Meeting of the Parliamentary and Scientific Committee on Tuesday 9th July

THE IMPORTANCE OF BEES

Tim Lovett
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To members of the British Beekeepers Association (BBKA), whose primary interest is the craft of beekeeping, the honey bee *(Apis mellifera)* is all important, but not to the exclusion of an interest in and understanding of the importance of wild bees and other insect pollinators.

The honey bee is but one of the more than 250 species of bee in this country. Notably, it inhabits the same environment, and experiences essentially the same environmental stresses and challenges, as wild bees, notwithstanding the fact that human intervention in the form of bee husbandry measures such as the provision of hives feeding and disease intervention aids its survival. It thus acts to some extent as a sentinel species; if honey bees are suffering from environmental challenges this may reflect problems for wild bees.

. . . same environmental stresses and challenges, as wild bees . . .

Honey bees are incredibly hard working. It is estimated that to produce a pound of honey worker bees will make around 30,000 foraging flights, each of which may last for up to half an hour. Each kilometre of flight may yield just 0.5mg honey or put another way, each 25g of honey involves the equivalent of flying around the globe. In addition to honey, bees produce wax, propolis, royal jelly and even bee venom is beginning to play a role in medicine. Some 25,000 tonnes of honey are consumed annually in the UK of which only some 20% even in a good year, may be produced locally, the balance being made up by imports.

. . . 25g of honey involves the equivalent of flying around the globe . . .

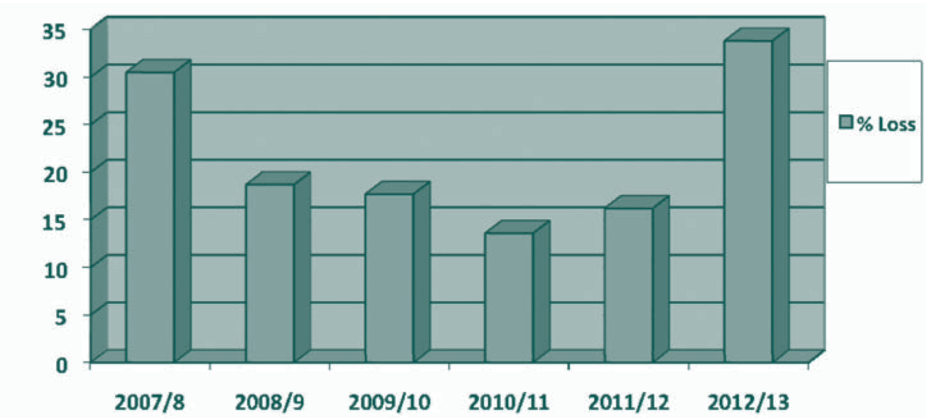
But even more important than producing these hive products, and honey in particular, is the honey bee's role in pollination. The honey bee has been shown to play a major part in pollinating food plants; up to a third of what we eat is dependent on insect and primarily, bee pollination. Work by ADAS some time ago, clearly established the importance of honey bees in enhancing productivity of key crops such as oil seed rape, field beans and especially soft fruit and top fruits (eg apples and pears), by up to 90% in some cases. The fact that honey bees over-winter in large numbers leaves them well placed to deliver pollination in the early part of the season when wild species are still re-building their numbers. They thus play a significant role in agricultural economics, contributing added value of more than £300 million/a. Their value together with other pollinators in the wild environment is unknown but is clearly substantial in the provision of fruits and seeds on which hosts of birds, mammals and invertebrates depend for survival. There is precious little financial payment for these substantial pollination services.

The honey bee faces a complex matrix of challenges which includes pest and diseases, loss of habitat and forage and in recent years, lousy weather! Amongst honey bee pests and diseases is the infamous blood-sucking, Varroa mite, against which there is a paucity of available medications and which spreads viruses in colonies being associated with debilitating disease such as Nosema fungal-type infections. These diseases acting in concert with the appalling, principally wet weather of the last couple of years and poor forage availability, have threatened honey bee numbers in no small way.

The Varroa mite – apicultural enemy number one!)

The BBKA has for years run a randomised survey of over-winter bee colony losses. As the graph here shows, we experienced reduced, though still unacceptably high levels of losses from 30% in the winter of 2007-8 returning however to a new peak of 33.8% last winter.

Over-winter colony losses



> . . . establish a National Pollinator Strategy is welcome. . .

These losses are fortunately not cumulative; if they were, we would have lost all our colonies over the last six winters. What it does mean is that our beekeepers have been working exceptionally hard to rebuild stocks, primarily by splitting colonies and building them back up to strength over the season. Splitting and rebuilding colonies means that honey production is reduced; in 2012 it was 70% down compared with the average annual output. Whether the pollination effort available was compromised is unclear but some fruit producers, which are highly dependent on insect pollinators, began to complain of inadequate pollination.

The unexplained, massive colony losses in the USA of up to 80%, reported around 2006 onwards, caused the BBKA to look at its own back-yard. Whilst the so-called Colony Collapse Disorder (CCD) did not appear to be occurring in Britain, losses were still unacceptably high. It became apparent that government was doing far too little in terms of bee health research (just £200K being spent annually by Defra) to ensure that better understanding and appropriate solutions would be found to combat colony losses. The BBKA met resistance from government to confront this issue and following a strong campaign with excellent support from the media, public and MPs, raising over 140,000 signatures on a petition presented to Number 10, some progress was made with the establishment of the Insect Pollinators Initiative (IPI), with £10 million being pumped into nine research projects and further money going into the National Bee Unit. A minority of the IPI projects are of direct benefit to honey bees but it is hoped that data gathered through the programme as a whole will benefit all pollinators, both wild and managed.

Pesticides and, in particular, the neonicotinoid class have been a focus of attention. Concerns that neonicotinoids cause sub-lethal damage to honey bee colonies have, following extensive lobbying by NGOs, brought political pressure to bear on the EU Commission, which has imposed restrictions on their use for two years starting 2014. The data are inconclusive and considered by many bee scientists as inadequate, yet a ban has been imposed. The principal lacuna in the data is lack of incriminating field rather than laboratory studies. The ban will make gathering this data extremely difficult in future. The BBKA is greatly concerned that older, more damaging pesticides will come back into use to plug the gap left by the neonicotinoids. It demands a comprehensive impact and risk assessment from government of the inevitable changes in agricultural practices which are likely to ensue. It is worth noting that the BBKA's winter loss data-set actually showed a reduction in colony losses over the six year period, (if one ignores the remarkable 2012-13 figures, which are widely attributed to the poor weather, as noted earlier) whilst neonicotinoid use grew strongly. The jury is still out on this potentially damaging factor's true role.

There can be no doubt that there are real problems facing our pollinators. As noted earlier, managed and wild pollinators meet the same or similar environmental challenges. For wild bees it is hard to improve their lot other than to improve habitat and minimise possible damage from stressors such as pesticides. In the case of the honey bee there is at least some comfort that man can intervene in the short term, indeed must do so, to ensure their survival. Steps can be taken to rebuild honey bee colonies, to provide feed in times of shortage and to combat disease. They will also benefit from improvements in habitat and forage availability in the longer run.

Whilst as a result of the BBKA's campaigning more money has gone into bee research it is still frankly inadequate. The research under way through the IPI is pure science, whilst many of the answers and solutions beekeepers need will mainly come from applied research, currently hard to fund. More money must be made available to support this work. The launch of the process to establish a National Pollinator Strategy is welcome and it is to be hoped that actions in terms of land use, habitat improvement, use of pesticides, all on a landscape scale, will be undertaken. There must be greater interaction between government, regulators, farmers and beekeepers. More research funds must be committed and beekeeper training supported to help optimise interventions and avoid decline of bee populations, wild or managed. It is only by positive action that the issues will be confronted and solutions found and implemented to ensure that not only will there be 'honey still for tea' but that all the other yet more important benefits of wild and managed pollinator activity can be ensured and its dependent food production secured.

THE IMPORTANCE OF WILD BEES

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Bees have been much in the public mind recently. In late August an email was sent to me from a member of the public. This person had found a hundred or so dead or dying bees on the side of the Cambridge guided busway. They were so worried about the bees that they contacted Mike Rands of the Cambridge Conservation Initiative. The dead bees turned out to be workers of several different bumblebee species, and have now been reported to the Wildlife Incident Investigation Scheme as a possible pesticide poisoning incident. This case illustrates how much people care about wild bees.

Why should we care about native wild bees? From a scientific perspective, they are important for two main reasons. Firstly, they are part of our biodiversity. Secondly, they pollinate crops and wildflowers, and this is an economically valuable service. Here I am only going to discuss crop pollination, but pollination of wild flowers is also valuable for aesthetic reasons.

BEES ARE PART OF BIODIVERSITY

There are 256 species of wild bee in the UK. Twenty four are social bumblebees, which form colonies and have sterile workers foraging to feed their brothers and sisters. 232 are solitary species, with no sterile workers and females that each find their own nest and care for their own young. All bees survive entirely on the nectar and pollen from flowers, both as larvae and as adults. They range from tiny black, hairless bees just a few mm long to large queen bumblebees, which can be 2 cm or more long.

The bee world is not straightforward. All around us there are unseen battles going on, mostly about who looks after whose larvae. Fully one quarter of the wild bee species (65 species) are not true bees, but cuckoo bees. They don't feed their own larvae, but lay eggs surreptitiously in the nest of another species. There are cuckoo bumblebees and cuckoo solitary bees. Most true bee species are under attack by one or more cuckoo species.

. . . estimate a value for crop pollination . . .

Beyond bees, many other insects visit flowers for food and can pollinate them. There are 256 British species of hoverfly. These eat only pollen or nectar as adults. Many other flies, wasps, beetles, butterflies and moths visit flowers occasionally for nectar, or to hunt. Unlike bees, all these other flower-visiting insects depend on sources of food other than flowers when they are larvae, including aphids, grass stems or detritus from silt at the bottom of ditches. In the flower-feeders one can find a diverse and intricate ecological system beloved by ecologists for its interesting interactions and its links with many other features of terrestrial ecosystems.

. . . declining numbers of beekeepers . . .

Within the UK, the community of flower feeders is not the same everywhere. A partnership of UK research funders[1] has funded a £9.6 million programme of research called the Insect Pollinators Initiative. One of its nine projects, led by the University of Leeds, has been measuring the flower visitor community in farmland in six regions of the UK, from Somerset to Inverness-shire. Results from the first year's sampling (2012) show a fairly strong difference between north and south, with regions north of a Mersey-Humber line having a higher proportion of hoverflies, and southerly regions a higher proportion of solitary bees.

These data are only from one summer. Ecologists know that flower visitor communities are different not only between places but also between years, especially when one looks at the identities of species. The most abundant species one summer can be very low the following year. The community providing the pollination service to flowers is characterised by what ecologists call 'spatio-temporal variation'.

WILD BEES AS POLLINATORS OF CROPS

The second reason bees and other flower visitors are important: 'Every third mouthful of food relies on pollinators'. This comes from a review by Alexandra Klein and colleagues from the University of Göttingen, in 2007 (Klein *et al.* 2007). They reviewed the scientific and agronomic literature and gathered studies for all the major global crops where the dependence of yield (fruit or seed production) on visits by pollinators had been measured. The results of this review can be searched, crop by crop, on the International Pollinators Initiative website at: www.internationalpollinatorsinitiative.org/pims.do. When Klein *et al* compiled all this, they found that 35% of global crop production came from crops that depend to *some extent* on pollinators. This is where the 'every third mouthful' statement comes from. Figure 1 shows how the fresh produce aisle of a supermarket looks if you remove all pollinator-dependent products.

The extent of dependence varies. Oilseed rape loses about 25% of oil yield without pollinators. Apples and raspberries lose between 40% and 90%, depending on the variety. Kiwi fruits have separate male and female flowers, and lose over 90% without pollinators.

Knowing the degree of dependence of crops on pollination, and the value of different crops, it is straightforward to estimate a value for crop pollination. This comes out at around £430 million for the UK, using 2007 prices, which was about 8% of the crop market value. Incorporate basic economic theory about the effect of lower supply on prices, and this is about 10% higher.

Not long ago, it was generally believed that honey bees *(Apis mellifera)* provided around 85% of this crop pollination service. Scientific evidence is now emerging from several sources to imply that wild pollinators, particularly the many species of wild bee, are delivering the majority of the service for most crops. One important piece of evidence is an analysis led by Tom Breeze of Reading University (Breeze *et al*, 2011). He estimated how many honey bee hives/ha were required to pollinate fully all the crops needing pollination in the UK, and compared this with the actual density of honey bee hives, to see if there was a shortfall. They found that the lower recommended hive densities for pollination in 2007 produced only 34% of the number of honey bee colonies needed to pollinate the crops. This pollination service capacity of honeybees has fallen from around 70% since 1984, partly due to declining numbers of beekeepers and hives combined with increasing areas of insect-pollinated crops being grown, particularly oilseed rape.

If honey bees only provide 34% of the pollination service, what about the other 66%? As yields of these insect-pollinated crops are rising in the UK, the authors surmise that wild insects must be covering the shortfall.

More evidence to suggest they are correct comes from another of the Insect Pollinators Initiative projects. The Sustainable Crop Pollination project, also led by the University of Leeds, started out by measuring the insect visitors to crop plants. Data from 2011 and 2012 show that honey bees are not the most abundant visitors to field bean, apple or oilseed rape flowers, and make up only 52% of the visits to strawberry flowers. For field bean flowers, 88% of visitors are bumblebees, whereas apple flowers are mostly visited by solitary bees (32%). Measuring flower visits does not demonstrate pollination. The abundance of visits is one element of pollinator effectiveness. Experimental data on the effectiveness of different pollinators at stimulating fruit set can be expected soon.

Earlier this year, an analysis of data from 41 crop systems across the world was published (Garibaldi *et al.* 2013). Each of the studies measured numbers of wild insects and honey bees visiting crop flowers, and also measured fruit set, in at least three different fields. There was good correlation between wild insect visitor numbers and fruit set in all the systems where wild visitors were present. The more insects counted, the more fruit was set. In most cases, there was not the same correlation for honey bees. The number of honey bee visits was unrelated to fruit set.

Taken together, these strands of evidence point towards wild insect visitors, particularly bumblebees and solitary bees, being important in providing the pollination service that is worth £100ms to the UK economy. Since we know this is a diverse group, with different species being important in different years and different places, the **diversity** of wild bees, rather than just their numbers, is important to the pollination service.

Figure 1 Whole Foods Market University Heights' produce department with and without items dependent on pollinator populations.
(PRNewsFoto/Whole Foods Market)

Footnote

1 Natural Environment Research Council (NERC), Biotechnology and Biological Sciences Research Council (BBSRC), Defra, The Wellcome Trust and the Scottish Government.

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BEE AND POLLINATOR DECLINE IS A COMPLEX ISSUE

Mr Don Pendergrast
National Farmers Union

There is a consensus in the scientific community that the decline in bee and pollinator populations is not down to one single cause. In 2010 the UN Environmental Programme published a report outlining around 13 factors impacting on the health of bees and other pollinators. However reports in the media continue to paint straightforward links between presence of pesticides and harm to bees and other wildlife.

The danger of this oversimplification of a complex issue, which fails to take a robust scientific and evidence-based approach to improving bee health, is that at best we risk taking actions that do nothing to improve bee populations but increase the cost of producing food. At worst, this simplistic approach risks taking actions that make the situation worse for bees or have other damaging consequences for the environment.

POSITIVE NEWS

A recent report from a group of well-respected scientists from Europe and the US, including top UK researchers from Reading and Leeds Universities, from Butterfly Conservation and the Natural History Museum (Carvalheiro *et al*, 2013) showed that:

- In Britain and other European countries the dramatic declines in biodiversity happened between the 1950s and 1980s.
- In Britain, declines in bumble bee biodiversity have slowed since 1990.
- The biodiversity of solitary bees has in some cases increased significantly in recent decades.

This is important and it calls into question the over-simplistic coverage of pollinator decline that has dominated recent discussions.

The authors suggest that the slowing and reversal of biodiversity losses has happened since 1990 because of conservation work and agri-environment programmes. Industry led initiatives such as the Campaign for the Farmed Environment have played an important part in promoting land management options to provide food and habitat for bees and in England there are now over 150,000ha of buffer strips, pollen and nectar mixtures, wild bird seed mixtures, hay meadows and wildflowers areas under agri-environment schemes – all measures that will benefit pollinators.

In addition, pesticide best practice has been widely encouraged in the agricultural industry for over a decade via schemes such as the Voluntary Initiative, which deliver training to spray operators and farmers as well as providing an annual test of the equipment used to apply pesticides. A range of other specific stewardship schemes also exist to mitigate specific risks to the environment.

. . . best practice has been widely encouraged . . .

The Defra announcement in July 2013 of a comprehensive review to understand better the factors that harm pollinators, as part of a National Pollinator Strategy, should help to develop existing opportunities further and create a more evidence-based approach to tackling the challenges facing all insect pollinators.

FARMING INDUSTRY SOLUTIONS

Whatever strategy is implemented, it is likely to be the farming industry that offers many of the practical solutions to improve bee and pollinator health. Therefore it is important that farmers are included in this process and incentivised to do more. However poorly-evidenced decisions, such as the one by the European Commission to impose restrictions on the use of neonicotinoids, risk alienating farmers. It does not help to engage farmers when policy and regulatory decisions are made based on limited evidence rather than field studies, particularly when these decisions directly affect a farmer's ability to control pests and produce reliable and affordable supplies of food and other crops.

Only profitable farming and growing businesses will be in a position to deliver solutions to improving bee and pollinator health. If farming profitability is marginal, farmers won't be in a position where they are able to dedicate time and resources to supporting pollinator services. Balanced policy making is critical to ensuring both environmental and economic sustainability is achieved. This must be based on a balanced consideration of all the evidence, and a holistic approach to addressing sustainable production that focuses on growing more while impacting less.

THE IMPORTANCE OF PESTICIDES

Pesticides deliver a critical service to society as a whole. The benefits they bring to farmer's businesses are just the start to the more significant benefits they bring to an entire supply chain, which provides reliable and affordable supplies of food and other products to consumers.

Pesticides are not cheap, but they are a known technology and farms are equipped to use the technology efficiently and effectively. Crop production is extremely susceptible to variation in weather, which in turn affects the seasonal risk from pests. As a result, technologies that protect the potential yield and give resilience in production are essential for farmers to build sustainable long-term business. Pesticide technology also helps ensure food prices remain under control and as such deliver a critical service to society.

In addition pesticides also

- Reduce wastage of other valuable inputs such as fertiliser, which could otherwise be taken-up by weeds with no environmental or economic benefit.
- Help to facilitate minimum tillage strategies in a timely and economically viable way, thereby reducing carbon emissions, nutrient loss and soil erosion.
- Improved food safety by reducing the presence of harmful contaminants such as ergot and myco-toxins.

Modern crop protection products have been developed to target delivery of the pesticide, minimising the impact on non-target habitats. Seed treatments have been seen as an important step forward in this process, reducing the overall environmental loading by replacing broad-spectrum insecticide sprays. This can be seen in the Food and Environment Research Agency pesticide use survey covering the period from 1990 to 2011 which show pesticide usage has fallen from more than 34m kg to less than 17m kg.

... reducing the presence of harmful contaminants ...

CASE STUDY: NEONICOTINOID RESTRICTION

Oilseed rape is the major UK crop affected by the restriction on neonicotinoids. The primary use of these insecticides is as a seed dressing on winter and spring oilseed rape to protect the crop during early growth (first 6-8 weeks) from cabbage stem flea beetle and flea beetle. Treatments at this stage also control peach-potato aphid, which transmits turnip yellows virus. In 2011, 71% of oilseed rape seed sown in the UK was treated with neonicotinoids (HGCA, 2013). Estimates suggest that the neonicotinoid restrictions could result in a national 10% yield loss (220,000 tonnes) worth around £72million (HGCA, 2013).

In addition to the direct yield losses, the early season sprays (eg 2 to 3 sprays of pyrethroids) would add a further £4.8-7million (HGCA, 2013) cost to production. The absence of other technologies means that increased pesticide resistance in aphids and flea beetles would be a possibility.

This places increased pressure on farming rotation, particularly when you consider that flea beetles and aphids are not just pests of oilseed rape, but also of other major field crops such as cereals, leafy vegetables and potatoes.

SUMMARY

The European Commission's simplistic and overly precautionary approach to restricting pesticide use does not fit well with the fact that bee and pollinator health is a complex multifactorial problem. It has certainly not reconciled the fact that use of neonicotinoids increased during a period when declines in pollinator biodiversity have slowed down or even reversed in NW Europe.

With regards to crop protection, farmers are asking 'where do we go from here?' Will there be other restrictions on crop protection products made on a similar precautionary basis? This would limit evaluations to perceived risks. It would fail to take account of field studies and would not meet the procedures agreed by Member States. Farmers are also concerned that the impacts of pesticide registration changes are not properly assessed in terms of taking into account the future availability of alternative products, the risks of resistance, unintended environmental impacts and the economic sustainability of production.

With regards to pollinators, we need to recognise that farmers and growers already offer, and can offer more, solutions to improve pollinator health. Policy decisions must balance economic and environmental sustainability if they are to be successful. Carvalheiro *et al* (2013) raise the following fundamental questions, which need to be answered by policymakers, and all others involved in pollinator health.

- Which pollinator services are we trying to protect? Do we want to protect common species of bees and pollinators which are doing OK, or rare species which are not doing well? Do we focus our efforts on protecting those species that contribute most to pollination services?
- What is our ambition? Should we focus on slowing and halting declines? Do we need to reverse the declines? If so, reverse them to what point (eg population levels in 1970, or 1950)?

Future actions taken to achieve this aim have to be based on all the evidence. Finally, determining the success of these actions on populations over time will require the evaluation of long-term trends, and effective future monitoring of insect pollinator populations.

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