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Surveys

Politics meets Science: The case of neonicotinoid insecticides in Europe

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In April 2013, based on reviews by the European Food Safety Authority (EFSA), the European Commission announced a two-year ban on the use of three insecticides in the neonicotinoid group on certain flowering crops, as well as on certain crops that are not attractive to bees at certain times of the year.

Abstract

Although there was strong lobbying against the proposed ban by the multinational chemical companies that produce the insecticides, along with farmer's groups, strong lobbying in support of the ban came from environmental groups, beekeeping organizations and the general public. Even after two rounds of voting, the European parliament did not reach a consensus, forcing the European Commission to exercise its rights and impose the ban – based especially on the evidence presented in a review of relevant scientific data produced by the European Union's own European Food Safety Authority. Various reports suggest that, on the one hand, some European governments were persuaded to support the position of the multinational chemical companies rather than be persuaded by the review of research data, while on the other hand, environmental groups over-played the risks posed by the insecticides in question and the potential benefits of the proposed ban.

This case study report briefly reviews the background data on recent reported declines in bee populations; cites some of the evidence put forward by EFSA and others in support of and against the ban; reports on the process of the legislation as it proceeded through the European parliament as well as the lobbying that went on during the votes, including an analysis of the roles of key players and commentators; and proposes a way forward to resolve the apparent dichotomy between the pesticide producers and those who support the ban.

KEYWORDS: Bees, Bumblebees, Neonicotinoid, Insecticide, Science Policy

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The quote "If the bee disappeared off the face of the earth, man would only have four years left to live" is often attributed (but almost certainly erroneously) to Albert Einstein.

No matter who said it, the truth is that about a third of the food we eat, including beans, brassicas such as cabbage or broccoli, tomatoes, apples and strawberries, rely either directly or indirectly on insect pollination. (The exceptions include cereals such as maize, rice and wheat).

1. THE INSECTS

Scientists have identified some 7,000 species of bee, just about all of them important pollinators of one plant or another. The recent debate in Europe, however, has focused (sometimes without distinction) on two main types: the domesticated European honey bee (*Apis mellifera*) and bumblebees (belonging to the genus *Bombus,* of which about 250 species are known worldwide).

The plight of the European honey bee (which was first introduced into America in 1622, with subsequent additional introductions) has been the focus of many studies since colony collapse disorder (CCD) was first identified in the winter of 2006-07 and described in 2009 (vanEngelsdorp *et al*., 2009). In that study, the working definition of CCD included, among other indicators, the rapid loss of adult worker bees from affected colonies, as evidenced by weak or dead colonies with excess brood populations relative to the adult bee population, as well as a noticeable lack of dead worker bees both within and surrounding the affected hives. Since the winter of 2006-07, the Bee Informed Partnership, in collaboration with the Apiary Inspectors of America and the United States Department of Agriculture (USDA), now keeps annual statistics on the overwintering survival of honey bee colonies across the United States. According to the latest figures, 31.1% of managed honey bee colonies in the United States were lost during the winter of 2012-13, a figure similar to the six-year average of 30.5% (vanEngelsdorp *et al*., 2013). The cause of CCD has yet to be determined, but it is likely that a number of compounding factors are involved (Williams *et al*., 2010). Scientists in Italy, for example, have demonstrated that the presence of the parasitic mite, *Varroa destructor*, in honey bee colonies can induce the normally benign deformed wing virus (DWV) into what they describe as a "rapidly replicating killer" (Nazzi *et al*., 2012: 1-2). However, in a study carried out in France, neonicotinoid insecticides have also been implicated (Henry *et al*., 2012). In this case, honey bees exposed to one particular neonicotinoid, thiamethoxam, showed impaired ability to navigate back to their hives.

The situation regarding bumblebees is a little different. Although colonies of this type of bee are marketed for their pollinating services (see, for example, Agralan[1] and Koppert Biological Systems[2]), bumblebees tend to live wild, making their nests in hedgerows and other overgrown areas, and thus provide their pollinating services 'for free'. In fact, Breeze *et al*. (2011) argue that more than 60% of crop pollination in the UK is carried out by wild insects such as bumblebees and hoverflies. In recent years, however, most likely because of the rise in intensive agriculture, populations of many species of bumblebee have been declining across Europe (Robinson & Sutherland, 2002).

Again in the UK, the apple bumblebee (*Bombus pomorum*) was last seen in 1864; Cullem's bumblebee (*Bombus cullumanus*) in 1941; and, more recently, the short-haired bumblebee (*Bombus subterraneus*) was last seen in 1989 (Buglife[3]). Indeed, across the European Union (EU), farmers are rewarded for taking measures that are designed to support populations of bumblebees (Carvell *et al*., 2007). Likewise, in North America, other species are disappearing, including the yellowbanded bumblebee (*Bombus terricola*), the rusty patched bumblebee (*Bombus affinis*) and the western bumblebee (*Bombus occidentalis*), while Franklin's bumblebee (*Bombus franklini*), once found only in southern Oregon and northern California, may already be extinct (Xerces Society for Invertebrate Conservation[4]).

As with honey bees, recent studies have implicated neonicotinoid insecticides as potential agents for the loss of bumblebee colonies (even if the three recorded British extinctions occurred prior to the introduction of neonicotinoid insecticides). A study of *Bombus terrestris* in the UK, for example, showed that exposure to imidacloprid (as well as another, non-neonicotinoid insecticide) impaired worker foraging and increased worker mortality, leading to impaired colony success (Gill *et al*., 2012). Likewise, in another British study, Whitehorn *et al*. (2012) demonstrated that laboratory contamination of colonies with the neonicotinoid imidacloprid – at concentrations designed to replicate field levels – reduced the number of new queens produced by *B. terrestris* colonies. The authors conclude:

"Our results suggest that trace levels of neonicotinoid pesticides can have strong negative consequences for queen production by bumblebee colonies under realistic field conditions and that this is likely to have a substantial population-level impact. Given the scale of use of neonicotinoids, we suggest that they may be having a considerable negative impact on wild bumblebee populations across the developed world." (p.351)

1 Agralan, Bumblebees for Pollination: http://www.agralan-growers.co.uk/bumblebees-for-pollination-12-c.asp.
2 Koppert Biological Systems, Natural Pollination: http://www.koppert.com/pollination/.
3 Buglife: http://www.buglife.org.uk/.
4 Xerces, Project Bumble Bee: http://www.xerces.org/bumblebees/.

2. THE INSECTICIDES

But what of the neonicotinoid insecticides themselves? First used in the late 1990s, neonicotinoids were hailed as having very low mammalian toxicity and as being less harmful to beneficial insects compared to other widely used pesticides, such as those in the carbamate and organophosphate groups.

There are currently at least seven different neonicotinoid insecticides approved for commercial use (Wikipedia[5]).

The first commercial neonicotinoid, imidacloprid, was developed by Bayer AG[6] and, marketed as Gaucho™, has since become the most widely used insecticide in the world. Like other neonicotinoids, it acts by binding to receptors in the insect's nervous system, thereby affecting the efficient transmission of nerve impulses, causing paralysis and eventually killing the insect. Along with imidacloprid, the two other neonicotinoid insecticides that were the subject of the debate in Europe were clothianidin, also produced by Bayer AG, and thiamethoxam, produced by Syngenta. Marketed as Cruiser®, for example, thiamethoxam seed treatment is claimed to be "an innovative, environmentally safe insecticide, which provides instant, early-season, broad-spectrum pest control, thereby enhancing plant vigour and crop yield potential. Seeds treated include corn [maize], cotton, cereals, sugar beet, oilseed rape (canola) and rice." (Syngenta[7])

As can be inferred from this statement, such neonicotinoids are generally used as seed treatments – a method of application that is very precise and thus reduces the amount of pesticide dispersed in the environment (in comparison with spraying or dusting, for example). As the plant grows, the insecticide is absorbed and, as it is water-soluble, it becomes systemic, moving to all parts of the plant. Thus, the whole plant becomes poisonous to insects that feed on it, whether they chew their way through leaves or roots, or suck sap directly from the plant's phloem. In other words, crop seedlings are protected from attack during their most vulnerable early growth stages.

However, it is both the use as a seed treatment and the fact that they are systemic that is creating the controversy surrounding these three neonicotinoids. Their systemic properties, for example, mean that traces of the pesticides are also present in pollen, and thus available to foraging bees, while their use at sowing, especially of maize, means that they are also susceptible to being dispersed in the environment among the dust particles thrown up during the planting process (Krupke *et al.*, 2012), again with the potential of contaminating flowers that bees would use to forage for nectar or pollen.

5 Wikipedia, 'Neonicotinoids': http://en.wikipedia.org/wiki/Neonicotinoid. Accessed 15/6/13

6 Bayer AG: http://www.bayer.com/.

7 Syngenta: http://www.syngenta.com/global/corporate/en/Pages/home.aspx, and Syngenta, Cruiser®: http://www.syngenta.com/global/corporate/en/products-and-innovation/product-brands/seed-care/Pages/cruiser.aspx.

3. EUROPEAN PROCESS

In January 2013, the European Food Safety Authority (EFSA) – the European Union (EU) agency charged with assessing risks linked to food and feed safety – published risk assessments examining the effects on bees of three neonicotinoids: clothianidin, imidacloprid and thiamethoxam (EFSA, 2013a, 2013b, 2013c). The risk assessments focused on three main routes of exposure: exposure from residues in nectar and pollen in the flowers of treated plants; exposure from dust produced during the sowing of treated seeds or application of granules; and exposure from residues in guttation fluid (dew-like droplets of sap that are exuded by some plants) produced by treated plants.

EFSA scientists reviewed some 30 scientific papers, data submitted to the EU by the industry when seeking approval and registration of the three products, plus other information submitted by individual EU Member States. Their conclusion was that three substances – imidacloprid, clothianidin and thiamethoxam – posed a significant threat to honey bees when used on flowering crops. In addition, risks were identified through their use on winter cereals and other crops that are not attractive to bees, especially through exposure to insecticide-laden dust dispersed into the atmosphere at sowing.

Based on these reviews, the European Commission proposed to restrict the use of the three compounds in question.

4. PARLIAMENTARY PROCESS

The ban on the three neonicotinoid insecticides was actually imposed after a series of two votes. The first vote, taken following an expert's meeting of the Standing Committee on the Food Chain and Animal Health on 15 March 2013, resulted in a stalemate.

Of the 27 EU Member States, 13 voted in favour of the ban (including France, Italy and Slovenia, all of which had national bans in place at the time of the vote); nine opposed the ban (including the Czech Republic, Hungary and Ireland); and five others abstained (Britain, Bulgaria, Estonia, Finland and Germany).

A complex weighting system, whereby more populous countries have greater voting powers, meant that the vote was inconclusive and thus a second round of voting was required. It was during this interim period of about six weeks that political lobbying – and interest in the popular press – reached its peak. It was also during this period that a number of beekeepers and environmental groups in the United States filed a lawsuit against the Environmental Protection Agency for its "failure to protect pollinators from dangerous pesticides"[8], citing especially the two neonicotinoids, clothianidin and

8 Press release, 21 March 2013: Beekeepers and Public Interest Groups Sue EPA Over Bee-Toxic Pesticides: http://www.theorganicview.com/wp-content/uploads/2013/03/Neonic-Suit-PR-3.21.13.pdf.

thiamethoxam.

Back in Europe, the second vote, held on 29 April 2013 in the European Commission, finished as follows:

- *In favour of the ban*: 15 – Belgium, Bulgaria, Cyprus, Denmark, Estonia, France, Germany, Latvia, Luxembourg, Malta, the Netherlands, Poland, Slovenia, Spain and Sweden.
- *Against the ban*: 8 – Austria, Czech Republic, Hungary, Italy, Portugal, Romania, Slovakia and the United Kingdom.
- *Abstentions*: 4 – Finland, Greece, Ireland and Lithuania.

Among the most notable swings during the interim period were those of Bulgaria and Germany (from abstention to support of the ban); Italy (from supporting the ban to voting against the ban); the UK (from abstention to voting against the ban); and Ireland (from opposing the ban to abstention).

Ireland initially opposed the ban, its Minister for Agriculture, Simon Coveney, claiming that not only did the ban go beyond EFSA's findings and take the decision-making power away from Member States, but that he also had some technical problems with the proposed terms of the ban (McDonald, 2013). By the time the second vote came around, a spokesperson for the Irish government was quoted as saying, "We wanted to allow time for further consideration of the scientific evidence and create space for a compromise that could have the broad support of all Member States" (Cahill, 2013). As that did not prove possible, Ireland neither supported nor opposed the ban.

The Italian situation is also rather unusual, especially as Italy has had a partial ban – on the use of four neonicotinoids on maize seeds – in place from 2008 until 31 January 2013 (Ministero della Salute, 2012), subsequently extended to the end of June and then the end of December 2013 (Ministero della Salute, 2013). However, it is thought that the lack of conclusive scientific evidence and the pest control needs of many of Italy's fruit and vegetable growers led to their representative opposing the ban.

Again, the weighted voting system meant that the result was inconclusive. The European Commission, therefore, decided to exercise its rights and impose the ban, basing its decision on the evidence presented in the EFSA reviews. The details of the ban were subsequently published on 24 May 2013 as Regulation (EU) no. 485/2013 (European Commission, 2013).

Under the terms of the ban, as of 1 December 2013, farmers will not be able to buy or sow seeds of crops deemed attractive to bees and treated with the three insecticides in question for a two-year period. The ban extends to certain crops that are not attractive to bees at certain times of the year, in particular spring cereals. After the two-year period, the EU will review additional evidence. The insecticides can, however, still be used on crops grown in greenhouses, on winter cereals and other crops not attractive to bees, and on field crops after flowering.

5. PARLIAMENTARY PRESSURES

In the months, weeks and days leading up to both the first and second votes, intense lobbying was carried out by interested parties on both sides of the debate. On the one side, internet activists Avaaz.com raised an online petition calling for the ban that eventually garnered the support of 2.6 million signatories. Mobilising an alliance of environmental groups, beekeepers and others, some 400 people marched on 10 Downing Street, home of the British prime minister, on 26 April – three days before the critical vote – and handed in the petition along with the results of a poll showing that 71% of UK respondents supported the ban. Celebrities Dame Vivienne Westwood and Katherine Hamnett led the march and ensured major coverage in the press[9].

Prior to the second EU vote, marches were also organized in Brussels, Cologne, London and Madrid[10] in a deliberate attempt to demonstrate to politicians the strength of public support for the ban on the controversial insecticides.

But was the public supporting the conclusions reached by EFSA based on the scientific evidence available for review? Or was the public responding to an emotional appeal from the campaign groups? It seems that it was the latter. Lynn Dicks, writing in *Nature* (Dicks, 2013), noted that the Avaaz online petition called on people to "save bees from extinction", which she defined as "absurd". Dicks also noted that the UK newspaper, *The Guardian*, "mangled" evidence she had presented to the UK parliament concerning populations of other pollinating insect species.

The motives of both the environmental campaign groups and, in its own way, the pro-environment *Guardian* newspaper are clear. Indeed, perhaps they should also be commended for raising such massive awareness of an environmental issue involving insects. Many comparable campaigns have focused on the so-called 'charismatic mega-fauna', *i.e.* species such as whales, dolphins, elephants, tigers and gorillas. The fact that bees pollinate our fruit crops, make honey, and can be 'kind of furry' has obviously been marketed to great emotive effect.

Coming back to the scientific evidence, it was Roger Pielke Jr., in his book *The Honest Broker: Making Sense of Science in Policy and Politics* (Pielke, 2007) who made the distinction between:

- the *pure scientist*, who stays distant from the decision-making process, making his or her scientific information available in a passive way, and is unconcerned with how (or even whether) the information is used by policy makers;
- the *science arbiter*, who engages with policy makers, serving as a resource and providing answers to factual questions that the policy maker may ask, but who does

9 Press release, 26 April 2013: Hundreds join "March of Beekeepers" on Parliament: https://secure.avaaz.org/act/media.php?press_id=421.

10 Press release, 29 April 2013: Avaaz welcomes European lifeline thrown to bees. https://secure.avaaz.org/act/media.php?press_id=422.

not make any specific recommendations;
- the *issue advocate*, who does make specific recommendations to policy makers, and tries to make a case for one alternative over another; and
- the *honest broker*, who attempts to provide background evidence for or against any of the range of decision options facing a policy maker, helping to clarify the choices available while leaving any actual decision to the policy maker, based on their own preferences and values.

As Pielke argued, the honest broker is the ideal case, but in practice it is difficult: (a) for policy makers (and others) to identify such honest brokers; and (b) for scientists themselves to avoid becoming issue advocates once they enter the political arena.

To its credit, it is the role of science arbiter that EFSA plays. A review of some of the participants in the UK discussions is revealing, however. Dave Goulson of the University of Sussex, for example, is a recognized expert on bees and has published a significant number of papers (see, for example, Carvell *et al*., 2007, and Whitehorn *et al*., 2012). He has also appeared in interviews with the press, so obviously cannot be considered a pure scientist. But is he a science arbiter, issue advocate or honest broker?

In many cases, Goulson's measured views and obvious expertise may mark him as an honest broker, but a check of his profile[11] shows that, in 2006, he founded the Bumblebee Conservation Trust, a charity devoted to reversing bumblebee declines, and that he has written on such subjects as the reintroduction of the short-haired bumblebee (*B. subterraneus*), extinct in the UK since the 1980s, from a population that survives from a 19th century introduction into New Zealand (Goulson, 2013). Thus, Goulson could be considered an issue advocate.

In contrast, Mark Walport, who took over as the UK government's chief scientific adviser in April 2013, certainly ought to act as an honest broker. Indeed, in an editorial published in the *Financial Times* immediately prior to the European Union's second vote (Walport, 2013), he wrote that: "The job of scientists is to undertake the scientific work and to advise politicians on science – and it is to them that we must turn for the final decisions", thus advocating the honest broker role.

He also wrote that the proposed ban was "based on a misreading of the currently available evidence" and that: "The consequences of such a moratorium could be harmful to the continent's crop production, farming communities and consumers," thus echoing the line taken by the chemical companies. In so doing, he went against the recommendations of a report from a cross-party House of Commons Environmental Audit Committee. Their report, published a month before Walport's opinion piece, came out heavily in support of the ban in the UK and also recommended that the UK's Department for Environment, Food and Rural Affairs (DEFRA) support such a moratorium at EU level (House of Commons Environmental Audit Committee, 2013).

Against this background, Walport's comments have led to accusations that he has "misinformed the public about the scientific method, risk and uncertainty" and that: "He has made groundless, unscientific and emotionally manipulative claims. He has indulged in scaremongering and wild exaggeration in support of the government's position." (Monbiot, 2013)

It should also be noted, however, that George Monbiot himself[12] has written about UK politics and against the growing power that corporations are exerting (Monbiot, 2000). In other words, Monbiot is certainly an issue advocate.

Another report published between the two EU votes was that of the UK's Food and Environment Research Agency, the scientific and advisory agency that operates under the auspices of DEFRA (Thompson *et al*., 2013). The report, which attempted to analyse the effects of neonicotinoids on bumblebee colonies adjacent to oilseed rape crops, was based on results from one season and was "not designed as a definitive statistically robust study," but rather as a "rapid response to concerns about the effects of neonicotinoids on bumble bee colonies raised by Whitehorn *et al*. (2012)" (p. 1). As such, it was the first field study published in the EU that addressed these concerns. Among its results, there was no observed relationship between levels of neonicotinoid in colonies and the success of those colonies. "The absence of these effects is reassuring but not definitive," (p.36) conclude the authors, who add that: "The study underlines the importance of taking care in extrapolating laboratory toxicology studies to the field, as well as the great need of further studies under natural conditions," (p.36) with the aim, presumably, being to counter the impact of the Whitehorn study.

The rush to publication, in March 2013 (*i.e.* prior to the second EU vote), somewhat backfired, however, as the lack of time for peer review of the document allowed critics, including EFSA, to pick over the results and claim that: "due to the weaknesses of the study design and methodology, the study did not allow to draw any conclusion on the effects of neonicotinoids on exposed bumblebee colonies" (EFSA, 2013d; p.1).

Of course, the two corporations themselves, Bayer AG and Syngenta, would be expected to advocate in support of their products. An idea of the commercial value of these pesticides can be gleaned from the fact that, in 2002, an intellectual property dispute between the two companies over neonicotinoid chemistry resulted in Syngenta paying Bayer some US$120 million for the right to produce thiamethoxam (Ong, 2002). At the time, Syngenta was generating annual sales of some US$100 million from thiamethoxam-based products, with the ambition of achieving sales of up to US$400 million per year.

Little wonder, then, that the two companies, along with

11 Goulson, D. http://www.sussex.ac.uk/profiles/126217.

12 Monbiot, G. http://www.monbiot.com/about/.

industry bodies such as the European Crop Protection Association (ECPA), came out fighting in efforts to support their products. Among their first shots was a series of letters to European commissioners, lobbying for support after the French had proposed a unilateral ban in 2012. The letters were made available to Corporate European Observatory under the European freedom of information legislation (Carrington, 2013).

Then, on 14 January 2013 (*i.e.* prior to the EFSA reports published on 16 January), the Humboldt Forum for Food and Agriculture (HFFA) published a report supported financially by Bayer and Syngenta. The report's authors analysed various scenarios and concluded that banning the neonicotinoids would cost between 3.8 and 6.3 billion Euros in lost revenues up and down the food production and processing value chain (Noleppa & Hanh, 2013). To put this value into context, the authors explained that: "The immediate potential damages to the overall EU welfare if neonicotinoid seed treatments were banned or their use suspended (4.5 billion Euro) are approximately as large as the entire agricultural value added of some smaller EU member states, e.g. Austria or Finland" (p.7). Thus, the two chemical companies were appealing directly to the agricultural and food processing industries, as well as – naturally – to politicians fearful that supporting a ban of the compounds could lead to significant job losses.

Additional documents released to Corporate European Observatory also reveal that Syngenta tried to influence EFSA, particularly in relation to the wording of the press release that announced the results of its literature review and recommendation that the three neonicotinoid insecticides in question be banned pending further investigations. Indeed, having failed in their attempt to persuade EFSA to reword the initial draft of the press release, Syngenta went on (unsuccessfully) to threaten the agency and its director with legal action (Pigeon, 2013; Carrington, 2013).

Eventually, having failed to stave off the EU ban, both companies naturally continued to make a case for their products. Immediately after the second vote, Syngenta chief operating officer, John Atkin, said:

> "The European Commission has again failed to win the necessary support for its proposed ban on this vital technology. The proposal is based on poor science and ignores a wealth of evidence from the field that these pesticides do not damage the health of bees. Instead of banning these products, the Commission should now take the opportunity to address the real reasons for bee health decline: disease, viruses and loss of habitat and nutrition."[13]

Bayer echoed the fact that the "real issues surrounding bee health" were issues such as "the Varroa mite, bee diseases and viruses, and the need to provide more nectar-rich habitat," [14] while continuing to claim that the ban would restrict farmers' "capability to grow abundant, high-quality, affordable food in Europe".[15]

Again, Lynn Dicks, in her *Nature* article (Dicks, 2013), notes that: "One headline widely reported in the UK farming press is that, without them [neonicotinoid insectides], UK wheat yields would decline by up to 20%," adding that this was a "disingenuous interpretation" of the industry-funded report.

Dicks goes on to say that: "As a scientist … I find this misinformation deeply frustrating. Yet I also see that the lies and exaggeration on both sides are a necessary part of the democratic process to trigger rapid policy change." The crux of the matter, claims Dicks, is that: "Politicians respond to public opinion much more readily than they respond to science."

It could be added: "Especially when the science indicates an effect – but is still inconclusive."

6. PRECAUTIONARY PRINCIPLE

The precautionary principle was established at the 1992 Rio Conference on the Environment and Development, during which the Rio Declaration on Environment and Development (United Nations, 1992) was adopted. Principle 15 of the declaration states that: "in order to protect the environment, the precautionary approach shall be widely applied by States according to their capability. Where there are threats of serious or irreversible damage, lack of full scientific certainty shall not be used as a reason for postponing cost-effective measures to prevent environmental degradation."

Although not enshrined in EU law, a communication from the European Commission in 2000 (European Commission, 2000) notes that the precautionary principle can be applied when "scientific evaluation does not allow the risk to be determined with sufficient certainty" (pgh 4). It goes on to state that: "The precautionary principle should be maintained so long as scientific information is incomplete or inconclusive, and the risk is still considered too high to be imposed on society, in view of chosen level of protection" (pgh 6) and that: "Measures should be periodically reviewed in the light of scientific

13 Press release. 29 April 2013. EU Member States again fail to agree restriction on key crop protection technology. http://www.syngenta.com/global/corporate/en/news-center/news-releases/Pages/130429.aspx.

14 Press release. 24 May 2013. Decision to restrict use of neonicotinoid-containing products will not improve bee health. http://www.cropscience.bayer.com/en/Media/Press-Releases/2013/Decision-to-restrict-use-of-neonicotinoid-containing-products-will-not-improve-bee-health.aspx.

15 It should be noted also that both companies have, for several years, worked with farmers in promoting schemes designed to protect and encourage pollinators, Bayer through its Bee Care programme (http://beecare.bayer.com/home) and Syngenta through its Operation Pollinator programme (http://www.operationpollinator.com).

progress, and amended as necessary" (*ibid.*).

On this basis, this is exactly what the EC has requested – a two-year ban with time to collect additional data followed by a thorough review of any new information.

It should be noted, however, that the precautionary principle itself has been called into question, with a recent publication by the US-based Council for Agricultural Science and Technology (CAST; Marchant *et al.*, 2013) claiming that it is "bias[ed] against new technologies" (p.1), predicting that "the precautionary principle will become increasingly controversial, marginalized and ignored in the future" (*ibid.*), and also claiming that it "does more harm than good" (p.16).

In many ways, the view of the CAST report authors, in the case of the neonicotinoid debate, has been re-argued by, among others, two experts from the University of Sussex's Laboratory of Apiculture and Social Insects (Carreck & Ratnieks, 2013) who maintain that, although both sides of the debate appealed to scientific evidence, "that evidence is far from clear cut." Indeed, Carreck and Ratnieks argue that the moratorium on the three neoniconinoid insecticides is not necessarily a victory for those worried about declining bee populations – especially as farmers are likely to revert to using older types of insecticides such as synthetic pyrethroids. As with neonicotinoids, the sub-lethal effects of this class of insecticides on either honey bees or bumblebees is unknown. In addition, note the authors, farmers are advised to spray pyrethroids early in the morning or late in the afternoon when honey bees are less active, and so avoid contact with these vital pollinators. However, bumblebees have different activity temperature thresholds and *are* often active early in the morning and late into the evening, and so would come into direct contact with such sprays.

Neither does the ban go any way towards unravelling the effects of exposure to other agrochemicals such as fungicides. As Pettis *et al*. (2013) describe, honeybees can be exposed to cocktails of pesticides. In their US-based study of more than 60 hives in seven different crops, pollen collected from bees returning to the hive contained an average of nine different pesticides (range: 3-21). In addition, bees fed pollen containing the fungicides chlorothanonil and pyraclostrobin showed increased susceptibility to the gut parasite, *Nosema ceranae*. "Our results show the necessity of testing for sub-lethal effects of pesticides on bees, and advocate for testing more broadly than the insecticides that are the targets of most current research," conclude the authors (Pettis *et al*., 2013: p.7).

7. WAY FORWARD

It seems that a first major step to resolving such issues is to overhaul the whole testing process for the registration of new insecticides. This is the view, for example, of Decourtye *et al*. (2013), writing in *Nature*, who assert that: "The current risk-assessment process for [synthetic pesticides] is outdated and does not incorporate developments from the past 30 years." They also argue that, while current tests evaluate adult honey bee survival after a short exposure period, they should also be required to determine other effects such as chronic toxicity and sub-lethal effects, including on larvae, as well as a broader range of exposure scenarios. The debates relating to many of the peer-reviewed publications cited above – and to whether or not the doses of insecticide received by the bees were 'realistic' under field conditions – lends weight to the recommendation of Decourtye *et al.* (2013).

Obviously, if such a recommendation were to be implemented it would likely add to the cost of research, development and registration of new insecticides and, in this case, would be resisted by the farming community who would see added costs eroding their profit margins. While the agrochemical industry could also potentially resist the additional requirements, it might appreciate the clarity of any new regulations that would, it is hoped, remove any uncertainty on whether approval can be obtained for new active ingredients. In other words, instead of regulators 'moving the goalposts', new regulations, based on sound science, could potentially reduce costs as the companies would be able to carry out only those specific tests required.

At this point, it is worth looking again at a previous major response to an impasse regarding an agricultural technology – that of the introduction of genetically modified (GM) crops into Europe, and into the UK in particular.

In late 1998, against a background of required checks that had been passed, a group of herbicide-tolerant crops, including sugar beet, oilseed rape and fodder maize, were due to be approved for commercial cultivation. However, there was still a weight of public opinion against their release – nourished by campaigns from environmental groups and the press (thus paralleling the situation with neonicotinoid insecticides). Fearing a political backlash, the UK government entered into partnership with an industry umbrella body, the Supply Chain Initiative on Modified Agricultural Crops (SCIMAC), to design and implement a major eco-environmental research programme aimed at evaluating the safety of the GM crops with regard to non-target wildlife including birds and insects.

The so-called Farm Scale Evaluations eventually lasted five years, included some 266 field trials around England, Scotland and Wales, and cost the UK government some £6 million (equivalent to US$9.2 million at today's exchange rate). Hailed as the "largest and most thorough [study] of its kind in the world" (Burke, 2004: p.2), the trials were carried out by a consortium of scientists from independent research institutions led by the respected Centre for Ecology and Hydrology, overseen by an Independent Scientific Steering Committee, and included other checks and controls. In particular, the design of the trials was left entirely to the scientists and remained free from government, industry and environmental lobby influences (Turner, 2004).

The results were published as a collection of eight papers in a special issue of the *Philosophical Transactions* of the Royal Society (Various, 2003) and the raw data made available on-

line. "For the first time, [researchers] have information on animal and plant numbers, and how different species interact with one another. The database gives researchers a baseline so they can monitor future changes to farmland wildlife," claimed Burke (2004: p.6).

While it is generally agreed that the trials did answer the questions they set out to answer – and that the science was sound – there is a feeling that other ecological issues, relating to the spread of GM pollen, for example, were not addressed. In addition, as Turner (2004; chair of SCIMAC at the time of the trials) points out, in any case the press misrepresented the results and continued with their headlines predicting continued erosion of wildlife populations if the crops were commercialised. (In fact, the trials showed the opposite to be true for fodder maize).

So where does this leave the neonicotinoids?

As Lord de Mauley, Parliamentary Under Secretary at DEFRA, recently pointed out at a Friends of the Earth (FoE) conference: "Bees will be vulnerable, whether or not we put more restrictions on insecticides. I don't think anyone would disagree that the picture is very much more complex." (de Mauley, 2013)

de Mauley used the FoE platform to announce the launch of an "urgent and comprehensive review of current policy, evidence and civil society action on pollinators to identify what needs to be done", including developing a better understanding of the factors that affect bees, as well as how future actions of government, other organisations and individuals can help. For example, de Mauley highlighted the fact that the UK government was "thinking seriously about how the successor to Environmental Stewardship under the new [EU] Common Agricultural Policy (CAP) might increase the benefits for, and reduce the pressure on, pollinators" and noted that:

> "This urgent review will form the basis of a National Pollinator Strategy, which will bring together all the pollinator-friendly initiatives already underway and provide an umbrella for new action. We will look across different causes of bee decline and across different bee species and across different insect pollinators."

Of course, as it has been all through the neonicotinoid debate, the case for a scientific evaluation was made. "In all of this, we must be led by science," confirmed de Mauley. "As part of the review, I have already asked DEFRA's Chief Scientific Adviser, Professor Ian Boyd, to convene a group of independent experts to look at the evidence on the state of our pollinators."

While such a report is welcome, it can only include a review of available evidence. As Carreck and Ratneiks (2013) point out, one thing that the current scientific literature highlights is the need for more research, for example regarding the extent of exposure of wild bees to neonicotinoid insecticides. Rather pessimistically, they add that: "Even if governments can be persuaded to fund such work, it will be hard to design a research programme that will find a definitive answer." They also conclude that, without such answers, we will be having the same debate in two years time when the current moratorium is about to expire.

The GM Field Scale Evaluations have demonstrated that such large-scale trials are possible, even if Turner (2004) was somewhat pessimistic when he wrote:

> "In view of their costs (both to the UK Government and the technology providers) together with the adverse response by the environmental campaign groups, and the length of time needed to carry out the work, it seems unlikely that an exercise of similar scale will be undertaken in the near future." (p.224)

Now, some 10 years on, perhaps it is time for governments – not just the UK government, but governments across Europe – to come together with a body such as the European Crop Protection Association (ECPA), that represents the relevant industry, as well as environmental lobby groups such as Buglife and Friends of the Earth, to appoint a Europe-wide group of experts that will not only review available data (as EFSA have already done to an extent), but who will also determine what additional evidence is needed and then design a robust continent-wide experiment that will provide that evidence in an open and audited fashion.

Without such a major initiative, it is certainly possible that the two-year moratorium could be extended. The fact that most European nations have yet to permit the planting of any commercial GM crop should provide a stark warning to the chemical companies, who must join the research consortium proposed above as open and willing partners.

This paper began with a quote. To conclude, therefore, let us consider what Oscar Wilde wrote in *The Importance of Being Earnest*: "The truth is rarely pure and never simple."

It is true that such a series of Europe-wide trials will not be simple (or cheap) to carry out. It is equally true, echoing the Farm Scale Evaluations, that the results may apply only to a narrow series of questions asked about the effects of neonicotinoids and, for example, may not take into account (although they should) the effects of using alternative pesticides – not only on bees, but also on other non-target organisms.

In fact, the whole debate is much wider and involves issues relating to integrated pest management rather than the prophylactic treatment that the easy-to-apply neonicotinoids have promoted. It also requires major discussions about alternative methods of pest control (*e.g.* biological control and GM crops), as well as ecosystem services: how much are they 'worth', and who should be required to pay to protect them? In short, the discussion is about the long-term sustainability of

our agriculture and what we are willing to accept to ensure our future food security against a background of ever-increasing world population and ever-increasing biodiversity loss.

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