LWEC
Living With Environmental Change

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How are pests and diseases affecting bee pollinators?

Wild and managed pollinating bees are susceptible to a range of diseases that are being shared between species.

Photo by Silvio Erler

Living With Environmental Change Policy and Practice Notes

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The Living With Environmental Change Partnership brings together 22 public sector organisations that fund, carry out and use environmental research and observations. They include the UK research councils, government departments with environmental responsibilities, devolved administrations and government agencies. The private sector is represented by a Business Advisory Board.

Bees are important insect pollinators; there are over 250 species in the United Kingdom, including solitary bees, bumblebees and the managed honeybee. Together they provide a pollinating service to crops and wild flowers. Bee numbers are affected by many environmental (eg land management, climate) and social-economic (eg global trade, beekeeping) factors. Pests and diseases can act alone or in combination with other factors to cause bee declines. Scientists are beginning to understand how pests and diseases contribute to bee losses and how they are moving between bee species.

What causes disease in bees?

Many different pests, disease-causing agents or pathogens, including viruses, bacteria, fungi, protozoa and nematodes, can affect bees. Research has focused on honeybees and, more recently, bumblebees:

— Pests and pathogens use host bees to reproduce and spread, thereby causing disease.
— Their virulence, or ability to cause disease symptoms, varies from minor changes in the health of the host bee, to killing individual bees or – for social species of bee – even entire colonies.
— Each pest or pathogen can be specific to a single bee species or shared between species. Honeybees (currently the best studied) are affected by many invertebrate pests and predators as well as viruses, bacterial and fungal pathogens, which can interact to exacerbate disease symptoms.

What are the most important diseases of honeybees and bumblebees?

Both honeybees and bumblebees are subject to many different pests and diseases but the virulence of these varies considerably:

— The *Varroa* mite (*Varroa destructor*) was first reported in the UK in 1992 and is now widespread across most of Britain. Mites transmit viruses when feeding on the blood of honeybees, profoundly altering viral epidemiology.
— The virus most commonly transmitted by *Varroa* is deformed wing virus. While winter losses of honeybee colonies are influenced by adverse weather, infection by deformed wing virus in the autumn increases overwinter mortality.
— The widespread distribution of *Varroa* has favoured the transmission of new variant strains of deformed wing virus with increased virulence. Once these strains predominate in a colony it may cause more rapid colony mortality.
— Two bacterial pathogens of honeybee larvae that cause diseases, European and American foulbrood, are very virulent and can both lead to colony losses.
— A new fungal disease of the honeybee (*Nosema ceranae*) has arrived and become widespread in the UK in the last decade, though its current impact on the honeybee is not fully understood.
— Bumblebees have a range of viral, bacterial and fungal pathogens and are attacked by numerous pests and predators including nematode worms, non-*Varroa* mites and fly larvae. The virulence of these varies considerably from mild to severe.

Are pests and diseases being shared between pollinator populations and species?

Recent research has found that some pathogens, originally described in honeybees, also infect wild bee species, though their role in regulating populations of these important pollinators is as yet unclear:

- Pests and pathogens were until recently regarded as being host-specific; however, the latest research and advances in molecular genetics show some honeybee pathogens are present in wild bee species and vice versa. How pathogens are transmitted between bee species is unknown but, because honeybees and wild bees visit the same flowers, the most likely route is via contaminated pollen or nectar.
- *Varroa* mites only feed on honeybees and so cannot carry pathogens directly from honeybees to wild bees. Yet deformed wing virus, which is transmitted by the mite, is also widespread in British wild bumblebees. The same virus strains appear in both honeybees and bumblebee species at the same sites, implying cross-species transmission.
- Experiments demonstrate that deformed wing virus from honeybees can cause deformities in British bumblebees, but the impact of the virus on the occurrence or size of wild bee populations has yet to be studied.
- Whilst bacterial foulbrood diseases only affect honeybees, recent work has demonstrated that trade in honeybees or their hive products has moved these diseases locally, regionally and internationally.
- Many pathogens (eg viruses, fungi) are capable of infecting different pollinator species, including honeybees, bumblebees, mason bees (*Osmia*), ground nesting or mining bees (*Andrena*), hoverflies, wasps and hornets. However, the symptoms and impact of these pathogens on populations of different pollinator species have yet to be understood.

How do pests and diseases interact with other factors?

Many different factors may affect bee pollinators' resilience to pests and diseases:

- Current UK forecasts regarding climate change indicate a shift to warmer and more unsettled conditions. Warmer conditions may allow individual bees to find more pollen and nectar and so be better able to resist pathogens and pests; however, those same conditions may favour the survival and transmission of these pathogens and pests. Conversely, more unsettled conditions may prevent foraging and increase disease pressure. The overall effect of climate change on the impact of pests and diseases on bees is therefore unclear.
- Adverse weather (cold, windy or wet) can stop many bee species from foraging, leaving them nutritionally stressed and more exposed to pathogens, like *Nosema* spp. and foulbrood-causing bacteria, which transmit from bee-to-bee within the nest.
- Changes, including farming practices and urbanisation that reduce the number of flowers available to bees, may leave them malnourished and unable to mount effective immune responses against pathogens.
- New threats are also continuing to emerge. For example, the exotic fungal pathogen of the honeybee, *Nosema ceranae*, outcompetes the native *Nosema apis* in regions of warmer southern Europe, but not in cooler northern areas, and its impact may increase with global warming.

What can be done to minimise pest and disease risks to wild and managed pollinator bees?

Policymakers should:

— Implement a more holistic approach to disease control; as many pathogens are shared amongst the insect pollinator community efforts to control disease in one pollinator could benefit the health of several pollinator species.
— Engage further with industry to understand the drivers for importation of managed bees and their hive products and work with stakeholders to minimize risks this poses to both managed and wild pollinators.
— Encourage creation of nectar- and pollen-rich habitats, both at national and local level to enhance bees' resilience to pests and diseases.
— Ensure regular review of surveillance and control efforts for bee pollinator diseases. Legislation on foulbrood disease in honeybees, for example, has worked well, but new evidence emerging about how diseases are transmitted must be taken into account in a timely manner.

Beekeepers are responsible for the health of their honeybees, and should appreciate the potential for honeybee pathogens to infect wild insects. In order to help protect both they should:

— Comply with the regulations when importing honeybee stocks.
— Practise good honeybee husbandry, including pest and disease surveillance, integrated pest management and provision of sufficient winter stores to maintain strong colonies.
— Be vigilant for declines in colony health and look for signs of new or exotic pests and pathogens.
— Manage colonies to minimize *Varroa* levels and the spread of virulent strains of deformed wing virus, thus improving colony health and reducing risks to other colonies and wild bees.
— Avoid high colony densities, which promote pest and pathogen transmission.

Further information

This policy and practice note was written by Robert Paxton, David Evans and Giles Budge. It draws on research carried out by three projects: 'Modelling systems for managing bee disease: the epidemiology of European foulbrood'; 'Unravelling the impact of the mite *Varroa destructor* on the interaction between the honeybee and its viruses'; and 'Impact and mitigation of emergent diseases on major UK insect pollinators', as part of the Insect Pollinators Initiative, which is funded by the Biotechnology and Biological Sciences Research Council, the Natural Environment Research Council, The Department for Environment, Food and Rural Affairs, The Scottish Government and the Wellcome Trust under the auspices of the LWEC Partnership.

Useful resources:

Insect Pollinators Initiative: https://wiki.ceh.ac.uk/display/ukipi/Home
BeeBase web information for beekeepers http://www.nationalbeeunit.com/
UK National Pollinator Strategy https://www.gov.uk/government/publications/national-pollinator-strategy-for-bees-and-other-pollinators-in-england
Impact and mitigation of emergent diseases on major UK insect pollinators www.beediseases.org.uk
Unravelling the impact of the mite *Varroa destructor* on the interaction between the honeybee and its viruses www.evanslab.org.uk/bees
LWEC PPN 9 What is causing the decline in pollinating insects? http://www.lwec.org.uk/sites/default/files/attachments_biblio/15742%20LWEC%20PP%20Note%2009_web.pdf
LWEC PPN 13 The benefits of managing pollinators for crop production http://www.lwec.org.uk/sites/default/files/attachments_biblio/LWEC_PPNote13_WEB.pdf
LWEC PPN 16 Protecting insect pollinators from pesticide risk (in press; will be available at http://www.lwec.org.uk/resources/policy-and-practice-notes)

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