Insect Pollinators Initiative Projects

Sustainable pollination services for UK crops

Led by Dr Koos Biesmeijer, University of Leeds

Insects are pollinators of 80% of all plant species in Europe, including most fruits, many vegetables and some biofuel crops. Their pollination service is worth up to £440 million each year in the UK. Clearly, the current declines in both wild pollinators and managed honeybees potentially affects UK agricultural production. This project will determine which wild and managed pollinators contribute to pollination of insect-dependent crops and whether at present the lack of wild pollinators limits agricultural production in UK landscapes. In addition, the researchers will analyze how the supply of managed honeybee hives for crop pollination can be improved. Next, the researchers will investigate whether climate change will affect UK crop pollination in the future. The results will pave the way towards sustainable crop pollination by providing knowledge that can be applied to decisions about crop, landscape and pollinator management practices in the UK. From the start of the project the team will collaborate with major stakeholders (farmers, beekeepers, land managers, conservation agencies) to guarantee that this research produces information required by the UK agricultural community.

This project is in partnership with Dr Mette Termansen and Dr Andy Challinor at the University of Leeds, Dr Giles Budge at the Food and Environment Research Agency National Bee Unit and Dr Simon Potts at the University of Reading.

Modelling systems for managing bee disease: the epidemiology of European foulbrood

Led by Dr Giles Budge, The Food and Environment Research Agency

Honeybees are an important managed pollinator, able to provide mobile pollination services to aid crop production. Honeybee populations are threatened by a range of established and emerging diseases. With new and increasing stresses on bees, it is important to examine ways of preventing and tackling these diseases. In the UK we have 20 years worth of data about where and when some diseases have been found. This project will use data on one of these diseases, European foulbrood (EFB), as an example to model how this and other diseases are moving in the UK landscape. It will also generate new data about how the pathogen behaves within the colony and study how the genetics of the bee, the behaviour of the beekeeper, and changing meteorological conditions determine the spread of disease. The project aims to create the first model of its kind that can be applied at different scales (colony, apiary, region etc.) and to different bee diseases.

Ultimately, this project aims to develop a system that can make predictions about the epidemiology of a range of bee diseases, and lead to the development of effective means of controlling disease occurrence. In the shorter term it seeks to deliver improvements in how we inspect and monitor for EFB, and how we may decrease the impact of EFB and related diseases on our honeybee population.

This project is in partnership with Dr Ed Feil at the University of Bath, Professor Stephen Rushton at Newcastle University and Professor Matt Keeling at the University of Warwick.

Investigating the impact of habitat structure on queen and worker bumblebees in the field
Led by Dr Claire Carvell, NERC Centre for Ecology and Hydrology

For the first time researchers are going to use a new high-tech approach to unravel fundamental aspects of the ecology of bumblebees and so help us understand why these essential pollinators are declining. Bumblebees are wild bees that live in colonies of at most a few hundred workers and a single queen. We know they need safe nesting sites and lots of flowers. But we don't know how the distribution of nesting and foraging habitats across a landscape, or habitat structure, affects in detail how nest-searching queens or foraging workers use these habitats. The researchers will analyse DNA from live wild bees to estimate how far queens fly to start new nests and how far workers fly to forage. All of this information will be fed into a computer and mapped out using details of the landscape collected during fieldwork alongside aerial scans of the area. The study will focus on five different species including the rare *Bombus ruderatus*, a UK Biodiversity Action Plan species. Because the English study landscape contains wildflower strips sown alongside fields especially to attract pollinators, the research will help farmers and conservationists decide how such schemes can be made as effective as possible.

This project is in partnership with Professor Andrew Bourke at the University of East Anglia and Dr Bill Jordan at the Institute of Zoology, Zoological Society of London.

An investigation into the synergistic impact of sublethal exposure to industrial chemicals on the learning capacity and performance of bees
Led by Dr Chris Connolly, University of Dundee

We rely on a varied cocktail of pesticides to protect crops from pest damage. Pesticides are also used to protect bees from mite infestation. Exposure to such chemicals could be harming beneficial pollinators and chronic exposure may be particularly important in the context of other challenges faced by these insects.

Many insecticides work by interfering with information flow in the brains of insects - either increasing or decreasing their brain activity. This group of researchers will be asking whether chronic exposure to chemicals used to control mites, combined with levels of agricultural pesticides that are not lethal but could be damaging, are affecting foraging, navigation and communication in bees.

Honeybees and bumblebees will be monitored and the researchers will investigate their ability to learn. To do this they will assess their performance using radio tagging of individual bees and assessment of specific learning tasks. In partnership with the Scottish Beekeepers Association they will carry out a three year survey of the impact of environmental chemicals on colony performance. The team will study the brain cells of bees in the laboratory to monitor the effects of pesticides (both single pesticides and also multiple combinations). They will be seeking to understand the molecular basis of learning and memory in bees and how this is affected by pesticide exposure. The researchers will also attempt to produce the first ever honeybee cell line to facilitate future pesticide screening.

This project is in partnership with Dr Jenni Harvey, the University of Dundee, Dr Nigel Raine at Royal Holloway, University of London, Dr Geraldine Wright at Newcastle University and Professor Neil Millar at UCL.

Linking agriculture and land use change to pollinator populations
Led by Professor Bill Kunin, University of Leeds

There is growing evidence that both domestic honeybees and wild pollinators are in trouble, and that many wildflowers that depend on them for pollination are also declining. What we do not yet know is how these trends are linked: whether pollinator declines are driving flower losses or vice versa. This project tests whether we can predict how common and diverse pollinators will be in a region from the local abundance and diversity of flowers, and similarly whether plant reproduction is affected by the pollinators available. The researchers will also test whether other factors such as pesticide usage and land use history have an impact on pollinators, and whether honeybees and wild pollinators affect one anothers' populations.

One part of the project will focus on re-surveying pollinators in sites where they have been studied in the past, to test whether they have been affected by changes in land use. The researchers will also survey both plants and pollinators in nearly 100 landscapes scattered around Britain, carefully chosen to represent contrasting land management. By examining how well plants and pollinators perform in these sites, we should greatly improve our understanding of how management affects them, how they affect one another, and what we can do to slow or reverse their recent declines.

This project is in partnership with Professor Jane Memmott at the University of Bristol, Dr Nigel Boatman at the Food and Environment Research Agency, Dr Richard Morton at the NERC Centre for Ecology and Hydrology and Dr Simon Potts at the University of Reading.

Urban pollinators: ecology and conservation
Led by Professor Jane Memmott, University of Bristol

Urban environments are growing across the UK, and perhaps surprisingly, flower rich oases in otherwise uninviting city habitats can support large numbers of pollinators. For example, 35% of British hoverfly species were found in a single Leicester garden and honeybees produce more honey in urban Birmingham than in the surrounding countryside. Pollinators supply a crucial ecological service, and finding ways to improve their lot is a major challenge.

This project will answer three questions: where exactly is the pollinator biodiversity in the UK – urban habitats, farmland or nature reserves, where are the hot-spots of pollinator biodiversity in cities and what can we do to improve their diversity and abundance? To answer the first two questions the researchers will look at whole communities of bees, flies, butterflies and beetles that visit flowers, constructing food webs that describe the patterns of flower-insect interactions. To answer the third question they will add flower mixtures high in nectar and pollen to selected city habitats in Bristol, Edinburgh, Leeds and Reading and test whether this increases pollinator species richness and abundance.

The research will provide the data that conservation practitioners working in urban habitats need to conserve pollinators. Seven practitioners are collaborators on the project and the research team will convey their results to the rest of the UK practitioner community via a fully funded practitioners' conference at the end of the project.

This project is in partnership with Dr Graham Stone at the University of Edinburgh, Dr Koos Biesmeijer and Professor Bill Kunin at the University of Leeds and

Dr Simon Potts at the University of Reading.

Impact and mitigation of emergent diseases on major UK insect pollinators
Led by Dr Robert Paxton, Queens University Belfast

One of the greatest challenges to bees is coping with new exotic diseases and diseases that are native to the UK but are becoming increasingly severe. The project will address this challenge head-on. Combining the expertise of five leading laboratories across the UK and the EU in a three year project, the research will focus on diseases caused by Deformed Wing Virus and a fungus-like microorganism called *Nosema ceranae*. These are amongst the most serious diseases that affect honeybees and they have recently been found to infect some bumblebees as well. Using laboratory and field experiments, including radar tracking of individual flying bees, researchers will investigate the direct impact of both diseases on affected honeybees and bumblebees, as well as any additional harm caused by a double infection – the whole effect may be greater than the sum of the two diseases. They will also look at the potential for the diseases to affect other bumblebee species. Cutting-edge mathematical modelling and a countrywide bee survey will assess the risk *Nosema ceranae* and Deformed Wing Virus pose to the UK's major pollinator species. The team will also test two new methods to control the microorganisms that cause such diseases which are based on pro-biotic bacteria and RNA interference technology. The project will provide an assessment of current and future risks to the UK's major pollinators that can inform government policy. New ways of controlling bee diseases will be of immediate benefit to the pollinator industry and hobby beekeepers in ensuring sustainable pollination in the UK.

This project is in partnership with Dr Mark Brown at Royal Holloway, University of London and Dr Juliet Osborne at Rothamsted Research.

Unravelling the impact of the mite *Varroa destructor* on the interaction between the honeybee and its viruses
Led by Dr Eugene Ryabov, University of Warwick

Introduction of the parasitic mite *Varroa* to the UK around 20 years ago had a major impact on honeybee health and beekeeping practice. Without regular control,*Varroa* levels rise significantly causing a decline in colony fitness and excessive winter losses. While feeding on honeybee 'blood' *Varroa* transmits viruses between bees. Previous studies by this team have shown that two of these viruses, Deformed Wing Virus (DWV) and *Varroa* Destructor Virus-1 (VDV-1), can combine to form a new sort of hybrid virus that current diagnostic methods cannot correctly identify. Susceptibility to *Varroa* and bee diseases is known to vary; for example, beekeepers breed in desirable traits such as hygienic behaviour that can help lower the risk of disease. However, the basis for honeybee resistance to *Varroa* and these viral diseases remains poorly understood – it is thought that it may be due to the genetics of different bees. This project will look at the natural genetic variation within the hive to study how honeybees respond to *Varroa*, to VDV-1, DWV and the new hybrid viruses. This will make it possible to show how some honeybees' own cells posess the ability to limit the severity of a viral infection. The team will identify molecular markers for resistance that will make it possible to select and breed bees with reduced susceptibility to *Varroa* and honeybee viruses. These will benefit beekeepers, farmers, and gardeners who rely upon honeybees for pollination, and could influence UK policies relating to bee health and queen importation

Can bees meet their nutritional needs in the current UK landscape?
Led by Dr Geraldine Wright, Newcastle University

Bees provide a valuable pollination service for many crop plants. In return for visiting flowers, they obtain food in the form of nectar and pollen. An important but often overlooked reason that bee populations are in decline is that these important pollinators can no longer obtain adequate nutrition as a result of changes in land management practices worldwide. This project aims to find out what are the nutritional needs of honeybees and bumblebees so that they remain fit and healthy and relate this to the way that bees forage on flowering plants. The researchers will also examine how nutrition influences susceptibility to diseases and to toxins that are sometimes found in the food consumed by bees. By measuring the nutritional value of the nectar and pollen of many UK agricultural, horticultural, and native plant species, the aim will be to identify UK plant species that are important floral food sources. The results will provide a basis for the development of nutritionally balanced, artificial food sources for bees and will allow farmers, land managers, beekeepers, and gardeners to improve foraging habitat for bee species worldwide.

This project is in partnership with Dr Phil Stevenson at the Royal Botanic Gardens, Kew.