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Where have all the ladybirds gone? Part 2

The authors explore the evidence for neonicotinoid impacts on honey bees, the role of governments in regulating pesticides, and the changes required to adequately evaluate their environmental safety.

By Marilyn Steiner and Stephen Goodwin

Honey bee on Xanthostemon.

The evidence for neonicotinoid impacts on honey bees

Despite all the losses of honey bees around the world, Bayer CropScience continues to claim that its neonicotinoids are one of the most environmentally compatible active ingredient groups for ecological systems when used correctly. In Europe, compensation to German and French farmers was paid in cases where acute toxicity was very closely tied to a treatment event. But in North America, the government has been very slow to act on negative reports at home and overseas. Most beekeepers need no convincing that pesticides, particularly neonicotinoids, are behind the massive losses in managed hives experienced now for several years. Faced with a strong beekeeper association and

several influential environmental advocacy groups in the US, significant research funds have been directed towards finding the causes of colony collapse disorder (CCD), but it has been a frustrating time for beekeepers. To an outsider, it seems that many of the projects are directed at first ruling out all other potential causes before considering pesticides. This is the last thing that anyone appears to want to look at. There is a great deal of research examining the role of parasites and pathogens such as *Nosema* and various viruses, but no obvious linkage to CCD has been found. The latest Progress

Report from the CCD steering committee makes interesting reading (www.ars.usda.gov/is/br/ccd/ccdprogressreport2010.pdf). Everyone agrees that bees are sick, but surely it must be that we are stressing the bees by carting them around the country or not feeding them properly? It's like watching a long spiral with the bullseye in the centre. You know where they should be heading, but they want to go all around the spiral first before they move in towards the bullseye. Two years ago, Dr Jeff Pettis, a leading ARS scientist in Pennsylvania, found an interesting synergistic effect between minute doses of imidacloprid and the microsporidia *Nosema*. Imidacloprid plus *Nosema* caused colonies to decline faster, a significant finding. In 2010 Alaux *et al.* in France, working independently, found the same effect, as did Vidau *et al.* (2011) with fipronil and thiacloprid in France. But Pettis didn't publish his results, and now questions are being asked as to why (www.independent.co.uk/environment/nature/exclusive-bees-facing-a-poisoned-spring-2189267.html).

Pettis appeared before the UK Parliament in March this year claiming that he still wasn't convinced that neonicotinoids should be blamed for bee losses, because he couldn't reproduce the results in the field. Yet field experiments are notoriously difficult to draw conclusions from because of the wide range of variables. This is particularly so for honey bees, which forage over many kilometres. You also have a product that has been shown to affect the immune system of honey bees at extremely low doses, almost below the limits of detection. It beggars belief that the world-wide loss of bees, and the corresponding release of neonicotinoids into the fields, forests and gardens of huge swathes of the world, is simply a coincidence. Particularly when we know that they do, in fact, exhibit the effects being seen in laboratory trials. A recent paper by Mullin *et al.* (2010) in the US found high levels of miticides and agrochemicals in North American apiaries, over 150 actives in all. It is hard to believe some or all of them are not having an impact. What they didn't find were any appreciable amounts of neonicotinoids, but potentially the bees could have consumed the contaminated pollen and nectar, which is usually where the residues are found, or not made it back to the hive. At higher concentrations imidaclorid is repellent, but perhaps they only start to pick it up at below the bees' own detection limits? Cumulative intake of tiny doses will eventually compromise their nervous and immune systems, which is the effect scientists are reporting.

There is a mounting body of evidence that not only will minute amounts of neonicotinoids produce the end results seen by beekeepers, but also some fungicides can produce synergistic effects when they are used in combination with neonicotinoids and other pesticides. In one case a certain fungicide increased neonicotinoid toxicity 1000-fold. Fungicides and neonicotinoids are combined routinely in many seed treatment formulations. Do the regulatory authorities consider the issue of synergism with other crop protection products, and to what extent? The possibilities for interaction are real and need to be addressed.

The dossier on known harmful effects of neonicotinoids is increasing. Many reports can be found in www.cbgnetwork.org, the German consumer watchdog group Coalition Against Bayer CropScience Dangers; www.buzzaboutbees.net/tom-theobald.html, a US site maintained by Tom Theobald, an activist US beekeeper; www.farmlandbirds.net/en/taxonomy/term/3, a Dutch site maintained by Henk Tennekes, exploring the links between bird and insect decline and neonicotinoids; and www.bijensterfte.nl/nl/node/ , another Dutch site run by the University of Utrecht detailing scientific studies. There is also an extensive report by ***Buglife***, The Invertebrate Conservation Trust, a UK environmental group (Kindemba 2009). A good review article on pesticides and honey bee toxicity provides breadth to the problem of CCD in the US (Johnson *et al.* 2010). Tennekes (2010a) states that the effects of neonicotinoids on the insect's nervous system are cumulative and irreversible; the total dose required to kill insects is smaller if administered over a longer time period. Even minute amounts can be fatal, so for honey bees there is no safe dose. In his subsequent book ***The Systemic Insecticides: a disaster in the making*** (Tennekes 2010b), he charts the decline of birds in Europe and draws a clear link between not only the loss of honey bees, but dramatic declines in birds and aquatic life. He points out that most of the birds in decline are those that eat insects, but direct effects on birds are also known. Neonicotinoid levels in groundwater in The Netherlands are high enough to far exceed toxicity ratings for a wide range of biota. A recent paper by Maini *et al.* (2010) also raises questions about the scientific neutrality of some of the published papers, and the narrow focus of toxicity evaluations. Other people in many countries are making the same observations about loss of birds and pollinators. For ourselves we have noted for several years the depressing declines in wildlife in the UK during our annual visits to relatives. During a half hour walk in a leafy suburb in southern England last September, we saw only one bird. There were no bees on the garden flowers, neither honey bees nor bumblebees. At one time you could be assured that cow parsley flowers would be teeming with flies, beetles and wasps, all vying for pollen and nectar. Not anymore. Yet the younger generation is largely unaware of this massive loss of biodiversity. The knock-on effect of the loss of pollinators has perhaps not yet been felt, though there are reports from China of workers having to hand-pollinate crops because the bees are no longer there.

The role of governments in regulating pesticides

In the United States, pesticides are regulated by the Environmental Protection Agency (EPA), which has a duty to ensure the safety of pollinators and other beneficials. However, it appears to operate on a principle of innocent until proven guilty. The EPA has long known about the problems with imidacloprid and chlothionidin in Europe, but maintains, as does Bayer CropScience, that these actives are safe if used correctly. The persistent enquiries of Tom Theobald, the Colorado beekeeper, recently uncovered an internal EPA memo dated November 2010 which documented a change in status of one of Bayer CropScience's submitted field trials on clothionidin from 'acceptable' to 'supplementary' (www.alternet.org/module/printversion/149150).

The EPA granted Bayer CropScience a **conditional registration** for clothianidin in 2003, despite the absence of a critical trial required to show safety to bees in the field. It took Bayer CropScience 3 years to conduct the trial, and the EPA another year to assess it, at which time they deemed it acceptable. Internal memos within the EPA showed scientists were concerned about the original trial protocol but it was approved anyway by the upper echelons. The National Resources Defence Council filed a lawsuit to examine the trials that Bayer CropScience had used to gain registration, succeeding finally in obtaining them. The disputed field trial was clearly inadequate and another trial has been requested, but this will not even be started until 2012. No rush then. Meanwhile, clothianidin was granted full registration by the EPA in 2010 and use continues unabated.

In March 2009, the California Department of Pesticides Regulation stepped into the fray, ordering a re-evaluation of four neonicotinoids following an adverse effects disclosure concerning imidacloprid. This follows finding high levels in leaves and blossoms and increases in residue levels over time. Bayer CropScience data indicated residues in soil remained relatively low for the first 6 months after application. However, there was then a dramatic increase in residue levels that remained stable for as many as 500 days after treatment. One step closer to that bulls-eye. In their recent review article (Johnson *et al.* 2010), the authors clearly indicate the inadequacies of traditional acute toxicity testing as the sole requirement for registration. This particularly relates to honey bees, whose genome is markedly deficient in the number of genes encoding detoxification enzymes. In other words, they are unable to detoxify even small doses, allowing the effects to accumulate over time.

In the UK, environmentalists and beekeepers have lobbied hard to persuade the UK government to ban neonicotinoids. The British Beekeepers Association itself has earned the ire of many beekeepers by not supporting a ban. Until last November, it received £17,500 a year from Bayer CropScience and Syngenta to endorse their pesticides with a 'bee friendly' logo, which is clearly a conflict of interest and relevant to our own concerns about undue influence.

The Buglife report has been criticised by Helen Thompson, UK Food and Environment Research Agency (FERA), who claims that there is no evidence of any association between neonicotinoids and bee deaths in the UK, in fact, no evidence of CCD. She maintained that the studies required are constantly being reviewed by various regulatory agencies in the UK and Europe. In a recent rebuttal, she did not refer to Tennekes' 2010 paper in Toxicology or his book. DEFRA, the regulatory agency in the UK, also states that there is insufficient evidence for withdrawing neonicotinoids. The UK government at the time of writing has taken no action, despite several representations to Parliament.
The Co-op, a major UK supermarket chain with 28,000 hectares under cultivation in the UK, banned usage of eight neonicotinoids on its own farms in 2009, and has since extended it to its suppliers. The European Union is undertaking a review of neonicotinoids and the type of trials that are needed to properly assess the new classes of pesticides.
The Green Party in New Zealand launched a petition in May this year calling on the NZ Government to suspend use of neonicotinoids, while the Federal Farmers opposed any need to even conduct an investigation. The NZ Government is taking a 'wait-and-see' approach. Australia's pesticide regulator, the APVMA, takes a similar position. It does not have the resources that the EPA and DEFRA have at their disposal, but an APVMA spokesman stated that the agency follows internationally observed OECD guidelines, and keeps informed through attendance at international conferences and regular contact with other regulators.

Drift from an air-blast sprayer can travel well outside the targeted spray zone. It's not difficult to see how environmental contamination can occur.

Changing the requirements for pesticide regulation

The system that is currently in place in most countries to regulate pesticides is driven by the needs of the end users. For all the talk about environmental safety, the precautionary principle is not operating here. A pesticide label stating in small print somewhere that the product is toxic to bees and aquatic life, and not to spray during crop flowering or near water, is next to useless. It will do little to affect its selection by the user, and will in any case not change the outcome. There is no way, with a systemic pesticide that moves into all parts of the plant, including flowers, is persistent in the environment for many seasons and can move in groundwater, that it will not be picked up by bees and other wildlife. The label warning, which must be specifically searched for (unless you know growers who read all the fine print and not just the application rate) should not be a 'get out of gaol free' card for either the regulator or the pesticide company.

So why do governments persist in maintaining registrations despite mounting evidence of serious environmental harm? While many people are jaded enough to claim pesticide companies are running the government, the fact is that the agricultural lobby is itself very influential. You have only to look at the case of **Movento** in the US to see where the real power lies. The beekeepers were concerned because Movento is reportedly toxic to bee larvae and is also systemic. It was de-registered by the EPA in April 2010 following a Federal Court ruling on a technicality, but in October it was re-registered following over 100 submissions in its favour. Many of these represented large agricultural organisations. The agricultural lobby is much stronger than the environmental and beekeeper lobby, and will support the pesticide company. Ironically, it was the precautionary principle that was quoted by our Federal government in 2007 to ban bumblebees from being brought onto the mainland to pollinate greenhouse tomato crops, in case they caused harm to native bees. This from the same government that is prepared to allow vast tracts of land to be routinely treated with pesticides known to be highly toxic to the same bees, not to mention many other forms of wildlife.

Farmers are now very dependent on pesticides, or at least they think they are. A common claim by pesticide companies, and sometimes regulators, is that removing neonicotinoids will compromise maximum crop production and result in a return to more toxic broad spectrum pesticides. Bees, birds and other wildlife are presumably acceptable collateral damage. The European Union is a strong advocate of IPM, which doesn't sit well with the idea that we should kill everything in the pursuit of greater yields, not to mention greater corporate profits. Farmers have become pesticide junkies. For many broadacre crops, almost 100% of seed is pre-treated with pesticide. You can't buy seed without it. Pesticide is being applied as a *precaution* against pests and diseases (and weeds, for that matter). It is the complete antithesis of IPM, which advocates a multi-pronged approach, with pesticides only to be applied as a last resort and only as needed.

Bayer CropScience supports IPM? Bah humbug. Broad scale use of pesticides ensures that not only are pests killed, but also all susceptible natural enemies and pollinators, not just honey bees. The farmer is then certainly dependent on the pesticide, because natural checks and balances have been destroyed. Whatever small inroads IPM was making are being rapidly eroded.

Targeted application and new age, so-called environmentally friendly pesticides were supposed to avoid all the problems that broad spectrum pesticides like organochlorines, organophosphates and pyrethroids caused. Perhaps that was the intention, but it isn't working out the way it was supposed to. Clear signs of impending trouble have been present since the early 1990s, and should have triggered independent regulatory oversight. Hindsight is telling us that the tests designed to show safety are not suited to evaluating systemic pesticides, nor those with sub-lethal or chronic effects. In particular, they are not suitable for evaluating effects on life stages other than the adult. It's hardly safe when short-term tests show an active is safe for the adult stage but prevents egg laying or kills larvae.

There is talk among regulators in Canada, Europe, the US and other countries about which additional tests might be appropriate, but agreement looks like it will take years. Meanwhile, the same pesticides causing concern are still being used.
Increasingly, the side-effects on arthropods other than bees are being queried. Where once bug accumulation on windshields was the norm, people are noticing that this is no longer occurring. The preservation of bugs from annihilation on windshields may have few devotees, but their lack may be indicative of a much wider malaise. An area little considered in the debate about honey bees and neonicotinoids are examples from the greenhouse industry.

There is quite an extensive literature on the side-effects of pesticides, including neonicotinoids, on bees (mostly bumblebees) and natural enemies. The International Organisation for Biological and Integrated Control of Noxious Animals and Plants (IOBC) (http://www.iobc-wprs.org/) has an Expert Working Group on Pesticides and Beneficial Organisms, dedicated to evaluating the side-effects of pesticides. It has many publications. You might think of greenhouses as small field experiments. Some papers have been reviewed recently by Cloyd & Bethke (2010), but key studies are missing. The long-term effects of imidacloprid on the parasitoid *Encarsia formosa*, for example, are known to last for months when applied as a soil drench. We and Dr Paul Horne, IPM Technologies, Victoria, have also conducted relevant side-effects studies (Horne *et al.* 2009). Paul said that the work he has carried out so far is only a starting point, but he has had his funding cut off. Charts of side-effects of pesticides on natural enemies in greenhouses are compiled by Koppert BV, Biobest, Australasian Biological Control and other companies marketing natural enemies, and can be accessed on their websites.

White-collared ladybird, Hippodamia variegata/ Poor ladybirds, poor world!

Testing for regulatory purposes is being carried out by pesticide companies on very few natural enemies, and these may not be present in the country in which the product is to be registered. As our own and Paul Horne's experiments clearly demonstrate, even different types of ladybirds or mites may show quite different sensitivity to a single pesticide. It's not possible to test all combinations, but a far broader range of key indicator species in each country needs to be included in mandatory testing. Needless to say, we support the use of selective pesticides with proven IPM credentials, but they will clearly not have the same money-making potential as broad-spectrum, persistent products, and are likely to remain a small part of a pesticide company's stable unless serious pressure is brought to bear.
We have talked a great deal about honey bees, which at least have an advocate in beekeepers and, to a more limited extent, farmers with crops which require pollination.

Attention now needs to be directed to other pollinators and arthropods in general, and the claims made in Tennekes' book seriously explored. The ramifications are enormous, and effects will cascade. As with climate change, the self-interest of multinational conglomerates (and politicians) is working against the urgent changes needed. Meanwhile, it's business as usual for the pesticide manufaturers. In a recent paper (Jeschke *et al.* 2011), Bayer scientists in Germany, in their overview of the status and global strategy for neonicotinoids, state that: "Because of the relatively low risk for non-target organisms and the environment, the high target specificity of neonicotinoid insecticides, and their versatility in application methods, this important class has to be maintained globally for integrated pest management strategies and insect resistance management programs."

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