistry of insects and mammalian olfaction.*

Prof. Felicioli and his team studied pollen partition between wild and managed bees on the Tuscan Archipelago, where they made an unusual discovery: a hybrid bumblebee, likely to be a combination of native *Bombus xanthopus* and exogeneous *Bombus terrestris*.

Between the Tuscan coast and Corsica, in the Mediterranean sea, bee biologist Antonio Felicioli has been studying pollinators on a preserved archipelago of seven islands. All of them have beekeepers, except for Montecristo Island, a completely wild island where human presence is forbidden.

One island is dedicated to the reproduction of *Apis mellifera ligustica*, the italian native honeybee. Most of the populations of *Apis mellifera* on these islands are *A. mellifera ligustica* hybrids.

The ideal flowering situation of the islands attracts foreign beekeepers who want to bring their hives, thus increasing honey production and diversity. In addition there is the risk that farmers of the islands buy bumblebees, mainly *B terrestris* in order to increase crop pollination without considering the local subspecies. Guidelines called *Bionet Parks* were developed to manage the bees on these islands.

Assessing competition and pollen partition

On Capraia island, a study by Professor Felicioli and his team from Pisa University focused on *Bombus xanthopus* and *Megachile sculpturalis*.They assessed interspecific trophic repartition between honey bees and other bees; hybridisation; spillover, and alien and parasitoid outbreak. To understand competition between honey bees and other bees, they used pollen gathered by bees to investigate resources and visitations.

Professor Felicioli and his team ran a palynological analysis to determine the pasture use in spring and late summer by these bees.They found a strong partition of pollen resources between honey bees and other bees, but could not assess whether it was the result of competition. Studying issues of spillover and alien parasitoid outbreaks are still in progress.

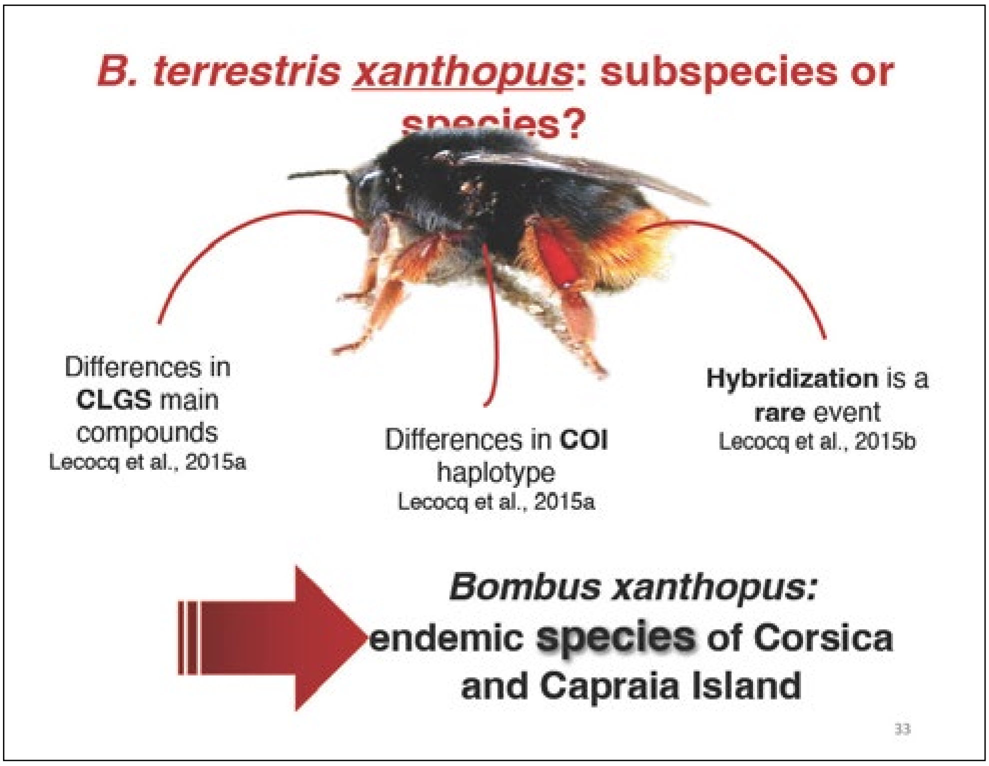
▲ SUMMARY RETURN

"Competition between honey bees and other bees is difficult to determine on Capraia Island. When it comes to trophic competition, many bees behave like the Freddie Mercury song: 'I want it all, and I want it now!'"

An unusual discovery

Surprisingly, they found *Bombus terrestris* on Capraia island, while this species was last seen over a hundred years ago. They found that this non native bumblebee mates with the local *B. xanthopus* resulting in hybridisation between *Bombus terrestris* and native *Bombus xanthopus* that was not reported before for this island.

This discovery led to ethical questions. Should this bumblebee be phased out in order to save *Bombus xanthopus*? Is it simply a natural evolution? What is the most ethical position towards these species? *Bombus terrestris xanthopus* and *Bombus terrestris terrestris* could be considered as subspecies or two different species.



Long distance migration

In order to establish whether this hybridation is accidental or not, Prof. Felicioli and his team looked for tunnels of tomatoes in agriculture and agreed that there were no commercial bumblebees. One hypothesis might be that bumbus itself covered the distance between the closest island and the island of Capraia, since they are able to migrate up to 50 km away. This was confirmed when the scientists found hybrids on the coast, most likely the result of migrations from the islands.

"It's not just the rare species that are in decline, it's the whole community.", reminded Professor Hans de Kroon on the first day of the conference, which was devoted to the protection of pollinators. © Ph. Besnard/POLLINIS

◀ SUMMARY RETURN

5. HONEY BEES SURVIVING *VARROA DESTRUCTOR* INFESTATIONS IN FRANCE: LESSONS WE LEARNED

By Fanny Mondet and Yves Le Conte,
Institut national de recherche pour l'agriculture, l'alimentation et l'environnement (FR)

POWERPOINT

Fanny Mondet *is a researcher at the Institut national de recherche pour l'agriculture, l'alimentation et l'environnement (INRAE), in the Bees & Environment unit. She specialises in bee pathology and focuses most of her research on the study of host-parasite relations between bees and Varroa destructor.*

Yves Le Conte *has been a beekeeper for 50 years and is a scientist who studies the biology, genetics and pathology, and more particularly the chemical ecology of bee colonies. He is a researcher at the Institut national de recherche pour l'agriculture, l'alimentation et l'environnement (INRAE). He discovered that pheromones, which are central to social regulation. His team studies Varroa host-parasite relationships and mite control, as well as the effects of pathogens and parasites on bee health and focuses on interactions with pesticides, from the molecular and socio-genomic level down to the colony and landscape level.*

Fanny Mondet and Yves Le Conte gave an overview of the knowledge on the cohabitation between *Apis mellifera* and *Varroa destructor*, a major biotic threat to honey bees. They also detailed the defence mechanisms at work against this parasite in untreated colonies living in the wild.

Varroa destructor is a mite of the honey bee *Apis mellifera* that originates from the Asian honey bee *Apis cerana*. The parasite depends on its host and has no interest in killing it. It is the main biotic threat to honey bees. It is present throughout the world with the exception of some islands. The island of Ouessant in Brittany was recently contaminated, and varroa was recently detected in Australia.

The relationship between honey bees and *Varroa destructor*

The parasite contributes to the transmission of certain bee viruses. Colonies die from transmitted viral infections. The success of varroa parasitism in honey bees is due to the fact that it reproduces in the brood of the workers, thus the more dynamic the colony, i.e. the more brood it has, the more the varroa mite develops. In most cases, the colony dies after a few months to years. Since the 1980s, the development of treatments has made it possible to limit colony losses. But the systematic treatment of colonies makes it impossible to observe and promote the evolutionary mechanisms at work, as they allow all bee colonies to survive. However, research has made it possible to identify wild or domesticated populations capable of surviving the varroa mite.

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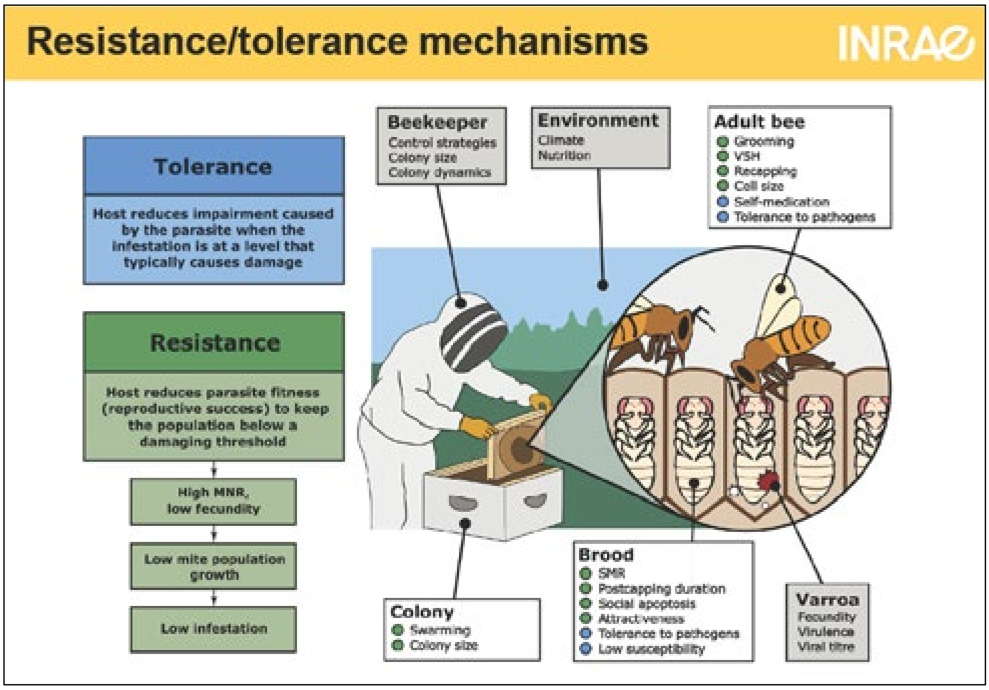
"I had a few hives and I knew at least 30 wild colonies. Everything was fine until the arrival of varroa mites in 1982. All these wild colonies died within two years. But more than ten years later, these colonies reappeared." Yves Le Conte

The defence mechanisms of bees against the parasite

Bees have developed two main defence mechanisms against varroa: tolerance (the host is not impacted by damage caused by the parasite) and resistance (development of defence systems against the parasite that keep the parasite population limited).

In the western bee, adult workers are able to detect the presence of parasites in the brood while it is in its cocoon (the varroa mite is able to mimic its smell). Honey bees can then clean out the contents of the cells, thus preventing the varroa mite from developing. Eoperculation, i.e. the opening and closing of brood cells, is another strategy honey bees use against varroa. These different mechanisms can result in the absence of varroa reproduction.

The population dynamics of the varroa mite also depend on the genetics of the mite and the environment, including beekeeping practices. A meta-analysis of studies carried out on untreated colonies over at least two years showed that the most recurrent mechanisms are suppressed mite reproduction (SMR , varroa-specific hygienic behaviour), grooming (i.e. self-cleaning or cleaning of conspecifics) and reoperculation (i.e. opening of the brood).



Observation of the mechanisms

Professor Le Conte grew up on a farm in a bee-friendly environment: hedges, old trees (hundred-year-old chestnut trees). He knew of the existence of some thirty wild colonies there that died within two years when the varroa mite arrived in 1982. After 10 years, these colonies started reappearing, and survived without any beekeeping care. Professor Le Conte decided not to treat them for varroa and to share this experience with other beekeepers.

Thanks to European funding, a study was carried out to see what was happening in France. To determine if this phenomenon of resistance could take hold over time, the research team looked for colonies that had not been treated for two or three years. They were able to collect 70 of them.Those collected in the northern part of France were placed in Orne and Sarthe, and those collected in the south were placed in Avignon, on sites that contain few pesticides. They are bocage environments, which could potentially influence the results due to a strong environment/resistance interaction. The colonies were monitored by marking the queen with two monthly visits. The 70 colonies survived for at least seven years, on average, without any treatment.

The factors of bee resistance in France

Bee resistance can be generated by co-evolution between various factors, and also by the absence of human intervention. The study made it possible to analyse several types of factors in order to assess their importance in this resistance phenomenon.

- Grooming behaviour: behaviour tests have shown that resistant bees are capable of recognising the varroa mite and destroying it, notably through chemical communication. The first difference between resistant and non-resistant bees is the chemical recognition of the parasite. Resistant bees are able to recognise molecules emitted by the varroa mite, partly thanks to their antennae, which detect the varroa mite better. The study of gene expression between the resistant and non-resistant bees revealed that certain olfactory genes are over-expressed in the resistant bees.
- Swarming is also a factor in varroa resistance. The swarming ability of resistant bees may explain their resistance to the parasite.
- A difference in reproduction in the brood: in resistant bees, the varroa mite reproduces much less.
- Hygienic behaviour (VSH): resistant bees clean the parasitised cells and develop re-operculation behaviour.

"The varroa mite favours the transmission of certain bee viruses. Varroa-infested colonies do not necessarily die directly from the varroa infestation, but from viral infections associated with the presence of the mite. This makes the host-parasite relationship even more complex." Fanny Mondet

The selection of varroa-resistant bees

Yves le Conte and his team propose two approaches:

- The identification of specific compounds emitted by infested cells and involved in their recognition by the bees: study of chemical compounds. These compounds could make it possible to characterise the bee colonies that are best at cleaning out the parasitized cells, and beekeepers could use this information to select resistant bees.

- The characterisation of genetic markers in the genome of cleaning behaviours, which could be used in beekeeping. Beekeepers would donate a few bees to identify the markers and assess the interest of a colony for selection.

6. THE ROLE OF AGRICULTURE PRACTICES AND ESPECIALLY PESTICIDES IN THE DECLINE OF BEES AND POLLINATING INSECTS

By Fani Hatjina, APIMONDIA Bee Health Commission/ Inst. of Animal Science - ELGO 'DIMITRA' (GR)

POWERPOINT

Fani Hatjina *is asenior researcher in bee science and Director of the Institute of Animal Science and Department of Apiculture in Greece. Her research focuses on honeybee breeding and mating behaviour, conservation of local honey bee populations, resistance to varroa, and environmental risk assessment. She serves as an expert in EFSA and OECD and is currently the elected President of APIMONDIA's Scientific Commission on Bee Health.*

Fani Hatjina analyses the effects of agricultural practices and pesticides on the health of bees. She explains the different factors that cause such a loss of biodiversity, and in particular, the rising mortality of bees.

There are many variables to explain biodiversity loss, especially the decline of pollinating insects. Dr Hatjina's presentation focuses on the negative effects of agriculture and pesticides on honey bees, which represent the majority of pollinating insects in terms of numbers.

The world is currently losing between 1 and 10% of biodiversity per decade. This loss does not only affect

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the equilibrium of natural ecosystems, but also the ecosystem functions insects provide, including the pollination services. According to Dr Hatjina, there are three types of deserts in the world that show the anthropogenic activities that lead to biodiversity loss and habitat destruction:

- **Natural deserts:** these are naturally desert areas, where there are no plants.
- **Green deserts:** these are large areas of crops (i.e. open field monoculture).. Herbicides and pesticides, deforestation and disturbance of the soil have destroyed pollinator nesting sites and do not attract bees, also killing many pollinators and providing no food for the survivors.
- **Criminal deserts:** mineral and hydrocarbon extraction sites (e.g. mines) exist in this desert, creating fully anthropised environments, with no space for nesting or feeding pollinating insects and bees.

Many reasons explain the loss of biodiversity, such as pesticides, pathogens, or lack of flowers, but the most important is the practice of intensive agriculture. Increased mortality of honey bees in the hives has raised several questions and worries because there is also a great need for pollination services. Research has proven that one of the main factors of colony loss is the extensive use of pesticides (e.g. insecticides, acaricides, herbicides and fungicides) which have lethal and sublethal effects on bees and other pollinators, as well as an effect on biodiversity and pollination services.

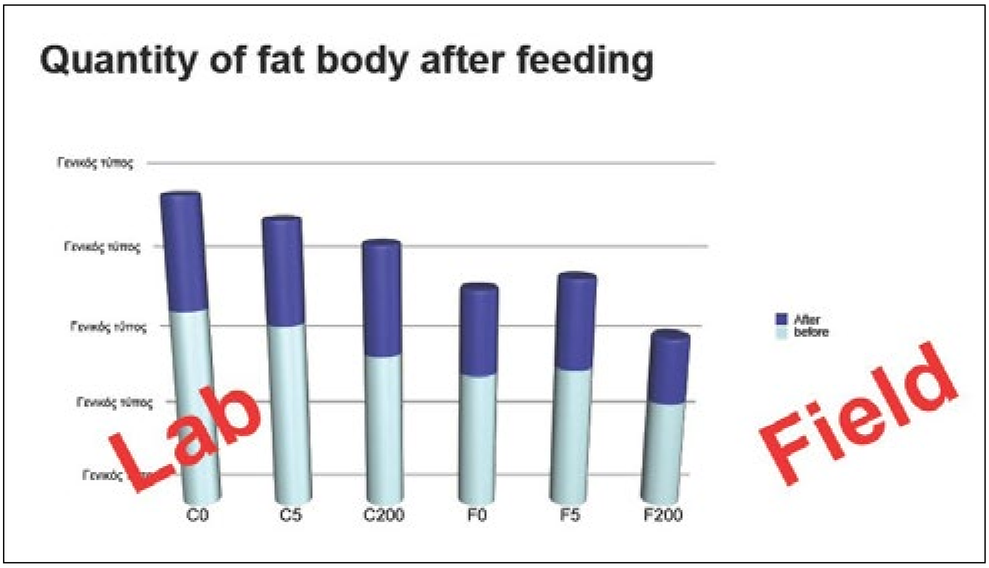
"APIMONDIA together with other environmental organisations is trying to influence the European Union to set reasonable and acceptable levels for pesticide effects on bees. The accepted mortality rate of 10% population loss for honey bees is too high. Still, no level has yet been determined for the solitary bees and bumblebees. We are trying to convince the EU not to exceed a 3% loss. Bumblebees and wild bees are more vulnerable to pesticides, they need more protection. Pesticides are the number one danger for them."

Honey bees can be used as a model to explain the effects of pesticides. Experiments have been run by Fani Hatjina's team in laboratories, in tunnels and in the field. But many of these tests have not yet been incorporated into risk assessment protocols. At the same time, the officially adopted tests for the risk assessment of honey bees are not adequate, and those for the solitary bees and bumblebees are not yet defined.

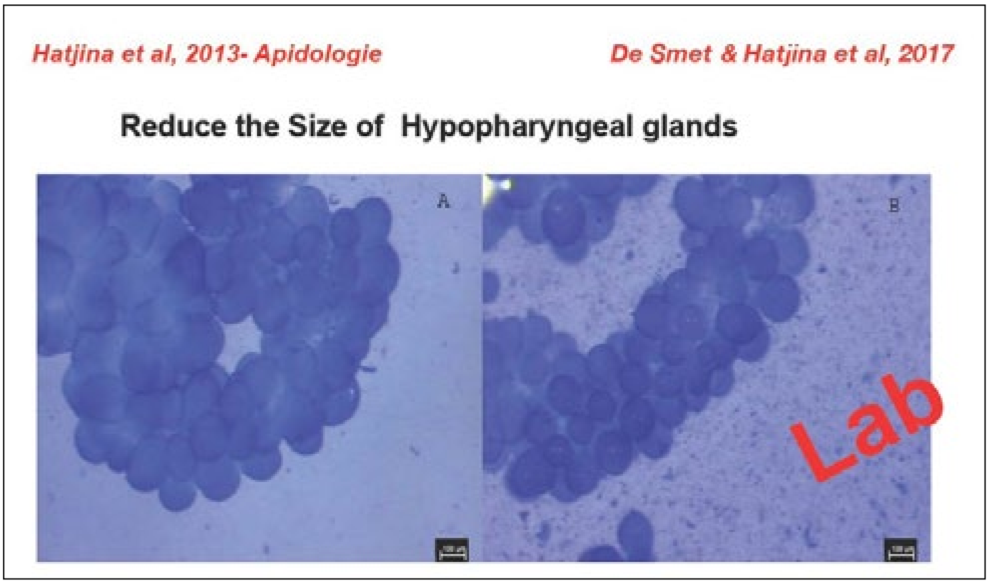
Tested effects of pesticides on honey bees

The heart of honey bees, located at the back of their abdomen, is about 10 times more sensitive than that of other insects. When affected by neonicotinoids insecticides, the heart rate accelerates to a standstill. Similarly, the normal regular breathing of bees is altered by pesticide exposure (short picks and less dense repetitions). Very quickly, the bee develops a respiratory problem, such as asthma, leading to difficulties in flying and returning to the colony with the pollen gathered.

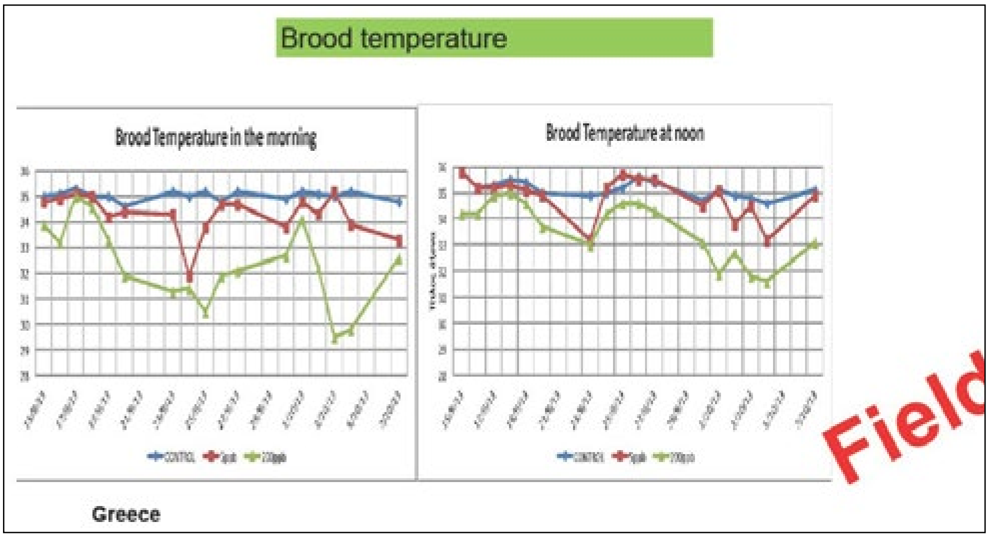
Fat body plays a central role for the immune system and longevity of bees, but are reduced in quality and quantity when honey bees are exposed to pesticides like neonicotinoids. As a result, bees are losing immunity and longevity. This has been demonstrated in laboratory as well as in field tests.



The size of the hypopharyngeal glands (from which bees produce royal jelly) is also reduced when exposed to neurotoxic substances such as imidacloprid or sulfoxaflor. Exposition results in an immediate reduction of glands by 15% to 20%. Bees stop producing the same quantity and quality of royal jelly and their lifespan is shortened, which impacts the productivity of the colony. Dr Hatjina's team also measured the development of the colony exposed to pesticides for six months showing a reduction in the colony population.



Honey bees, like wild bees, need to keep a specific temperature for their brood. When exposed to pesticides, they lose this ability to maintain a constant temperature in the hive, and although they might try to compensate for the loss of temperature at mid-day, they cannot do so throughout the day, especially in the morning. The brood temperature drops so low, that is results in brood losses.



Exposure to neonicotinoids also alters and reduces hygienic behaviour. The viability of drone sperm is reduced, and consequently the level of fertility, making it difficult to replace the queen.

In an experiment looking at the impact of pesticides on orientation and memory, Dr Hatjina's team placed a colony of bees and food on either side of a tunnel to force the bees to fly through it to find food (tunnel flight is more difficult for bees). The researchers then opened the tunnels to see if the bees could find food outside and then find the tunnel door. They did not and got lost, showing that the neurotoxic substances affect their sense of orientation and memory.

The enzymes responsible for the detoxification are also impacted and deregulated in exposed bees. They lose their ability to detoxify and fight against stress (induced by heat or intoxication). The bees are therefore more vulnerable to disease.

For three days, some twenty international scientists came together to speak and exchange views on the specific characteristics of bees and pollinators in Groix.
© Ph. Besnard/POLLINIS

7. INTERNATIONAL POLITICAL DEVELOPMENTS AND POLLINATORS

By Friedrich Wulf, Friends of the Earth Europe, c/o Pro Natura, (CH)

POWERPOINT

Friedrich Wulf *is a biologist with a long track record in counter-lobbying and advocacy work on biodiversity policy. After completing his studies at the University of Freiburg (Breisgau), he started coordinating biodiversity work of the NGO Friend of the Earth Europe and represented the network in various EU working groups. His areas of work include Natura 2000 (since 1996) and the Bern Convention (both at the international level and their national implementation), biodiversity strategies and targets (German and Swiss NBSAP, CBD Strategic Plan, EU Biodiversity strategy), as well as international conventions related to biodiversity and financialisation of nature.*

Friedrich Wulf detailed the issues raised by new genomic techniques such as the CRISPR CAS9 molecular scissors. They are being used for gene silencing pesticides or alteration of gut bacteria in honey bees in the absence of knowledge of the risk for biodiversity and human health.

There is an unprecedented decline of pollinators in recent decades. Moreover, American beekeepers have lost more than 30% of their colonies every year since 2006. This decline is multifactorial, due to monoculture and intensive agriculture leading to a decrease of flowers and therefore of biodiversity. This phenomenon is aggravated by the massive use of spray and systemic pesticides (including neonicotinoids) and the appearance of new GMOs.

> *"Gene silencing pesticides instantly turn a normal organism into a GMO organism."*

The GMO issue

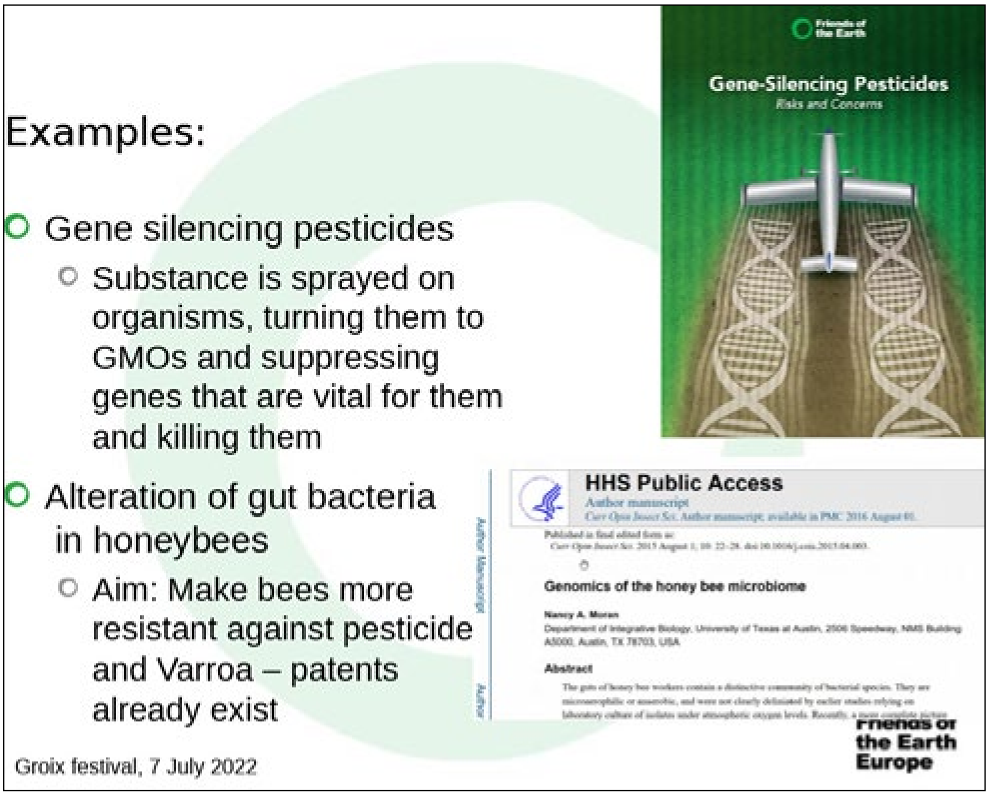
The purpose of GMOs is to modify an organism of interest such as wheat to make it more resistant. Conventional GMOs insert the gene of interest and change the expression of their genes. These methods remain highly uncertain and their effectiveness is unpredictable.

But in recent years new genomic techniques have emerged. This second generation uses molecular scissors CRISPR CAS9 by removing a part of the gene or by adding a new part. This method is reported to be more efficient, yet still presents a high rate of unpredictability.

Two problematic examples of the application of this new method:

- **Gene silencing spray:** The genes are disrupted or made inactive making the organism unable to build the protein of the targeted gene. Pesticides are spread in the fields and instantly transform a normal organism into a GM organism because they penetrate into its cells and change the genome. Moreover, the spray is not specific, and affects non-target organisms.

- **Alteration of gut bacteria in honey bees:** GM bacteria modify the bees' gut flora to make them resistant to pesticides. It is not yet known if these "super bees" will be effective. Another issue is that non-target pollinators will continue to die from the use of pesticides.



There is a high interest for some multinational companies like Syngenta, Bayer and BASF to develop GM pesticides and organisms that kill pests. It raises numerous issues:

- There is no concrete idea of the threats that these technological solutions pose to biodiversity and human health.
- There is no solution to control these technologies and prevent them from spreading into nature, becoming invasive or virulent.
- On top of everything, these pesticides and "super pollinators" will be in the hands of a very few number of global corporations.

The alternative proposed by Pro Natura is to develop agroecological cultures without pesticides and without GMOs, with new methods of cultivation using mixed cropping and rotating crops, as this helps to reduce pests. Using an agro ecological system would lead to more biodiversity, to a more resilient ecosystem without dependency and lower risk for the farmers.

Current policy processes:

Overview of policies on pesticides and pollinators :

- In the European Union, pollinators are finally included, in particular in the "Farm-to-Fork" strategy, with a 50% pesticide reduction target. As each Member State can set its own target, some of them might obtain a waiver to lower their reduction target to 35%.
- The European Citizens' Initiative on Pollinators to save bees and farmers was a great success. This ICE could force the European Parliament and the Commission to propose additional measures to protect bees and farmers.
- The sustainable Use of pesticides Regulation (SUR), currently discussed, could prohibit pesticides in "sensitive areas" such as urban areas and protected areas (i.e. Natura 2000, etc.). But

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exemptions are possible and the 3 metre buffer zone between the application and the sensitive area is far too small to be effective.
- COP 15 on biodiversity to be held in december 2022 in Montreal is expected to set new targets to be achieved by 2030 to protect biodiversity.

In conclusion, there is a lack of ambition when it comes to stop the use of the most toxic pesticides and the most damaging practices. A real focus on agro-ecology is missing with too much focus on precision agriculture and other technological solutions while forgetting to question the risks posed by GMOs.

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In addition to the conference, scientists Jeff Pettis and Fabrice Requier guided a group of participants on the tracks of the honey bee colonies living in the wild on the island of Groix. © Ph. Besnard/POLLINIS

DAY 2 | THE ISLAND OF GROIX: AN EXCEPTIONAL OPEN-AIR LABORATORY

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1. LINKS BETWEEN BEE HEALTH, PESTICIDE EXPOSURE AND ACCESS TO FLORAL RESOURCES

By Ben Woodcock, UK Centre for Ecology & Hydrology (UK)

POWERPOINT

Ben Woodcock *has been working on reconciling the impacts of modern intensive agriculture on biodiversity. This work has focused on supporting farmers to manage pollinating insects in a sustainable way, with a focus on habitat creation and developing a better understanding of the impacts of agrochemical use on biodiversity. The goal of his work has been to future-proof farming systems to support pollination ecosystem services and long term native biodiversity support.*

Honey bees and wild bees are exposed to complex mixtures of agrochemicals, which have contributed to population decline. Ben Woodcook warned of the long-term consequences of low level but long term exposure to pesticides, an impact which may currently not be adequately taken into account by the pesticide regulatory process.

The worldwide value of pollination is 235 to 577 billion US$ in terms of its contribution to agricultural productivity. In the UK, however, the availability of managed honey bees is sufficient only to support 34% of pollination demands. This is why it is essential to preserve wild pollinators which have the potential to fill this pollination gap. As such they represent a crucial societal resource that needs to be conserved.

However, these wild species are declining. A third of UK pollinator species experience declines, especially hoverflies, likely due to a variety of complex factors, (i.e habitat loss, fragmentation, climate change, disease, invasive species and agricultural intensification, including agrochemical use[6]). The ecosystems are becoming increasingly deficient in these vital beneficial insects - as such effective management of wild pollinators is crucial.

[6] Powney, G.D., Carvell, C., Edwards, M. *et al.* Widespread losses of pollinating insects in Britain. *Nat Commun* 10, 1018 (2019).

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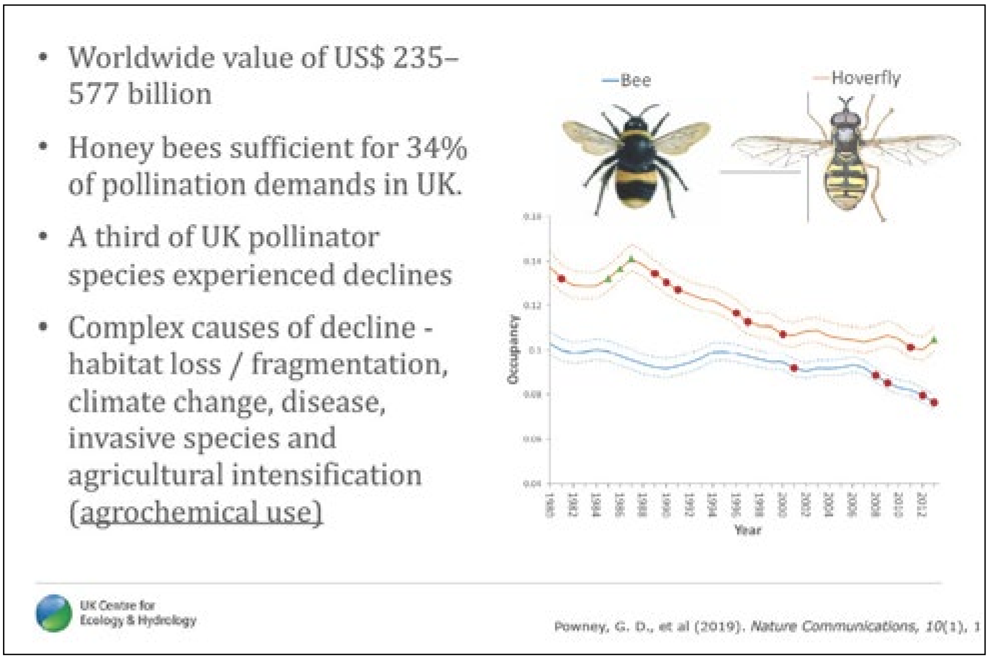

Lessons learned from neonicotinoïd effects on bees

The widespread use of neonicotinoids on mass flowering crops (like oilseed rape or sunflower) represents a good case study of the potential (and unforeseen) consequences of pesticide use. Neonicotinoids were one of the most widely used insecticides, which were commonly used as seed treatments. Seed treatments coat the seeds with the active product, it is then absorbed through the plant as it grows, killing pest species that feed on the sensitive seedlings.

At the time the regulatory approval process assumed that by the time the plant flowers the concentrations were far too low to be toxic. Unfortunately, this did not take into account the long flowering periods of these crops, which expose bees to these chemicals at low rates but for a very long period of time. In order to assess the impact of pesticides under real world conditions in UK fields, we assessed how the distributions of 62 species of wild bees, using data from citizen science (Bees, Wasps & Ants Recording Society), changed over a nearly 20 year period covering both before and after the introduction of neonicotinoids.[7] Species were separated into two groups: those known to be oilseep rape visitors (the main crop in the UK treated with neonicotinoids), and those who don't feed on this crop. They found that wild bees feeding on oilseed rape were more negatively affected by neonicotinoid use.

To investigate further, a field scale study (60-70ha rape fields) on the impact of neonicotinoids on bees[8] was lead. This scale is important as the bees forage over large areas, and lab or semi-field studies do not capture the reality of real field interaction with the environment. Fields of oilseed rape not treated with neonicotinoids were compared to those that had been treated in three countries, the UK, Germany and Hungary. The results showed that wild bees reproductive success, specifically the buff-tailed bumblebee and the red mason bee, was reduced the more they were exposed to neonicotinoids.

For honeybees the picture was more complex. Only in some countries did these managed pollinators seem to suffer from neonicotinoid (specifically clothianidin) exposure. It appears that the honeybees that did show a negative effect tended to have little wild flowering plants to forage on, so they fed to a greater extent on the treated oilseed rape crop. In some cases, the large colony sizes of managed honeybees can insulate them against the effects of neonicotinoids, but when the bees are unhealthy or have a restricted

[7] Woodcock, B., Isaac, N., Bullock, J. *et al.* Impacts of neonicotinoid use on long-term population changes in wild bees in England. *Nat Commun* 7, 12459 (2016).
[8] B. A. Woodcock, J. M. Bullock, *et al.* Country-specific effects of neonicotinoid pesticides on honey bees and wild bees. Sciences (2017).

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diet they become more sensitive to the effects of this pesticide. This points to the complex interaction between the environment and pesticides on bee populations.

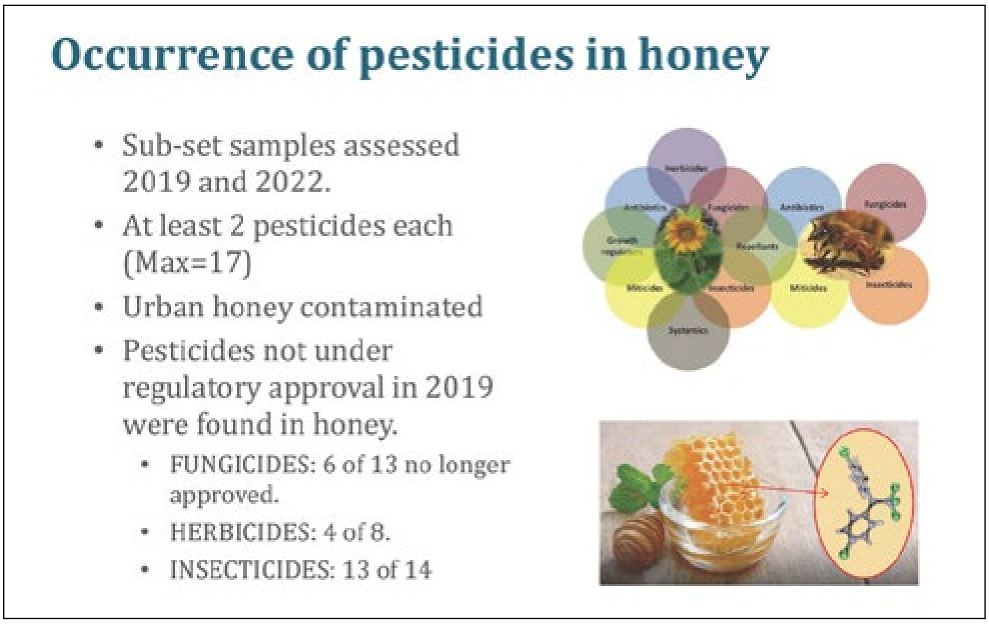
One ongoing issue for pesticides is the existence of limited post regulatory approval monitoring. As the regulatory approval process may not adequately predict real world risk to bees (e.g. this issue of long term low level exposure, or even unexpected interactions between pesticides) there is a real need for such monitoring.

"There are complex interactions in the field. And many of these complexities cannot be considered by the current risk assessment. One of the big problems is that pesticides spread into the soils and can end up into crops, but also wild plants. It is essential to put into play a post regulation monitoring programme."

Assessing post regulation monitoring of pesticides in the UK

The UK Centre for Ecology and Hydrology with the UK Department for Food and Rural Affairs is currently working on creating post regulation monitoring of agrochemicals in the environment. This builds on the National Honey Monitoring Scheme which collects honey samples provided by amateur and professional beekeepers across the UK. Running since 2018 this scheme now has in excess of 3 000 archived honey samples. These samples are metabarcoded so that we can use DNA in pollen grains suspended in the honey to identify what the bees have been feeding on.

In 2019 and 2022 a pilot study analyzed a subset of 200 of these honey samples. Pesticides were widespread, with at least 2 pesticides found in each sample in 2019, and some with as many as 17 substances.



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As for neonicotinoid pesticides, the analysis found residues in the honey even after they were banned in 2018 in Europe. In part, the neonicotinoid residue may be due to their continued use on non-flowering cereal crops like wheat. Residues applied to wheat could be taken up by both wild flowering plants, and untreated crops like oilseed rope grown in the same field the next year, as only 1-20% of the coated substance is absorbed by the crop: the other 80% ends up in the soil.

As in the UK temporary permission to use one neonicotinoid for sugarbeet has been granted, the honey samples collected as part of the National Honey Monitoring Scheme provides an opportunity to understand if these derogations are adequate to protect bees.

This research suggests that there is a wide variety of complex interactions occurring in the field that affect pollinators. These complex interactions are hard to take into account during the regulatory risk assessment and as such long term monitoring under real world agricultural conditions is needed to effectively manage pesticide risk for bees and other wildlife.

2. THE COHABITATION BETWEEN THE BEES OF GROIX (WILD AND MANAGED) AND *VARROA DESTRUCTOR*

By Jeff Pettis, APIMONDIA (USA)

Jeff Pettis *is a recognised expert on honey bee health. He is also a beekeeper and the current president of Apimondia, the International Federation of Beekeepers' Associations. Recently he has conducted research on the black bees of Groix and how they are living with the Varroa destructor.*

Pettis has been monitoring bee colonies and varroa mites on Groix.

As we try to understand the relationship between Groix black bees and the Varroa parasite, it is important to start with these three facts about varroa:

- It is exotic, from Asia and is not local;
- most beekeepers treat honey bees when they have varroa, but in Groix, the honey bees are not treated for varroa;
- mite populations are generally lower in the spring, they grow throughout the year and they grow rapidly in the fall, but in Groix, they are relatively stable during the year.

In the spring, with the help of POLLINIS, Jeff Pettis monitored the mite populations and expected them to increase. But they didn't and stayed pretty much the same. Why have these mite populations remained stable? The scientist believes that the bees play an active role in keeping the mites low and that they probably use multiple resistance mechanisms.

On Groix, beekeepers do not treat bees for varroa

A scientist would find it hard to believe that beekeepers on Groix do not treat bees for varroa. To prove it, Jeff Pettis took a wax sample from the hives and studied and tested it for 260 chemicals. The results showed that the wax was very pure and that the beekeepers were not treating their hives, as only six

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chemicals were found at a very low level.

In the absence of treatment against varroa, one would expect colonies to die. However, after two years of research, mortality was 36% (only 18% per year), and 64% of the colonies were alive after two years, which is not bad.

Scientists have been studying varroa for 30 years, trying to understand the resistance mechanisms of bees. The bees of Groix know the answer: they have adapted, because in Groix, bees and mites co-exist.

Native black bees on the island of Groix have found a way to live with the parasitic mite varroa. Unlike most parts of the world where this mite kills colonies if the beekeeper does not treat against the mite. The beekeepers in Groix take a hands-off approach and do not treat or feed their bees. By doing so, they have allowed natural selection to take place and only the best locally-adapted bees have survived, even with varroa mites.

"Native black honey bees on the island of Groix have found a way to live with the parasitic mite varroa. We don't need to fully understand the mechanisms involved to know that these bees are special and deserve protection from other honey bees and mites. The knowledge gained in Groix could help other beekeepers learn how to better manage their own bees."

Resistance mechanisms

There are different types of resistance mechanisms:

- The **hygienic behaviour**: when the bee detects something in the cell, it uncaps it and removes the content. We tested the bees on Groix and indeed some but not all colonies showed high levels of hygienic behaviour.
- Another resistance mechanism is **capping behaviour**: the bees walk over the cells, uncapping and re-capping them without removing anything, but this seems to disturb the varroa.
- Another mechanism again is **grooming**: bees sting or injure mites that fall to the floor of the hives. Again, some hives showed high levels of grooming while others did not.

These are only three of the resistance mechanisms of bees to varroa. There are others, and we can be sure that the Groix bees do not use only one type of resistance mechanism, but combine them.

We do not fully understand how bees and mites co-exist in Groix, but it is certain that bees use multiple resistance mechanisms, such as grooming behaviour, hygienic behaviour, swarming and others. We don't need to fully understand the mechanisms involved to know that the black bees of Groix are special and deserve to be protected, from other bees, and from mites. Let us protect Groix and the unique cohabitation between bees and mites as a living laboratory. The knowledge gained on Groix could help other beekeepers to learn how to better manage their own bees.

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During a workshop tracking wild pollinators, bee specialist Antonio Felicioli led some twenty participants along coastal paths to observe and recognise the specificities of the island's pollinators. © Ph. Besnard/POLLINIS

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3. A FIRST SURVEY OF THE WILD BEE SPECIES ON THE ISLAND OF GROIX

By Violette Le Féon,
ecologist specialised in wild pollinators (FR)

POWERPOINT

Violette Le Féon *has a PhD in biology and specialises in the ecology of wild bees. She completed her thesis at the University of Rennes in landscape ecology on the effects of agricultural intensification on wild pollinators. She also completed a post-doctorate at the University of Buenos Aires (2011) and then at the INRAE in Avignon (2012 - 2016). She is now pursuing her activities on the topic of wild pollinators as a freelancer, working with communities, associations and research organisations.*

A year ago, thanks to the support of POLLINIS, Violette Le Féon conducted an inventory of wild bee species on the island of Groix to gather knowledge to better protect them. Dr Le Féon's preliminary results are presented below.

Five kilometres off the mainland coast, Groix is an unspoiled island of 1,500 hectares, virtually pesticide-free, with a warmer, sunnier and drier microclimate than mainland Brittany.

Of approximately 1,000 species of wild bees listed in France, 275 are found in Brittany. The ecologist Dr Le Féon began her study by analysing the dataset on wild bees in Groix. By consulting the databases of associations or naturalist sites and forums, she found three species of wild bees that were already known to be present in Groix. To complete this initial research, she collected data four times on the island between 2020 and 2022.

These visits were carried out at different times of the year between March and September - when the wild bee species have different flight periods - to observe the bees (during ideal temperatures of above 15°C, no wind and little to no cloud cover).

Research protocol

On the entire island, the surveys were carried out in two main groups of habitats:

- natural habitats of the François le Bail nature reserve, managed by Bretagne Vivante; and
- the gardens of private individuals.

The bees were collected using two methods:

Standardised random transects: on a site, all the bees observed over a period of 20 minutes were collected. These standardised collections will allow comparisons to be made between habitats (natural versus anthropised, or between different types of natural habitats) and temporal comparisons, if collections are made again in the future.

"Opportunistic" collections: these are collections made outside the 20-minute transects.

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In both cases, collections can be made of individuals on a nesting site, in flight or foraging.

As much information as possible was recorded during the collection: insect activity, type of nesting site or flower foraged, if applicable.The bees were collected with a "butterfly net". With rare exceptions, all specimens are preserved for later identification using a binocular magnifying glass.

Due to the particular vulnerability of the island's populations of animals and plants, the ecologist chose to collect bees with a net, as this method limits the number of specimens collected. Trapping techniques such as coloured cups can lead to the collection of a large number of specimens and the death of many insects other than those targeted by the study (e.g. butterflies, flies and beetles), and, therefore have an ecological impact that is difficult to reconcile with respect for the island's fauna.

"The island of Groix is a preserved environment, few pesticides are used and the microclimate is favourable, with temperatures slightly higher than those of mainland Brittany. These aspects promote a high diversity of wild bees."

Preliminary results: 80 species detected

To date, approximately one third of the species present in Brittany have been detected on Groix. For 370 individuals collected, 80 species have been identified. By way of comparison, on the Channel Islands, where the acquisition of knowledge began earlier, 170 species of wild bees have been detected; and approximately 70 in the nearby islands of Houat and Hoedic.

Violette le Féon presented some of the wild bee species that are abundant on Groix:

- the willow bee (*Colletes cunicularius*), which is 1.5 cm long and looks a bit like the honey bee. It nests in sandy soils and is very abundant on the Groix coastline in early spring;
- the ivy bee (*Colletes hederae*), which flies in autumn and is abundant in the interior of the island;

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- *Lasioglossum malachurum*, one of the most common *Halictidae* species in Europe;
- the two species of bumblebee, *Bombus terrestris* and *Bombus pascuorum*.

The ecologist then presented the rarer or "heritage" species found on Groix:

- *Colletes fodiens*, a species classified as threatened on the Red List of European bees, was found in a garden in Kervedan;
- a first sighting of Armorican Massif** ;
- two first records for Brittany** ;
- nine first records for Morbihan**;
- the presence of species of southern affinity, which probably benefit from the microclimate of Groix.

*** According to the work published in 2018 on the Observatoire des Abeilles website («Listes départementales des abeilles sauvages de Bretagne, Pays-de-la-Loire et Basse-Normandie»).*

Perspectives

This is an initial state of knowledge, and there is certainly much to discover. For example, are species of the *Mellitidae* family present on the island? By the end of 2022, the results of this first inventory will be available, with a comparison between the different types of habitats and an analysis of the network of plant-pollinator interactions (thanks to the help of the botanist Pauline le Hyaric, who has identified the plants on which Violette le Féon collected the bees). This study will be published on the POLLINIS website.

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The scientific conference enabled the inhabitants of Groix, whether amateur or professional beekeepers, scientists or simple holidaymakers to discover the priceless natural heritage of the Breton island. © Ph. Besnard/POLLINIS

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4. BEECONNECTED: A EUROPEAN PROJECT EXAMINING HONEY BEE ECOLOGY AND INVOLVING GROIX HIVES

By Fabrice Requier from Université Paris-Saclay, CNRS, IRD, UMR Évolution, Génomes, Comportement et Écologie (FR)

POWERPOINT

Fabrice Requier, *from the EGCE (Évolution, Génomes, Comportement et Écologie) laboratory at the University of Paris-Saclay in France, is interested in the agroecology and ecology of pollinators. His research focuses on pollinator adaptation to changes in landscape structure, exposure to agrochemicals and pressures from biotic (invasive) factors, and their implications for biological conservation and ecosystem services.*

The European BeeConnected project aims to understand the mechanisms that influence the risk of winter colony mortality and to identify its early signs. It is being carried out on 135 hives in 27 sites in France – notably on the island of Groix –, Germany and Greece, in order to help beekeepers limit their losses.

In a European primary research framework, funded by the Horizon 2020 programme, electronics are used to monitor biodiversity in a less invasive way. Researchers have found that colonies are now dying more in winter. Pesticides, varroa mites and lack of floral resources are stress factors, but how do they lead to a collapse? What is the common trigger for all colonies that die? Can we observe and anticipate these losses (for beekeepers) thanks to early indicators?

While researchers have observed that colonies die more in winter, the BeeConnected project aims to understand the mechanisms underlying the risk of winter mortality of honey bee colonies, and to identify early warning indicators that could help beekeepers limit colony losses and their resulting economic deficits. Replicated in Europe in three countries: France, Germany and Greece, this project is conducted in partnership with researchers and a network of beekeepers. In France, FEdCAN, the European Federation of Black Bee Conservatories, was selected to monitor the genetics of bees in different contexts.

> *"This is a primary research project with an applied purpose, the idea is to be able to understand what happens in winter, in the 'black boxes', to help beekeepers anticipate colony deaths."*

Methods and location

In each of the apiaries studied, common protocols were set up. The hives are equipped with scales to measure both the weight of the hive every 5 minutes (connected hives) and the temperature inside and outside of the hive (monitoring of hive thermoregulation).

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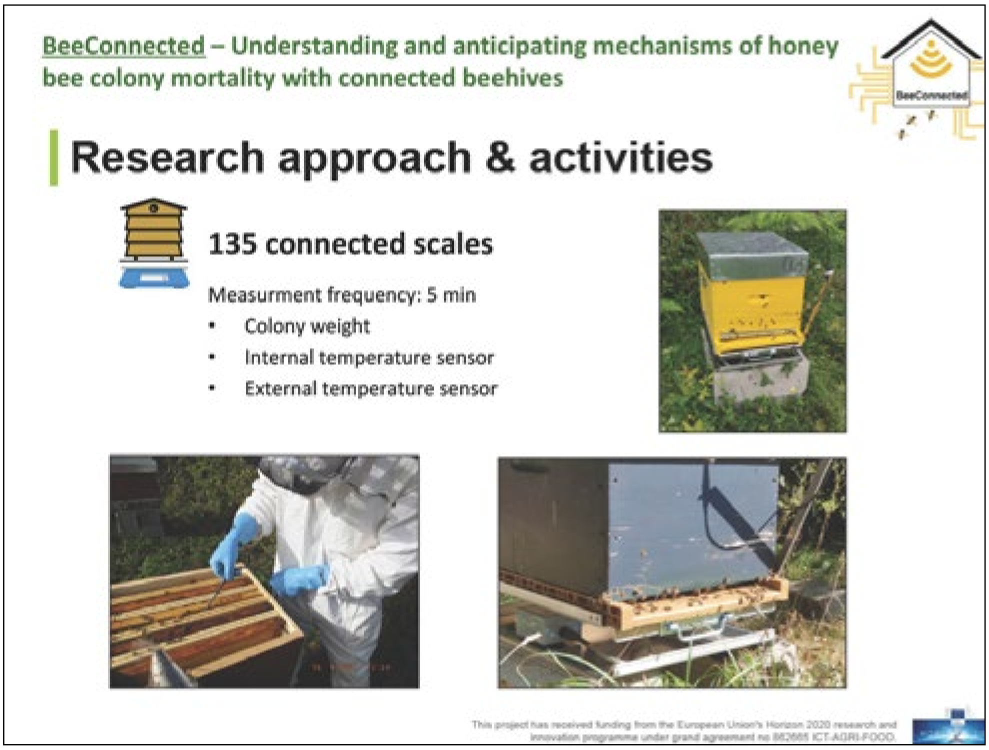
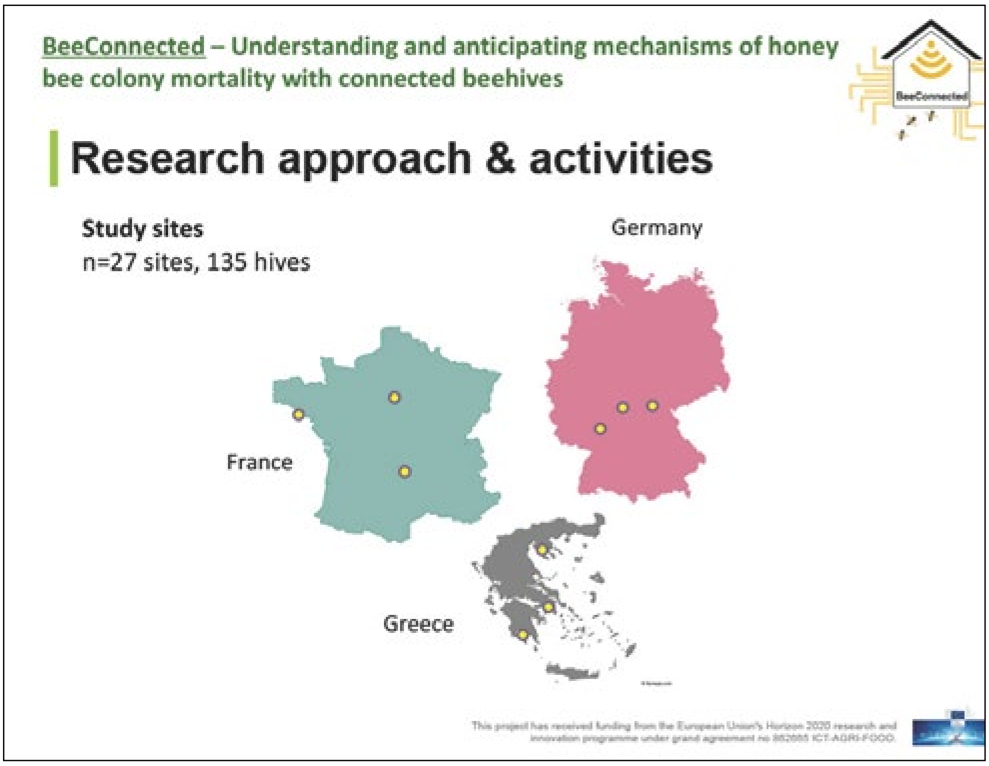


On a European scale, 135 colonies are equipped with these scales in the three participating countries. These apiaries have been selected along a climatic gradient at the European scale and within each country (continental, temperate and Mediterranean). Landscape gradients (agricultural, urban, semi-natural) have also been considered in the selection.



Three study zones were determined based on the black bee conservatories in France:

- Clermont Ferrand (CANEC conservatory)
- Île-de-France (CANIF)
- Lorient-Île de Groix (ASAN.GX)

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For the Lorient-Groix site, some apiaries were placed in Lorient (urban site), and two apiaries were studied on the island of Groix, one on the site of Pen-Men (semi-natural site) and the other one at the President of ASAN.GX Christian Bargain's apiary (the most agricultural apiary).

A total of 1,800 temperature sensors were installed across Europe. They are good estimators of colony robustness and size in winter, a period when colonies collapse, while beekeepers cannot open the hives that become "black boxes".

By monitoring what is happening inside the hive with the temperature sensor, the study can measure whether the bees are producing heat to survive. If so, the temperature will be higher inside the hive than outside.

This research project involves a doctoral thesis in each participating country. In France, the thesis focuses on the ecology of bees in winter. In Germany, it focuses on the nutrition-landscape relationship (how the landscape affects pollen entry and potentially the overwintering of colonies) and in Greece, it focuses on the sound and bioacoustics of the hives.

The aim of this primary research, with an applied purpose, and led as an international collaborative project with beekeepers, is to understand what happens in the hives during winter. The data collected will improve knowledge of bee ecology and create decision support tools for beekeepers in order to support their economic activities.

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5. *APIS MELLIFERA MELLIFERA*: THE GENETIC OF THE BLACK BEES OF GROIX

By Lionel Garnery, Université Paris Saclay - IRD, Laboratoire Évolution, Génomes, Comportement et Écologie (FR) and Per Kryger from Aarhus University (DK)

POWERPOINT - LIONEL GARNERY

POWERPOINT - PER KRYGER

Lionel Garnery *is specialised in the study of genetic diversity and evolution of the honey bee (Apis mellifera). His research focuses on the genetic structure of bees and how to relate it to the history of the evolution of the species. Since 2008, he has been involved in the establishment of honey bee genetic preservation centres in France. He is also president of FEdCAN (European Federation of Black Bee Conservatories).*

Per Kryger *is a senior researcher at the Department of Agroecology at the University of Aarhus, and Head of the Danish Honey Bee Health Laboratory. He is involved in the conservation of the local Apis mellifera mellifera population on the island of Læsø and in training beekeepers in early detection of bee diseases and hygiene measures to minimise the risk of epidemics.*

Lionel Garnery and Per Kryger studied the almost non-existent hybridisation level of the black bees of Groix through two distinct methods: mitochondrial DNA and microsatellite marker on one hand, and single nucleotide polymorphism (SNP) on the other.

Thanks to morphometry, the first 24 subspecies of bees were identified by the Austrian bee specialist Friedrich Ruttner in the 1980s. We now count between 26 and 31 subspecies. This work showed that these races can be divided into four major evolutionary lineages: Western Mediterranean (M), Northern Mediterranean (C), Eastern (O) and African (A). These four lineages were confirmed by the use of DNA markers. Thanks to the molecular markers, the scientists were able to date the lineages, and conclude that *Apis mellifera* and *Apis cerana* separated 6 million years ago and that the diversity observed in *Apis mellifera* corresponds to an evolutionary time of 1 million years.

The natural diversity in bees is the result of a long and complex evolution. The first colonisation of the species took place 1 million years ago and gave birth to the western Mediterranean lineage in Europe. A second lineage moved southwards and colonised Africa. During the successive Quaternary glaciations (Riss and Wurm), populations were isolated in refuge areas of southern Europe. They are at the origin of the three European lineages (Eastern, Western Mediterranean, and Northern Mediterranean). Following these glaciations, the bees of the refuge populations recolonized the north of Europe and developed the geographical races which accumulated mutations and progressively adapted to the diverse flora and climates of Europe.

Thus, each breed is the result of its own biogeographical and adaptive history.

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Apis mellifera mellifera

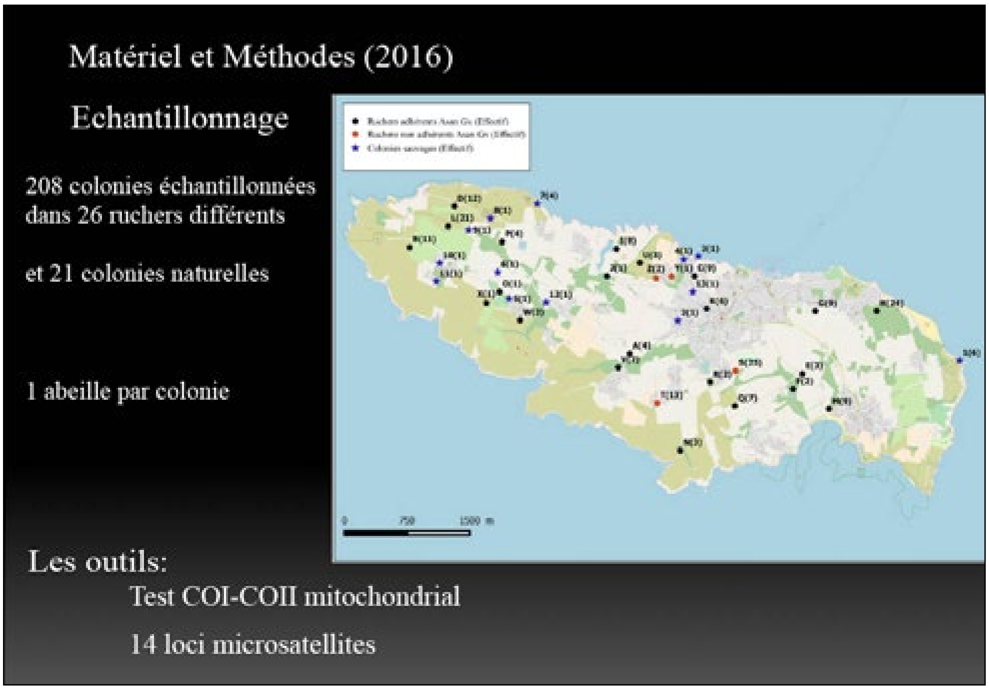
Like the other European breeds, *Apis mellifera mellifera* has a recent history, stemming from the last Quaternary glaciation. The West Mediterranean lineage, of which it is a part, is the one that shows the least diversity because it has passed through two ice ages, 200,000 years ago and 10,000 years ago. Thanks to this, it shows remarkable capacities for adaptation to climatic variations, which must be conserved.

The black bee (*Apis mellifera mellifera*), which is of agronomic interest, is suffering from the impact of human activity and beekeeping practices and is now in danger of extinction. Research carried out over the last 30 years shows a progressive increase in hybridisation levels, which has particularly accelerated in the last ten years. The level of hybridisation currently observed in most French bee populations is between 30 and 40%. Regions with intensive beekeeping are the most affected.

Genetic study of the bees of Groix

Two series of samplings were carried out. First, in 2008, at the request of ASAN GX, following the introduction of 20 colonies of Caucasian bees on the island, and then, the following year, by 80 colonies of Italian bees. It should be noted that these colonies did not survive one season. The purpose of this first sampling was to determine the impact of these imports on the structure of the population. In 2016 a new series of sampling aimed to assess the level of hybridisation of the island's population.

The studies were carried out on 208 colonies from 26 apiaries, of which 21 colonies were natural free-ranging swarms. Dr Garnery took one bee per colony and analysed it using two molecular tools: mitochondrial DNA (which indicates the maternal origin of the colony) and microsatellite markers (to characterise hybridisation). The results showed 100% local mitochondrial haplotypes. Hence, imports seem to have had no impact.



Within the lineages, however, he identified variants that correspond to particular mutations. In the two studies conducted, five different haplotypes were identified, including the M32 haplotype found so far only on the island of Groix, and nowhere else, despite sampling throughout Brittany. Because of naturally occurring events, the M32 is unique to Groix and underwent a local mutation giving it its specific type

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of bees on the island. In the same way, in the Mediterranean, each island also has its specific breed of bee.

"Artificially maintaining unadapted colonies by feeding them undermines natural adaptation, not letting nature do its work." Lionel Garnery

On Groix, "pure" black bees

On Groix, the researcher Lionel Garnery found a relatively low nuclear diversity, with the proportion of heterozygotes in the population being 0.34 in 2008, and 0.33 in 2016 (on a scale of 0 to 1, where 1 represents the maximum diversity). These figures suggest that in Groix, the genetic diversity of the bees is quite low, and has not changed much. Out of 100 bees analysed in 2008, 5 showed a level of hybridisation above 20%. In 2016, only one bee reached a level of 18%. The level of hybridisation in the Groix bee population is less than 1% overall, which shows that island's bees are "pure" black bees.

Danish scientist, Per Kryger, confirmed the genetic "purity" of Groix bees using a new method, called Single Nucleotide Polymorphisms or SNPs. Jeff Pettis collected 35 bees from Groix and sent them to Per Kryger for analysis. The SNP technique revealed 95% of the genes unique to *Apis mellifera mellifera*. One of them came up with only 77%: Jeff Pettis confessed he had collected it in Paris in order to test his colleague's method, which consequently, proved particularly effective.

"For Groix, beekeepers are the custodians of Apis mellifera mellifera in a natural conservatory. Isolation helps to protect against hybridisation of its honey bees and also helps the bees cope with varroa." Per Kryger

The ecologist Violette Le Féon has drawn up an initial assessment of the inventory of wild bees that she is carrying out on the island of Groix with the support of POLLINIS. She has listed 80 species of bees out of the 275 species that are known in Brittany.
© Ph. Besnard/POLLINIS

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6. FRANÇOIS LE BAIL NATIONAL NATURE RESERVE'S EXPANSION PROJECT

By Léa Trifault,
Réserve naturelle nationale François Le Bail (FR)

POWERPOINT

Léa Trifault *has been the curator of the François Le Bail National Nature Reserve, managed by the Bretagne Vivante association, since 2019. She previously worked in Guadeloupe for two and a half years as a project manager in two national nature reserves (Désirade and Petite Terre).*

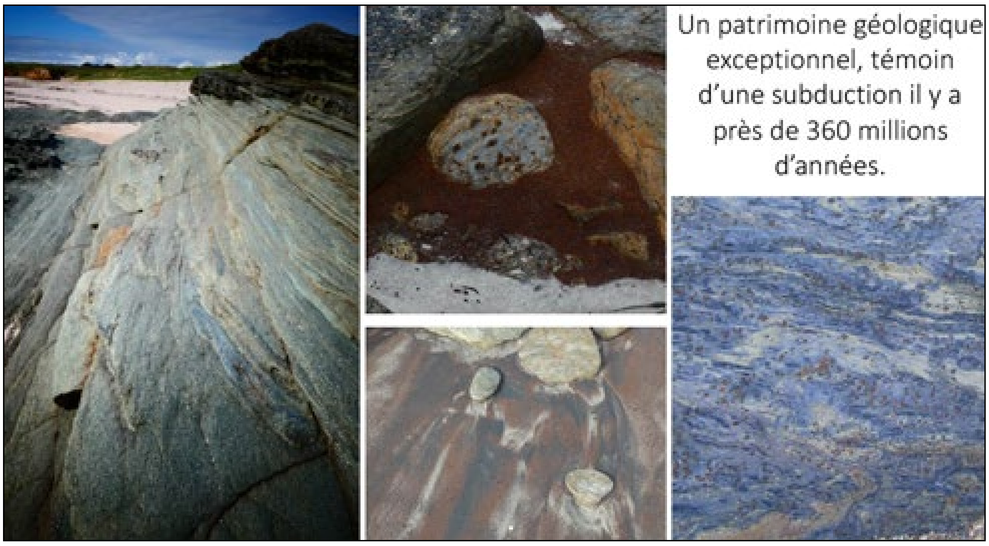
In her presentation, Léa Trifault detailed the ecological interest of the landscapes of the island of Groix, such as the heather moors, which are habitats for pollinators.

The 98 hectares National Nature Reserve of Groix, created in 1982, is built around the protection of the remarkable geological and natural heritage of the island. The Conservatoire du Littoral is the landowner of the Nature Reserve managed by the association Bretagne Vivante.

The island of Groix: specific habitats

The island of Groix is an island with multiple landscapes and specific habitats. At Poulziorec, there is an eelgrass bed which is a nursery for marine fauna. In Pen-Men and Beg Melen, cliffs present a specific floral biodiversity. The typical geomorphology of the island and its hanging valleys provide information on the geological eras and periods of glacial warming and cooling. In Port Saint-Nicolas, an ancient ria abounds in lichens (more than 200 species), a species considered as a bio-indicator. It is a biodiversity hotspot. The Plage des Grands Sables is a convex and travelled beach, with a very strong biodiversity.

Geology of the island of Groix and protection



The François le Bail Nature Reserve, created to preserve a rare geological heritage and colonies of nesting seabirds, is named after François le Bail, a passionate mineralogist who inventoried some sixty minerals on the island. The rocks bear witness to a geological past where a small ocean subducted about 360 million years ago up to 40 km below ground. Basalt and clay were transformed by metamorphism into blue schist and mica schist. Then the rocks came back to the surface and, with retromorphism, the blue schist was transformed back into green schist.

To understand biodiversity, we need to look at the bedrock. The roots of this particular fauna and flora are in the rocks. Groix is also home to colonies of breeding seabirds (gulls, cormorants, northern fulmars) and migratory birds, as the island is a stopover for certain species.

Geographically, the island has a sheltered coastline and a windward coastline, offering a diversity of foreshores. The tidal flats are a source of food for shorebirds. The flora and fauna follow to the rhythm of the tides. One of the missions of the Nature Reserve is to conserve these habitats by monitoring the barnacle populations.

"In order to protect, we need knowledge, we need more information. This is what POLLINIS and Violette le Féon have enabled us to do through the inventory of wild pollinators. We need to understand these species and their habitats in order to protect them better."

Moors and aerial lawns

29% of the Reserve's surface area is occupied by heathland with ash and vagrant heather of European interest, a species protected at European level. This is a natural and cultural heritage, and also a habitat for pollinators.

The management of the Nature Reserve includes three different missions: conservation, raising awareness and gathering knowledge. The Nature Reserve team is responsible for scientific studies and monitoring, management of the coastal moors, maintenance of the natural environment, surveillance and raising awareness.

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A project to extend the Nature Reserve

There is an ongoing project to extend the Nature Reserve by about 800 hectares around the island in a few years. Protection challenges outside the current perimeter of the Reserve have been identified. This project will preserve areas that are different in terms of biotope than those already protected. This extension will also make it possible to integrate species that are not yet protected, threatened and disappearing. The project should be completed in 2024/2025.

7. OF BEES AND MEN: AN ISLAND TALE

By Christian Bargain, ASAN GX (FR)

Christian Bargain *is a beekeeper and the president of ASAN.GX, the association for the protection of the black bee of Groix. He has been working for many years to promote the black bee of Groix and ensure its preservation.*

Christian Bargain, a former sailor converted to beekeeping, looks back at the history of ASAN.GX, the Association for the protection of the black bee and beekeeping on the island, and the implementation of the protection of the island which has allowed the conservation of the specificities of the bees of Groix.

Research by local historians shows that the oldest honey barrels discovered on the island date back to 1540 and 1638. These historians found a rock in which there was honey, a discovery that proves the presence of bees at the time on the island of Groix.

Testimonies from the 1950s and 1970s attest to the modernity of beekeeping on the island. In the 1950s, Groix beekeepers were using beehives without frames, with wooden bars and boxes. At that time, there were 12-13 hives, and honey was collected by weighing and sulphuring the bees (i.e. killing them). This practice continued until 2008, when the association for the protection of the black bee on the island of Groix (ASAN.GX) was created.

> *"We also have a project to create a scientific apiary with Jeff Pettis. This local apiary would be installed in the Grognon fort and would have a naturalistic aim."*

Varroa destructor, the hives on the island of Groix and the ASAN.GX

The *Varroa destructor* was first spotted on the island of Groix in 1989 and its arrival was documented by beekeepers. The ASAN.GX association was quickly confronted with the problem of importing bees from the mainland, a possible vector of the mite. In 2007, a beekeeper settled with Caucasian bees on the Grognon and refused to follow the island's traditions, particularly that of recovering swarms which are given, and not sold, by beekeepers to renew their colonies.

The idea of a municipal decree therefore emerged to protect the island's colonies. It was adopted and strengthened, based on that of the island of Ouessant. This decree prohibits the importation of bees and used equipment (outfits, cages, etc.). However, if one fails to abide by this decree, the fine of 35 euros is

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not deterrent. Stronger legal protection must be sought, such as a State decree to effectively protect black bees and pollinators, on the model of the one concerning the protection of the Nature Reserve. But other tools are also available:

- Education to inform about the black bee
- Free access, necessary to disconnect protection from the economic interest that a bee can create
- Scientific monitoring of colonies, which has already been in place for 10 years through the studies of Lionel Garnery and Jeff Pettis
- Meeting with other conservatories. A first meeting at the Natural History Museum was organised in this sense to federate and open the island to scientists who would like to come and study the black bee
- The search for political support, at the level of deputies, senators and ministers
- The search for local support, from local associations and NGOs such as POLLINIS

8. SCIENTISTS' CALL FOR THE PROTECTION OF GROIX - WILD POLLINATORS AND MANAGED COLONIES

By Jeff Pettis APIMONDIA (USA)

Jeff Pettis *is a recognised expert on honey bee health. He is also a beekeeper and the current president of Apimondia, the International Federation of Beekeepers' Associations. Recently he has been conducting research on the black bees of Groix and how they co-exist with the Varroa destructor mite.*

Jeff Pettis presents the scientists' appeal to the French government to protect all wild pollinator biodiversity on the island of Groix, including the threatened *Apis mellifera mellifera* population.

"Leading scientists from around the world have recognised the unique nature of Groix by signing the plea. We need the French government to find a way to protect Groix."

The scientific community, beekeepers, together with ASAN.GX are seeking to protect Groix. Islands are special places because they are isolated, but this isolation is threatened by importation of exogenous bee species. We have to find a way to protect the unique pollinators, including the native honey bees of Groix.

Unlike Denmark, there is no legal framework in France to protect bees. It's necessary to anticipate the implementation of such a framework before species end up on the European Red List of IUCN, or reach a critically threatened stage.

The island of Groix has unique vegetation, natural habitats and would make an ideal pollinator sanctuary. The indigenous black honey bees are threatened by hybridisation with other non-indegenous bees being brought in by some beekeepers.

These introductions can bring in new or different mites, and the equilibrium between mites and bees of Groix that has co-evolved, would be destroyed.

Towards legal protection of Groix

Importation of new bee sub-species should be prevented in order to preserve Groix as a sanctuary for pollinators and a living laboratory. POLLINIS, ASAN.GX and others have drafted a plea to protect the island of Groix, signed by 20 international scientists and recently, a new signatory, Lucas Alejandra Garibaldi, has agreed to join, along with Professor Tom Seeley, a pioneer of natural beekeeping. This call must be heard.

At the end of the second day of the conference, Apimondia's president, Jeff Pettis, presented the scientists' appeal asking the French government to protect the pollinators and the bees of Groix. © Ph. Besnard/POLLINIS

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DAY 3 | LEGAL PROTECTION FOR ALL POLLINATORS OF GROIX

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1. LES CONSÉQUENCES POTENTIELLES D'UNE GESTION DÉPLACÉE DES ABEILLES

By Benoît Geslin Institut Méditerranéen de Biodiversité et d'Écologie Marine et Continentale (FR)

POWERPOINT

Benoît Geslin *is a lecturer at Aix Marseille University and is part of the Institut Méditerranéen de Biodiversité et d'Écologie Marine et Continentale (IMBE). He is an ecologist specialised in plant-pollinator interaction networks and wild bee communities. He is interested in agricultural, urban and natural environments. His latest work focuses on invasive alien species and the management of wild bee populations.*

Benoît Geslin presents the characteristics of solitary bees affected by the biodiversity crisis, and points out false solutions for their conservation, particularly in urban environments.

When thinking of bees, the first thing that comes to mind is the honey bee. However, there are also solitary bees, wild bees in nature. There are 20,000 species of wild bees in the world, 250 in Brittany, 80 in Groix. These bees are different from domestic bees. They are solitary and do not live in colonies: the mother bee feeds her brood alone (ten and fifteen eggs on average). These species nest in the ground, in dead wood, in cavities, or in snail shells. They each have a particular ecology and depend on the diversity and quantity of plants, and on the quality of the environment. Whether they are specialists in a single plant species or generalists, they are in serious decline due to habitat fragmentation, pesticides, global warming, and the multiplication of pests and invasive alien species.

However, this role as a standard-bearer has led to a number of problems, such as the massive installation of hives of honey bees in urban areas, with a view to safeguarding biodiversity.

Erected as an emblem of biodiversity, the honey bee has made it possible to carry out certain battles, such as the ban on neonicotinoids, pesticides that are deadly for both domestic and wild bees. However, this overly regular focus on the honey bee can sometimes cause problems, such as the massive installation of hives of honey bees everywhere in the belief that they are helping to safeguard biodiversity.

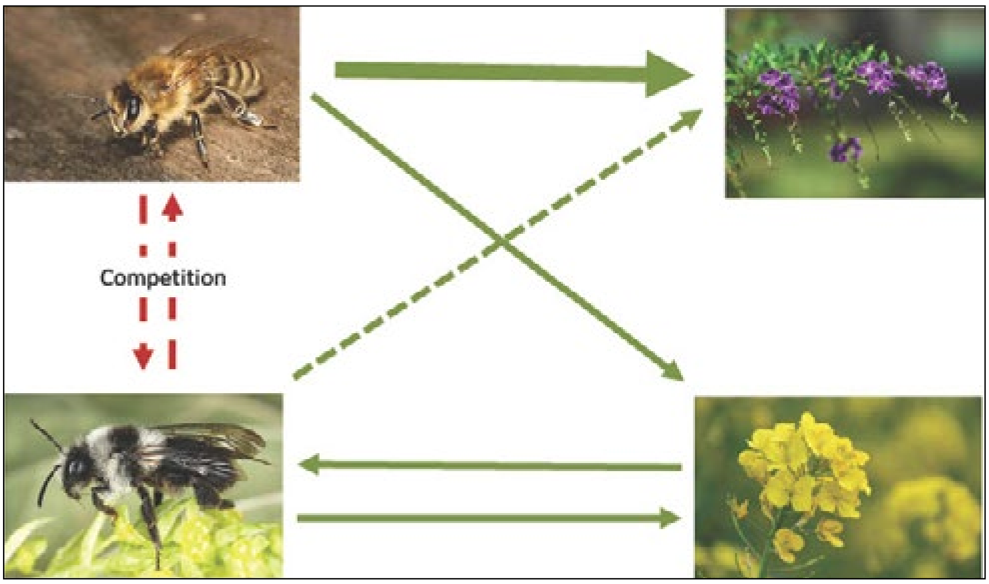
Beehives in Paris and "beewashing"

Many practices thought to be positive are actually detrimental to ecological wealth and trophic resources. An Australian study analysed publications in mainstream newspapers to see how often the solitary bee was mentioned. In 80% of the articles, they were not mentioned at all, only honey bees were mentioned. The result is that public policies, companies and city dwellers install more and more hives to "green-up" their image, in the mistaken belief that they are protecting biodiversity.

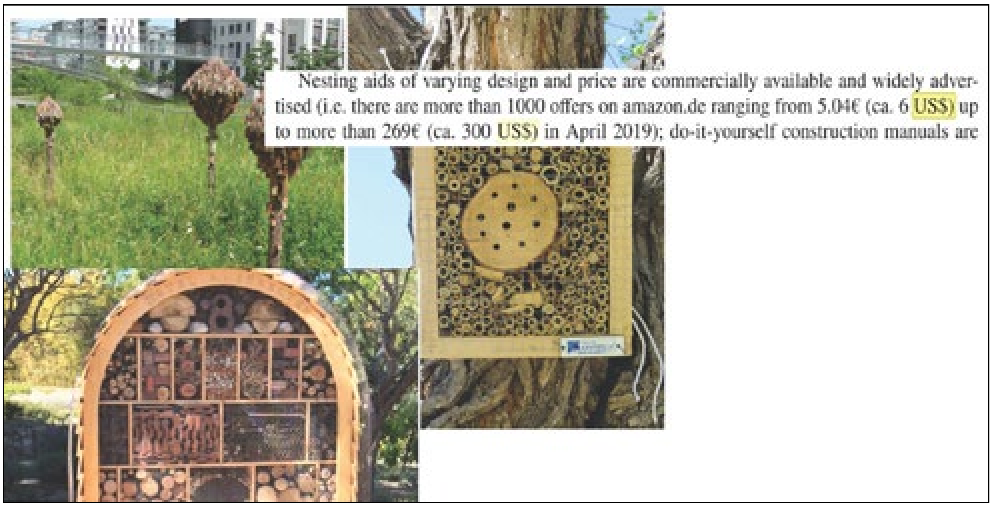
But sometimes this is purely a communications practice and when companies such as Sony, McDonald's and Galeries Lafayette install beehives, we can talk of "beewashing". The number of beehives has increased exponentially in urban areas: in 2013, Paris counted about 600 beehives, when 2000 were declared in 2017. In France, there are 2.5 beehives per square kilometre, but in Paris, this figure is estimated to be 10 times higher, while the city is also home to a diverse fauna with over 145 species of wild bees detected.

Consequences of the proximity of hives on wild pollinators

The excessive presence of hives can be a vector for the transmission of parasites to wild bees, and vice versa. Similarly, a high abundance of honey bees can lead to a decrease in the activity of wild bees in the vicinity. A study carried out in the natural environment of the Calanques National Park looked at the competition between honey bees and wild bees. The researchers studied these interactions in 17 locations. They observed that in the vicinity of honey bee hives, there is a decline in the activity of wild bees and a change in their feeding behaviour towards less profitable resources. This change in diet may, for example, have an effect on the reproduction of solitary bees.



Another practice that can sometimes negatively affect biodiversity is the installation of insect hotels. No study shows that they are beneficial to wild bee populations and the rare studies on the topic conclude that more than 50% of the individuals that benefit from these hotels are exotic insects (Canada). In Marseille, out of 96 insect hotels in 12 parks, only 5 species of bees were detected and 46% of the abundance was made up of exotic species. However, these hotels participate to raise awareness on the need to protect biodiversity.



The sale of wild bee cocoons online is another damaging practice. Benoît Geslin has listed 42 sites selling osmies of 8 different species, some of which are not present in France. It is likely that at least one of them will end up being detected outside its species range due to this trade, with significant consequences for native ecosystems.

Biodiversity is the diversity of life forms, its heterogeneity. Groix is an ecosystem that allows for the implementation of real protection of biodiversity, with the presence of a line of pure black bees and beekeeping practices that have been respectful of the environment for over 30 years. The island is an open-air laboratory and a remarkable example of the protection of wild bees and the environment.

"Bees are often seen as a flagship of biodiversity. Like a canary in a coal mine, they tell us when there is a big problem with biodiversity. However, putting honey bees everywhere to protect biodiversity is as relevant as putting chickens everywhere to protect birds..."

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2. CREATING THE RIGHT CONDITIONS TO CONSERVE POLLINATORS

By Lynn Dicks, Cambridge University (UK)

POWERPOINT

Dr Lynn Dicks *is an Associate Professor in Animal Ecology at the Department of Zoology, at the University of Cambridge. She is a Fellow of Selwyn college and leads the Agroecology Research Group in the Department of Zoology. She is the Lead Author of the IPBES Thematic assessment of pollinators, pollination and food production and has authored over 80 scientific publications on insect conservation, agricultural biodiversity and evidence-based conservation in agricultural landscapes.*

Numbers of wild pollinators, including butterflies, moths and bees, are declining in many parts of the world. This decline is largely caused by the way humans manage land. Lynn Dicks promotes possible solutions to halt the decline of pollinators to farmers, the general public and governments.

Although, it is difficult for scientists to quantify the rate of pollinator decline, it is largely caused by the way that land is managed : intensive agriculture, loss of habitats and flower resources, and simplification of landscapes, are the main causes, with pesticides close behind and climate change set to become increasingly important.

The world has this very rich diversity of pollinators that includes bees, butterflies, flies, hoverflies, beetles and wasps. Those insects visit flowers and crops and carry out pollination service. An analysis from the UK, where they have pretty good data on the long term records of wild bees and hoverflies, shows that since 1980, every square kilometre in the country has lost eleven species on average; that's four species of bees and seven species of hoverflies, just no longer there. Moths and butterflies are also declining in numbers, at a rate of about 1% a year. These rates of loss are relatively small, but they are steady and ongoing, adding up over time to something calamitous.

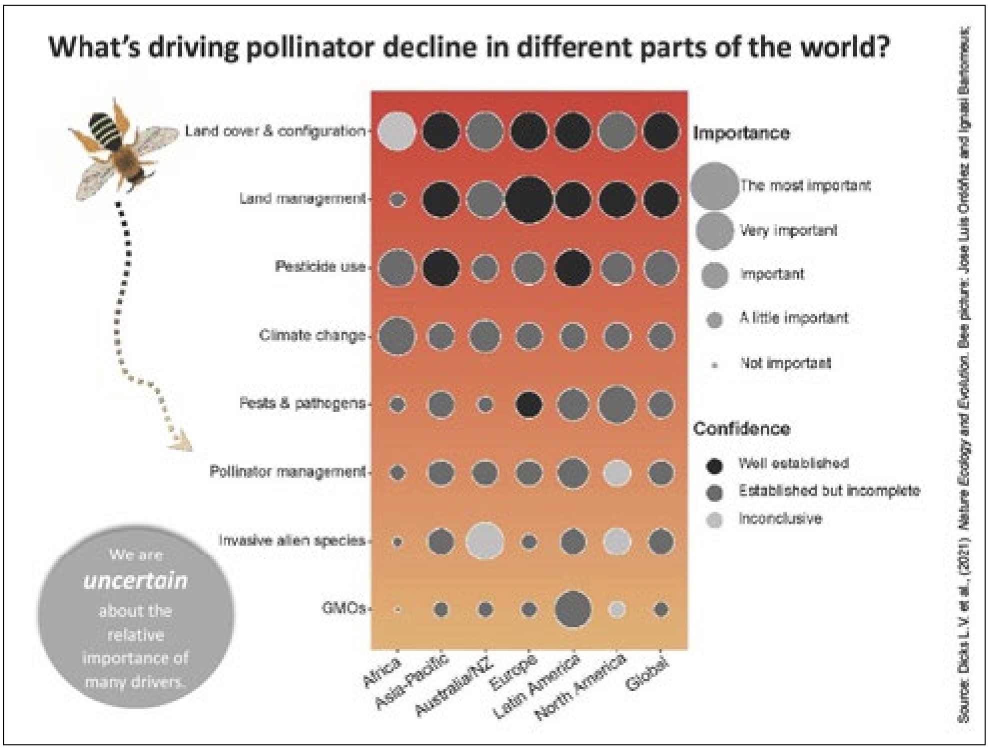
"Insects don't like the way we've tidied up the world. Let's keep it messy for them!"

Resources, flowers and habitats

In 2010, Profesor Dicks spent a year and a half reading and summarising the scientific literature to understand what science says about bee conservation via 59 different actions identified out of 100 studies.

Among the solutions, actions that provide flower-rich habitats, like flowering meadows and hedges, were the most effective. They increase the number of flowers, which leads to an increase in the number of bees. There are also a range of actions to reduce pesticide use: organic farms are bee-friendly, for example. The efficacy of specific initiatives, however, can be challenging to maintain. Scientists must keep working to understand better how to protect pollinators.

It is common knowledge that bees rely entirely on flowers for their food (nectar and pollen) so it makes sense that they need flowers in the landscape. But intensive agriculture is destroying most of these flowers.



Pollinator strategy

So far, 30 countries have developed pollinator strategies. There is one in England: the National Pollinator Strategy, and Dr Dicks is advising the UK Government on its implementation. The Strategy focuses on providing flower-rich habitats, research, monitoring and public engagement ("the bees' needs" in the UK), but has never included better regulation for wild pollinators. To improve protection of pollinators, civil society also needs to be part of the discussions.

In agriculture, there is a need to focus policies and educate policy makers on wild pollinator issues. In the UK, Professor Dicks and her team have advised the government on how to encourage farmers to plant more flowers.

There are several key questions: how much pollinator habitat is needed? How many hectares are needed to support bees? It is extremely difficult to answer, as the answer depends on many variables: what exactly do bees eat; how many bees are there in the landscape; and how many bees do you want, and which species?

Increasing the number of some bees, particularly managed honey bees, too much could end up having a negative impact on other populations, as the ecology of the wild bees population is extremely complex. This is one of the problems with policy: it requires us to give simple numbers and ignores the nuance and complexity in science.

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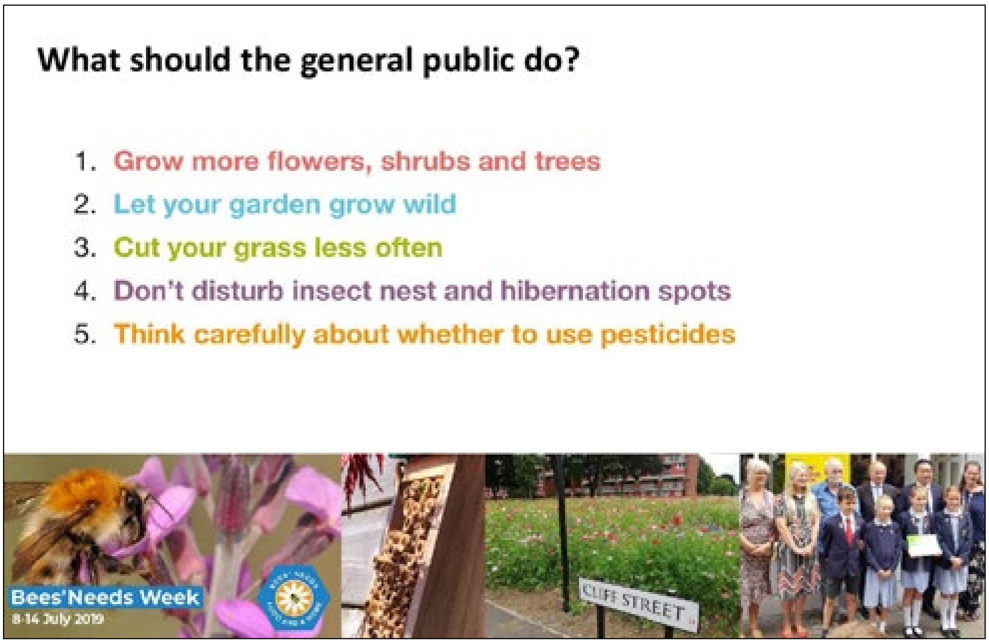
How can we stop this decline?

To protect pollinators, there are some simple rules to follow. Everyone can take action at a local level, by following certain rules to protect bees and hoverflies:

- don't use pesticides; and
- allow more flowers to grow.



Bees have been around for a long time, they have developed various ways to survive in a diversity of habitats. Some pollinators have quite different habitat and flower requirements. Some hoverflies live in wet ditches and mud when they are larvae. Others are predatory and eat aphids. Pollinators prefer messy environments, with a mosaic of spaces that do not follow the standards of cleanliness.

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3. THE COMPETING PRESSURES FOR PROTECTING NATURAL ENVIRONMENTS

By Lucas Alejandro,
Universidad Nacional de Rio Negro (AR)

POWERPOINT

Dr Lucas Alejandro Garibaldi *is a renowned scientist whose research is aimed at promoting biodiversity, healthy food production, and physical, mental, and social well-being. His focus is on agroecology, pollination, and nature's contributions to people. He is the co-chair of IPBES, and coordinates large working groups, including IRNAD (Instituto de Investigaciones en Recursos Naturales, Agroecología y Desarrollo Rural), PITES - Agroecology in Argentina, and beekeepers' associations, including APIMONDIA.*

Natural habitats for native species should not only be restored in preserved areas, but within working landscapes that account for two thirds of existing landscapes. Dr Garibaldi gives insights on how it can be done by international law, and in the field.

Restoration policies usually focus on natural and semi-natural habitats, "native" habitats composed of native species of plants or insects, in natural reserves, in order to preserve natural heritage. But science shows that we also need to protect these habitats in working landscapes.

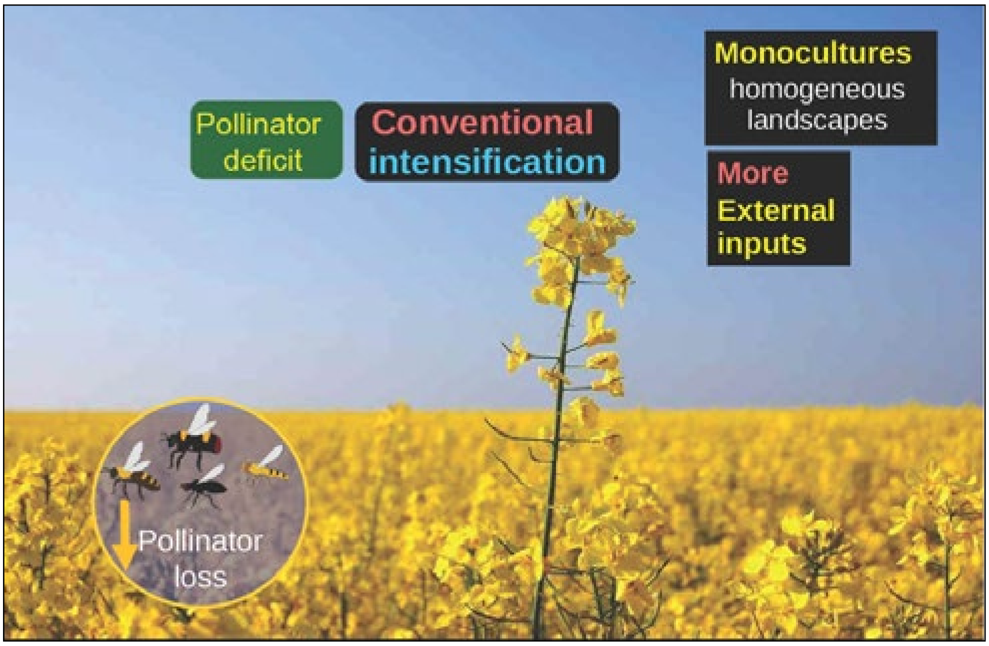
In the last decade, the idea that natural habitats are necessary in this type of landscape has been reinforced. Studies have shown that natural habitats have a role in productive systems, making biodiversity protection a concern for agronomists and farmers too.

Protecting native habitats in working landscapes is important for many reasons. They are listed in the 18 categories of nature's contribution to people, among which are reducing water and soil contamination and erosion, increasing crop pollination, etc.

"Our planet doesn't come in squares. Squared fields are unnatural. We are trying to change the way we organise fields."

Protecting natural habitats by law

The most important international agreement on the issue of natural habitats is the Convention on Biological Diversity (CBD), which formulates targets for each country to protect 17% of its surface. Most countries have complied, although some less (for example, Argentina has only protected 4-5% of its territory so far). Ongoing negotiations foresee an increase of up to 30%, but there are no discussions on what should be done with the remaining 70% of the territory. Today, the scientific consensus on the need to protect biodiversity within agricultural landscapes has not reached the political level.



At the national level, the law is also deficient. Last year, Dr Garibaldi and colleagues did a review of 82 countries' legislation covering 73% of all working landscapes in the world. They found that only 38% of these countries have legislations to protect native habitats within working landscapes, mostly focused on forests, leaving large parts of grasslands and wetlands unprotected. There was significant heterogeneity in the protected countries, most of which are in Europe. The study has been integrated into the technical unit of CBD, and should be considered on its agenda.

How much native habitat do we need?

Scientists reviewed scientific literature regarding 18 descriptions of nature's contributions to people, such as pest control, pollination, and climate control to seek a consensual percentage of preserved native habitat that can improve these NCPs, without reaching an agreement on a common value.

However, based on this evidence through mathematical modelling, we concluded that we need to restore a minimum of 20% of native habitats, considering the study of costs and benefits for farmers. This threshold is not reached today in any country in the world, with the exception of Brazil.

On the final day of the conference, Lynn Dicks, Associate Professor at Cambridge, spoke in favour of the development of flowering meadows and hedgerows as particularly effective solutions for pollinator conservation. © Ph. Besnard/POLLINIS

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4. THE HONEY BEES OF PANTELLERIA ISLAND: MAPPING, IDENTIFYING AND PROTECTING

By Paolo Fontana and Valeria Malagnini,
Edmund Mach Foundation - Technology Transfer Centre (IT)

POWERPOINT

Valeria Malagnini*'s principal fields of research are applied entomology, molecular biology, apidology, beekeeping and melissopalynology. She is part of the Italian honey tasters, International Honey Commission and Api & Benessere group. She has been teaching beekeeping courses and has an intense dissemination activity in the field of beekeeping. She is also a beekeeper and collaborates in her husband's beekeeping farm, mainly in the management of colonies to produce honey and pollen.*

Paolo Fontana *worked as an entomologist at the University of Padua up to 2009 before joining the Edmund Mach Foundation (San Michele all'Adige, Trento, Italy) as an apidologist. He is the author or co-author of several monographs like Il Piacere delle api (2017 and 2021) and The Joy of Bees (2019). Paolo Fontana is a member of the Accademia Roveretana degli Agiati and of the Accademia Olimpica of Vicenza and is the president of World Biodiversity Association Onlus. He has also been a beekeeper for over 30 years.*

Thanks to their work on free living honey bee colonies on the island of Pantelleria and throughout Italy with citizen participation, scientists Paolo Fontana and Valeria Malagnini helped draft a law, to be discussed by the Italian Parliament in order to protect all bees in Italy.

The study of bees on the island of Pantelleria, conducted in cooperation with the apidologists of the Edmund Mach Foundation and the University of Palermo, started only a year ago, and the results are preliminary, contrary to Groix, where the knowledge on local bees started decades ago.

The Island of Pantelleria is located between Italy and Tunisia. It has a warm climate mitigated by wind. Rainfall is limited, and mainly in winter. There are two periods of flowering that allow beekeeping practices: the beginning of spring, and the end of autumn. It can be observed there that managed honey bees coexist with free living colonies, as they do in Groix.

"Groix and Pantelleria are good evidence of the importance of conservation practices, but small-scale protection will not lead us very far: we need to push for protection of the territory in its entirety, with national and European laws." Paolo Fontana

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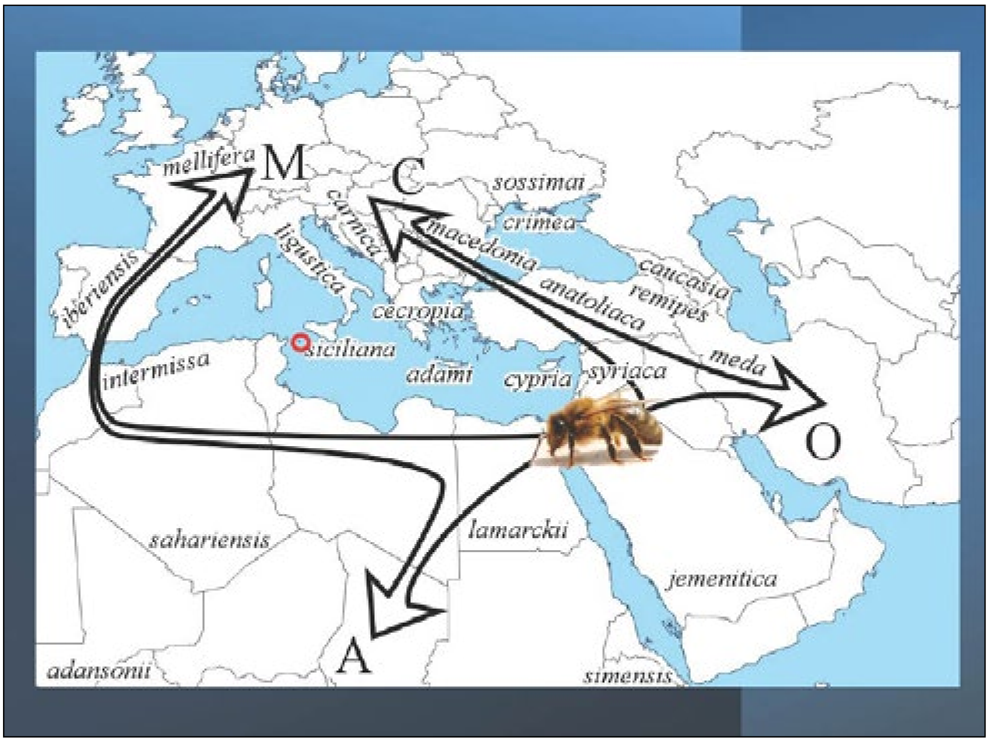
A unique geotypical position between two lineages of *Apis mellifera*

But Pantelleria is also situated in the middle of two evolutionary lineages of *Apis mellifera*: lineage A of African bees, and lineage C that originated the Italian honey bee *Apis mellifera ligustica*. This is due to the particular position of the island between the European and African continents.

Pantelleria's honey bees are probably partly *Apis mellifera ligustica*, as beekeepers bought them for honey production. For similar reasons of geographical proximity, *Apis mellifera siciliana*, that is particular to the island of Sicily, is also present in the island. But no one knows the history of the honey bees of Pantelleria and where and when these imports came from.



Identifying the honey bees of Pantelleria

In order to understand what kind of subspecies are present on the island, not only in beekeepers' hives but also in free living colonies, the scientists mapped wild colonies, using the BeeWild application for smartphones, and also mapped beekeepers' colonies.

They collected samples, and ran morphological and molecular analyses. The study of wing characteristics revealed that many honey bees are similar to *Apis mellifera siciliana* and some to *Apis mellifera ligustica*.

The scientists then analysed mitochondrial DNA to assess the lineage and haplotype of the bees and found that:

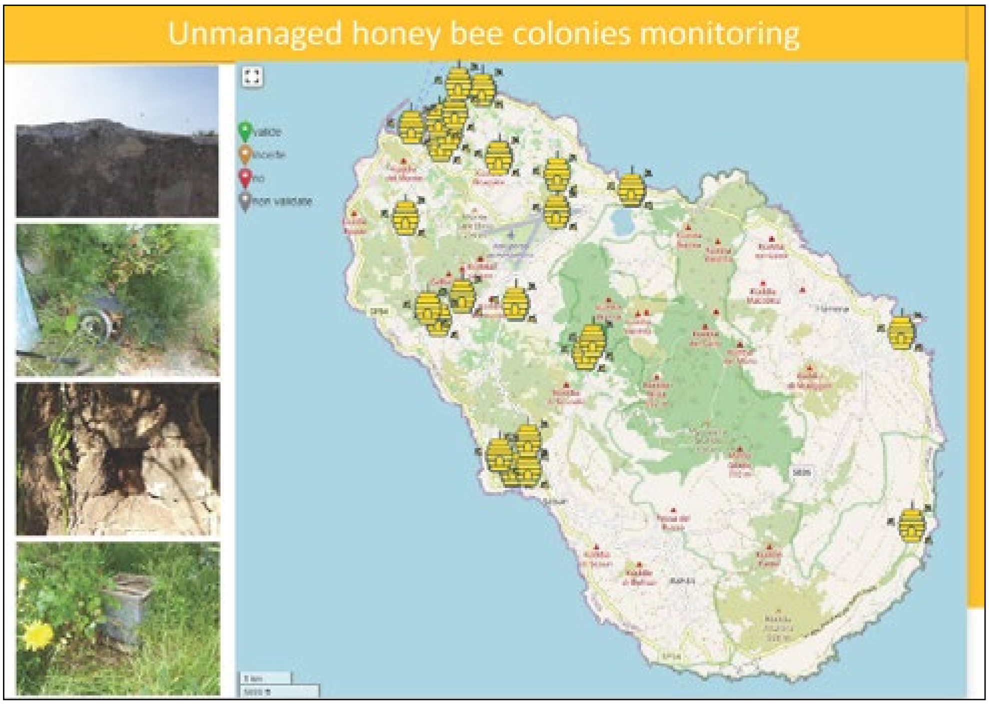
- 5 haplotypes belonged to lineage C, 3 of which to *Apis mellifera siciliana*;
- among managed bees, 50% belonged to lineage C, and 50% belonged to lineage A; and
- among the free living colonies, scientists only found lineage A. This tends to suggest that the African lineage of honey bees seems to be more adapted to the climate of the island, surviving without beekeeper management.

“Managed bees are the alibi for the use of pesticides. If there were no managed bees, it wouldn’t be possible to use pesticides.”
Valeria Malagnini

Getting to know the wild colonies in Italy

In 2015, a contact with natural beekeeping made the scientists recognise that *Apis mellifera* is indeed a wild animal. There was no difference in behaviour and characteristics, despite beekeepers’ selection, between wild and managed populations. In 2018, 30 of the most relevant scientists collectively wrote and signed the *San Michele all’Adige* declaration, presented to beekeepers, politicians and citizens, statuating that honey bees are a part of the environment, and that their conservation is of great importance.

The scientists then started to collect data from all parts of Italy, and they reported that free living colonies had not disappeared from the country. Through the BeeWild application, they received information on how they nest, in what types of cavities, and their spatial distribution.The collection of data revealed that places with a greater concentration of wild colonies are apparently also the ones where the genetic composition of bees was most preserved.



Towards a legal protection for all bees

In May 2022, the apidologists of the Edmund Mach Foundation and the University of Palermo, in cooperation with the Pantelleria Island National Park, organised an international meeting on wild honey bee colonies on the island of Pantelleria. Participants in the conference worked on a short document for the protection of wild colonies of *Apis mellifera*.

For a year, a team, coordinated by Paolo Fontana and Valeria Malagnini, worked to set up a law for protection of all *apoidea anthophila*. This includes the protection of all species of bees, in a broad framework under the control of the Italian Ministry of the Environment.

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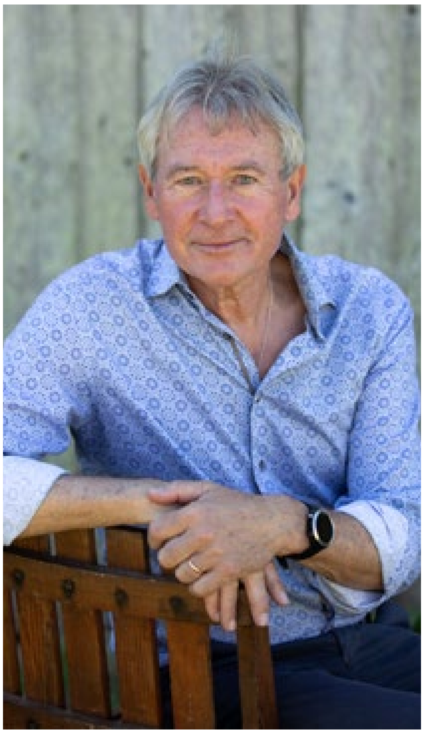
In Italy, there are at least four subspecies of *Apis mellifera*: *Apis mellifera mellifera, A. mellifera carnica, A. mellifera ligustica, and A. mellifera siciliana*, with mixtures of species at the country's borders. These existing different sub-species are difficult to protect if we apply a "species" approach. Understanding this, the scientists tried to apply this protection throughout the country and not only in specifically defined areas, in order to prohibit the introduction of non native species and subspecies.



5. CONSERVATOIRE DU LITTORAL (THE FRENCH COASTAL PROTECTION AGENCY): PROTECTING THE ECOSYSTEMS OF FRENCH ISLANDS

By Didier Olivry, Conservatoire du Littoral (FR)

POWERPOINT

Didier Olivry *is the Shoreline Delegate of the Conservatoire du Littoral (the French Coastal Protection Agency) for the Brittany region. A doctorate in environmental engineer by training, he heads the delegation in charge of the protection of more than 12,000 hectares of the Breton coastline, made up of natural areas, but also human-made heritage (e.g. lighthouses, forts, semaphores, coastal houses, etc.). Monitoring, managing, developing and implementing actions to maintain and develop biodiversity and the quality of the landscape, and also to facilitate public access are his main responsibilities.*

Didier Olivry presents the action of the Conservatoire du Littoral in France, and in particular on the islands and coasts of Brittany, where it protects habitats that are essential to the conservation of wild pollinators and bees, including the island of Groix.

The Conservatoire du Littoral operates throughout France, with 6,000 km of coastline in mailland and 12,000 km in the French overseas territories.

It protects the coastline, purchasing properties in order to prevent any possible development or urbanisation and to maintain the quality of the landscape and biodiversity. The Conservatoire du Littoral also combats the loss of activity that leads to the abandonment of certain coastal areas pending hypothetical urbanisation. Opening those areas to the public is a French tradition. It makes it possible to grant free access to the coast for all populations. It also plays a role in the prevention of climate change as it is necessary to adapt coastal management against submersion and marine erosion.

The Conservatoire du Littoral intervenes to buy and protect these coastal areas forever: they are inalienable and imprescriptible. This is a strong and permanent protection.

"On a national scale, Groix is a good illustration of what the Conservatoire du Littoral can do to protect bees and wild pollinators."

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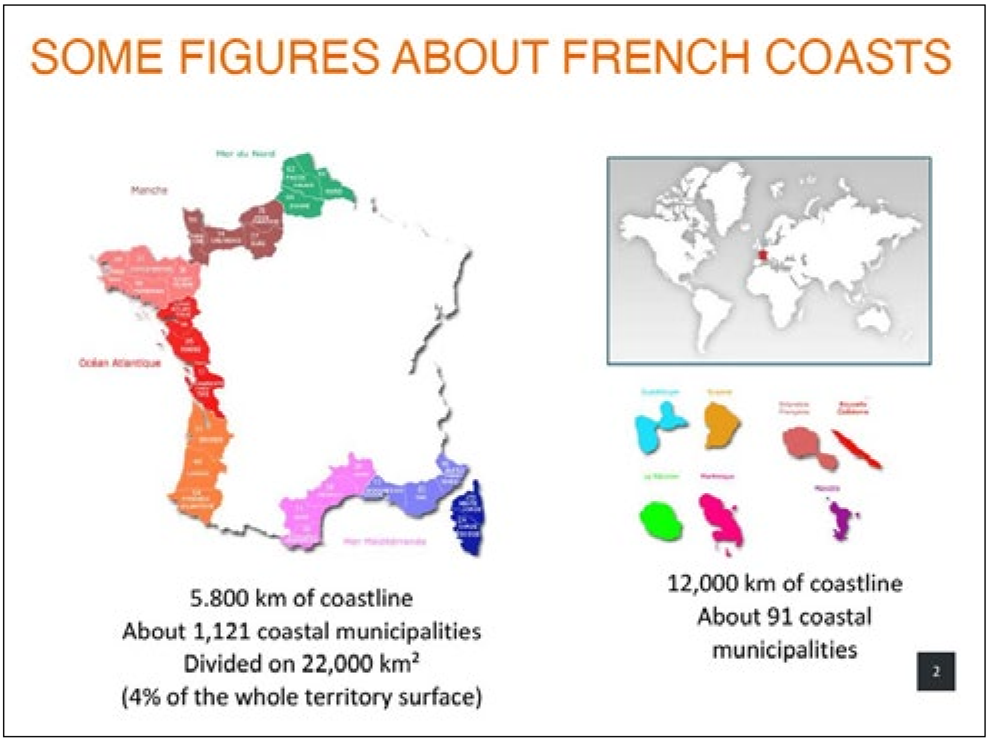

Protection and management of the coastline

As the owner, the Conservatoire du Littoral, decides on protection measures, and entrusts 400 partner communities and organisations to manage the land. In Groix, management is carried out by the commune of Groix and by the association Bretagne-Vivante. As the owner, the Conservatoire guides the implementation of a management plan in order to define the directions for the protection of biodiversity and the quality of the landscape.

15% of the French coastline is protected by the Conservatoire du Littoral in mainland France and overseas. The objective is to reach 30%, at the rate of more than one property purchase a day on average, with 400 acts per year, including 120 in Brittany. A total of 220,000 hectares are already protected, with the aim of reaching 350,000 hectares by 2050.

Protection of pollinators in the areas of the Conservatoire du Littoral

The Conservatoire du Littoral is home to a large number of nationally protected animals and plant species, some of which are found only in these areas. Based on the work of INRAE, guidelines for the protection of pollinators have been defined. On the 220,000 hectares of the Conservatoire, 1,200 colonies of "domestic" pollinators are present and managed by beekeepers in the traditional way. Beekeepers are not allowed on the 150 islands and islets protected by the Conservatoire du littoral in Brittany. The food resources are not considered sufficient to allow hives and wild pollinators to cohabit. Free evolution is implemented, i.e. the development of greater naturalness that favours pollinators and plant diversity. This is a national decision, and applies to all lands.

Conversion of land to natural habitats to promote biodiversity?

To restore the quality of the habitats, allochthonous habitats (houses, woodland, exotic species, etc.) will be controlled in order to support natural ones that are more conducive to biodiversity. In its conventions signed with partners, the conservatory prohibits pesticides and inputs and farmers have to set up

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hedges, embankments and flowering grass strips. For the human built heritage, keeping crevices in the walls or ivy is suggested to house and feed pollinators. Some buildings are even dedicated to promoting biodiversity by accommodating bats, birds or bees.

The uniqueness of the island of Groix

On Groix, the Conservatoire du Littoral owns more than 300 hectares of the wild coastline, from the Pointe Pen-men to the Pointe des chats. As part of the project to extend the National Nature Reserve, the objective is to integrate all its properties into the future reserve. To favour wild pollinators and black bees, the former semaphore will be dedicated to the ASAN.GX association, and educational apiaries will be set up in collaboration with the association.

6. PROTECTING WILD POLLINATORS: A POLITICAL JOURNEY

By Nicolas Laarman, POLLINIS (FR)

Nicolas Laarman *is co-founder and Director general of POLLINIS, an NGO which acts at French and European levels to stop the extinction of bees and wild pollinators.*

In his closing speech at the scientific conference, Nicolas Laarman promoted four essential measures for the conservation and protection of honey bees and wild pollinators: restoring landscapes, reducing the use of pesticides, protecting pollinators against parasites and imported diseases and improving scientific knowledge about pollinators.

Invertebrates are the heart of our ecosystems and their precipitous decline represents a crisis for our environment. The decline of bees, hoverflies and butterflies is among the most serious declines in modern biodiversity documented to date. The speakers have already made us aware of all these issues. I would like to return to four essential measures to protect bees and pollinators:

1. Restore wildflower-rich landscapes. More than 80% of semi-natural grasslands have disappeared in European territories. We need to increase their number and put in place a sustainable management of flower-rich meadows. Hedgerows and scrubland provide favourable habitats for pollinators. Creating and restoring sustainable habitats help to optimise the conservation of native wild plants and their pollinators.

2. Reduce damage to pollinators from pesticides and other inputs. Insecticides, fungicides and synergistic effects have disastrous impacts on biodiversity. More than 400 active substances are authorised in the countries of the European Union. More than 100 substances have been banned because of their harmful effects on human health. The evaluation procedures do not properly evaluate these products. A re-evaluation is necessary to know their cocktail effects on the environment. We must remove all pesticides from the market within 10 years, we have no choice but to change the way we produce our food, for all of us today and for future generations. We can reduce our production by over 20% worldwide.

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3. Protect wild pollinators from imported pests and diseases. Imported pollinators can spread diseases (American wild bumble bees and honey bees) and while their importers claim that their stock is disease free, this is not true. Establishing local production and stricter regulations would reduce the risk.

4. Improve knowledge of pollinators. Existing resources are difficult to use or unavailable, and we have data deficiencies on many wild pollinators, including the IUCN Red Lists. We need to set up a pollinator monitoring programme that provides solid information to protect bees, flies, wasps and beetles, including their abundance, diversity and their relationships with plants, flowers and trees. We need to support and develop expertise in insect taxonomy.

But how do we achieve all this? By defending the general interest, raising public awareness and putting pressure on politicians. In Groix, we must do the same, by restoring landscapes that are abundant in wild flora, reducing damage from pesticides and protecting pollinators from parasites and imported diseases.

"The island's black bees are endangered by the introduction of bees of other subspecies. We must protect this population from introgression and continue to improve our scientific knowledge. These are the reasons to support the legal protection of the Island of Groix."

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ABOUT THIS PUBLICATION

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POLLINIS
STOP POLLINATOR EXTINCTION